# Appendix - A

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT

FOR

CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2

AND

400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION NO.RVPN/KfW/ICB-1**

**VOLUME – II**

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**VOLUME – III : TECHNICAL SPECIFICATION OF CIVIL WORKS**

**Superintending Engineers (P&P)**
**Rajasthan RajyaVidyutPrasaran Nigam Ltd.**
**VidyutBhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**Nov 2014**

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

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# AND
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## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**GENERAL SPECIFICATION &**
**BILL OF MATERIAL**
**Part- 1**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**2015**

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**VOLUME-II, PART-1**

# ESTABLISHING OF 400/220 KV, 2 X 500 MVA GRID SUB STATION AT JAISALMER-2 ALONGWITH BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## 1.0 PREAMBLE:

1.1 Rajasthan Rajya Vidyut Prasaran Nigam Ltd. is a STU (State Transmission Utility), engaged in transmission of electrical power from the projects of RRVUNL, Shared projects and from various Central Govt. Power agencies such as NTPC, POWERGRID etc. to various utilities / beneficiaries.

1.2 RVPN is establishing new 400 / 220 kV substation at Jaisalmer-2 (Including of IEC-61850 based Substation Automation system) on decentralized architecture on a concept of bay oriented distributed intelligence for evacuation system of Solar and Wind Projects in Jaisalmer, Barmer, Jodhpur and Bikaner Districts.

## 2.0 SCOPE

### (A) 400kV GSS JAISALMER-2

The scope of this specification broadly covers the construction of new 400 kV substation at Jaisalmer-2 with the provision of following bays:-

a) 2 Nos. 400 kV bays for termination of 400 kV D/C (Twin Moose) Jaisalmer-2-Barmer transmission lines.
b) 1 No. 400 kV bay for termination of 400 kV S/C (Twin Moose) Jaisalmer-2-Akal-1 transmission lines .
c) 2 Nos. 400 kV bays for installation of 2x500 MVA, 400/220/33 kV Auto Power Transformers
d) 400kV bay for installation of 1 No.,400KV,1x125 MVAR, Bus Reactor
e) 2 Nos. 220 kV bays for installation of 2 Nos, 2x500 MVA, 400/220/33 kV Auto Power Transformers
f) 2 Nos. 220kV Bus Coupler Bays.
g) 1 No. 220kV Transfer Bus Coupler Bay.
h) 1 No. 220kV Bus Sectioanlizer Bay.
i) 9 Nos. 220 kV bays for termination of 220 kV transmission lines/feeders.

### (B) 400kV GSS Barmer

The scope of this specification broadly covers the construction of following bays at 400 kV GSS Barmer.

a) 2 Nos. 400 kV bays for termination of 400 kV D/C (Twin Moose) Jaisalmer-2-Barmer transmission line.

**(C) 400kV GSS Akal-1**

The scope of this specification broadly covers the construction of following bays at 400 kV GSS Akal-1 (Jaisalmer).

a) 1 No. 400 kV bay for termination of 400 kV S/C (Twin Moose) Jaisalmer-2-Akal-1 transmission lines.

## 2.1 400 kV GSS JAISALMER-2

2.1.1 **DESIGN, ENGINEERING, MANUFACTURE, TESTING, SUPPLY ON F.O.R DESTINATION SITE BASIS INCLUDING TRANSPORTATION AND INSURANCE, STORAGE, ERECTION, TESTING AND COMMISSIONING OF THE EQUIPMENTS / ITEMS COMPLETE IN ALL RESPECT AS PER TECHNICAL SPECIFICATION(S).**

a) Circuit breakers, Isolators, Current Transformers, Capacitor voltage transformers, Surge Arrestors, Wave Traps alongwith terminal connectors etc.
b) Complete Substation Automation based on IEC-61850 including hardware and software for Remote Control Station alongwith associated equipments and Kiosks for the scope of specification.
c) Complete control and protection system.
d) DG Set 160KVA
d) PLCC equipments / system and OPGW communication system.
e) Battery & Battery Chargers
f) Complete lighting and illumination of the switchyard, street lighting and buildings (Control room, Fire fighting pump house, Kiosks, Store Shed with Open Platform, Security Room etc.)
g) Fire protection system.
h) Air-conditioning System.
i) 1.1 kV grade Power & control cables alongwith complete accessories.
j) Lattice & pipe structures (galvanised).
k) Bus post insulators, Insulator strings & hardwares, clamps & connectors (all type), Aluminium tubes, Bus bar & earthing materials, Shield Wire, Bay marshalling kiosks, spacers, cable supporting angles/ channels, cable trays & covers, sag compensating springs, junction box, Buried cable trenches etc.
l) 33/0.4 kV, 800 kVA LT Transformer for tertiary loading of 400/220/33kV Auto Transformer & 33/.4 kV, 630 kVA LT Transformer for DISCOM electric supply.
m) LT Switchgear (AC & DC Distribution Board)
n) Truck mounted 6000 LPH Oil Purification Plant
o) Truck Mounted 8 MT Crane
p) Testing, maintenance and condition monitoring of equipments.
q) General Tools and Tackles, Testing and Measuring Equipment, Office & Miscellaneous Equipments/Items
r) Mandatory spares
s) Any other equipment / material required to complete the specified scope.
t) All necessary safety equipments such as flexible earthing sets, voltage test roads,helmets, Rubber Hand Gloves, Safety belts etc.

The equipments to be designed, engineered, manufactured, tested, supplied, installed and commissioned shall be in accordance with the specification and shall include but not limited to the above major items.

### 2.1.2 **CIVIL & STRUCTURAL WORKS**

The civil work to be provided by the contractor in accordance with the specification shall comprise of the entire requirement of the substation (as detailed in Vol.-III of the specification ) and shall include but not limited to the following major items:-

a) Soil investigation.
b) Contouring and substation leveling
c) Foundation of 2 Nos. 500 MVA,400/220 kV Auto Power Transformers , 1 No. 125 MVAR Bus type shunt Reactor including associated foundation bolts, jacking pads, rail cum road track pylon supports, fire resistance wall etc.
d) Foundation(s) for 800 kVA and 630 kVA, 33/0.433 kV LT transformers along with associated equipments.
e) Foundation for lattice & pipe structures for equipments.
f) Foundation for lighting poles & masts, marshalling box, panels, control cubicles of equipments
g) Cable trenches along with covers & sump pits
h) Cable trench crossing with roads, culverts, rail tracks, drains etc.
i) Roads & Rail tracks inside substation fencing
j) PCC, anti weed treatment & Gravel filling of complete switchyard area.
k) Drainage system in the substation.
l) Permanent water supply for control room cum administrative building, firefighting pump house building and firefighting system.
m) Buildings for firefighting pump house.
n) Switchyard fencing and gates
o) Buildings for bay level kiosks.
p) Control room cum administrative building for the substation.
q) Rain water harvesting as per technical specification.
r) Other civil works: Security Room, Sewerage System, Vehicle Parking Sheds, Fire wall etc.
s) Site office for employerûs staff.
t) Store Shed with Open Platform.

All materials required for the civil and construction/ installation work shall be supplied by the contractor. The cement & steel shall also be supplied by the contractor.

## 2.2 BAY WORK AT 400kV GSS Barmer

### 2.2.1 **DESIGN, ENGINEERING, MANUFACTURE, TESTING, SUPPLY ON F.O.R. DESTINATION SITE BASIS INCLUDING TRANSPORTATION AND INSURANCE, STORAGE, ERECTION, TESTING AND COMMISSIONING OF THE FOLLOWING EQUIPMENTS / ITEMS COMPLETE IN ALL RESPECT AS PER TECHNICAL SPECIFICATION(S).**

a) Circuit breakers, Isolators, Current Transformers, Capacitor voltage transformers, Surge Arrestors, Wave Traps along with terminal connectors etc.
b) Augmentation of existing Substation Automation system by providing bay control units along with associated equipments and Kiosks for 400 kV bays under the scope of specification. The contractor shall be responsible for successful integration of the supplied BCUs and protection IEDs with existing

sub-station augmentation system at Barmer (IEC:61850 compliant) including updating the database, displays, development of additional displays and reports as required.

c) Complete control and protection system under present scope as per specification.
d) PLCC equipments / system and OPGW communication system.
e) Bus post insulators, Insulator strings & hardware, clamps & connectors (all type), Aluminum tubes, Bus bar & earthing materials, Shield Wire, Bay marshalling kiosks, spacers, cable supporting angles/ channels, cable trays & covers, sag compensating springs, junction box, Buried cable trenches etc.
f) Lighting and illumination of the switchyard under present scope.
g) The main earth mat is available in existing Switchyard with spacing between main earth conductors is 20M. The Earth mat shall be extended by the successful bidder as shown in Specification Drawing. All the equipments, structure, Cable Trenches, Auxiliary Earth mat for Isolators etc. shall be earthed by connecting them to the main earth mat by the contractor.
h) Air-conditioning System of Bay Level Kiosks.
i) 1.1 kV grade Power & control cables along with complete accessories.
j) Lattice & pipe structures (galvanised).
k) Mandatory spares
l) Any other equipment / material required to complete the specified scope.

The equipments to be designed, engineered, manufactured, tested, supplied, installed and commissioned shall be in accordance with the specification and shall include but not limited to the above major items.

### 2.2.2 **CIVIL & STRUCTURAL WORKS**

The civil work to be provided by the contractor in accordance with the specification shall comprise of the entire requirement of the substation (as detailed in Vol.-III of the specification) and shall include but not limited to the following major items:-

a) Soil investigation.
b) Foundation of bay equipments.
c) Foundation for lattice & pipe structures for equipments.
d) Foundation for lighting poles & masts, marshalling box, panels, control cubicles of equipments
e) Drainage system, Cable trenches along with covers for extended switchyard area.
f) Cable trench crossing with roads, culverts, rail tracks, drains etc.
g) Anti weeds treatment & Gravel filling of extended switchyard area.
h) In areas where gravels are already laid, the removal & re-spreading of gravel after cleaning / washing, spreading extra gravels (if required) shall be in the bidders scope.
i) Buildings for bay level kiosks.
j) Roads and Fencing for extended switchyard area.
k) Any other work required to complete the specified scope.

All materials required for the civil and construction/ installation work shall be supplied by the contractor. The cement & steel shall also be supplied by the contractor.

## 2.3 BAY WORK AT 400kV GSS Akal-1

### 2.3.1 DESIGN, ENGINEERING, MANUFACTURE, TESTING, SUPPLY ON F.O.R DESTINATION SITE BASIS INCLUDING TRANSPORTATION AND INSURANCE, STORAGE, ERECTION, TESTING AND COMMISSIONING OF THE FOLLOWING EQUIPMENTS / ITEMS COMPLETE IN ALL RESPECT AS PER TECHNICAL SPECIFICATION(S).

a) Circuit breakers, Isolators, Current Transformers, Capacitor voltage transformers, Surge Arrestors, Wave Traps along with terminal connectors etc.
b) Augmentation of existing Substation Automation system by providing bay control units along with associated equipments and Kiosks for 400 kV bays under the scope of specification. The contractor shall be responsible for successful integration of the supplied BCUs and protection IEDs with existing sub-station augmentation system at Akal-1 (IEC:61850 compliant) including updating the database, displays, development of additional displays and reports as required.
c) Complete control and protection system under present scope as per specification.
d) PLCC equipments / system and OPGW communication system.
e) Bus post insulators, Insulator strings & hardware, clamps & connectors (all type), Aluminum tubes, Bus bar & earthing materials, Shield Wire, Bay marshalling kiosks, spacers, cable supporting angles/ channels, cable trays & covers, sag compensating springs, junction box, Buried cable trenches etc.
f) Lighting and illumination of the switchyard under present scope.
g) The main earth mat is available in existing Switchyard with spacing between main earth conductors is 12M. The Earth mat shall be extended by the successful bidder as shown in Specification Drawing. All the equipments, structure, Cable Trenches, Auxiliary Earth mat for Isolators etc. shall be earthed by connecting them to the main earth mat by the contractor.
h) Air-conditioning System of Bay Level Kiosks.
i) 1.1 kV grade Power & control cables along with complete accessories.
j) Lattice & pipe structures (galvanised).
k) Mandatory spares
l) Any other equipment / material required to complete the specified scope.

The equipments to be designed, engineered, manufactured, tested, supplied, installed and commissioned shall be in accordance with the specification and shall include but not limited to the above major items.

### 2.3.2 CIVIL & STRUCTURAL WORKS

The civil work to be provided by the contractor in accordance with the specification shall comprise of the entire requirement of the substation (as detailed in Vol.-III of the specification) and shall include but not limited to the following major items:-

a) Soil investigation.
b) Foundation of bay equipments.
c) Foundation for lattice & pipe structures for equipments.
d) Foundation for lighting poles & masts, marshalling box, panels, control cubicles of equipments

e) Drainage system, Cable trenches along with covers for extended switchyard area.
f) Cable trench crossing with roads, culverts, rail tracks, drains etc.
g) Anti weeds treatment & Gravel filling of extended switchyard area.
h) In areas where gravels are already laid, the removal & re-spreading of gravel after cleaning / washing, spreading extra gravels (if required) shall be in the bidders scope.
i) Buildings for bay level kiosks.
j) Roads and Fencing for extended switchyard area.
k) Any other work required to complete the specified scope.

All materials required for the civil and construction/ installation work shall be supplied by the contractor. The cement & steel shall also be supplied by the contractor.

2.4 A) Receipt, storage, erection, testing and commissioning of 2 Nos. 500 MVA, 400/220 /33kV Auto Power Transformers and 1 No. 125 MVAR 400 kV Bus /Line Shunt Reactors at 400kV GSS Jaisalmer-2 shall be in scope of the contractor.

B) Supply (excluding erection, testing & commissioning) of PLCC equipments/panels for 220kV remote (developerâs) end, matching with the equipments to be supplied/installed at 400KV GSS Jaisalmer-2 at 9 Nos. 220KV feeders bays are in the scope of the bidder as per clause No.2.5 of Vol-II,Part-I of the specification.

2.5 Interconnection (s) between 33 / 0.433 kV, 630 kVA, LT station transformer (to be supplied, installed and commissioned by the contractor to take construction power and alternate auxiliary supply from DISCOM**)** and the LT distribution boards (in control room) through twin lengths of 630 Sq.mm FRLS armoured XLPE insulated power cable with suitable connectors including suitable change-over switch **(**Contractor supplied material as per BOQ) and also the same arrangement for interconnection(s) with one No. 800 kVA, 33 / 0.433 kV Aux. transformer (to be supplied, installed & commissioned by the contractor on tertiary of one no. 500 MVA, 400 / 220 kV Auto transformer) at 400kV GSS Jaisalmer-2 shall be in scope of the contractor.

2.6 Before proceeding with the construction work as per scope of the specification, the Contractor shall himself fully familiarize with the site conditions, general arrangements and scheme etc. Though the Purchaser shall endeavor to provide the information, it shall not be binding for the Purchaser to provide the same. The bidders are advised to visit the substation (s) site and acquaint themselves with the topography, infrastructure and design philosophy. The bidder shall be fully responsible for providing all equipments, materials, system and services specified or otherwise which are required to complete the construction, testing and successful commissioning of the Substation/Bays in all respect.

2.7 The complete design (unless specified otherwise in specification elsewhere) and detailed engineering shall be done by the contractor based on conceptual drawings.

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

2.9 The bay width for 400 kV and 220kV switchyard shall be 24 meters (minimum) and 16.6 meters (minimum) respectively. The short circuit forces values applicable for equipment support structures for the substation shall be calculated by the contractor. Design of substation and its associated electrical & mechanical auxiliaries systems which includes preparation of single line diagrams, installation drawings & electrical lay outs, erection key diagrams, electrical and physical clearance diagrams, design calculations for Earth mat, Direct Stroke Lighting Protection (DSLP), Bus Bar & Spacers, Control and Protection schematics, design of Fire fighting system and Air conditioning system, outdoor / indoor lighting / illumination and other relevant drawings & documents required for engineering of all facilities within the fencing as to be provided under this contract, are covered under the scope of the Contractor.

2.10 Specific exclusions-

a) Erection, testing and commissioning of PLCC equipments/panels of 220kV remote (developerג€™s) end.
b) Training and Handholding of 400 kV GSS Akal and Barmer.

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

2.12 **Schedule of Quantities**

The detailed description of various items/ equipments and civil works are indicated in **Vol-II & III.** The bills of quantity of major equipments are also indicated and wherever the quantities are not indicated, the bidder is required to compute the quantity. Bidder is required to indicate unit rate and total price of the items under respective heads in bid proposal sheets**.** Bidders should include all such items in the bid proposal sheets which are not specifically mentioned but are essential for the execution of the contract.

2.13 **FUNCTIONAL AND COMPOSITE TESTING**

(a) Calibration, Pre-commissioning and commissioning tests shall be conducted on equipments after completion of erection in the presence of RVPNג€™s Authorized Representative from point of view of completeness followed by commissioning.
(b) The system availability test for 1000 hrs. on the total substation automation system as a whole after commissioning of total sub-station automation system shall be conducted before taking over the substation.

2.14 **Training and Handholding Requirements**

**A) Training:**

**a)** The Substation based on IEC-61850 Automation System are newer technologies to be adopted in RVPN. The effective training and handholding shall be useful for implementation and further maintenance of the substation.

The Training for Substation Automation System shall be as follows:-

| S.No. | Training description | No. of Trainees | Training duration in week | Total Man weeks |
|---|---|---|---|---|
| 1 | Computer system hardware | 8 | 2 | 16 |
| 2 | Computer system software | 8 | 2 | 16 |
| 3 | Application Software | 8 | 2 | 16 |

The detailed scope of training is available at clause No. 10.0 of Part 3 (II) Vol. II (Tech.)

**b)** The successful bidder / contractor will also be required to impart thorough training on following equipments.

| S.No. | Training description | No. of Trainees | Training duration in week | Total Man weeks |
|---|---|---|---|---|
| 1 | Outdoor Type 6000 LPH capacity Truck mounted oil Filtration Machine to be supplied as per Vol.-II of Specification | 2 | 1 | 2 |
| 2 | Truck mounted semi mobile cranes to be supplied as per Vol.-II of Specification | 2 | 1 | 2 |

**c) TRAINING CHARGES IN INDIA / Abroad**

The bidder is required to indicate **training charges lump sum in the price schedule to be carried out at Manufacturer's Works in India / abroad for the training mentioned above** which shall be considered for price bid evaluation. These charges should include:

To and Fro Air Ticket, Training, accommodation (boarding & lodging), food, local transport etc.

B) **Handholding:**

Immediately after the handing over of the substation, the successful bidder/ contractor shall place his at least 2(Two) Nos. expert Engineers at substation for 12 months who can handle the initial operational problems and shall run the substation alongwith the RVPN Engineers. They shall also simultaneously train RVPN Engineers on total aspect of the system installed at substation.

2.15 **Material receipt and related activities**

i) The equipment & material to be furnished by the Employer shall be supplied to the Contractor at the depots established by the Contractor or the Employee. The Lorry Receipts for the materials will be handed over to the Contractor by the representative of the Employer as and when the same are received. The Contractor shall be responsible for taking delivery of these materials from the railways/ road transporter, unloading them from the transporter, carting them to different stores built by him for the purpose, the unloading and cartage being at the cost of the Contractor. However, any octroi or toll tax if legally payable by the Contractor shall be reimbursed to him at actual, subject to production of documentary evidence. All wharfage and demurrage charges incurred due to delay in taking delivery will be to the Contractorûs account, except those due to reasons beyond his control in which case the contractor shall immediately intimate the Project Engineer/ Project Manager for setting and claims. The Contractor shall be responsible for proper handling and storage of these materials from the time of receipt upto the time of taking over of the complete transmission line by the Employer.

ii) Yards and store provided by the Contractor for stacking and storage of materials shall be open for inspection by the Employer as and when required. The cost of handling and storage shall be to the Contractorûs account

iii) In case the material being arranged by the Employer and supplied to the Contractor for erection are received short broken or damaged an entry shall be made in the delivery register of the railway authorities/ road transporter as far as possible and a report of the same giving full details of shortage and damages along with a copy of report entered in the delivery register of the road transporter/ railways shall be submitted by the Contractor to the Project Engineer/ Project Manager0 and Employerûs consignee immediately, who shall take further action in the matter.

3.0 **LAYOUT ARRANGEMENTS**

For the 400 KV voltage level, breaker and half bus, for 220 kV and 132 kV voltage level, double main ï auxiliary bus and for 33kV voltage level, main ï auxiliary bus switching scheme arrangements shall be applicable. The electrical layout arrangements are enclosed with the bid documents.

4.0 **LOCATION OF THE SUBSTATION**

The location of substation /switchyard to be constructed is indicated below:-

| S.No. | Name of 400kV Substation | Distt / State | Nearest Railway station |
|---|---|---|---|
| 1. | Jaisalmer-2 | Jaisalmer (Raj.) | Jaisalmer |
| 2. | Barmer | Barmer (Raj.) | Barmer |
| 3. | Akal-1 | Jaisalmer (Raj.) | Jaisalmer |

## 5.0 METEOROLOGICAL DATA

The meteorological data of the substation shall be provided to the successful bidder during detailed engineering. However for design purposes, maximum ambient temperature should be considered as 50°C.

## 6.0 SOIL DATA

The bidder shall be responsible for carrying out the required tests and should fully satisfy himself about the nature of soil expected to be encountered prior to the submission of bid. Any variation of soil data during detailed engineering or construction stage shall not constitute a valid reason in affecting the terms and conditions of the bid.

## 7.0 DRAWINGS

The reference drawings which form a part of the specifications are enclosed with tender documents. The bidder shall maintain the overall dimensions of the substation, bay length, bay width, phase to earth clearance, phase to phase clearance and sectional clearances, clearances between buses, bus heights but may alter the locations of equipment to obtain the statutory electrical clearances required for the substation.

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

## 8.0 SPARES:

### 8.1 Mandatory Spares

The spare parts and maintenance equipments shall be included in the bid proposal by the bidder. The prices of these spares shall be given by the Bidder in the relevant schedules and shall be considered for evaluation of bid. It shall not be binding on the Purchaser to procure all of these mandatory spares and maintenance equipments.

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 a part of the equipment only.

8.2 **Optional Spares**

The bidder shall identify and recommend the list of optional spare parts required together with their quantity to meet the specified performance for a period of three years. The item schedule and prices of these shall be given by the Bidder in relevant schedule and shall not be considered for evaluation of the bid. The Bidder must also indicate the basis for recommendation of optional spares. The Bidder shall also recommend their source of availability and technical particulars. The Bidder may also suggest addition or deletion of spare items over this list. The list of spare parts shall be finalized between the Purchaser and the Contractor after the completion of detailed engineering.

8.3 The Contractor shall advise the Purchaser of the required lead time for ordering of spares and the minimum re-order quantities.

## 9.0 SPECIFIC REQUIREMENT

9.1 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 arrange for obtaining clearance if required from any statutory bodies before commissioning. Any additional items, modification if required for any clearance shall be provided by the Contractor at no extra cost to the Purchaser.

9.2 In addition to meeting the qualification requirement stipulated in Section-ITB, Volume-I, the bidder of its own or his manufacturer/sub-vendor/ fabricator shall also meet the qualifying Technical Requirement set forth for all the equipments in the relevant sections of the technical specification, failing which the bid is liable to be rejected.

## 10.0 SPECIAL TOOLS AND TACKLES

The bidder may include in his proposal the deployment of all such special tools and tackles required for erection, testing, commissioning and maintenance of the equipment. 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 equipments in a manner to be referred by the Purchaser during the operation of these equipments.

## 11.0 FACILITIES TO BE PROVIDED BY THE PURCHASER

11.1 Purchaser shall make available the auxiliary HT power Supplies (DISCOM) 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 has to make necessary arrangements like diesel sets etc. so that progress of work is not affected and the Purchaser shall in no case be responsible for any delay in works because of non-availability of power.

11.2 Purchaser shall make available at a single point construction water supply on chargeable basis. All further distribution for the same shall be made by the Contractor. In case of non availability of inadequate availability of water for construction work, the

contractor shall make his own arrangement at his own cost and the Purchaser shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

**ANNEXURE-I**

## SCHEDULE OF QUANTITIES

**400 kV GSS JAISALMER-2**

### A. TRANSFORMER

| S.No. | Item Description | Unit | Quantity |
|---|---|---|---|
| **1. (a)** | **33/.433 kV, 800 kVA,** 250 kV BIL LT three phase transformer complete with all fittings, accessories and associated equipment as per specification. | Nos. | 1 |
| **(b)** | **Spares** | | |
| | i) Bushing with metal parts & gaskets(HV&LV) | Nos. | 1 |
| | ii) Winding temperature indicator with contacts | Nos. | 1 |
| | iii) Oil temperature indicator with contacts | Nos. | 1 |
| | iv) Pressure relief device | Nos. | 1 |
| | v) Buchholz relay complete with contacts | Nos. | 1 |
| | vi) Magnetic oil level gauge | Nos. | 1 |
| | vii) Set of gaskets | Nos. | 1 |
| **2. (a)** | **33/.433 kV, 630 kVA,** 170 kV BIL LT three phase transformer complete with all fittings, accessories and associated equipment as per specification. | Nos. | 1 |
| **(b)** | **Spares** | | |
| | i) Bushing with metal parts & gaskets(HV&LV) | Nos. | 1 |
| | ii) Winding temperature indicator with contacts | Nos. | 1 |
| | iii) Oil temperature indicator with contacts | Nos. | 1 |
| | iv) Pressure relief device | Nos. | 1 |
| | v) Buchholz relay complete with contacts | Nos. | 1 |
| | vi) Magnetic oil level gauge | Nos. | 1 |
| | vii) Set of gaskets | Nos. | 1 |

### B. EQUIPMENTS

| S.No. | Item Description | Unit | Quantity |
|---|---|---|---|
| **1.** | **Circuit Breaker** | | |
| **(a) (i)** | **420 kV,** 2000 Amp., 40 kA rupturing capacity circuit Breaker suitable for single and three phase rapid auto reclosing complete with mounting structures, foundation bolts and nuts and first filling of SF6 gas plus 20% spare gas including accessories and auxiliaries. | Nos. | 8 |
| **(a) (ii)** | Terminal Connectors for above item (a) (i). | Nos. | 48 |
| **(a) (iii)** | **420 kV,** 2000 Amp., 40 kA rupturing capacity circuit Breaker **for controlling Shunt Reactor (Bus Type)**, suitable for single and three phase rapid auto reclosing complete with mounting structures, foundation bolts and nuts and first filling of SF6 gas plus 20% spare gas including accessories and auxiliaries. | Nos. | 2 |
| **(a)(iv)** | Terminal Connectors for above item (a) (iii). | Nos. | 12 |
| **(a)(v)** | Microprocessor based point of wave controller for above item (a)(iii) | Nos. | 2 |
| **(b)** | **Spares for 420 kV circuit breaker** | | |

| | | | |
|---|---|---|---|
| | (i) One pole of circuit breaker with grading capacitor complete with pole column and interrupter with M.B. but without support structure and operating mechanism. | Nos. | 1 Pole |
| | (ii) Rubber gaskets, öDôrings and seals | Set | 1 |
| | (iii) Fixed contacts | Nos. | 12 |
| | (iv) Moving contacts | Nos. | 12 |
| | (v) Terminal pads and connectors | Nos. | 6 |
| | (vi) Molecular filter | Nos. | 6 |
| | (vii) Density / pressure monitoring systems (if applicable) | No. | 2 |
| | (viii) Relays, power contactors, switch fuse units, limit switches, push buttons, timers and MCB etc. | Set | 2 |
| | (ix) Closing assembly valve | Set | 2 |
| | (x) Trip assembly valve | Set | 2 |
| | (xi) Pressure switches | Set | 2 |
| | (xii) Pressure gauge and coupling | Set | 2 |
| | (xiii) Auxiliary switch assembly | Set | 2 |
| | (xiv) Operation counter | No. | 2 |
| | (xv) Closing Coils | Nos. | 10 |
| | (xvi) Tripping coils | Nos. | 20 |
| | (xvii) Support insulator complete for one pole of breaker | Set | 1 |
| **(c)(i)** | **245 kV**, 2000 Amp. 40 kA rupturing capacity circuit breaker suitable for single and three phase rapid auto reclosing complete with mounting structures, foundation bolts, nuts and first filling of SF-6 gas plus 20% spare gas including accessories and auxiliaries | Nos. | 15 |
| **(c)(ii)** | Terminal Connectors for above (c)(i) | | 90 |
| **(d)** | **Spares for 245 kV circuit breakers** | | |
| | (i) One pole of circuit breaker with grading capacitor complete with pole column and interrupter with M.B. but without support structure and operating mechanism. | Nos. | 1 Pole |
| | (ii) Rubber gaskets, öDôrings and seals | Set | 1 |
| | (iii) Fixed contacts | Nos. | 10 |
| | (iv) Moving contacts | Nos. | 10 |
| | (v) Terminal pads and connectors | Nos. | 6 |
| | (vi) Molecular filter | Nos. | 6 |
| | (vii) Density / pressure monitoring systems (if applicable) | No. | 1 |
| | (viii) Relays, power contactors, switch fuse units, limit switches, push buttons, timers and MCB etc. | Set | 1 |
| | (ix) Closing assembly valve | Set | 1 |
| | (x) Trip assembly valve | Set | 1 |
| | (xi) Pressure switches | Set | 1 |
| | (xii) Pressure gauge and coupling | Set | 1 |
| | (xiii) Auxiliary switch assembly | Set | 1 |
| | (xiv) Operation counter | No. | 1 |
| | (xv) Closing Coils | Nos. | 15 |
| | (xvi) Tripping coils | Nos. | 30 |
| | (xvii) Support insulator (set complete for one pole of breaker) | Set | 1 |
| **2.** | **Current Transformer** | | |
| **(a)(i)** | 2000-1000-500/1-1-1-1-1 Amp. **420 kV** single phase multi core current transformers (**Live Tank Type only)** | Nos. | 36 |
| **(a)(ii)** | Terminal Connectors for above item (a)(i) | Nos. | 72 |
| **(b)** | Spare of 420kV Current Transformer | | |
| | (i) Complete CT(**Live Tank Type only)** | Nos. | 3 |
| | (ii) Terminal Connector | Nos. | 6 |

| | | | |
|---|---|---|---|
| **(c)(i)** | 2000-1000-500/1-1-1-1-1 Amp. **245 kV** single phase multi core current transformers. (**Live Tank Type only)** | Nos. | 54 |
| **(c)(ii)** | Terminal Connectors for above item (c)(i) | | 108 |
| **(d)** | Spare of 245kV Current Transformer | | -- |
| | (i) Complete CT(**Live Tank Type only)** | Nos. | 3 |
| | (ii) Terminal Connector | Nos. | 6 |
| **(e)(i)** | 2000-1000-500/1-1 Amp. **245 kV** single phase two core current transformers for Metering(0.2 s class) (**Live Tank Type only)** | Nos. | 27 |
| **(f)(ii)** | Terminal Connectors for above item (e)(i) | | 54 |
| **(g)** | Spare of 245kV metering Current Transformer | | -- |
| | (i) Complete CT (0.2 s class)(**Live Tank Type only)** | Nos. | 3 |
| | (ii) Terminal Connector | Nos. | 6 |
| **3.** | **Capacitive Voltage Transformer** | | |
| **(a)(i)** | **420 kV** single phase 4400 pF CVT suitable for high frequency (HF) coupling required for power line communication with voltage ratio 400/0.11 kV and three secondary windings. | Nos. | 15 |
| **(a)(ii)** | Terminal Connectors for above item (a)(i) | Nos. | 15 |
| **(b)** | Spare of 420kV Capacitive Voltage Transformer | | |
| | (i) Complete CVT | Nos. | 3 |
| | (ii) Terminal Connector | Nos. | 3 |
| **(c) (i)** | **245 kV** single phase 4400 pF CVT suitable for carrier coupling voltage ratio 220/0.11 kV | Nos. | 36 |
| **(c)(ii)** | Terminal Connectors for above item (c)(i) | Nos. | 36 |
| **d)** | Spare of 245kV Capacitive Voltage Transformer | | -- |
| | (i) Complete CVT | Nos. | 3 |
| | (ii) Terminal Connectors | Nos. | 3 |
| **(e)(i)** | **245 kV** single phase 4400 pF CVT suitable for metering voltage ratio 220/0.11 kV. (0.2 class) | Nos. | 27 |
| **(e)(ii)** | Terminal Connectors for above item (e)(i) | Nos. | 27 |
| **(f)** | Spare of 245kV Capacitive Voltage Transformer | | -- |
| | (i) Complete CVT | Nos. | 3 |
| | (ii) Terminal Connectors | Nos. | 3 |
| **(e)(i)** | **36kV, 52kV class EMVT** | Nos. | 6 |
| **(e)(ii)** | Terminal Connectors for above item (e)(i) | Nos. | 6 |
| **4.** | **Isolator** | | |
| **(a)(i)** | **420 kV** 2000 Amp. triple pole, gang operated Horizontal Double break type, motor operated, outdoor, Isolator metallic fitted with single earth blade complete with accessories. | Set | 22 |
| **(a)(ii)** | Terminal Connectors for above item(a)(i) | Nos. | 132 |
| **(a)(iii)** | Post insulators for above item (a)(i) | Nos. | 198 |
| **(b)(i)** | **420 kV** 2000 Amp. triple pole, gang operated horizontal double break type motor operated, outdoor Isolator metallic with double earth blade complete with accessories. | Set | 7 |
| **(b)(ii)** | Terminal Connectors for above item(b)(i) | Nos. | 42 |
| **(b)(iii)** | Post insulators for above item (b)(i) | Nos. | 63 |
| **(c)** | **Spares for 420 kV Isolators** | | |
| | i) One complete pole with support insulator and motor operating mechanism excluding structure | Nos. | 2 |
| | ii) Copper contact fingers for male and female contacts. | Set | 1 |
| | iii) Open / close contractor assembly, timers, key interlock push button switch | Set | 1 |
| | iv) Limit switch and auxiliary switch | Set | 1 |

| | | | |
|---|---|---|---|
| | v) Motor housing bearing assembly | Set | 1 |
| | vi) Terminal pads and connectors | Nos. | 6 |
| | vii) Motor with gear assembly and bevel gear assembly | Nos. | 1 |
| | viii) Corona shield rings | Nos. | 2 |
| | ix) Hinge pins | Nos. | 2 |
| | x) Bearings | Set | 1 |
| | xi) Current carrying assembly | Nos. | 2 |
| | xii) Interlocking coil | Nos. | 2 |
| **(d)** | **245 kV** 2000 Amp. triple pole, gang operated Horizontal Double break type, motor operated, outdoor, Isolator metallic **without earth blade** complete with all accessories. | Set | 12 |
| **(d)(ii)** | Terminal Connectors for above item(d)(i) | Nos. | 72 |
| **(d)(iii)** | Post insulators for above item (d)(i) | Nos. | 108 |
| **(e)(i)** | **245 kV** 2000 Amp. triple pole, gang operated Horizontal Double break type, motor operated, outdoor, Isolator metallic fitted **with single earth blade** complete with all accessories. | Set | 16 |
| **(e)(ii)** | Terminal Connectors for above item(e)(i) | Nos. | 96 |
| **(e)(iii)** | Post insulators for above item (e)(i) | Nos. | 144 |
| **(f)(i)** | **245 kV** 2000 Amp. triple pole, gang operated Horizontal Double break type, motor operated, outdoor, Isolator metallic fitted **with double earth blade** complete with all accessories. | Set | 14 |
| **(f)(ii)** | Terminal Connectors for above item(f)(i) | Nos. | 84 |
| **(f)(iii)** | Post insulators for above item (f)(i) | Nos. | 126 |
| **(g)(i)** | **245 kV** 2000 Amp. triple pole, gang operated Horizontal Double break type, motor operated, outdoor, Isolator metallic for **tandem operation** complete with all accessories. | Set | 14 |
| **(g)(ii)** | Terminal Connectors for above item(g)(i) | Nos. | 84 |
| **(g)(iii)** | Post insulators for above item (g)(i) | Nos. | 126 |
| **(h)** | **Spares for 245 kV Isolators** | | |
| | i) One complete pole with support insulator excluding structure and motor operating mechanism | Nos. | 2 |
| | ii) Copper contact fingers for male and female contacts. | Set | 1 |
| | iii) Open / close contractor assembly, timers, key interlock push button switch | Set | 1 |
| | iv) Limit switch and auxiliary switch | Set | 1 |
| | v) Motor housing bearing assembly | Set | 1 |
| | vi) Terminal pads and connectors | Nos. | 6 |
| | vii) Motor with gear assembly and bevel gear assembly | Nos. | 1 |
| | viii) Corona shield rings | Nos. | 2 |
| | ix) Hinge pins | Nos. | 2 |
| | x) Bearings | Set | 1 |
| | xi) Current carrying assembly | Nos. | 2 |
| | xii) Interlocking coil | Nos. | 2 |
| **(i)** | **72.5 kV** , 800 Amp. , triple pole, gang operated, horizontal double break type Isolator without earth switch alongwith complete metallic and accessories. | Set | 1 |
| **(i)(ii)** | Terminal Connectors for above item(i)(i) | Nos. | 6 |
| **(i)(iii)** | Post insulators for above item (i)(i) | Nos. | 9 |
| **5.** | **Surge Arresters** | | |

| | | | |
|---|---|---|---|
| **(a)(i)** | Single pole voltage -coordinated, outdoor station class heavy duty current limiting type 390 kV lightning arresters suitable for connection between phase and ground on 3 phase 420 kV neutral grounded system complete with insulating base, surge counter and current meter, accessories. | Nos. | 18 |
| **(a)(ii)** | Terminal Connectors for above item(a)(i) | Nos. | 18 |
| **(b)** | Spare of 390kV Surge Arresters | | |
| | (i) Complete LA with insulating base | Nos. | 3 |
| | (ii) Terminal Connector | Nos. | 3 |
| **(c)** | Single pole voltage -coordinated, outdoor station class heavy duty current limiting type 198 kV lightning arresters suitable for connection between phase and ground on 3 phase 245 kV neutral grounded system complete with insulating base, surge counter and current meter, and all accessories as per specification. | Nos. | 33 |
| **(c)(ii)** | Terminal Connectors for above item(c)(i) | Nos. | 33 |
| **(d)** | Spare of 198kV Surge Arresters | | |
| | (i) Complete LA with insulating base | Nos. | 3 |
| | (ii) Terminal Connector | Nos. | 3 |
| **e(i)** | Single pole voltage coordinated, outdoor station class heavy duty current limiting type 120kV lightning arresters suitable for connection between phase and ground on shunt reactor with insulating base, surge counter & current meter and all accessories as per specification. | Nos. | 1 |
| **e(ii)** | Terminal Connectors for above item (e)(i) | Nos. | 1 |
| **f(i)** | **42 kV, 52kV class** Lightning arresters | Nos. | 3 |
| **f(ii)** | Terminal Connectors for above item (f)(i) | Nos. | 3 |

**6. Wave Trap**

| **S.No.** | **Name of Equipment** | **Unit** | **Quantity for 400 / 220 kV GSS Jaisalmer- 2 end** | |
|---|---|---|---|---|
| | | | **400kV (3Nos.)** | **220kV (9 Nos.)** |
| **1** | **2** | **3** | **4** | **5** |
| **6(a)** | 400 kV, 1.0mH / 2000 A. Wave Traps Pedestal mounting type with tuning unit, protection device, terminals clamps, corona rings, bird barriers etc. | **Nos.** | 6 | -- |
| **6(b)** | 220 kV, 0.5 mH / 2000 A Wave traps Pedestal mounting type with tuning unit protection device, terminals clamps, corona rings, bird barriers etc. | **Nos.** | -- | 18 |

## C (1). CONTROL, RELAY & PROTECTION PANELS & ASSOCIATED MANDATORY SPARES/EQUIPMENTS

| S.No. | Particulars | Unit | Quantity |
|---|---|---|---|
| **1.** | 400kV Relay Panel for line with auto reclose scheme | Set | 3 |
| **2.** | 400kV Relay Panel for 500 MVA, 400/220kV Transformer | Set | 2 |
| **3.** | 400kV Relay Panel for Tie Breaker with auto reclose scheme and common relay panel | Set | 4 |
| **4.** | 400kV Relay Panel for Reactor | Set | 1 |
| **5.** | 220kV Relay Panel for feeder | Set | 9 |
| **6.** | 220kV Relay Panel for 500 MVA, 400/220kV Transformer | Set | 2 |
| **7.** | 220kV Relay Panel for Bus Coupler | Set | 2 |
| **8.** | 220kV Relay Panel for Transfer Bus Coupler | Set | 1 |
| **9.** | 220 kV relay panel for sectionalizer | Set | 1 |
| **10.** | Bus Bar Protection Scheme having one no. central unit and 16 nos. peripheral units (PU) considering all existing and future dia of 400kV Switchyard designed for one & half breaker scheme (IEC-61850 Compliant). | Set | 1 |
| **11.** | Bus Bar Protection Scheme having one no. central unit and 22 nos. peripheral units (PU) considering all existing and future bays of 220kV Switchyard designed for double main and transfer bus scheme with sectionalizer (IEC-61850 Compliant). | Set | 1 |
| **12.** | GPS with Digital clock | Set | 1 |
| **13.** | Necessary software and hardware along with laptop to up / down load the data / from the relays from / to the laptop. The supply of laptop is covered under this scope. | Set | 1 |
| **14.** | **Mandatory Spares** for C&R panels (similar items as used in the quoted panels) | | |
| **(a)** | Line relay Panel:<br>• Main-I type relay<br>• Main-II Type Relay<br>• Over voltage Protection relay<br>• Auxiliary relay, Tripping Relay, Supervision relays, timers (one of each type used in the panel)<br>• Under-voltage relay for isolator/earth switch<br>• LBB Relay | <br>No.<br>No.<br>No.<br>Set<br>No.<br>No. | <br>1<br>1<br>1<br>1<br>1<br>1 |
| **(b)** | Transformer Relay panel<br>• Main-I type Differential relay<br>• Main-II type Differential relay<br>• High impedance differential (Circulating current) Relay<br>• Over flux relay<br>• Transformer overload protection relay<br>• Restricted Earth fault relay<br>• Directional back up over current & E / F relay with non directional high set feature.<br>• LBB<br>• Three phase trip relays, Flag relays, auxiliary relays, timers (One of each type used in the panel) | <br>No.<br>No.<br>No.<br>No.<br>No.<br>No.<br>No.<br>No.<br>Set | <br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1<br>1 |

| | | | |
|---|---|---|---|
| **(c)** | Shunt Reactor Relay panel<br>• Numerical differential protection Relay<br>• High impedance differential (Circulating current) Relay<br>• Restricted Earth fault relay<br>• Back up impedance relay<br>• Auxiliary, Tripping, supervision relays (One of each type used in the panel. | <br>No.<br>No.<br>No.<br>No.<br>Set | <br>1<br>1<br>1<br>1<br>1 |
| **(d)** | Tie Breaker / Bus coupler / Sectionlizer / Transfer bus coupler.<br>• Auto Relcose Relay<br>• Non directional over current & earth fault relay.<br>• LBB | <br>No.<br>No.<br>No. | <br>1<br>1<br>1 |
| **(e)** | 400kV Bus bar Protection<br>• Peripheral unit (PU) | <br>No. | <br>2 |
| **(f)** | 220kV Bus bar Protection<br>• Peripheral unit (PU) | <br>No. | <br>2 |

## C(2) SUBSTATION AUTOMATION SYSTEM FOR 400kV GSS JAISALMER-2

| S.No. | Particulars | Unit |
|---|---|---|
| **1.** | Complete substation automation system alongwith necessary spares for 5 years satisfactory operation as per scope of the specification. | LOT |

**D-1. PLCC EQIPMENTS**

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Jaisalmer end | | Quantity for Developer end |
|---|---|---|---|---|---|
| | | | 400kV (3Nos.) | 220kV (9Nos.) | 220kV (9No.) |
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | SSB single Channel Carrier Set (40 W) suitable for transmitting Data and super imposed channels along with Remote subscriber facility and emergency calling set. | Nos. | 12 | 36 | 36 |
| 2 | A.F. Protection coupler microprocessor based suitable for Four commands. | Nos. | 6 | 18 | 18 |
| 3 | VFT equipment (Modem) suitable for transmission of Data through PLCC links based on frequency shift keying modulation techniques programmable for both baud rate from 50 Baud to 2400 Baud and center frequency through switches or jumpers (A.F. Shift Channel) | Nos. | 3 | 9 | 9 |
| 4. | Coupling Devices for Phase to Phase coupling having Band width programmable at site with protective Device & balancing transformer matching with line impedance of respective voltage level. | Set | 3 | 9 | 9 |
| 5. | HF Armoured Coaxial cable having 125 Ohms unbalanced impendance. | Kms. | LOT | | -- |
| 6. | PLCC Electronic Private Automatic Exchange (EPAX) suitable for 24 subscribers lines and 16 tie lines with redundancy of critical cards. | Nos. | 1 | | -- |
| 7. | Telephone Sets (Push Button Type) | Nos. | 30 | | -- |

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Jaisalmer end | | Quantity for Developer end |
|---|---|---|---|---|---|
| | | | 400kV (3Nos.) | 220kV (9Nos.) | 220kV (9No.) |
| 8. | 20 Pair jelly filled armoured telephone cable having copper conductor of Dia. 0.63 mm. | Km. | LOT | | -- |
| 9. | 5 Pair jelly filled armoured telephone cable having copper conductor of Dia. 0.63 mm. | Km. | LOT | | -- |
| 10. | Sleeved copper wire of 8 SWG. | Mts. | LOT | | -- |
| 11. | Any other item bidder may require to complete the PLCC System as per specification's requirements. | | LOT | | -- |
| 12. | **Mandatory Spares** | | | | |
| (i) | SSB single Channel Carrier Set (40 W) suitable for transmitting Data and super imposed channels along with Remote subscriber facility and emergency calling set. | Nos. | 1 | | -- |
| (ii) | A.F. Protection coupler microprocessor based suitable for Four commands. | Nos. | 1 | | -- |
| (iii) | VFT equipment (Modem) suitable for transmission of Data through PLCC links based on frequency shift keying modulation techniques programmable for both baud rate from 50 Baud to 2400 Baud and center frequency through switches or jumpers (A.F. Shift Channel) | Nos. | 1 | | -- |
| (iv) | Coupling Devices for Phase to Phase coupling having Band width programmable at site with protective Device & balancing transformer matching with line impedance of | Sets | 1 | | -- |

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Jaisalmer end | | Quantity for Developer end |
|---|---|---|---|---|---|
| | | | 400kV (3Nos.) | 220kV (9Nos.) | 220kV (9No.) |
| | respective voltage level. | | | | |
| **(v)** | Cards for PLCC carrier terminal for each type | Set | 1 | | -- |
| **(vi)** | Coaxial cable | Km | 0.2 | | -- |
| **(vii)** | Set of electronic cards of each type | Set | 1 | | -- |
| **(viii)** | Coaxial connectors | Nos. | 2 | | -- |
| **(ix)** | Straight through joint | Nos. | 1 | | -- |
| **13.** | **Mandatory testing and maintenance equipments** | | | | |
| **(i)** | Print testing kit for PLCC terminal, of following items packed in a briefcase. | Set | 1 | | -- |
| | (a) Screw driver set with multiupfixing features | | | | -- |
| | (b) Nose pliers | | | | -- |
| | (c) Cutting pliers | | | | -- |
| | (d) Ordinary pliers | | | | -- |
| | (e) Adjustable wrenches | | | | -- |
| | (f) Soldering iron with trip earthed | | | | -- |
| | 150 Watts | | | | -- |
| | 35 Watts | | | | -- |
| | 10 Watts | | | | -- |
| | (g) Desoldering pump | | | | -- |
| | (h) Print extender | | | | -- |
| | (i) Large selection of test leads | | | | -- |
| | (j) Solder wire | | | | -- |
| | (k) Large selection of plugs, jacks & pistol probes compatible with equipment supplied | | | | -- |
| | (l) Dummy load | | | | -- |
| | (m) Interface card/ print for Tx to Rs loop- back | | | | -- |
| | (n) Test oscillator/ tone | | | | -- |

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Jaisalmer end | | Quantity for Developer end |
|---|---|---|---|---|---|
| | | | 400kV (3Nos.) | 220kV (9Nos.) | 220kV (9No.) |
| | generator with indicating meters-either built or separte. | | | | |
| | (o) ESD wrist back | | | | -- |
| | (p) ESD conducting mat | | | | -- |
| (**ii)** | Digital level oscillator ET71 / A of ELECTRO - NIKA,HUNGARY MAKE with rechargeable battery and built in charger. | No. | 1 | | -- |
| **(iii)** | Digital level meter ET 71/ V with measuring attachment ETM-4 of ELECTRONIKA, HUNGARY MAKE with rechargeable battery and built in charger. | No. | 1 | | -- |
| **(iv)** | Digital multi meter Portable of SANWA Make Model PC 5000 Japan, auto ranging, having following features:-<br>(a) True rms measurement for A/C Signals up to 750.0 V & 100 KHz.<br>(b) Frequency measurement from 5 Hz to 2 MHz.<br>(c) Voltage measurement in dB from ï 11.76 dB to +54.25 dB.<br>(d) Resistance measurement up to 50 MΩ.<br>(e) DC Voltage up to 1000 V. | No. | 1 | | -- |
| **(v)** | Digital storage Oscilloscope (Model No. TDS 1002B) TEKTRONIX Make. | No. | 1 | | -- |
| **(vi)** | Digital Frequency Counter having following features:- | No. | 1 | | -- |
| | (a) Freq. range- 20 Hz to 550 MHz | | | | -- |
| | (b) Sensitivity- 30 mv | | | | -- |
| | (c) Resolution -10 Hz | | | | -- |

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Jaisalmer end | | Quantity for Developer end |
|---|---|---|---|---|---|
| | | | 400kV (3Nos.) | 220kV (9Nos.) | 220kV (9No.) |
| | (d) Display -8 Digit | | | | -- |

**Note:-**

1) **The PLCC equipments / panels for developer end (220 kV) are only supply items and ETC of the same are not in the scope works.**

**D-2 FOTE TERMINAL EQUIPMENTS**

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Jaisalmer-2 end |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1 | Fully wired cabinet with base 19ò equipment rack (incl. front cover, cable tray, common cards) with fan unit and control, synchronization, Alarm, dual Power supply input cables | Set | 1 |
| 2 | Central Processing Card ï CPU | Nos. | 2 |
| 3 | Power supply unit ï 48 VDC 85 W | Nos. | 2 |
| 4. | OLTE ï 4 Port STM-1 (155 Mbps Card) along with SFPs | Set | 1 |
| 5. | Optical Amplifier / Booster equipment (comprising of wave length translator, Wavelength Converter, Booster Amplifier; 21 dBm, Pre Amplifier and Raman Amplifier + Software) for main as well as protected parts | Set | 2 |
| 6. | OFC Patch Cords (Set of 48 nos.) | Set | 1 |
| 7. | 8 Port 2w/4w E&M interface Card | Nos. | 1 |
| 8. | 4 port Data Interface Card (Programmable) | Nos. | 2 |
| 9. | 4 Port Data interface Card (Programmable) for remote end (to be located at nearest SLDC / Sub-LDC) | Nos. | 2 |
| 10. | Ethernet over SDH transport card (with four 10/100 base, one 100Base ï FX and one 1000 Base-LX/SX front interfaces) | Nos. | 1 |
| 11. | 4 command integrated Tele-protection Card | Nos. | 4 |
| 12. | Line Differential Relay Interface Card (4 ports) | Nos. | 1 |
| 13. | Engineering Order Wire Phone | Nos. | 1 |
| 14. | Craft Terminal (LAPTOP PC) with element manager software | Nos. | 1 |
| **15.** | **Mandatory testing and maintenance equipments (for OPGW/ OFAC)** | | |
| i) | Hand-held BER Meter for G.703, V.24, V.11, V.35 and Jitter / Wander Measurements | Nos. | 1 |
| ii) | Optical Time Domain Reflecto-meter | Nos. | 1 |
| iii) | Optical Power Meter | Nos. | 1 |
| iv) | Test Equipment for Tele-protection Module | Nos. | 1 |
| **16.** | **Interface Cable for Power, Data, Voice, Tele-protection, Time Synchronizing etc. as per respective site requirement** | Lot | 1 |
| **17. a.** | **Spare fully wired cabinet (same as Item No.1)** | Set | 1 |
| **17.b.** | **Set of Spare Modules** | Set | 1 |
| **18.** | **Approach Cable and necessary joint box for OPAW** | Set | 1 |
| **19** | **Optical Fibre Distribution Panel (for 72 fibre) with spleing and patch parul** | Set | 1 |

## E. BATTERY AND BATTERY CHARGER

| S.No. | Particulars | Unit | Quantity |
|---|---|---|---|
| **1.** | 220 V, 600 AH VRLA (maintenance free) Battery set (108 cells) along with accessories, stand etc. | Set | 2 |
| **1(a).** | Spare for 220 V, 600 AH VRLA (maintenance free) Battery set | | |
| | i) Cells for 220 V bank | Nos. | 2 |
| | ii) Connectors | Nos. | 4 |
| | iii) Terminal lugs | Nos | 5 |
| | iv) Digital Multimeter | Nos. | 2 |
| | v) Spanner Set | No. | 1 |
| **2.** | 220V, 100Amp/70Amp float cum boost Battery Charger (Separate sections for float and boost charging operation). | Set | 2 |
| **2(a).** | Spare for 220 V battery charger | | |
| | i) Set of control cards for charger | Set | 1 |
| | ii) Set of relays | Set | 1 |
| | iii) Rectifier transformer | Nos | 1 |
| | iv) Control transformer | Nos. | 1 |
| | v) Series inductor | Nos. | 1 |
| | vi) Micro-Switches | Set | 1 |
| | vii) Filter Capacitor | Nos. | 1 |
| | viii) Thyristor diode | Nos. | 1 |
| | ix) Set of switches | Set | 1 |
| | x) Set of wound resistors | Nos. | 1 |
| | xi) Potentiometers | Nos. | 1 |
| | xiii) Fuses of thyristor with indicators | Set | 2 |
| **3.** | 48 V, 600 AH VRLA (maintenance free) Battery set (23 Cells) along with accessories, stand and spares. | Set | 2 |
| **3(a).** | Spare for 48 V, 600 AH VRLA (maintenance free) Battery set | | |
| | i) Cells for 48 V bank | Nos. | 2 |
| | ii) Connectors | No. | 4 |

| | | | |
|---|---|---|---|
| | iii) Terminal lugs | Nos | 5 |
| | iv) Digital Multimeter | Nos | 2 |
| | v) Spanner Set | No. | 1 |
| **4.** | 50 V, SMPS battery charger of 100 Amp. DC Load capacity alongwith additional one No. 25 Amp. SMPS Module. | Set | 2 |

## F. LT SWITCHGEAR

| S.No. | Particulars | Unit | Quantity |
|---|---|---|---|
| **A.** | **AC DISTRIBUTION BOARD** | | |
| 1. | 415 V, 1000 A, AC Main switch board | Set | 1 |
| 2. | 415 V, 400 A, AC Distribution Board | Set | 1 |
| 3. | 415 V, 400 A, Main lighting Distribution Board | Set | 1 |
| 4. | 415 V, 200 A, Emergency lighting Distribution Board | Set | 1 |
| 5. | 3 Phase, 415V, 800Amp. Changeover switch | Set | Lot |
| 6. | 415 V, Air conditioning distribution panel | Set | 1 |
| 7. | **SPARES** | | |
| i) | MCCB of each rating | Set | 1 |
| ii) | MCB of each rating | Set | 1 |
| iii) | LT Breaker | No. | 1 |
| iv) | Spring Charging motor | No. | 1 |
| v) | Aux. contact set | No. | 1 |
| vi) | Moving contacts set | No. | 1 |
| vii) | Fixed contacts set | No. | 1 |
| viii) | Spring closing / opening | No. | 1 |
| ix) | Closing Coil | No. | 1 |
| x) | Tripping coil | No. | 1 |
| xi) | Aux. finger contacts | Set | 1 |
| xii) | Limit Switches | Set | 1 |
| xiii) | Breaker Trolley | No. | 1 |
| xiv) | Relays | Set | 1 |
| xv) | CTs and PTs | Set | 1 |
| **B.** | **DC DISTRIBUTION BOARD** | | |
| 1. | 220 V, 400 A, DC Distribution Board (for 2 DC Sources in two parts with bus coupler) | Set | 1 |
| 2. | 50 V, 200 A, DC Distribution Board (for 2 DC Sources in two parts with bus coupler) | Set | 1 |
| 3. | **Spares** | | |
| i) | MCCB of each rating | Set | 1 |
| ii) | MCB of each rating | Set | 1 |
| iii) | CT, PT (each type) | Set | 1 |
| iv) | Voltmeter and Ammeter (each type) | Set | 1 |
| v) | Fuses (each type) | Set | 2 |
| vi) | Indicating bulbs | Nos | 10 |

**Note:-** ACDB & DCDB should be designed in such a manner so that each AC and DC feeder have duplicate connectivity i.e. separate connection wiring to source -1 and source-2 (Refer drawings at Volume-II, Part-24 ).

## G. DG SET

| S.No. | Particulars | Unit | Qty. |
|---|---|---|---|
| **1.** | Diesel Generator set of stationary type having a net electrical out put of 160KVA capacity at specified site conditions with all its accessories for installation at 400 kV substation | No. | 1 |
| **1(a)** | Spare | | |
| | i) Set of filters | Set | 1 |
| | ii) Solenoid coil assembly | No. | 1 |
| | iii) Self starter assembly | No. | 1 |
| | iv) Lub oil pressure safety control | No. | 1 |
| | v) High water temp. safety control | No. | 1 |
| | vi) AVR card for each type of DG set | No. | 1 |

**SCOPE OF WORK OF THE CONTRACTOR FOR BUS BAR MATERIALS, INSTALLATION HARDWARE, MECHANICAL AND ELECTRICAL AUXILIARIES, STRUCTURES AND CIVIL WORKS**

The items under the Hardwares, Mechanical/Electrical auxiliaries, Structures and civil works have been listed for the purposes of Bid preparation. The Bidder is required to estimate the quantities. The bidder is required to indicate unit rate and total price of the items under respective heads in bid proposal sheets. The bidder may note that the list indicated below is not exhaustive and he may modify the same to meet the complete requirement of specification. The cement and steel shall be supplied by the Contractor.

## H. HARDWARES AND MECHANICAL/ELECTRICAL AUXILIARIES

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| **1. (a)** | **400 kV** Double Tension String assembly with double anchoring points with 25 Nos. antifog type disc insulator per string with all hardware accessories including corona ring, turn buckle, arcing horn and tension clamp set suitable for **Twin / quadruple** Moose ACSR bundle with 450 mm sub-conductor spacing. | Nos. | Lot |
| | **i)** With Turn Buckle | | |
| | **ii)** Without Turn Buckle | | |
| **(b)** | **400 kV** Single Suspension string insulator assembly with 25 Nos. anti fog type disc insulators with all hardware accessories including corona ring with dropper / through type clamp set for **Twin / quadruple** Moose ACSR with 450 mm sub-conductor spacing. | Nos. | Lot |
| | **i)** Quad / Twin Moose through type | | |
| | ii) Quad / Twin Moose Dropper type | | |
| **(c)** | **245 kV** double tension string assembly with single anchoring points with 15 Nos. anti fog type disc per string with all hardware accessories, including corona ring, turn buckle, arching horn and tension clamp set suitable for **single / Twin Tarantulla** bundle with 300mm sub conductor spacing. | Nos. | Lot |
| | **i)** With Turn Buckle | | |
| | **ii)** Without Turn Buckle | | |
| **(d)** | **245 kV** single suspension string insulator assembly with 15 Nos. anti fog type disc insulators with all hardware accessories including corona ring, arching horn and suitable for through / drop clamp set for **single / Twin Tarantulla** bundle with 300mm sub conductor spacing. | Nos. | Lot |
| | **i)** through type | | |
| | **ii)** Dropper type | | |
| **2.** | **a) 400 kV** Bus Post Insulator stacks with corona ring other than those not included with individual equipment. | Nos. | Lot |
| | **b) 245 kV** Bus Post Insulators other than those not included with individual equipment. | Nos. | Lot |
| | **c) 72.5 kV** Outdoor Post Insulators other than those not included with individual equipment. | Nos. | Lot |
| **3.** | **400 kV** Corona bellow / sphere for 4òIPS Al. tube | Nos. | Lot |
| **4.** | **a) 400 kV** clamps and connectors other than those not included with individual equipment. | Nos. | Lot |
| | **b) 245 kV** Clamps and Connectors other than those not included with individual equipment. | Nos. | Lot |

| | | | |
|---|---|---|---|
| | **c) 72.5 kV** Clamps & Connectors other than those not included with individual equipment. | Nos. | Lot |
| | **d)** All type clamp and connectors for **earthwire and GS flat** | Nos. | Lot |
| **5.** | **a) 400 kV** Spacers(All types) | Nos. | Lot |
| | **i)** Rigid type | | |
| | **ii)** Flexible type | | |
| | **b) 245 kV** Spacers (All types) | Nos. | Lot |
| | **i)** Rigid type | | |
| | **ii)** Flexible type | | |
| **6.** | Grounding Conductor (GS & MS flats of all sizes and Cu/Al Flexible braids) | Mtrs. | Lot |
| **7.** | (a) 40 mm dia MS Rod<br>(b) 40 mm dia 3000 mm long MS rod (earth electrodes) with/without test links, RCC pits, C.I .cover hinged at C.I. frame alongwith all associated civil works<br>(c) 40 mm dia, 3000 mm long GS pipe electrodes with test links and treated earth pits with C.I. cover hinged to C.I. frame alongwith all associated civil works | Mtrs.<br>Nos.<br><br>Nos. | Lot<br>Lot<br><br>Lot |

**Note:- (i) The GS/MS flats to be used for earthing of the equipment shall be required to be drilled/welded at site as per the needs and M.S. Flats shall be properly painted as per the stipulations. Supply of necessary bolts, nuts & washers shall also be in the scope of the contractor.**

**(ii) All the dropped jumpers shall be of Y-type.**

| | | | |
|---|---|---|---|
| **8.** | **a) 4" IPS** (EH) Al. Tube (OD. 114.2 mm, Thickness-8.51 mm) | Mtrs. | Lot |
| | **b) 3" IPS** (EH) Al. Tube (OD. 73.03mm Thickness 7.01mm) | Mtrs. | Lot |
| **9.** | **a)** Welding sleeves for 4òIPS Al. tube | Nos. | Lot |
| | **b)** Welding sleeves for 3òIPS Al. tube | Nos. | Lot |
| **10.** | Bay Marshalling kiosks | | |
| | **a)** For 400 kV | Nos. | 10 |
| | **b)** For 220 kV | Nos. | 15 |
| **11.** | Earthwire tension clamps with D. Shackle assembly and earth bond | Nos. | Lot |
| **12.** | Lugs to suit 10.98 mm GS Earthwire | Nos. | Lot |
| **13.** | Junction boxes | Nos. | Lot |
| **14.** | Cables (FRLS) | | |
| | (a)1.1 KV grade PVC insulated armoured control cables ï Cu | Mtrs. | LS |
| | (b) 1.1 kV grade XLPE / PVC insulated armoured Al. conductor power cable | LS | LS |
| **15.** | Straight through joints for 1.1 kV XLPE / PVC power cables as required | LS | LS |
| **16.** | Double compression type cable gland for 1.1 kV grade insulated cables & its termination as per cable sizes. | LS | LS |
| **17.** | Crimping type cable lugs (Tinned copper) of size of cable as required. | LS | LS |
| **18.** | PVC Pipes for Laying cables as per IS 4985 (the sizes shall be recommended by the bidder) | Mtrs. | LS |
| **19.** | Hume pipes for road crossing (NP-4 class). (Sizes shall be recommended by the bidder) | Mtrs. | LS |
| **20.** | Pressure die cast AL (LM6) Nylon 6 made trefoil clamp for recommended cables | Nos. | Lot |
| **21.** | MS Angle Flat and ISMC channel (All size) | Kg. | Lot |
| **22.** | ACSR Moose conductor | Km. | Lot |
| **23.** | AAC Tarantulla conductor | Km. | Lot |

| | | | |
|---|---|---|---|
| **24.** | 10.98mm dia GS earth wire | Km. | Lot |
| **25.** | **72.5 kV,** 50 Amp. single phase horn gap fuse unit (Three phase) | Set | 3 |
| **26.** | Heat shrinkable tube / tape | LS | LS |
| **27.** | **Any Other Item** | | |

**Note:- Bidder shall supply 5% of the erected quantities of above Bus Bar Material, clamp connector, spacers and accessories as spare except for item no. 6, 7, 8, 10, 13, 15, 16, 18, 19 to 25. Any fractions will mean the next higher integer number.**

## I. IIIUMINATION SYSTEM :-

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| **A.** | **Switchyard Flood Lighting** | | |
| **1.** | Flood Light Luminaries | | |
| | For one lamp | Nos. | Lot |
| | For two lamps | Nos. | Lot |
| **2.** | High Pressure sodium vapour lamps | Nos. | Lot |
| **3.** | Distribution pillars | Nos. | Lot |
| **4.** | Cable Trays | Mtrs | Lot |
| **5.** | Cable | Sized Mtrs | Lot |
| **6.** | MCBôs | Sized | Lot |
| **7.** | Control Gears | Nos. | Lot |
| **8.** | Aluminum Ladders of each size | Set | 2 |
| **9.** | Mobile Flood Light Tower | No. | 1 |
| **B.** | **CONTROL ROOM BUILDING AND STREET LIGHTING** | | |
| **1.** | Lighting transformers | Nos. | 3 |
| **2.** | Steel tubular poles | Nos. | Lot |
| **3.** | Contactors | Nos. | Lot |
| **4.** | Fuses | Size & No. | Lot |
| **5.** | MCBôs | Size & No. | Lot |
| **6.** | Junction boxes | No. & Type | Lot |
| **7.** | Lighting Panels | No. & Type | Lot |
| **8.** | Conduit and accessories | Size & Metre | Lot |
| **9.** | Switch Board & Switches | No. and Meter | Lot |
| **10.** | Cable | Size & Meter | Lot |
| **11.** | Fluorescent lamps | No. | Lot |
| **12.** | Fluorescent lamps fixtures | No. & type | Lot |
| **13.** | Incandescent lamps | No. | Lot |
| **14.** | Incandescent lamps fixtures | No. & type | Lot |
| **15.** | Fans | Nos. | Lot |
| **16.** | Desert Coolers | Nos. | Lot |
| **17.** | Exhaust Fans | Nos. | Lot |
| **18** | Aluminum Ladders of each size | Set | 1 |
| **19.** | Any other items | Nos. | Lot |
| **C.** | **Spares** | | |
| **1.** | Sodium vapour lamps of each rating | Nos. | 4 of each rating |
| **2.** | Ballast | Nos. | 4 of each rating |
| **3.** | Capacitors | Nos. | 4 of each rating |
| **4.** | Switches, fuses | Set | 2 |
| **5.** | Fixtures (each type) | Set | 2 |

| | | | |
|---|---|---|---|
| **6.** | Lighting Board | Set | 2 |
| **7.** | MCCB each rating | Set | 2 |
| **8.** | MCB of each rating | Set | 2 |
| **9.** | Timer | Set | 2 |
| **10.** | Fluorescent lamps | Set | 5% of Total |
| **11.** | Fluorescent lamps fixtures | Set | 5% of Total |
| **12.** | Incandescent lamps | Set | 5% of Total |
| **13.** | Incandescent lamps fixtures | Set | 5% of Total |

**J. FIRE FIGHTING SYSTEM ( AS PER TECHNICAL SPECIFICATION)**

**(A) Mulsifyre System**

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| **1.** | Diesel Engine driven pump set of 410 M3/hr capacity 70 M Head<br>(a) Diesel engine pump complete with accessories<br>(b) Foot valve with strainer 300 mm<br>(c) Stop valve 250 mm<br>(d) CIDF suction pipe 300 mm<br>(e) Fittings<br>(f) Diesel Engine Controller with VRLA Maintenance free Battery, SMPS charger complete | set | 1 |
| **2** | Electric Motor driven pump set of 410 M3/hr capacity 70 M Head<br>(a) Pump & motor complete with starter<br>(b) Foot valve with strainer 300 mm<br>(c) Stop valve 250 mm<br>(d) CIDF suction pipe 300 mm<br>(e) Fittings | set | 1 |
| **3.** | Air Vessel size 300 mm dia 1500 mm long | Nos. | 1 |
| **4.** | Set of interconnecting pipes, stop valves for interconnecting in pump house building<br>(a) 250 mm dia Gate valve<br>(b) 250 mm dia Steel pipe | <br>Nos.<br>Mtrs | Lot |
| **5.** | Mulsifyre Strainer | Nos. | Lot |
| **6.** | Automatic starter, Diesel Engine starting panel | Set | Lot |
| **7.** | Compressor with driving motor | No. | Lot |
| **8.** | G.I. piping with fittings<br>(a) G.I. pipe 25 mm dia<br>(b) Fittings for 25 mm dia pipe | <br>Mtrs<br>Lot | Lot |
| **9.** | M.S. pipes suitable for overgrond and under ground as per relevant BIS<br>(a) 250 mm dia pipe.<br>(b) Fittings for 250 mm dia pipe<br>(c) 200 mm dia pipe.<br>(d) Fitting for 200 mm dia pipe<br>(e) 150 mm dia pipe.<br>(f) Fittings for 150 mm dia pipe<br>(g) 100 mm dia pipe.<br>(h) Fittings for 100 mm dia pipe. | <br>Mtrs<br>Lot<br><br>Mtrs<br>Lot<br><br>Mtrs<br>Lot<br><br><br>Mtrs<br>Lot | Lot |

| | | | |
|---|---|---|---|
| **10.** | Set of Deluge valve stop valves, supports projectors, detectors with pipe, alarm motor and gang for the mulsifyre protection of shunt reactors.<br><br>(a) Mulsifyre projectors<br>(b) Quartzoid bulb Detectors<br>(c) 150 mm dia Deluge valve<br>(d) 250 mm dia Drain valve<br>(e) 150 mm dia GI pipe<br>(f) 100 mm dia GI Pipe<br>(g) 80 mm dia GI Pipe<br>(h) 50 mm dia GI Pipe<br>(i) Alarm Motor & Gonge<br>(j) D.A. Switches | <br><br>Nos.<br>Nos.<br>Nos.<br>Nos.<br>Mtrs<br>Mtrs<br>Mtrs<br>Mtrs<br>Nos.<br>Nos. | Lot |
| **11.** | Alarm & 32 section Annunciation panel for complete installation | Nos. | Lot |
| **12.** | LT distribution Panel suitable for 3 ½ x 300 sq. mm. incoming & 6 Nos. 3 ½ x185 / 95 Sqmm for 3 Phase outgoing feeders of capacity meeting the requirement of each motor | Nos. | Lot |
| **13.** | Power Cables & Control Cables<br>(a) 3 ½ x 300 Sqmm FRLS Cable<br>(b) 3 ½ x 185 Sqmm FRLS Cable<br>(c) 3 ½ x 95 Sqmm FRLS Cable<br>(d) 3x30 sq. mm. FRLS cable<br>(e) Control cable (Copper)<br>(f) Earthing | <br>Mtrs<br>Mtrs<br>Mtrs<br>Mtrs<br>Mtrs<br>Sets | <br>Lot<br>Lot<br>Lot<br>Lot<br>Lot<br>Lot |
| **14.** | Any other specified item for completion of Hydrant system | | |

**Note :- BOQ shown above is indicate only. It shall be finalized at the time of detail engineering as per the specification / requirement.**

**J (B) Hydrant System**

| **S.No.** | Item / Description | Unit | **Qty.** |
|---|---|---|---|
| **1.** | Electric Motor driven pump set of 410 M3/hr capacity 70 M Head | Set | 1 |
| **a)** | Electric pump motor & starter complete | Set | Lot |
| **b)** | Foot valve with strainer | Set | Lot |
| **c)** | Stop valve & size | No. | Lot |
| **d)** | CIDF suction pipe & size | Meter | Lot |
| **e)** | Fittings | Lot | Lot |
| **2.** | Pump & infeed piping with automatic priming arrangement | Lot | Lot |
| **a)** | Jockey pump & starter complete set | Set | 2 |
| **b)** | GI suction pipe & size | Meter | Lot |
| **3.** | Air vessel of 300 mmdia 1.5 metre long | Nos. | 1 |
| **4.** | Set of pipes & valves | | Lot |
| **a)** | Check valve & size | Nos. | Lot |
| **b)** | Gate valve & size | Nos. | Lot |
| **c)** | Steel pipe 7 size | Meter | Lot |
| **d)** | Elbow & size | Nos. | Lot |
| **5.** | Electric Control Panel including switchgear & wiring for manual and automatic start / stop of pumps | Nos. | Lot |
| **6.** | Ring main with pipes and fittings | Set | Lot |
| **a)** | 150mm dia CITJ pipe / MS pipe | Meter | Lot |
| **b)** | Fittings of 150mm dia pipe | Lot | Lot |
| **c)** | 100 mm dia CITJ pipe / MS pipe | Meter | Lot |
| **d)** | Fittings of 100mm dia pipe | Lot | Lot |

| | | | |
|---|---|---|---|
| **7.** | Hydrant Female Oblique type with stand pipe | | Lot |
| **a)** | Single headed stand pipe | Nos. | Lot |
| **b)** | Double Headed stand pipe | Nos. | Lot |
| **c)** | Gun metal landing valve | Nos. | Lot |
| **8.** | 150mm dia Isolator valves | Nos. | Lot |
| **9.** | 63mm dia 15M long hose pipe | Nos. | Lot |
| **10.** | Hose cabinets | Nos. | Lot |
| **11.** | Branch pipe & jets | Nos. | Lot |
| **12.** | Fog type Nozzle | Nos. | Lot |
| **13.** | Any other specified item for completion of Hydrant system | | |

**Note :- BOQ shown above is indicate only. It shall be finalized at the time of detail engineering as per the specification / requirement.**

**J (C) FIRE DETECTION AND ALARM SYSTEM**

| **S.No.** | Item / Description | Unit | **Qty.** |
|---|---|---|---|
| **1.** | Micro-processor based Main fire detection control panel wired for suitable number of zones complete with control unit P.S. system, built in a battery and battery charger | No. | Lot |
| **2.** | Addressable Photo Electronic light scattered smoke detectors | No. | Lot |
| **3.** | Addressable Photo Electronic light scattered smoke detectors with duct caging | No. | Lot |
| **4.** | Addressable lonization chamber smoke detector | Nos. | Lot |
| **5.** | Linear Heat sensor cable | Meter | Lot |
| **6.** | Heat Detector | Nos. | Lot |
| **7.** | Electronic Hooters | Nos. | Lot |
| **8.** | FRLS Control cables | | Lot |
| **a)** | 2x1.5 sq.mm | Meter | Lot |
| **b)** | 10x1.5 sq.mm | Meter | Lot |
| **9.** | Any other specified item for completion of fire detection and alarm system | | |

**Note :- BOQ shown above is indicate only. It shall be finalized at the time of detail engineering as per the specification / requirement.**

**J (D) HAND APPLIANCES**

| **S.No.** | Item / Description | Unit | **Qty.** |
|---|---|---|---|
| **1.** | Pressurized, water type portable fire extingusher of 9 litre capacity complete with fill | Nos. | Lot |
| **2.** | Dry chemical powder type portable fire extingusher of 5 Kg. capacity complete with fill | Nos. | Lot |
| **3.** | Carbon di-oxide type portable fire extinguisher of 4.5 Kg. capacity complete with fill. | Nos. | Lot |

**NOTE :- Quantities of each item shall be finalized during approval of detailed engineering for respective substations.**

## J (E) SPARES FOR MULSIFYRE / HYDRANT SYSTEM

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| **1.** | HVW ï Pumps & Jockey pump | | |
| **a)** | Sfaft-Sleeve | Set | 1 |
| **b)** | Gland packing | Set | 1 |
| **2.** | Diesel Engine drive | | |
| **a)** | Fuel oil filter | Set | 1 |
| **b)** | Lubricating oil filter | Set | 1 |
| **3.** | Nozzles | Nos. | 10% of total |
| **4.** | Quartzoil Detectors | No. | 1 |
| **5.** | Level Switch | No. | 1 |
| **6.** | Pressure Switch | No. | 1 |
| **7.** | Hydrant Valve | No. | 1 |

## J (F) SPARES FOR FIRE ALARM

| S.No. | Item Description | Unit | Qty. for Jaisalmer-2 |
|---|---|---|---|
| **1.** | Smoke Detectors | Nos. | 10% of Total |
| **a)** | Photo electric type | Nos. | 10% of Total |
| **b)** | Ionization type | Nos. | 10% of Total |
| **c)** | Heat Detectors | Nos. | 10% of Total |

## K. AIR-CONDITIONING AND VENTILATION SYSTEM WHICH SHALL INCLUDE FOLLOWING

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| **1.** | Design, supply, installation, testing and commissioning of Air conditioning & ventilation system for the control room building for following rooms alongwith the necessary spares for satisfactory operation for 5 (five) years.<br><br>i) Control Room and OLTE / SAS Panel Room<br>ii SE / XEN Room<br>iii) Battery Room<br>iv) Rest Rooms etc. | Lot | Lot |
| **2.** | Design, supply, installation, testing and commissioning of Air conditioning & ventilation system for all kiosks of bay level units in switchyard as per clause No. 4.3 of Part 3 Section-II Vol-II alongwith the necessary spares for satisfactory operation for 5 (five) years. | Lot | Lot |

## L(1). OIL PURIFICATION PLANT

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| **1.** | Truck mounted Oil Purification Plant Capacity 6000 ltr / hr. | Nos. | 1 |

## L(2). MOBILE CRANE

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| **1.** | Truck mounted crane capacity 8 Ton | Nos. | 1 |

**M. STRUCTURES:**

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| | **STRUCTURES :**<br>Design, engineering, procurement of materials, fabrication galvaising, proto-assembly, FOR destination delivery & erection including nuts, bolts, gusset plates, base plates, foundation bolts, fixing arrangement for control cabinets/MB of equipments and other accessories for lattice steel structure. Conforming to IS:2062 and GI pipe conforming to grade YST 22 or higher grade as per IS:806. | | |
| **(A)** | **LATTICE STRUCTURE** | | |
| **(a)** | Tower (400 kV) MKD TC | Nos. | 8 |
| **(b)** | Tower (400 kV) MKD TH | Nos. | 4 |
| **(c)** | Tower (400 kV) MKD TI | Nos. | 8 |
| **(d)** | Tower (400 kV) MKD TJ | Nos. | 4 |
| **(e)** | Tower (400 kV) MKD TM | Nos. | 8 |
| **(f)** | Girder (400 kV) MKD G1 | Nos. | 8 |
| **(g)** | Girder (400 kV) MKD G2 | Nos. | 16 |
| **(h)** | Lightning Mast 24 Mtr. Height | Nos. | 21 |
| **(i)** | 220 kV tower type AT4 | Nos. | 28 |
| **(j)** | 220 kV tower type AT8 (A6 With Peak) | Nos. | 12 |
| **(k)** | 220 kV tower type AT6 (Without Peak) | Nos. | 10 |
| **(l)** | 220 kV tower type AT1 | Nos. | 24 |
| **(m)** | 220 kV Beam type AB1 / AB2 | Nos. | 60 |
| **(n)** | 400 kV C.T. Support structure | Nos. | 36+6 |
| **(o)** | 220 kV CT support structures | Nos. | 54 |
| **(p)** | 220 kV CT (metering) support structures | Nos. | 27 |
| | | | |
| **(B)** | **PIPE STRUCTURES** | | |
| **(a)** | 400 kV CVT | Nos. | 15 |
| **(b)** | 220 kV CVT | Nos. | 36 |
| **(c)** | 220 kV CVT (metering) | Nos. | 27 |
| **(d)** | 400 kV Surge Arrestor | Nos. | 18 |
| **(e)** | 220 kV Surge Arrestor | Nos. | 33 |
| **(f)** | 120kV Surge Arrestor | Nos. | 1 |
| **(g)** | 400 kV Isolator | Set | 29 |
| **(h)** | 220 kV Isolator | Set | 56 |
| **(i)** | 400 kV Wave Trap | Nos. | 6 |
| **(j)** | 220kV Wave Trap | Nos. | 18 |
| **(k)** | 400 kV BPI | Lot | Lot |
| **(l)** | 220 kV BPI | Lot | Lot |
| **(m)** | 72.5 kV Isolator | Set | 1 |
| **(n)** | 42kV, 52 class Lightning arresters | Set | 1 |
| **(o)** | 36kV, 52 class EMVT (3 phase) | Set | 2 |
| **(p)** | 72.5 kV Horn gap fuse (3 phase) | Set | 3 |
| | 72.5 kV Post insulators | Lot | Lot |

**Note:- (1)The above estimated quantities of structures are only for tender purpose. The contractor shall supply, erect & commission the structures to meet out complete requirement for successful commissioning , maintenance & operation of the substation in accordance with the specification.**

**(2) Details of Tower structures & girders / beams available in Vol.II, Part-24 of specification are tentative and for tender purpose only. The bidder shall have to design the structures & girders / beams based on actual loadings on the basis of short circuit force calculations, if required.**

## (N) TESTING AND MEASURING EQUIPMENTS

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| 1 | 50 k-Ohms Earth Tester | Nos. / Set | 1 |
| 2 | Insulation Tester / Meggar (5 kV) | Nos. / Set | 1 |
| 3 | Digital Multi-meter | Nos. / Set | 1 |
| 4 | Digital Clamp Meter | Nos. / Set | 1 |
| 5 | Analog Multi-meter | Nos. / Set | 1 |
| 6 | **Universal Computerized Relay Test Kit** alongwith Laptop (Core 2 Duo, 2.4 GHz, 15ò TFT, 160 GB HDD, 2 GB Ram, DVD R/W) and associated configuration software | Nos. / Set | **1** |
| 7 | Dew Point Meter | Nos. / Set | 1 |
| 8 | Contact Resistance Meter | Nos. / Set | 1 |
| 9 | Transformer oil break down Voltage Test Set | Nos. / Set | 1 |
| 10 | Three Phase Transformer Turn Ratio Tester Meter | Nos. / Set | 1 |
| 11 | SF6 Gas Leakage Detector | Nos. / Set | 1 |
| 12 | Circuit Breaker Analyzer | Nos. / Set | 1 |
| 13 | SF6 Gas filling and evacuation Kit | Nos. / Set | 1 |
| 14 | Portable Primary Injection Test kit | Nos. / Set | 1 |
| 15 | Microprocessor Based Dielectric Strength Analyzer | Nos. / Set | 1 |

## (O) GENERAL TOOLS & TACKLES

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| 1 | Telescopic ladder aluminum 6 M height | No. | 1 |
| 2 | Vacuum Cleaner | No. | 1 |
| 3 | Oil Sample Bottles | No. | 2 |
| 4 | Ring Spanner Set | No. | 1 |
| 5 | Tube Spanner Set | No. | 1 |
| 6 | Pipe Wrench 24ò | No. | 1 |
| 7 | Pipe Wrench 18ò | No. | 1 |
| 8 | Hydraulic Crimping Tools upto 630 Sq. mm | No. | 1 |
| 9 | Threading die set for pipe threading | No. | 1 |
| 10 | Welding machine (Arc welding) 10 KVA | No. | 1 |
| 11 | Heavy Duty Drilling Machine | No. | 1 |
| 12 | 5 celled torch | No. | 1 |
| 13 | Insulated cutting plier 12ò | No. | 1 |
| 14 | Insulated cutting plier 8ò | No. | 1 |
| 15 | Line live tester | No. | 1 |
| 16 | Screw Driver 18ò | No. | 1 |
| 17 | Screw Driver 12ò | No. | 1 |
| 18 | Hammer 8 lbs | No. | 1 |
| 19 | Hammer 2 lbs | No. | 1 |
| 20 | Chain pulley block 5 tonnes | No. | 1 |
| 21 | Pipe Derrick | No. | 1 |
| 22 | Allen keys | No. | 1 |
| 23 | Box spanner Set | No. | 1 |
| 24 | Screw Driver Set | No. | 1 |

## (P) OFFICE & MISCELLANEOUS EQUIPMENTS / ITEMS

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| 1. | **Furniture for Control Room building** | | |
| i) | Junior executive table with three drovers on right side One Cup board left side with prelaminated decolam top 20mm thick over painted M.S. Frame ( 4 ½ feet x 2½ feet x 2½ feet) ) | Nos. | 4 |
| ii) | Control Desk Type Table for Control room accommodating the Main and Redundant Computer System monitors, Workstations, printer, Logger, Maintenance / Engineering Terminal, telephone etc.(Size, Shape, Colour etc. to be got approved from Owner) | Set | 1 |
| iii) | Steel tubular chair ñSò type with continuous and one feet dia 14 gauge pipe, cane seat backing, teak wood with quality cane. | Nos. | 10 |
| iv) | Five Leg Revolving Chair with arms | Nos. | 3 |
| v) | Steel Almirah of size 6½ feetx3 feet x 19 inch with four shelves making five compartments in 18 guage with three way locking system | Nos. | 4 |
| vi) | Steel Almirah (With Glass door) of size 6½ feetx3 feet x 19 inch with four shelves making five compartments in 18 guage with three way locking system | Nos. | 4 |
| vii) | Minor Almirah of size 4½ feet x 30 inch x 17 inch with three shelves making four compartments in 18 guage with three waylocking system | Nos. | 3 |
| viii) | Steel rack of size 5 feet x 3 feet x 16 inches with six shelves making five compartments (22 guage) | Nos. | 5 |
| ix) | Steel file trays of size 16 inches x11 inches x 3 inches of guage 14 SWG. | No. | 1 |
| x) | Steel stools of size 15 inch x 15 inch x 18 inch square pipe 16 guage | Nos. | 3 |
| xi) | Steel waste paper baskets of size 12 inch x 10 inch x 10 inch | Nos. | 2 |
| xii) | Short bench of 4 feet x 14 inch x 1 ½ inch with laminated top. | Nos. | 2 |
| xiii) | Key board (wooden) | No. | 1 |
| 2. | First Aid box | No. | 1 |

| | | | |
|---|---|---|---|
| 3. | Shock Treatment Chart | Nos. | 2 |
| 4*. | Substation Glow sign board (Area Approx. 15 Sqm each, Size and Colour etc. to be got approved from owner) | No. | 2 |
| 5. | Danger Plate (Size and colour etc. to be got approved from owner) | Nos. | 10 |
| 6. | Insulated mat (SMC Chequered ) (1000m x 500 x2.5mm) | Nos. | 60 |
| 7. | Insulation Rubber Gloves (15 kV Tested) | Nos. | 4 |
| 8. | Water Cooler Storage Type (Storage Capacity 40 Litre Cooling Capacity 20 Litre per Hour) | No. | 1 |
| 9. | Water purifier / Filter | No. | 1 |

*** Drawing for tender purpose is available in Part-24 (Drawing), Vol.II of spec.**

## (Q) CIVIL WORKS

| S.No. | Description | Unit | Qty. |
|---|---|---|---|
| 1 | **GEO TECHNICAL INVESTIGATION** | LS | Lot |
| | Soil Investigation of substation / switchyard area as per technical specification. | | |
| 2 | **FOUNDATIONS :** | | |
| | Design, Engineering, supply of all labour, material and construction of RCC footings and pedestals of any section/size including the cost of excavation in all types of soil/rock, back filling with available approved earth or borrowed/new earth, disposal of surplus earth/rock to the places directed, concrete (RCC M20 Grade and Lean concrete 1:4:8), reinforcement steel,form work ,grouting , underpinning, foundation strengthening in expansive / B.C soil , curing, sundries and other items not mentioned herein but required for the completion of the work for the following station towers and equipments support structures as per technical specification, approved drawings and directions of the Engineer- in-charge of work | | |
| | | | |
| (A) | **LATTICE STRUCTURE** | | |
| (a) | Tower (400 kV) MKD TC | Nos. | 8 |
| (b) | Tower (400 kV) MKD TH | Nos. | 4 |
| (c) | Tower (400 kV) MKD TI | Nos. | 8 |
| (d) | Tower (400 kV) MKD TJ | Nos. | 4 |
| (e) | Tower (400 kV) MKD TM | Nos. | 8 |
| (f) | Lightning Mast 24 Mtr. Height | Nos. | 21 |
| (g) | 220 kV tower type AT4 | Nos. | 28 |
| (h) | 220 kV tower type AT8 (A6 With Peak) | Nos. | 12 |
| (i) | 220 kV tower type AT6 (Without Peak) | Nos. | 10 |
| (j) | 220 kV tower type AT1 | Nos. | 24 |
| (k) | 400 kV C.T. Support structure | Nos. | 36+6 |
| (l) | 220 kV CT support structures | Nos. | 54 |
| (m) | 220 kV CT (Metering) support structures | | 27 |
| (n) | 400kV Circuit Breaker | Nos. | 10 |
| (o) | 220kV Circuit Breaker | Nos. | 15 |
| | | | |
| (B) | **PIPE STRUCTURES** | | |
| (a) | 400 kV CVT | Nos. | 15 |
| (b) | 220 kV CVT support structures | Nos. | 36 |
| (c) | 220 kV CVT(metering) support structures | | 27 |
| (d) | 400 kV Surge Arrestor | Nos. | 18 |
| (e) | 220 kV Surge Arrestor | Nos. | 33 |
| (f) | 120kV Surge Arrestor | Nos. | 1 |
| (g) | 400 kV Isolator | Set | 29 |
| (h) | 220 kV Isolator | Set | 56 |
| (i) | 400 kV Wave Trap | Nos. | 6+3 |
| (j) | 220kV Wave Trap | Nos. | 18+9 |
| (k) | 400 kV BPI | Lot | Lot |
| (l) | 220 kV BPI | Lot | Lot |

| | | | |
|---|---|---|---|
| **(m)** | 72.5 kV Isolator | Set | 1 |
| **(n)** | 42kV, 52 class Lightning arresters | Set | 1 |
| **(o)** | 36kV, 52 class EMVT (3 phase) | Set | 2 |
| **(p)** | 72.5 kV Horn gap fuse (3 phase) | Set | 3 |
| **(q)** | 72.5 kV Post insulators | Lot | Lot |
| **(C)** | Steel tubular lighting poles | Lot | Lot |
| **(C)** | **FOUNDATION FOR 500MVA, 400/220kV AUTO TRANSFORMER:-** | Set | 2 |
| | Design, engineering, supply of labour, material equipments and construction of Auto Transformerôs foundation (Conc. M-20) including cost of all associated works, rail tracks , jacking pads, anchor block, RCC, PCC, Misc. Structural Steel including M.S. grating, gravel filling pylon supports system and other items not mentioned herein but required for the completion of work as per technical specification. | | |
| **(D)** | **FOUNDATION FOR 125 MVAR, 400kV SHUNT REACTOR AND ASSOCIATED EQUIPMENTS:-** | Set | 1 |
| | Design, engineering, supply of labour, material equipments and construction of 80MVAR, 400kV Shunt Reactors and associated equipments foundation (Conc. M-20) including cost of all associated works, rail tracks , jacking pads, anchor block, RCC, PCC, Misc. Structural Steel including M.S. grating, gravel filling pylon supports system and other items not mentioned herein but required for the completion of work as per technical specification. | | |
| **(E)** | **FOUNDATION FOR 33 / .433 KV, 630 KVA TRANSFORMER:-** | Set | 1 |
| | Design, engineering, supply of labour, material equipments and construction of station Transformerôs foundation including cost of all associated works, RCC, PCC, back fill material, etc. if required, miscellaneous structural steel and other items not mentioned herein but required for the completion of work as per approved design , drawing and technical specification. | | |
| **(F)** | **FOUNDATION FOR 33 / .433 KV, 800 KVA TRANSFORMER:-** | Set | 1 |
| | Design, engineering, supply of labour, material equipments and construction of station Transformerôs foundation including cost of all associated works, RCC, PCC, back fill material, etc. if required, miscellaneous structural steel and other items not mentioned herein but required for the completion of work as per approved design , drawing and technical specification. | | |
| **(G)** | **FOUNDATION / PLATEFORM FOR DG SET.** | Set | 1 |
| **3** | **CABLE TRENCH** | | |

| | | | |
|---|---|---|---|
| | Design, engineering and construction of R.C.C. cable trenches for required depths precast R.C.C. covers, water stops, brick works wherever required including the supply of labour, material, cement, reinforcement steel, steel angles, flats and providing P.C.C.(1:4:8) below cable trenches as per technical specification and approved drawings | | |
| **(a)** | Section B | Mtrs. | Lot |
| **(b)** | Section C | Mtrs. | Lot |
| **(c)** | Section D | Mtrs. | Lot |
| **(d)** | Sump pits with a provision of automatic dewatering pumps | LS | Lot |
| **4** | **CABLE TRENCH CROSSING** | | |
| | Design, engineering, construction including supply of labour, material, cement, reinforcement steel, form work etc. and all associated works for construction of cable trench crossings as per technical specification and approved drawings | | |
| **(a)** | Section B crossing road | No. | Lot |
| **(b)** | Section C crossing road | No. | Lot |
| **(c)** | Section D crossing road | No. | Lot |
| **(d)** | Section B crossing rail track | No. | Lot |
| **(e)** | Section C crossing rail track | No. | Lot |
| **(f)** | Section D crossing rail track | No. | Lot |
| **5** | **TRENCHES** for directly buried cables | Mtrs. | Lot |
| **6** | **ANTIWEED TREATMENT AND BASE LAYER OF PCC** | | |
| **6(a)** | Providing and supplying all labour material including borrowed / removal of earth for maintaining the FGL, equipments etc., soil sterilization / antiweed treatment including excavation, mixing / injecting chemicals to achieve the guaranteed effectiveness of treatment at least up to one years, rolling dressing, compacting the excavated earth within substation areas as per technical specification 100mm thick PCC (1:4:8) with 20 / 40mm graded aggregate as per technical specification. | Sq. M. | Lot |
| **6(b)** | Providing and supplying all labour, material including borrowed / removal of earth for maintaining the FGL, equipments etc., soil sterilization / antiweed treatment including excavation, mixing / injecting chemicals to achieve the guaranteed effectiveness of treatment at least up to one years, rolling dressing, compacting the excavated earth beyond the area of switchyard i.e. considered for future scope / work, laying of brick edging etc. as per technical specification. | Sq. M. | Lot |

| | | | |
|---|---|---|---|
| **7** | **JELLY SPREADING** | Sq. M. | Lot |
| | **a)** After laying cement concrete (1:4:8) / brick edging in required slope / grade, 100mm thick layer of granite/basalt/trap jelly of 20mm size shall be spread over the entire switchyard area as per drawing and directions of engineer incharge of the work.<br>The 20 mm nominal size shall pass 100% through IS. Sieve designation 40 mm and nothing through 16.00 mm IS Sieve. The whole switchyard area (excluding buildings pathway road, drainages, cable trenches, equipments/ structures plinths etcé ) shall be covered with jelly spreading. The jelly used shall be free from dirt, organic materials and flakes<br>**b)** Barricades shall be provided to confine Jelly Spreading which include construction of solid concrete block masonry in CM (1:6) with cement concrete solid blocks of proportion (1:5:3) crushing strength not less than 50 Kg. per Sq.cm / 40x40x20 cms. Size (l, b, h) conforming to IS 32185-196) including necessary curing etc. complete. The concrete block shall be 100 mm above gravel top. The exposed surface of barricades shall be plastered with 12 mm thick in cm (1:6) & two coat of water proof cement paint. | | |
| **8** | **ROAD WORK** | | |
| | Design and construction of roads and walkways/shoulders within sub-station or outside the station as per specification, layout, sectional detail drawing and directions of Engineer-in-charge of work etc. complete in all respect. | | |
| | a) 5.00 Mtr. Wide Road | **Mtrs.** | Lot |
| | b) 3.75 Mtr. Wide Road. | **Mtrs.** | Lot |
| **9** | **STORM DRAINAGE SYSTEM** | LS | Lot |
| | Design, construction if storm water drainage scheme including road, culverts, crossing of drains with cable trenches, sump pits etc. as per specification including outlet sump pit with provision of low head high discharge automatic pump. | | |
| **10** | **FIRE WALL** | Set | 2 |
| | Design, engineering, supply of labour, material including all associated works for construction of fire protection wall as per technical specification. | | |
| **11** | **RAIN WATER HARVESTING** | Set | 2 |
| | This is a lump sum item. The contractor shall be required to complete the work in all respect as per drawings furnished by the bidder and approved by the owner. All the items including excavation, miscellaneous steel, RCC, reinforcement , bore well, brick work, filling of boulders, gravel, sand, pipes etc. shall be deemed to be included in this lump sum rate. | | |
| **12** | **CONTROL ROOM BUILDING** | Set | 1 |
| | Design and construction of control room building as per drawing and specification. | | |
| **13** | **BAY LEVEL KIOSK BUILDING (S) :** Design & construction as per drawing and specification | | |

| | | | |
|---|---|---|---|
| **a)** | **400kV level** | Set | 4 |
| **b)** | **220kV level** | Set | 8 |
| **14** | **FIRE FIGHTING PUMP HOUSE BUILDING** | Set | 1 |
| | Design, Engineering and construction of fire fighting pump house including pump foundation, cable trench, water reservior etc. | | |
| **15** | **WATER SUPPLY :-** Distribution of water supply for the sub-station including drinking water and water for fire fighting system, land scaping & plantation as per specification | LS | Lot |
| **16** | **SEWERAGE SYSTEM :-** Providing internal & external sewerage system for the control room building, septic tank etc. in the S/S as per Technical Specification | LS | Lot |
| **17** | **CHAIN LINK FENCING OF SWITCH YARD.** | LS | Lot |
| **18** | **OTHER CIVIL WORKS** | | |
| **i)** | Security room | Set | 1 |
| **ii)** | Vehicle parking shed (Four wheeler / two wheeler) | Set | 1 |
| **iii)** | Store Shed with open platform | Set | 1 |
| **iv)** | Any other specified work | LS | Lot |

## SCHEDULE OF QUANTITIES

**400kV GSS Barmer**

**A. EQUIPMENTS**

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| **S-I.** | **Circuit Breaker** | | |
| 1 | **420 kV,** 2000 Amp., 40 kA rupturing capacity circuit Breaker suitable for single and three phase rapid auto reclosing complete with mounting structures, foundation bolts and nuts and first filling of SF6 gas plus 20% spare gas including accessories and auxiliaries. | Nos. | 4 |
| 2 | Terminal Connectors for above item 1 | Nos. | 24 |
| **3** | **Spares for 420 kV circuit breaker** | | |
| | (i) One pole of circuit breaker with grading capacitor complete with pole column and interrupter with M.B. but without support structure and operating mechanism. | Nos. | 1 Pole |
| | (ii) Rubber gaskets, ôOôrings and seals | Set | 1 |
| | (iii) Fixed contacts | Nos. | 12 |
| | (iv) Moving contacts | Nos. | 12 |
| | (v) Terminal pads and connectors | Nos. | 6 |
| | (vi) Molecular filter | Nos. | 6 |
| | (vii) Density / pressure monitoring systems (if applicable) | No. | 2 |
| | (viii) Relays, power contactors, switch fuse units, limit switches, push buttons, timers and MCB etc. | Set | 2 |
| | (ix) Closing assembly valve | Set | 2 |
| | (x) Trip assembly valve | Set | 2 |
| | (xi) Pressure switches | Set | 2 |
| | (xii) Pressure gauge and coupling | Set | 2 |
| | (xiii) Auxiliary switch assembly | Set | 2 |
| | (xiv) Operation counter | No. | 2 |
| | (xv) Closing Coils | Nos. | 4 |
| | (xvi) Tripping coils | Nos. | 8 |
| | (xvii) Support insulator complete for one pole of breaker | Set | 1 |
| **S-II.** | **Current Transformer** | | |
| 1 | 2000-1000-500/1-1-1-1-1 Amp. **420 kV** single phase multi core current transformers | Nos. | 12 |
| 2 | Terminal Connectors for above item 1 | Nos. | 24 |
| **3** | Spare of 420kV Current Transformer | | |
| | (i) Complete CT(**Live Tank Type only)** | Nos. | 3 |
| | (ii) Terminal Connector | Nos. | 6 |
| **S-III.** | **Capacitive Voltage Transformer** | | |
| 1 | **420 kV** single phase 4400 pF CVT suitable for high frequency (HF) coupling required for power line communication with voltage ratio 400/0.11 kV and three secondary windings. | Nos. | 6 |
| 2 | Terminal Connectors for above item 1 | Nos. | 6 |
| **(b)** | Spare of 420kV Capacitive Voltage Transformer | | |
| | (i) Complete CVT | Nos. | 3 |

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| | (ii) Terminal Connector | Nos. | 3 |
| **S-IV.** | **Isolator** | | |
| 1 | **420 kV** 2000 Amp. triple pole, gang operated Horizontal Double break type, motor operated, outdoor, Isolator metallic fitted with **single earth blade** complete with accessories. | Set | 10 |
| 2 | Terminal Connectors for above item 1 | Nos. | 60 |
| 3 | Post insulators for above item 1 | Nos. | 90 |
| 4 | **420 kV** 2000 Amp. triple pole, gang operated horizontal double break type motor operated, outdoor Isolator metallic with **double earth blade** complete with accessories. | Set | 2 |
| 5 | Terminal Connectors for above item 4 | Nos. | 12 |
| 6 | Post insulators for above item 4 | Nos. | 18 |
| **(c)** | **Spares for 420 kV Isolators** | | |
| | i) One complete pole with support insulator and motor operating mechanism excluding structure | Nos. | 2 |
| | ii) Copper contact fingers for male and female contacts. | Set | 1 |
| | iii) Open / close contractor assembly, timers, key interlock push button switch | Set | 1 |
| | iv) Limit switch and auxiliary switch | Set | 1 |
| | v) Motor housing bearing assembly | Set | 1 |
| | vi) Terminal pads and connectors | Nos. | 6 |
| | vii) Motor with gear assembly and bevel gear assembly | Nos. | 1 |
| | viii) Corona shield rings | Nos. | 2 |
| | ix) Hinge pins | Nos. | 2 |
| | x) Bearings | Set | 1 |
| | xi) Current carrying assembly | Nos. | 2 |
| | xii) Interlocking coil | Nos. | 2 |
| **S-V.** | **Surge Arresters** | | |
| 1 | Single pole voltage ï coordinated , outdoor station class heavy duty current limiting type 390 kV lightning arresters suitable for connection between phase and ground on 3 phase 420 kV neutral grounded system complete with insulating base , surge counter and current meter, accessories. | Nos. | 6 |
| 2 | Terminal Connectors for above item 1 | Nos. | 6 |
| **3** | Spare of 390kV Surge Arresters | | |
| | (i) Complete LA with insulating base | Nos. | 3 |
| | (ii) Terminal Connector | Nos. | 3 |
| **S-VI.** | **Wave Trap** | | |
| 1 | 400 kV, 1.0mH / 2000 A. Wave Traps Pedestal mounting type with tuning unit, protection device, terminals clamps, corona rings, bird barriers etc. | Nos. | 4 |
| **S-VII** | **Battery & Battery Charger** | | |

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| | **Battery** | | |
| **1.** | 220 V, 600 AH VRLA (maintenance free) Battery set (108 cells) along with accessories, stand etc. | Set | 2 |
| **1(a).** | Spare for 220 V, 600 AH VRLA (maintenance free) Battery set | | |
| | i) Cells for 220 V bank | Nos. | 2 |
| | ii) Connectors | Nos. | 4 |
| | iii) Terminal lugs | Nos | 5 |
| | iv) Digital Multimeter | Nos. | 2 |
| | v) Spanner Set | No. | 1 |
| **2.** | 220V, 100Amp/70Amp float cum boost Battery Charger (Separate sections for float and boost charging operation). | Set | 2 |
| **2(a).** | Spare for 220 V battery charger | | |
| | i) Set of control cards for charger | Set | 1 |
| | ii) Set of relays | Set | 1 |
| | iii) Rectifier transformer | Nos | 1 |
| | iv) Control transformer | Nos. | 1 |
| | v) Series inductor | Nos. | 1 |
| | vi) Micro-Switches | Set | 1 |
| | vii) Filter Capacitor | Nos. | 1 |
| | viii) Thyristor diode | Nos. | 1 |
| | ix) Set of switches | Set | 1 |
| | x) Set of wound resistors | Nos. | 1 |
| | xi) Potentiometers | Nos. | 1 |
| | xiii) Fuses of thyristor with indicators | Set | 2 |

**S-VIII. PLCC EQIPMENTS**

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Barmer end |
|---|---|---|---|
| | | | 400kV (2Nos.) |
| **1** | **2** | **3** | **4** |
| **1** | SSB single Channel Carrier Set (40 W) suitable for transmitting Data and super imposed channels along with Remote subscriber facility and emergency calling set. | Nos. | 8 |

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Barmer end |
|---|---|---|---|
| | | | 400kV (2Nos.) |
| | | | |
| **2** | A.F. Protection coupler microprocessor based suitable for Four commands. | Nos. | 4 |
| **3** | VFT equipment (Modem) suitable for transmission of Data through PLCC links based on frequency shift keying modulation techniques programmable for both baud rate from 50 Baud to 2400 Baud and center frequency through switches or jumpers (A.F. Shift Channel) | Nos. | 2 |
| **4.** | Coupling Devices for Phase to Phase coupling having Band width programmable at site with protective Device & balancing transformer matching with line impedance of respective voltage level. | Set | 2 |
| **5.** | HF Armoured Coaxial cable having 125 Ohms unbalanced impendance. | Kms. | LOT |
| **6.** | Sleeved copper wire of 8 SWG. | Mts. | LOT |
| **7.** | Any other item bidder may require to complete the PLCC System as per specificationôs requirements. | | LOT |
| **8.** | **Mandatory Spares** | | |
| **(i)** | SSB single Channel Carrier Set (40 W) suitable for transmitting Data and super imposed channels along with Remote subscriber facility and emergency calling set. | Nos. | 1 |
| **(ii)** | A.F. Protection coupler microprocessor based suitable for Four commands. | Nos. | 1 |
| **(iii)** | VFT equipment (Modem) suitable for transmission of Data through PLCC links based on frequency shift keying modulation techniques programmable for both baud rate from 50 Baud to 2400 Baud and center frequency through switches or jumpers (A.F. Shift Channel) | Nos. | 1 |
| **(iv)** | Coupling Devices for Phase to Phase coupling having Band width programmable at site with protective Device & balancing transformer matching with line impedance of respective voltage level. | Sets | 1 |
| **(v)** | Cards for PLCC carrier terminal for each type | Set | 1 |
| **(vi)** | Coaxial cable | Km | 0.2 |
| **(vii)** | Set of electronic cards of each type | Set | 1 |
| **(viii)** | Coaxial connectors | Nos. | 2 |
| **(ix)** | Straight through joint | Nos. | 1 |

## S-IX FOTE TERMINAL EQUIPMENTS

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Barmer end |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1 | Fully wired cabinet with base 19ò equipment rack (incl. front cover, cable tray, common cards) with fan unit and control, synchronization, Alarm, dual Power supply input cables | Set | 1 |
| 2 | Central Processing Card ï CPU | Nos. | 2 |
| 3 | Power supply unit ï 48 VDC 85 W | Nos. | 2 |
| 4. | OLTE ï 4 Port STM-1 (155 Mbps Card) along with SFPs | Set | 1 |
| 5. | Optical Amplifier / Booster equipment (comprising of wave length translator, Wavelength Converter, Booster Amplifier; 21 dBm, Pre Amplifier and Raman Amplifier + Software) for main as well as protected parts | Set | 2 |
| 6. | OFC Patch Cords (Set of 48 nos.) | Set | 1 |
| 7. | 8 Port 2w/4w E&M interface Card | Nos. | 1 |
| 8. | 4 port Data Interface Card (Programmable) | Nos. | 2 |
| 9. | 4 Port Data interface Card (Programmable) for remote end (to be located at nearest SLDC / Sub-LDC) | Nos. | 2 |
| 10. | Ethernet over SDH transport card (with four 10/100 base, one 100Base ï FX and one 1000 Base-LX/SX front interfaces) | Nos. | 1 |
| 11. | 4 command integrated Tele-protection Card | Nos. | 4 |
| 12. | Line Differential Relay Interface Card (4 ports) | Nos. | 1 |
| 13. | Engineering Order Wire Phone | Nos. | 1 |
| 14. | Craft Terminal (LAPTOP PC) with element manager software | Nos. | 1 |
| **15.** | **Mandatory testing and maintenance equipments (for OPGW/ OFAC)** | | |
| i) | Hand-held BER Meter for G.703, V.24, V.11, V.35 and Jitter / Wander Measurements | Nos. | 1 |
| ii) | Optical Time Domain Reflecto-meter | Nos. | 1 |
| iii) | Optical Power Meter | Nos. | 1 |
| iv) | Test Equipment for Tele-protection Module | Nos. | 1 |
| 16. | Interface Cable for Power, Data, Voice, Tele-protection, Time Synchronizing etc. as per respective site requirement | Lot | 1 |
| 17. a. | Spare fully wired cabinet (same as Item No.1) | Set | 1 |

| | | | |
|---|---|---|---|
| 17.b. | Set of Spare Modules | Set | 1 |
| 18. | Approach Cable and necessary joint box for OPAW | Set | 1 |
| 19 | Optical Fibre Distribution Panel (for 72 fibre) with spleing and patch parul | Set | 1 |

**S-X CONTROL, RELAY & PROTECTION PANELS & ASSOCIATED MANDATORY SPARES/EQUIPMENTS (Complete in all respect, refer section I, II, Part-3, Vol. II)**

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| 1. | 400kV Relay Panel for line with auto reclose scheme | Set | 2 |
| 2. | 400kV Relay Panel for Tie Breaker with auto reclose scheme and common relay panel | Set | 2 |
| 3 | Necessary peripherial units, hardware, software wiring for adding new 400 kV bays (as per scope of specification) in the existing 400 kV Bus Bar Protection Scheme (M/s.Areva Make).<br><br>Note:- 2Nos. 400 kV Bus Bar Protection Scheme are provided. | LOT | 1 |
| 4 | Supply. erection, testing & commissioning of Ethernet Switch, OFC, BCU, IEDs etc. to complete the scope specification of integrating of. 400 kV feeder bays with the existing M/s Areva supplied SAS system. | LOT | 1 |
| **5** | Necessary software and hardware along with laptop to up / down load the data / from the relays from / to the laptop. The supply of laptop is covered under this scope. | Set | 1 |
| 6 | Mandatory Spares for C&R panels (similar items as used in the quoted panels) | | |
| (a) | Line relay Panel:<br>• Main-I type relay<br>• Main-II Type Relay<br>• Over voltage Protection relay<br>• Auxiliary relay, Tripping Relay, Supervision relays, timers (one of each type used in the panel)<br>• Under-voltage relay for isolator/earth switch<br>• LBB Relay | <br>No.<br>No.<br>No.<br>Set<br><br>No.<br><br>No. | <br>1<br>1<br>1<br>1<br><br>1<br><br>1 |
| (b) | Tie Breaker / Bus coupler / Sectionlizer / Transfer bus coupler.<br>• Auto Relcose Relay<br>• Non directional over current & earth fault relay.<br>• LBB | <br>No.<br>No.<br>No. | <br>1<br>1<br>1 |

**S-XI LT SWITCHGEAR**

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| **I.** | **AC DISTRIBUTION BOARD** | | |
| 1. | 415 V, 400 A, AC Distribution Board(for Two AC Sources in two parts with bus coupler) | Set | 1 |
| **II.** | **DC DISTRIBUTION BOARD** | | |
| 1. | 220 V, 400 A, DC Distribution Board (for Two DC Sources in two parts with bus coupler) | Set | 1 |

**Note:-** ACDB & DCDB should be designed in such a manner so that each AC and DC feeder have duplicate connectivity i.e. separate connection wiring to source -1 and source-2 (Refer drawings at Volume-II, Part-24 ).

## S-XII HARDWARES AND MECHANICAL/ELECTRICAL AUXILIARIES

### SCOPE OF WORK OF THE CONTRACTOR FOR BUS BAR MATERIALS, INSTALLATION HARDWARE, MECHANICAL AND ELECTRICAL AUXILIARIES, STRUCTURES AND CIVIL WORKS

The items under the Hardwares, Mechanical/Electrical auxiliaries, Structures and civil works have been listed for the purposes of Bid preparation. The Bidder is required to estimate the quantities. The bidder is required to indicate unit rate and total price of the items under respective heads in bid proposal sheets. The bidder may note that the list indicated below is not exhaustive and he may modify the same to meet the complete requirement of specification. The cement and steel shall be supplied by the Contractor.

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| 1 | 400 kV Double Tension String assembly with double anchoring points with 25 Nos. antifog type disc insulator per string with all hardware accessories including corona ring, turn buckle, arcing horn and tension clamp set suitable for Twin / quadruple Moose ACSR bundle with 450 mm sub-conductor spacing. | | |
| | i) With Turn Buckle | Lot | 1 |
| | ii) Without Turn Buckle | Lot | 1 |
| 2 | 400 kV Single Suspension string insulator assembly with 25 Nos. antifog type disc insulators with all hardware accessories including corona ring with dropper / through type clamp set for Twin / quadruple Moose ACSR with 450 mm sub-conductor spacing. | | |
| | i) Quad /Twin Moose through type | Lot | 1 |
| | ii) Quad /Twin Moose Dropper type | Lot | 1 |
| 3. | 400 kV Bus Post Insulator stacks with corona ring other than those not included with individual equipment. | Lot | 1 |
| 4. | 400 kV Corona bellow / sphere for 4òIPS Al. tube | Lot | 1 |
| 5. | a) 400 kV clamps and connectors other than those not included with individual equipment (All Type). | Lot | 1 |
| | b) All type clamp and connectors for **earth wire and GS flat** | Lot | 1 |
| 6. | 400 kV Spacers | | |
| | i) Rigid type | Lot | 1 |
| | ii) Flexible type | Lot | 1 |
| 7. | Grounding Conductor (GS & MS flats of all sizes and Cu/Al Flexible braids) | Lot | 1 |
| 8. | (a) 40 mm dia. MS Rod<br><br>(b) 40 mm dia. 3000 mm long MS rod (earth electrodes) with/without test links, RCC pits, C.I .cover hinged at C.I. frame along with all associated civil works | Lot<br><br>Lot | 1<br><br>1 |

**Note:- (i) The GS/MS flats to be used for earthing of the equipment shall be required to be drilled/welded at site as per the needs and M.S. Flats shall be properly painted as per**

**the stipulations. Supply of necessary bolts, nuts & washers shall also be in the scope of the contractor.**

**(ii) All the dropped jumpers shall be of Y-type.**

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| 9. | **4" IPS** (EH) Al. Tube (OD. 114.2 mm, Thickness-8.51 mm) | Lot | 1 |
| 10. | Welding sleeves for 4òIPS Al. tube | Lot | 1 |
| 11. | Bay Marshalling kiosks | | |
| | For 400 kV | Nos. | 4 |
| 12. | Earth wire tension clamps with D. Shackle assembly and earth bond | Lot | 1 |
| 13. | Lugs to suit 10.98 mm GS Earth wire | Lot | 1 |
| 14. | Junction boxes | Lot | 1 |
| 15. | **Cables (FRLS)** | | |
| | (a)1.1 KV grade PVC insulated armoured control cables ï Cu | Lot | 1 |
| | (b) 1.1 kV grade XLPE / PVC insulated armoured Al. conductor power cable | Lot | 1 |
| 16. | Straight through joints for 1.1 kV XLPE / PVC power cables as required | Lot | 1 |
| 17. | Double compression type cable gland for 1.1 kV grade insulated cables & its termination as per cable sizes. | Lot | 1 |
| 18. | Crimping type cable lugs (Tinned copper) of size of cable as required. | Lot | 1 |
| 19. | PVC Pipes for Laying cables as per IS 4985 (the sizes shall be recommended by the bidder) | Lot | 1 |
| 20. | Hume pipes for road crossing (NP-4 class). (Sizes shall be recommended by the bidder) | Lot | 1 |
| 21. | Pressure die cast AL (LM6) Nylon 6 made trefoil clamp for recommended cables | Lot | 1 |
| 22. | MS Angle ,Flat and ISMC channel (All size) | Lot | 1 |
| 23. | ACSR Moose conductor | Lot | 1 |
| 24. | 10.98mm dia. GS earth wire | Lot | 1 |
| 25. | **Any Other Item** | | |

**Note:- Bidder shall supply 5% of the erected quantities of above Bus Bar Material, clamp connector, spacers and accessories as spare except for item no. 7, 8, 9, 11, 14 to 17, 19 to 24. Any fractions will mean the next higher integer number.**

**S-XIII. ILLUMINATION SYSTEM**:-

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| 1. | **Switchyard Flood Lighting** | | |
| i. | Flood Light Luminaries | Lot | 1 |
| | For one lamp | | |
| | For two lamps | | |
| ii. | High Pressure sodium vapor lamps | Lot | 1 |
| iii. | Distribution pillars | Lot | 1 |
| iv. | Cable Trays | Lot | 1 |
| v. | Cable | Lot | 1 |
| vi. | MCBs | Lot | 1 |
| vii. | Control Gears | Lot | 1 |
| 2. | Add: Any other item bidder may require to complete the Illumination System as per specification requirements | Lot | 1 |

## S-XIV. FIRE FIGHTING SYSTEM FOR PROPOSED LINE BAYS (AS PER TECHNICAL SPECIFICATION)

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| 1 | **FIRE DETECTION AND ALARM SYSTEM FOR AC KIOSK**<br>By providing addressable Photo Electronic light scattered smoke detectors with / without duct caging, addressable ionization chamber smoke detectors, FRLS control cables etc. | Lot | 1 |
| 2 | **HAND APPLIANCES**<br>Carbon di-oxide type portable fire extinguisher of 4.5Kg capacity complete with fill. | Lot | 1 |
| 3 | Extension of existing hydrant system upto 400 kV Kiosk including Hose pipe of suitable length and fitted with accessories like branch pipes, Nozzles etc. kept in Hose boxes. | Lot | 1 |

**S-XV STRUCTURES:**

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| | **STRUCTURES :**<br>Design, engineering, procurement of materials, fabrication galvaising, proto-assembly, FOR destination delivery & erection including nuts, bolts, gusset plates, base plates, foundation bolts, fixing arrangement for control cabinets/MB of equipments and other accessories for lattice steel structure. Conforming to IS:2062 and GI pipe conforming to grade YST 22 or higher grade as per IS:806. | | |
| **(A)** | **LATTICE STRUCTURE** | | |
| **(a)** | Tower (400 kV) MKD TC | Nos. | 4 |
| **(b)** | Tower (400 kV) MKD TH | Nos. | 4 |
| **(c)** | Tower (400 kV) MKD TJ | Nos. | 7 |
| **(d)** | Tower (400 kV) MKD TK | Nos. | 2 |
| **(e)** | Tower (400 kV) MKD TL | Nos. | 2 |
| **(f)** | Girder (400 kV) MKD G1 | Nos. | 2 |
| **(g)** | Girder (400 kV) MKD G2 | Nos. | 12 |
| **(h)** | Lightning Mast 24 Mtr. Height | Nos. | 7 |
| **(i)** | 400 kV C.T. Support structure | Nos. | 12+6 |
| **(B)** | **PIPE STRUCTURES** | | |
| **(a)** | 400 kV CVT | Nos. | 6 |
| **(b)** | 400 kV Surge Arrestor | Nos. | 6 |
| **(c)** | 400 kV Isolator | Set | 12 |
| **(i)** | 400 kV Wave Trap | Nos. | 4 |
| **(k)** | 400 kV BPI | Lot | Lot |

**Note:- (1)The above estimated quantities of structures are only for tender purpose. The contractor shall supply, erect & commission the structures to meet out complete requirement for successful commissioning , maintenance & operation of the substation in accordance with the specification.**
**(2) Details of Tower structures & girders / beams available in Vol.II, Part-24 of specification are tentative and for tender purpose only. The bidder shall have to design the structures & girders / beams based on actual loadings on the basis of short circuit force calculations, if required.**

**S-XVI AIR CONDITIONING SYSTEM**

| S. No. | Item Description | Unit | Qty. |
|---|---|---|---|
| 1 | Design, supply, installation, testing and commissioning of Air conditioning & ventilation system for kiosk of bay level units in switchyard as per specification alongwith the necessary spares for satisfactory operation for 5 (five) years. . | LOT | 1 |

**CIVIL WORKS AT 400 KV GSS BARMER**

| S. No. | Item Description | Unit | Qty. |
|---|---|---|---|
| 1 | **GEO TECHNICAL INVESTIGATION** | Lot | 1 |
| | Soil Investigation of substation / switchyard area as per technical specification. | | |
| 2 | **FOUNDATIONS :** | | |
| | Design, Engineering, supply of all labour, material and construction of RCC footings and pedestals of any section/size including the cost of excavation in all types of soil/rock, back filling with available approved earth or borrowed/new earth, disposal of surplus earth/rock to the places directed, concrete (RCC M20 Grade and Lean concrete 1:4:8), reinforcement steel,form work ,grouting , underpinning, foundation strengthening in expansive / B.C soil , curing, sundries and other items not mentioned herein but required for the completion of the work for the following station towers and equipments support structures as per technical specification, approved drawings and directions of the Engineer- in-charge of work | | |
| **(A)** | **LATTICE STRUCTURE** | | |
| **(a)** | Tower (400 kV) MKD TC | Nos. | 4 |
| **(b)** | Tower (400 kV) MKD TH | Nos. | 4 |
| **(c)** | Tower (400 kV) MKD TJ | Nos. | 7 |
| **(d)** | Tower (400 kV) MKD TK | Nos. | 2 |
| **(e)** | Tower (400 kV) MKD TL | Nos. | 2 |
| **(f)** | Lightning Mast 24 Mtr. Height | Nos. | 7 |
| **(g)** | 400 kV C.T. Support structure | Nos. | 12+6 |
| **(h)** | 400kV Circuit Breaker | Nos. | 4 |
| **(B)** | **PIPE STRUCTURES** | | |
| **(a)** | 400 kV CVT | Nos. | 6 |
| **(b)** | 400 kV Surge Arrestor | Nos. | 6 |
| **(c)** | 400 kV Isolator | Set | 12 |
| **(d)** | 400 kV Wave Trap | Nos. | 4+2 |
| **(e)** | 400 kV BPI | Lot | Lot |
| **3** | **CABLE TRENCH** | | |
| | Design, engineering and construction of R.C.C. cable trenches for required depths precast R.C.C. covers, water stops, brick works wherever required including the supply of labour, material, cement, reinforcement steel, steel angles, flats and providing P.C.C.(1:4:8) below cable trenches as per technical specification and approved drawings | | |
| (a) | Section C | Lot | 1 |
| (b) | Section D | Lot | 1 |
| (c) | Sump pits with a provision of automatic de-watering pumps | Lot | 1 |
| **4** | **CABLE TRENCH CROSSING** | | |

| S. No. | Item Description | Unit | Qty. |
|---|---|---|---|
| | Design, engineering, construction including supply of labour, material, cement, reinforcement steel, form work etc. and all associated works for construction of cable trench crossings as per technical specification and approved drawings | Lot (as per Layout drawing) | |
| (a) | Section C crossing road | Lot | 1 |
| (b) | Section D crossing road | Lot | 1 |
| (c) | Sump pits with a provision of pumps | LOT | 1 |
| **5** | **ANTIWEED TREATMENT** | | |
| | Providing and supplying all labour material including borrowed / removal of earth for maintaining the FGL, equipments etc., soil sterilization / antiweed treatment including excavation, mixing / injecting chemicals to achieve the guaranteed effectiveness of treatment at least up to one years, rolling dressing, compacting the excavated earth within substation areas as per technical specification | Lot | 1 |
| **6** | **JELLY SPREADING** | Lot | 1 |
| | **a)** 100mm thick layer of granite/basalt/trap jelly of 20mm size shall be spread over the entire switchyard area as per drawing and directions of engineer in-charge of the work.<br>The 20mm nominal size shall pass 100% through IS. Sieve designation 40mm and nothing through 16.00mm IS Sieve. The whole switchyard area (excluding buildings pathway road, drainages, cable trenches, equipments/ structures plinths etc) shall be covered with jelly spreading. The jelly used shall be free from dirt, organic materials and flakes<br>**b)** Barricades shall be provided to confine Jelly Spreading which include construction of solid concrete block masonry in CM (1:6) with cement concrete solid blocks of proportion (1:5:3) crushing strength not less than 50 Kg. per Sq.cm / 40x40x20 cms. Size (l, b, h) conforming to IS 32185-196) including necessary curing etc. complete. The concrete block shall be 100 mm above gravel top. The exposed surface of barricades shall be plastered with 12 mm thick in cm (1:6) & two coat of water proof cement paint. | | |
| **7** | **ROAD WORK** | | |
| | Design and construction of roads and walkways/shoulders within sub-station or outside the station as per specification, layout, sectional detail drawing and directions of Engineer-in-charge of work etc. complete in all respect. | | |
| | a) 3.75 Mtr. Wide Road. | Lot | 1 |
| **8** | **CIVIL WORKS:- BAY LEVEL KIOSK BUILDING (S) :** Design & construction as per drawing and specification | | |
| | **400 kV level** | Set | 2 |
| **9** | Add: Any other/ optional item bidder may require to complete the Civil Works as per specification requirements | Lot | 1 |

## SCHEDULE OF QUANTITIES

**400kV GSS Akal-1**

### A. EQUIPMENTS

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| **S-I.** | **Capacitive Voltage Transformer** | | |
| 1 | **420 kV** single phase 4400 pF CVT suitable for high frequency (HF) coupling required for power line communication with voltage ratio 400/0.11 kV and three secondary windings. | Nos. | 3 |
| 2 | Terminal Connectors for above item 1 | Nos. | 3 |
| **S-II.** | **Isolator** | | |
| 1 | **420 kV** 2000 Amp. triple pole, gang operated horizontal double break type motor operated, outdoor Isolator metallic with **double earth blade** complete with accessories. | Set | 1 |
| 2 | Terminal Connectors for above item 1 | Nos. | 6 |
| 3 | Post insulators for above item 1 | Nos. | 9 |
| **S-III.** | **Surge Arresters** | | |
| 1 | Single pole voltage ï coordinated , outdoor station class heavy duty current limiting type 390 kV lightning arresters suitable for connection between phase and ground on 3 phase 420 kV neutral grounded system complete with insulating base , surge counter and current meter, accessories. | Nos. | 3 |
| 2 | Terminal Connectors for above item 1 | Nos. | 3 |
| **S-IV.** | **Wave Trap** | | |
| 1 | 400 kV, 1.0mH / 2000 A. Wave Traps Pedestal mounting type with tuning unit, protection device, terminals clamps, corona rings, bird barriers etc. | Nos. | 2 |

### S-V. PLCC EQIPMENTS

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Akal-1 end |
|---|---|---|---|
| | | | 400kV (1No.) |
| **1** | **2** | **3** | **4** |
| **1** | SSB single Channel Carrier Set (40 W) suitable for transmitting Data and super imposed channels along with Remote subscriber facility and emergency calling set. | Nos. | 4 |
| **2** | A.F. Protection coupler microprocessor based suitable for Four commands. | Nos. | 2 |
| **3** | VFT equipment (Modem) suitable for transmission of Data through PLCC links based on frequency shift keying modulation techniques programmable for both baud rate from 50 Baud to 2400 Baud and center frequency through | Nos. | 1 |

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Akal-1 end |
|---|---|---|---|
| | | | 400kV (1No.) |
| | switches or jumpers (A.F. Shift Channel) | | |
| **4.** | Coupling Devices for Phase to Phase coupling having Band width programmable at site with protective Device & balancing transformer matching with line impedance of respective voltage level. | Set | 1 |
| **5.** | HF Armoured Coaxial cable having 125 Ohms unbalanced impendance. | Kms. | LOT |
| **6.** | Sleeved copper wire of 8 SWG. | Mts. | LOT |
| **7.** | Any other item bidder may require to complete the PLCC System as per specifications requirements. | | LOT |

**S-VI FOTE TERMINAL EQUIPMENTS**

| S.No. | Name of Equipment | Unit | Quantity for 400 / 220 kV GSS Akal-1 end |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1. | OLTE ï 4 Port STM-1 (155 Mbps Card) along with SFPs | Set | 1 |
| 2. | 4 command integrated Tele-protection Card | Nos. | 1 |
| 3. | Line Differential Relay Interface Card (4 ports) | Nos. | 1 |
| 4 | Any other item require to complete the System as per specification requirements | LOT | 1 |

**S-VII CONTROL, RELAY & PROTECTION PANELS & ASSOCIATED MANDATORY SPARES/EQUIPMENTS (Complete in all respect, refer section I, II, Part-3, Vol. II)**

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| **1.** | 400kV Relay Panel for line with auto reclose scheme | Set | 1 |
| 2 | Necessary peripherial units, hardware, software wiring for adding new 400 kV bays (as per scope of specification) in the existing 400 kV Bus Bar Protection Scheme (M/s.Areva Make).<br><br>Note:- 2Nos. 400 kV Bus Bar Protection Scheme are provided. | LOT | 1 |
| 3 | Supply. erection, testing & commissioning of Ethernet Switch, OFC, BCU, IEDs etc. to complete the scope specification of integrating of. 400 kV feeder bays with the existing M/s Areva supplied SAS system. | LOT | 1 |
| **4** | Necessary software and hardware along with laptop to up / down load the data / from the relays from / to the laptop. The supply of laptop is covered under this scope. | Set | 1 |
| 5 | Mandatory Spares for C&R panels (similar items as used in the quoted panels) | | |
| (a) | Line relay Panel:<br>• Main-I type relay<br>• Main-II Type Relay<br>• Over voltage Protection relay<br>• Auxiliary relay, Tripping Relay, Supervision relays, timers (one of each type used in the panel)<br>• Under-voltage relay for isolator/earth switch<br>• LBB Relay | <br>No.<br>No.<br>No.<br>Set<br><br>No.<br><br>No. | <br>1<br>1<br>1<br>1<br><br>1<br><br>1 |

**SCOPE OF WORK OF THE CONTRACTOR FOR BUS BAR MATERIALS, INSTALLATION HARDWARE, MECHANICAL AND ELECTRICAL AUXILIARIES, STRUCTURES AND CIVIL WORKS**

The items under the Hardwares, Mechanical/Electrical auxiliaries, Structures and civil works have been listed for the purposes of Bid preparation. The Bidder is required to estimate the quantities. The bidder is required to indicate unit rate and total price of the items under respective heads in bid proposal sheets. The bidder may note that the list indicated below is not exhaustive and he may modify the same to meet the complete requirement of specification. The cement and steel shall be supplied by the Contractor.

**S-XII HARDWARES AND MECHANICAL/ELECTRICAL AUXILIARIES**

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| 1 | 400 kV Double Tension String assembly with double anchoring points with 25 Nos. antifog type disc insulator per string with all hardware accessories including corona ring, turn buckle, arcing horn and tension clamp set suitable for Twin Moose ACSR bundle with 450 mm sub-conductor spacing. | | |
| | i) With Turn Buckle | Lot | 1 |
| | ii) Without Turn Buckle | Lot | 1 |
| 2 | 400 kV Single Suspension string insulator assembly with 25 Nos. antifog type disc insulators with all hardware accessories including corona ring with dropper / through type clamp set for Twin Moose ACSR with 450 mm sub-conductor spacing. | | |
| | i) Twin Moose through type | Lot | 1 |
| | ii) Twin Moose Dropper type | Lot | 1 |
| 3. | 400 kV Bus Post Insulator stacks with corona ring other than those not included with individual equipment. | Lot | 1 |
| 4. | a) 400 kV clamps and connectors other than those not included with individual equipment (All Type). | Lot | 1 |
| | b) All type clamp and connectors for **earth wire and GS flat** | Lot | 1 |
| 5. | 400 kV Spacers | | |
| | i) Rigid type | Lot | 1 |
| | ii) Flexible type | Lot | 1 |
| 6. | Grounding Conductor (GS & MS flats of all sizes and Cu/Al Flexible braids) | Lot | 1 |
| 7. | (a) 40 mm dia. MS Rod<br><br>(b) 40 mm dia. 3000 mm long MS rod (earth electrodes) with/without test links, RCC pits, C.I .cover hinged at C.I. frame along with all associated civil works | Lot<br><br>Lot | 1<br><br>1 |

**Note:- (i) The GS/MS flats to be used for earthing of the equipment shall be required to be drilled/welded at site as per the needs and M.S. Flats shall be properly painted as per the stipulations. Supply of necessary bolts, nuts & washers shall also be in the scope of the contractor.**

**(ii) All the dropped jumpers shall be of Y-type.**

| S. No. | Item Description | Unit | Quantity |
|---|---|---|---|
| 8. | Earth wire tension clamps with D. Shackle assembly and earth bond | Lot | 1 |
| 9. | Lugs to suit 10.98 mm GS Earth wire | Lot | 1 |
| 10. | Junction boxes | Lot | 1 |
| 11. | **Cables (FRLS)** | | |
| | (a)1.1 KV grade PVC insulated armoured control cables ï Cu | Lot | 1 |
| 12. | Double compression type cable gland for 1.1 kV grade insulated cables & its termination as per cable sizes. | Lot | 1 |
| 13. | Crimping type cable lugs (Tinned copper) of size of cable as required. | Lot | 1 |
| 14. | PVC Pipes for Laying cables as per IS 4985 (the sizes shall be recommended by the bidder) | Lot | 1 |
| 15. | Pressure die cast AL (LM6) Nylon 6 made trefoil clamp for recommended cables | Lot | 1 |
| 16. | MS Angle ,Flat and ISMC channel (All size) | Lot | 1 |
| 17. | ACSR Moose conductor | Lot | 1 |
| 18. | 10.98mm dia. GS earth wire | Lot | 1 |
| 19. | **Any Other Item** | Lot | 1 |

**Note:- Bidder shall supply 5% of the erected quantities of above Bus Bar Material, clamp connector, spacers and accessories as spare except for item no. 6, 7, 10 to 12, 14 to 18. Any fractions will mean the next higher integer number.**

**S-XIII STRUCTURES:**

| S.No. | Item Description | Unit | Qty. |
|---|---|---|---|
| | **STRUCTURES :**<br>Design, engineering, procurement of materials, fabrication galvaising, proto-assembly, FOR destination delivery & erection including nuts, bolts, gusset plates, base plates, foundation bolts, fixing arrangement for control cabinets/MB of equipments and other accessories for lattice steel structure. Conforming to IS:2062 and GI pipe conforming to grade YST 22 or higher grade as per IS:806. | | |
| **(A)** | **LATTICE STRUCTURE** | | |
| **(a)** | Tower (400 kV) MKD TG | Nos. | 2 |
| **(b)** | Girder (400 kV) MKD G1 | Nos. | 1 |
| **(B)** | **PIPE STRUCTURES** | | |
| **(a)** | 400 kV CVT | Nos. | 3 |
| **(b)** | 400 kV Surge Arrestor | Nos. | 3 |
| **(c)** | 400 kV Isolator | Set | 1 |
| **(i)** | 400 kV Wave Trap | Nos. | 2 |
| **(k)** | 400 kV BPI | Lot | 1 |

**Note:- (1)The above estimated quantities of structures are only for tender purpose. The contractor shall supply, erect & commission the structures to meet out complete requirement for successful commissioning , maintenance & operation of the substation in accordance with the specification.**
**(2) Details of Tower structures & girders / beams available in Vol.II, Part-24 of specification are tentative and for tender purpose only. The bidder shall have to design the structures & girders / beams based on actual loadings on the basis of short circuit force calculations, if required.**

**CIVIL WORKS AT 400kV GSS Akal-1**

| S. No. | Item Description | Unit | Qty. |
|---|---|---|---|
| 1 | **FOUNDATIONS :** | | |
| | Design, Engineering, supply of all labour, material and construction of RCC footings and pedestals of any section/size including the cost of excavation in all types of soil/rock, back filling with available approved earth or borrowed/new earth, disposal of surplus earth/rock to the places directed, concrete (RCC M20 Grade and Lean concrete 1:4:8), reinforcement steel,form work ,grouting , underpinning, foundation strengthening in expansive / B.C soil , curing, sundries and other items not mentioned herein but required for the completion of the work for the following station towers and equipments support structures as per technical specification, approved drawings and directions of the Engineer- in-charge of work | | |
| **(A)** | **LATTICE STRUCTURE** | | |
| **(a)** | Tower (400 kV) MKD TG | Nos. | 2 |
| **(B)** | **PIPE STRUCTURES** | | |
| **(a)** | 400 kV CVT | Nos. | 3 |
| **(b)** | 400 kV Surge Arrestor | Nos. | 3 |
| **(c)** | 400 kV Isolator | Set | 1 |
| **(d)** | 400 kV Wave Trap | Nos. | 2+1 |
| **(e)** | 400 kV BPI | Lot | 1 |
| **3** | **CABLE TRENCH** | | |
| | Design, engineering and construction of R.C.C. cable trenches for required depths precast R.C.C. covers, water stops, brick works wherever required including the supply of labour, material, cement, reinforcement steel, steel angles, flats and providing P.C.C.(1:4:8) below cable trenches as per technical specification and approved drawings | | |
| (a) | Section D | Lot | 1 |
| **6** | **SITE SURFACING & JELLY SPREADING** | | |
| **(a)** | Providing and supplying all labour, material including disposal of excess earth from the Switchyard for maintaining FGL etc. , removal of weeds, soil sterilization / antiweed treatment including excavation, mixing / injecting chemicals to achieve the guaranteed effectiveness of treatment at least up to one year etc., rolling, dressing, compacting the earth in Extended Switchyard area including providing and laying base layer of 150 mm thick crusher dust/ morrum/ quarry rubbish or any other locally available CNS having infertile behavior shall be laid to prepare base for jelly spreading as per specification. | Lot | 1 |

| S. No. | Item Description | Unit | Qty. |
|---|---|---|---|
| **(b)** | After compacting earth in required slope / grade 100mm thick layer of granite / basalt / trap jelly of 20mm size shall be spread over the extended switchyard area as per drawing and directions of engineer in charge of the work. | Lot | 1 |
| **7** | Add: Any other/ optional item bidder may require to complete the Civil Works as per specification requirements | Lot | 1 |

Note :-

1. In areas where gravels are already laid, the removal & re-spreading of gravel after cleaning / washing, spreading extra gravels (if required) shall be in the bidders scope.
2. Any repair / remodeling required to execute above civil works shall also be in the scope of successful bidder without any additional cost.

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**GENERAL TECHNICAL REQUIREMENTS**
**VOLUME-II (Part-2)**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-2 (Vol-II)**

**GENERAL TECHNICAL REQUIREMENTS**

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## PART-2 (Vol-II)

## GENERAL TECHNICAL REQUIREMENTS

### 1.0 GENERAL

1.1 This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical specification.

1.2 The provisions under this section are intended to supplement general requirements for the materials, equipments and services covered under other sections and is not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirement specified under respective sections shall hold good.

### 2.0 INSTRUCTION TO BIDDERS

2.1 The bidders shall submit the technical requirements, data and information as per the technical data sheets provided in the Volume III of bid documents.

2.2 The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc. fully in conformity with the technical specification.

2.3 It is recognised that the Contractor may have standardized on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturerôs standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser. Unless brought out clearly, the Bidder shall be deemed to confirm to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the schedule, will not be considered as valid deviation.

2.4 Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting completion.

2.5 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 but which are necessary for commissioning and satisfactory operation of the switchyard 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.

2.6 The contractor shall supply type tested ( including special tests as per technical specification) equipments and materials. The test reports shall be furnished by the Contractor along with equipment/material drawings. In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification and/or IEC/IS, same shall be carried out without any additional cost implication to the Purchaser. The Purchaser reserves the right to get any or all type/tests conducted/repeated. In case of repetition of the type and special test, if required by the purchaser, their tests charges shall be payable.

2.7 Unless brought out clearly in the respective Schedule of Deviations, it will be considered that, the bid proposals scrupulously conforms compliance to the Specification. The bidders must bring out all the devotions in the bid proposals.

2.8 In case there is a discrepancy between the data of offered equipment and catalogue furnished, and unless the deviations are brought out clearly in the Technical Deviation Schedule, the equipment will be deemed to conform compliance to the Specification scrupulously.

## 3.0 STANDARDS

3.1 The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

3.2 The equipment to be furnished under this specification shall confirm to latest issue with all amendments of standard specified under Annexure-C of this section as well as under respective Sections of the specification.

3.3 In addition to meeting the specific requirement called for in the respective sections of the Technical Specification, the equipment shall also conform to the general requirement of the relevant standards which shall form an integral part of the specification.

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

3.5 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 IS/IEC.

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

3.7 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards referred shall also be accepted. Copies of such standards shall be submitted by the bidder.

3.8. In case governing standards for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in additional information schedule of Vol. III along with English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to Purchaserôs approval.

3.9 The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

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

4.1 The 420 kV system is being designed to limit the switching surge over voltage to 2.5 pu and the Power frequency over voltage to 1.5 pu In case of the 420 kV system, the initial value of the temporary over voltages could be 2.0 pu for 1-2 cycles. 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 and in system where line lengths would extend up to 500 KMs.

4.2 All equipments shall also perform satisfactorily under various other electrical, electro mechanical and meteorological conditions of the site of installation.

4.3 All equipment shall be able to withstand all external and internal mechanical, thermal and electro mechanical 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 the various forces for which the terminal connectors of the equipment are required to withstand.

4.5 The equipment shall also comply to the following:

a) All outdoor EHV equipments except marshalling kiosks shall be suitable for hot line washing.

b) To facilitate erection of equipment, all items to be assembled at site shall be ñmatch markedò.

c) 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 Operating times of circuit breakers, proto type relays and PLCC equipment have been specified in respective sections. However bidders is allowed to have minor variations in the individual equipment timing subject in the conditions that overall fault clearing time remains within 100 ms at 400 kV level under comparable conditions.

## 5. ENGINEERING DATA

5.1 The furnishing of engineering data by the Contractor shall be in accordance with the Schedule for each set of equipment as specified in the Technical Specifications.

5.2 The review of these data by the 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.

5.3 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.

## 6. DOCUMENTS

6.1 List of Documents

6.1.1 The bidder must furnish a detailed list of drawings/documents alongwith the bid proposal which he intends to submit to the owner after award of the contract.

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

6.1.3 The Contractor shall submit 6 (Six) sets of drawings/design documents/test reports as may be required for the approval of the Purchaser.

6.2 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.

6.3 Drawings

6.3.1 All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearances and spaces required for installation and interconnections between various portions of equipments and any other information specifically requested in the specifications.

6.3.2 Each drawing 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. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

6.3.3 Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

6.4 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 only of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

6.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractorôs 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 Contractorôs drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the contract.

6.6 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.

6.7 Approval Procedure

The scheduled dates for the submission of these as well as for, any data/information to be furnished by the Purchaser would be discussed and finalized at the time of award. The Contractor shall also submit six (6) copies of all drawings/design documents/test reports for approval of the Purchaser. The following schedule shall be followed generally for approval.

| | | |
|---|---|---|
| i) | Approval/comments/ by Purchaser on initial submission | As per agreed schedule |
| ii) | Resubmission (whenever required) | Within 3(three) weeks from date of comments including both ways postal time). |
| iii) | Approval of Comments | Within 3 weeks of receipt of resubmission. |
| iv) | Furnishing of distribution copies in bound volume (5 copies per substation and one copy for Purchase Office). | 2 weeks from the date of final approval. |
| v) | Furnishing of distribution copies of test reports | |
| | (a) Type test reports (one copy per sub-station plus one | 2 weeks from the date of final approval |

| | | |
|---|---|---|
| | copy for Purchase Office) | |
| | (b) Routine Test Reports (one copy for each Substation plus one copy for Purchase office) | -do- |
| vi) | Furnishing of instruction/ operation manuals (4 copies per substation and two copies for Purchase Office) | As per agreed schedule |
| vii) | VCD highlighting installation and maintenance techniques/ requirement of circuit breaker & isolators (one per substation plus one for Purchase Office) | -do- |
| viii) | As built drawings & CDs /Optical Disc (Two sets per substation plus one set for Purchase Office) | On completion of entire works |

**NOTE:**

(1) The contractor may please note that all resubmissions must incorporate all comments given in the prior 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) The drawings which are required to be referred frequently during execution should be submitted on cloth lined paper. The list of such drawings shall be finalised with the Contractor at the time of Award.

(3) All major drawings should be submitted in Auto Card Version 2000 or better.

(4) 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.

(5) 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.

(6) The Contractor shall furnish to the Purchaser, spare parts catalogues also.

6.8 **The list of major drawings and General Technical Parameters to qualify for interim advance as per section SCC shall be as per Annexure –V2-P2-4.**

## 7. COLOUR SCHEME AND CODES FOR PIPE SERVICE

7.1 The contractor shall propose a color scheme for the those equipments/items for which the colour scheme has not been specified in the specification, for the approval of Purchaser. The decision of Purchaser shall be final. The scheme shall include:

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

7.2 All steel structures, plates etc. shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all Purchaserôs electrical equipment in Purchaserôs switchyard are painted with shade 631 of IS-5. All the indoor cubicles shall be of same colour scheme and for other miscellaneous items colour scheme will be approved by the Purchaser.

## 8. MATERIAL/WORKMANSHIP

8.1 General Requirement

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

8.1.2 In case where the equipment, materials or components are indicated in the specification as ñsimilarò 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 supplied installed or used with out 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.

8.1.3 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 and shall be used through out the design. 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 form the Purchaser.

8.1.4 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 be interchangeable with, 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.

8.1.5 All materials and equipment shall be installed in strict accordance with the manufacturerôs recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be constructed as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, leveling, 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 manufacturerôs tolerances and instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustment made as necessary to re-establish the manufacturerôs 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.

8.1.6 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.

8.1.7 All oil, grease and other consumables used in the Works/equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help Purchaser in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

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

8.2 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 favorable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

8.2.1 Space Heaters

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

8.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heaters to minimize

deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

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

8.2.2 Fungistatic 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.

8.2.3 Ventilation Opening

In order to ensure adequate ventilation, compartments shall have ventilation openings provided with the 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.

8.2.4 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 IS:13947 (Part-I)/ IEC-947(Part-I). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

## 9. RATING PLATES, NAME PLATES AND LABELS

9.1 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 manufacturerôs name, year of manufacture, equipment name, type of 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.

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

## 10. 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, in to successful Operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

## 11. DESIGN IMPROVEMENTS

11.1 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.

11.2 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 extend 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.

11.3 Any change in design or manufacturing process which the contractor incorporates in the equipment as a measure of improvement on his own shall not entitlement him for any extra payment.

## 12. QUALITY ASSURANCE PROGRAMME

12.1 To ensure that the equipment and services under the scope of this contract whether manufactured or performed within the Contractorôs Works or at his Sub-Contractorôs premises or at the Purchaserôs 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 outlined by the Contractor and shall be finally accepted by the Purchaser after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

(a) His organization structure for the management and implementation of the proposed quality assurance programme;

(b) Documentation control system;

(c) Qualification data for bidderôs key personnel;

(d) the procedure for purchases of materials, parts components and selection of sub-Contractorôs 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 authorizing 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 authorized representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendorôs quality management and control activities.

12.2 Quality Assurance Documents

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after Despatch of the equipment.

(a) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication and reports including radiography interpretation reports.

(b) Welder and welding operator qualification certificates.

(c) Welderôs identification list, listing welderôs and welding operatorôs qualification procedure and welding identification symbols.

(d) Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.

(e) Stress relief time temperature charts/oil impregnation time temperature charts;

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

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

## 13.0 INSPECTION, TESTING & INSPECTION CERTIFICATE

13.1 The NIGAM, his duly authorized representative and/or out side inspection agency acting on behalf of the NIGAM/ Owner shall have at all reasonable times access to the Contractor's 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 and if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain from the manufacturer / his duly authorized representative permission for inspection by NIGAM as if the works were manufactured or assembled on the Contractor's own premises or works with the concurrence of NIGAM.

The NIGAM reserves the right to witness any or all type, acceptance and routine tests specified, for which at least 15 (Fifteen) days notice in advance shall be given by the Contractor. Contractor shall ensure before giving notices for type test that all drawings and quality plans have been got approved. The equipment shall be despatched to site only after approval of test certificates by the NIGAM.

13.2 The Contractor shall give the NIGAM/Inspector Fifteen (15) days written notice of any material being ready for testing, for each stage of testing as identified in the approved quality plan and CIP. Such tests shall be to the Contractorôs account. The NIGAM/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 with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the NIGAM six copies of duly certified test reports.

13.3 The NIGAM 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/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 NIGAM/Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

13.4 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the NIGAM/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 NIGAM/Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the NIGAM/Inspector. Failure of the NIGAM / 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 NIGAM / Owner to accept the equipment, should it on further tests after erection, be found not to comply with the Contract.

13.5 In all cases where the contract provides for tests whether at the premises or 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 NIGAM/Inspector or his authorized representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the NIGAM/Inspector or to his authorized representative to accomplish testing.

13.6 The inspection by NIGAM 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.

13.7 Material Inspection Clearance Certificate (MICC) shall be issued by the NIGAM after inspection of the equipment. NIGAM may waive off the presence of NIGAM's inspecting engineer. In that case test will be carried out as per approved QP & test certificate will be furnished by the Contractor for approval. MICC will be issued only after review & approval of the test reports.

13.8 The NIGAM /Owner 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 to aforesaid type and routine tests, to satisfy that the material comply with the specification.

13.9 The NIGAM /Owner reserves the right for getting any field tests conducted on the completely assembled equipment at site.

13.10 Factory tests

The equipment offered shall be subjected all type, routine and acceptance tests as per the relevant standards specified.

13.11 Routine tests:

13.11.1 After completion of manufacture of the equipment routine tests shall be performed as per Approved standards free of cost and requisite copies of test certificates shall be furnished.

13.11.2 Various components of the equipment shall be routine tested in accordance with approved standards and manufacturerôs standards.

13.11.3 Each completely wired cubicle shall be tested to ensure that all of its protective control systems are satisfactorily functioning as required.

13.12 Type Tests:

13.12.1 After completion of manufacture, at least one equipment of each type offered shall be type tested as specified in relevant standards and in standard specification(s) and requisite number of copies of test certificates as per distribution schedule shall be furnished.

13.12.2 The NIGAM may, at his discretion, waive type tests provided type test reports of tests carried out on identical equipment(s) manufactured by the Contractor are furnished. The Bidder shall furnish copies of such type test reports with the Bid.

13.12.3 All the equipment offered, shall be fully type tested as per the relevant standards before commencement of supply. The bidder shall furnish three sets of the type test reports along with the offer. Bids offered without type test reports will be treated as incomplete and termed as non-responsive and rejected. The dates of type tests shall not be pertaining to a period earlier than 7 (Seven) years reckoned from the date of bid opening. In case the type test reports pertain to a period earlier than 7 years the bidder if contract is awarded shall arrange repetition of those type tests free of cost if requested by NIGAM. Bids not agreeing this condition shall be rejected. 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 additional type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

The NIGAM reserves the right to demand repetition of some or all the type tests in the presence of purchaser's representative even in cases where type tests have been earlier conducted not earlier than 7 years considered from the date of bid opening and test reports are duly enclosed to the bid. For this purpose the bidder shall quote unit rates for carrying out each type test. Payment would be made for only such type tests for which, bidder has already enclosed type test reports conducted on an equipment similar to one offered in the bid but nevertheless the NIGAM has asked to repeat the test in his/Engineer's presence. NIGAM reserves the right to witness all the type tests. For witnessing type test, contractor will give 45 (forty five) days advance notice.

The rates quoted for type test (as mentioned) shall be included in the bid evaluation. In case Bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test; his offer shall be considered incomplete and shall be liable to be rejected.

13.12.4 The Purchaser also reserves the right to waive the repeating of type tests partly or fully and in case of waival, test charges for the same shall not be payable.

13.13 TEST REPORTS

Four (4) copies of all tests reports shall be supplied for approval before shipment of equipment. The receipts shall indicate clearly the standard values specified for each test, to facilitate checking of the test reports. Fourteen (14) bound copies of test report shall be submitted after approval of test results along with the equipment.
These shall incorporate all tests carried out on all equipment and its components, as well as characteristic curves of the equipment, including reports on official tests, waves, failure, detention data and copies of final test oscillograms, as relevant in terms of the applicable technical specifications.

Test reports of factory tests carried out on the equipment shall furnish the following information:

i) Complete identification data including serial number.
ii) Method of application and duration of tests.
iii) A description of the test equipment with diagram showing arrangement of the test instruments and devices.
iv) Sample computation, where necessary of desirable, to show the test values employed in the equations.
v) Curves showing relation of tests quantities.
vi) Data in tabulated form.
vii) Comparison of the test results with the guarantee requirements of the specifications and explanation of deviations, if any.
viii) Oscillograms, if any.

13.14 Testing Facility

The Bidder shall state in the proposal, testing facilities available at his at his sub-contractorôs works. Should full capacity testing equipment be not available at his works, the Bidder shall state in his bid where he would arrange to get the full capacity tests carried out. For such of the characteristics for which he proposes to adopt any alternative to full capacity testing, he shall state in his bid the method proposed to be adopted giving detailed computations and full justifications for suitability of the method to reliably ascertain equipment characteristics corresponding to full capacity testing.

## 14. COMMISSIONING CUM ACCEPTANCE TESTS

14.1 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 Contractorôs quality assurance programme.

14.2 The Contractorôs commissioning Engineers, specifically identify as far as possible shall be responsible for carrying out all the pre-commissioning tests. On completion of inspection, checking and after the pre-commissioning tests are completed satisfactorily over, the complete equipment shall be placed on initial operation during which period the complete equipment shall be operated integral with sub systems and supporting equipments as a compete system.

14.3 The specific tests to be conducted on equipment have been brought out in the respective chapters of the technical specification.

14.4 The contractor in-charge of erection testing and commissioning shall provide, at free of cost, all testing instruments, control equipment etc., for conducting above tests, in fully calibrated condition along valid Calibration Certificates. The NIGAM reserves the right to get the testing instruments/control equipment re-calibrated before the test at a laboratory of his choice at the cost of the contractor. NIGAM will apply proper corrections in calculations, to take into account conditions which do not correspond to the specified conditions.

14.5 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

14.6 The guaranteed performance figures of the equipment shall be provided by the Contractor during these commissioning and acceptance Tests. Should the results of these tests show any decrease from the guaranteed values the Contractor shall modify the equipment as required to enable it to meet the guarantees. In such case, commissioning and acceptance Tests shall be repeated within one month, from the date the equipment is ready for re-test and all cost for modifications including labour materials and the cost of additional testing to prove the equipment meets the guarantee, shall be borne by the Contractor.

## 15. PACKAGING

15.1 All the equipments shall be suitably protected, coated, covered or boxed and created 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/materials, the limitation from the point of view of availability of Railway Wagon sizes in India should be taken account of. 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.

## 16. PROTECTION

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

## 17. FINISHING OF METAL SURFACES

### 17.1 GENERAL

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 springs washers shall be electro galvanized to service conditions. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS:2629.

### 17.2 HOT DIP GALVANIZING

17.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum thickness of coating shall be 85 microns for all items thicker than 6 mm. For items lower than 6 mm 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. mm minimum.

17.2.2 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 discolored patches, bare spots, unevenness 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.

17.2.3 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.

17.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.

17.2.5 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

17.2.6 Galvanised 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.

17.3 PAINTING

17.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 ñcode of practice for phosphating iron and sheetò. All surfaces which will not be easily accessible after shop assembly shall before hand 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 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.

17.3.2 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 or ready mixed, stoving type zinc chromate primer. the first coat may be flash dried while the second coat shall be stoved.

17.3.3 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.

17.3.4 The exterior color of the paint shall be as per shade no: 631 of IS-5 and inside shall be glossy white. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipment.

17.3.5 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 Purchaserôs review & approval.

## 18. HANDLING, STORING AND INSTALLATION

18.1 In accordance with the specific installation instructions as shown on manufacturerôs 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, workman like 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.

18.2 Contractor may engage manufacturerôs 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 manufacturerôs supervisory engineer(s) and shall extend full co-operation to them.

18.3 In case of any doubt/misunderstanding as to the correct interpretation of manufacturerôs 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 manufacturerôs drawings/instructions correctly.

18.4 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.

18.5 Contractor shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaserôs 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, warfare and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

18.6 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating conditions 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.

18.7 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.

18.8 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which require indoor storage.

18.9 The words ôerectionô and ôinstallationô used in the specification are synonymous.

18.10 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

18.11 The minimum phase to earth, phase to phase and section clearance alongwith other technical parameters for the various switchyard voltage levels to be maintained. However, the clearance as shown in the layout drawings shall be maintained. In case of Switchyard Equipment/Switchgears the minimum phase to earth clearance (live parts clearance) shall be accordance with the relevant IEC/IS for insulation coordination.

18.12 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 equipments(s) do not meet the above minimum clearances, the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

## 19. PROTECTIVE GUARDS

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

## 20. DESIGN CO-ORDINATION

20.1 The Contractor shall be responsible for the selection and design of appropriate equipments 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.

20.2 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.

## 21. DESIGN CO-ORDINATION MEETING

The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractorôs and the Consultants of the Purchaser ( if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at Jaipur or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

## 22. 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.

## 23. 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.

## 24. AUXILIARY SUPPLY

24.1 The sub-station auxiliary supply is normally met through a system indicated under section-5 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.

| Normal Voltage | Variation in Voltage | Frequency in Hz. | Phase/Wire | Neutral connection |
|---|---|---|---|---|
| 415 V | ± 10% | 50 ± 5% | 3/4 wire | Solidly Earthed |
| 240 V | ± 10% | 50 ± 5% | 1/2 wire | Solidly Earthed |
| 220 V | 190 V to 240 | DC | - | Isolated 2 wire system |
| 50 V | - | DC | - | 2 wire system (+) Earthed |

Combined variation of voltage and frequency shall be limited to ± 10%.

## 25. SUPPORT STRUCTURE

25.1 Purchaser has standardized the design of support structure and other control dimensions as given in Drawings for 420 kV and 245 kV equipments respectively. The Bidder shall strictly adhere to these dimensions. The Contractor is required to supply a standard structures of various equipments.
Bidder may also refer the technical specification under head ñStructuresò in this regard. The height of centre line of 420 kV & 245 kV equipment interconnections shall be 8.0 meters and 5.5 meters from plinth level respectively. Any substructure or adopter plate required to meet the above bus termination height other than the standard structure will be supplied by the Contractor as part of the equipment. All brackets, angles, stool or other members necessary for attaching the operating mechanism to the supporting structure shall be engineered and supplied by the Contractor. The support structures for all the equipments / accessories shall be supplied by the Contractor.

25.2 The support structures should be hot dip galvanised with minimum 610 gram/m2 net of zinc.

25.3 Incase of any deviation in this regard the bid is liable to be considered technically non responsive and shall be liable to be rejected.

25.4 Support structure shall meet the following mandatory requirements.

25.4.1 The minimum vertical clearance from any energised metal part to the plinth, shall be 8.0 meters and 5.5 meters for 420 kV & 245 kV equipments respectively.

25.4.2 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 meters.

25.4.3 The design calculations taking into account the environmental conditions of the substations shall be furnished for sizing of the structure.

## 26. CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

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

| | | |
|---|---|---|
| a. | For connecting ACSR Conductors | Aluminum alloy casting, conforming to designation A6 of IS:617 and shall be tested for all test as per IS:617. |
| b. | For connecting equipment terminals made of copper with ACSR conductors | Bimetallic connectors made from aluminium alloy casting, conforming to designation A6 of IS 617 with 2 mm thick bimetallic liner and shall be tested as per IS:617. |
| c. | **Bolts, nuts and plain washers for above clamps and connectors (a) & (b)** | **Stainless steel minimum size M12.** |
| d. | For connecting G.I. shield wire | Galvanised mild steel. |
| e. | Bolts, nuts & Plain washers for above (d) | Electro-galvanised for sizes below M12, for others hot dip galvanized. |
| f. | Spring washers for above Items (a), (b) & (d) | Electro-galvanised mild steel suitable for atleast service condition-3 as per IS:1573 |

26.2 Each equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor terminations of equipment shall be either expansion, sliding or rigid type suitable for 4ò IPS (OD :114.2 mm, ID:97.18 mm) aluminium tube or suitable for Quad/Twin Moose ACSR Conductor (450 mm sub-conductor spacing and 300 mm sub-conductor spacing for 400 kV & 220 kV respectively). The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position. 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.

26.3 Where copper to aluminium connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress. The design details of the joint shall be furnished to the purchaser by the Contractor.

26.4 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.

26.5 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 aluminium body for Bi-metallic clamps.

26.6 All casting shall be free blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

26.7 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 ñIPSò 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.

26.8 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.

26.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

26.10 Clamps and connectors shall be designed to be corona controlled. Corona extinction voltage for 400 kV class clamps shall not be less than 320 kV (rms) and R.I.V. level shall not be more than 1000 micro volts at the test voltage specified in respective sections.

26.11 Tests

26.11.1 Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Type tests/special tests shall be carried out on three samples.

The following is the list of type tests.

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.

## 27. CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

27.1 All type of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-439, as applicable, and the clauses given below:

27.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminium 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. 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 aluminium enclosed box the thickness of aluminium shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

27.3 Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements.

27.4 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.

27.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged/cracked during the ten years of operation of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

27.6 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 projecting at least 150 mm 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. The gland shall project at least 25 mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

27.7 A 240 V, 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.

27.8 For illumination of a 20 Watts fluorescent tube or 15 watts CFL shall be provided. The switching of the fittings shall be controlled by the door switch.

27.9 All control switches shall be of rotary switch type and toggle/piano switches shall not be accepted.

27.10 Earthing

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

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

27.12 A typical drawing of bay marshalling kiosk is appended with the specification at Annexure-E.

27.13 Tests :

a) The following type tests / the routine tests as per IS:5039 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 be type tested for IP-55 as per IS:13947. After IP-55 test, 2.5 KV rms for 1 (one) minute, insulation resistance and functional test should be conducted.

## 28. AUXILIARY SWITCHES

The auxiliary switch shall confirm to the following type tests:

(a) electrical endurance test ï A minimum of 2000 operation for 2 A D.C. with a time constant greater than or equal to 20 millisecond with a subsequent examination of mV drop/visual defects/temperature rise test.

(b) Mechanical endurance test ï A minimum of 1,00,000 operations with a subsequent checking of contact pressure test/visual examination.

(c) Heat run test on contacts.

(d) IR/HV test etc.

## 29. TERMINAL BLOCKS AND WIRING

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

29.2 Terminal blocks shall be 1100 V grade and have continuous rating to carry the maximum expected current on the terminals. Those shall be of moulded piece, complete with insulated barriers stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal block shall be non-disconnecting stud type equivalent to Elmex type CATM4, Phoenix cage clamp type of Wago or equivalent. The insulating material of terminal block shall be nylon 6.6 which shall be free of halogens, flour carbons etc.

29.3 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.

29.4 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 if is done intentionally.

29.5 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.

29.6 The terminal clocks shall be of extensible design.

29.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

29.8 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.

29.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

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

29.10 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.

29.11 At least 20% spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

29.12. There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate. Also the clearances between two rows of terminal blocks shall be a minimum of 150 mm.

29.13 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. For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge over voltages either transferred through the equipment or due to transients induced from the EHV circuits.

29.14 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 intefaces of the equipment.

## 30. LAMPS AND SOCKETS

30.1 Lamps:

All incandescent lamps shall use a socket base as per IS:1258, except in the case of signal lamps.

30.2 Sockets

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

30.3 Hand Lamp:

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

30.4 Switches and Fuses:

30.4.1 Each control 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 switch fuse 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 fuses.

30.4.2 All fuses shall be of HRC cartridge type conforming to IS:9228 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.

30.4.3 All control switches shall be of rotary type and toggle/piano switches shall not be accepted.

## 31. BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS:

31.1 Bushings shall be manufactured and tested in accordance with IS:2009 & IEC:137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS:5621. The support insulators shall be manufactured and tested as per IS:2544/IEC 168 and IEC 273. The insulators shall also conform to IEC 815 as applicable.

The bidder may also offer composite silicon insulator, conforming to IEC-1109.

31.2 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.

31.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

31.4 Support insulators/bushing/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

31.5 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.

31.6 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.

31.7 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.

31.8 Tests

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

31.9 Technical parameters of bushing/Hollow column insulators/ support insulators:

| | | For 420 kV System | For 245 kV System | For 72.5 kV System |
|---|---|---|---|---|
| a) | Rated Voltage( kV) | 420 | 245 | 72.5 |
| b) | Impulse withstand voltage (Dry & Wet) (kVP) | ± 1425 | ± 1050 | ± 325 |
| c) | Switching surge with stand voltage (dry and wet) (kVp) | ± 1050 | - | - |
| d) | Power Frequency with stand voltage (dry and wet) (kV(rms)) | 630 | 460 | 140 |
| e) | Total creepage distance (mm) | 10500 | 6125 | 1813 |
| f) | Pollution Class-III Heavy (as per IEC 71) and as specified in Section-2 for all class of equipment | | | |
| g) | Insulator shall also meet requirement of and IEC-815 for 420 kV, 245 kV system, as applicable having alternate long & short sheds | | | |

32.0 **MOTORS**

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

32.1 Enclosures

a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP 55 as per IS:4691. 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.

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 casting.

d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

32.2 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 24.0 of this section.

32.3 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 alongwith 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.

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 24.0 shall be capable of withstanding atleast two successive starts from cold conditions 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 conditions at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds of 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.

32.4 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 (for 3 ï 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. 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 minimum with rated load commencing from hot condition.

32.5 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.

## 33.0 CLIMATIC CONDITIONS

The equipments to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

| | | |
|---|---|---|
| 1. | Maximum ambient temperature, °C. | 50ºC |
| 2. | Minimum ambient air temperature in shade ºC. | (-) 5ºC. |
| 3. | Maximum daily average ambient temperature, °C. | 45ºC |
| 4. | Maximum yearly weighted ambient temperature, °C. | 35ºC |
| 5. | Average No. of thunder storm days per annum | 40 days. |
| 6. | Average No. of months of tropical monsoon condition per annum | 4 |
| 7. | Maximum relative humidity | 100% |
| 8. | Minimum relative humidity | 10% |
| 9. | Height above mean sea level | Less than 1000 M |
| 10. | Dust storms are liable to occur in the period from | March to July. |

| | | |
|---|---|---|
| 11. | Maximum wind load | 195 Kg./$M^2$ |
| 12. | Seismic level Horizontal acceleration | 0.3 g. |
| 13. | Average annual rainfall (mm) | 10 to 100cm. |
| 14. | Degree of Pollution | Heavy |
| 15. | Intensity of Solar Radiation | 1 kW/ $M^2$ |

Moderately hot and humid tropical climate, conducive to rust and fungus growth.

## 34.0 MEASURING INSTRUMENTS

34.1 All instruments and meters shall be suitable for operation under the climatic conditions prevailing at site. The instrument cases shall be dust proof, water tight, vermin proof and specially constructed to adequately protect the instruments against damages for deterioration due to high ambient temperatures and humidity, special care being taken in the protection of instruments for outdoor service. The details, pointers etc., shall be designed to facilitate accurate reading by minimizing parallax and glare from instrument window and by providing clear, bold dial markings. The size of dial and length of the scales of indicating instruments shall be subject to the approval of the NIGAM in each case. The scale of the indicating instrument shall cover approximately 300 degrees movement of the indicator. The scale plates of panel mounted indicating instruments shall have a permanent white matty finish with black graduation. The pointers or the pointer indicating contact setting (in contact working instruments) shall be distinguished from the main pointer by a distinct colour and/or shape. The current transformer shall be designed for secondary current of One Ampere and Voltage transformer shall be designed for secondary voltage of 110 volts or 110/3 V as specified, unless stated otherwise.

34.2 Instruments mounted on panels shall be of the semi flush type and shall be back-connected. All instruments on a switchboard or instrument panel shall be of matching pattern, shape and finish so as to present a pleasing appearance consistent with the functional requirements. The finish of the instrument case shall be subject to the approval of the NIGAM. All instruments shall be designed for accurate measurement under all conditions of operations and any errors due to change in the ambient temperature, over the entire range of temperatures obtainable at site, shall be kept to a minimum. The instruments shall be provided with all the auxiliary appliances and any special tools required for their maintenance.

34.3 The metric units shall be used for marking the instrument dials. The range shall generally be such that the normal operating values are indicated in the middle third of the scale.

34.4 All electrical instrument coils shall be designed for continuous operation on atleast 110 percent of the full rated current and for potential of the instruments. The instrument coil rating shall be coordinated with those of the associated instrument transformers.

34.5 The VA burden of instrument coils shall be as low as possible, consistent with the best modern design.

34.6 Electrical indicating instruments shall comply generally with the requirements of the Indian/IEC or any other International Standards and shall be of the accuracy specified in relevant sections.

34.7 Recording instruments shall be of the strip chart type with chart scales having suitable width. The charts shall be gear-driven by a self-starting synchronous motor wound spring device having

ample torque even at reduced voltage and with at least 8 hours spring reserves. The device for producing the record on the chart shall be a reliable ink recording or printing type and shall produce clear, legible record under all normal conditions of operation. The recording instruments shall be of withdrawal type for easy access to maintenance work. Sufficient number of chart rolls, recording ink for two years of operation and any special tools required for the maintenance of the instruments shall be furnished with each recorder.

34.8 Integrating watt-hour meters shall comply generally with the requirements of the International Standards and shall be first grade for the purpose of accuracy classification.

34.9 Contact making instruments shall have contacts suitable for 240 Volts, A.C. or 220 Volts D.C. Circuits.

34.10 All instruments shall have as high accuracy as possible consistent with best modern design. The construction of instruments shall be mechanically sound and shall ensure permanence in the accuracy. The limits of error for different instruments shall be stated in the Bid and their accuracy classification, where otherwise not specified, shall be subject to the approval of the NIGAM. All instruments shall be tested in accordance with the requirements of the standard, wherever specified. In case where no specific standards are mentioned, the Contractor shall submit the list of the standards in accordance with the Instruments proposed to be manufactured and tested and these shall be subject to the approval of the NIGAM in every case.

34.11 The instruments shall be capable of withstanding the following tests viz., effect of shock, effect of vibration and effect of humidity and dielectric tests of 2000 volts RMS to ground for one minute in accordance with relevant standards.

## 35.0 EARTHING

35.1 The Contractor shall provide earthing terminals on all the equipment supplied under the Contract and shall connect the earthing conductors to these terminals as approved or directed by the NIGAM.

35.2 Unless specified otherwise, the earthing conductors from the station earthing bus to the equipment will be provided by the Contractor. The Contractor shall provide suitable test terminals at convenient points of the equipment being supplied to enable periodic testing of the resistivity and insulation level of the equipment.

## 36.0 UNITS

36.1 Metric units according to the latest edition of the relevant Indian/IEC publications shall be used for this Contract.

36.2 For the purpose of design/calculations, M.K.S. units shall be used and the equivalent British units may be given in the brackets.

## 37.0 DESIGN AND STRESSES

37.1 The design, dimensions and materials of all parts of the equipment shall be such that they will not suffer damage under the most adverse service conditions. Mechanism shall be so constructed as to avoid sticking due to rust or corrosion.

37.2 The Contractor shall be responsible for an adequate design. The principal stresses in the materials used shall be indicated in the Bid.

37.3 The equipment shall be designed for operation in an earthquake zone. The equipment and each part of it shall be strong enough and sufficiently well connected to resist total operating stresses, including any stress resulting from an earthquake with a ground acceleration of 0.3 g. in any horizontal direction and 2/3rd of above value in vertical direction.

37.4 All equipment shall be designed to:

i) minimize the risk of fire and any consequential damage;
ii) prevent accidental contact with live parts;
iii) be capable of continuous operation or as required with minimum attention and maintenance under the conditions prevailing in a power development in a tropical climate.

37.5 Complete information regarding maximum unit stresses used in the design shall be provided by the Contractor.

## 38.0 ELECTRICITY RULES

All works shall conform to the rules in force under the Indian Electricity Act, 2003 and other applicable legislations.

## 39.0 COOPERATION WITH OTHER MANUFACTURERS

Contractor shall exchange, with other manufacturers of items not covered in this specification or alternatively covered in these specifications but forming partial supply of others, all necessary drawings, templates, gauges and other information required to ensure the complete and proper design and coordinated manufacture of all connecting or related parts of the various equipment.

## 40.0 COORDINATION WITH OTHER CONTRACTORS

It is envisaged that there will be a number of areas where there would be an interface between equipment to be supplied under this contract and equipment proposed to be purchased from other contractors such as line contractors etc. The Contractor shall cooperate with the NIGAM to Co-ordinate with all other manufacturers involved in design, control and instrumentation system which will perform the role contemplated without any problem. There shall be no extra cost payable for performing this role.

## 41.0 LIMIT OF CONTRACT

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 respective specifications unless included in the list of exclusions. All similar standard equipment provided, shall be interchangeable with one another.

## 42.0 FOUNDATIONS

Foundations shall be laid in accordance with the basic design data to be supplied by the Contractor. All fixtures necessary for proper erection of embedded parts shall be supplied by the Contractor. The Contractor shall furnish designs for foundation and supporting structures for all equipment.

## 43.0 SEISMIC FORCES

The equipment shall be designed to withstand seismic forces corresponding to a seismic coefficient 0.3 g. in the horizontal direction and 2/3rd of above value in vertical direction. Details of the calculations made for the designs of the various equipment taking into account the above seismic forces shall be furnished to the NIGAM.

## 44.0 MAJOR TECHNICAL PARAMETERS

### A) FOR 420 KV CIRCUIT BREAKER AND ISOLATOR

| | |
|---|---|
| Rated voltage (kV, rms) | 420 |
| Rated frequency (Hz.) | 50 |
| No. of Poles | 3 |
| Design ambient temperature (ºC) | 50 |

Rated Insulation levels

| | | |
|---|---|---|
| 1) | Full wave impulse withstand voltage (1.2/50 microsec.) | |
| - | between line terminals and ground | ± 1425 kV peak |
| - | between terminals with with circuit breaker/ Isolator open | ± 1425 kVp impulse on one terminal and 240 kVp power frequency voltage of opposite polarity on other terminal. |
| 2) | Switching impulse withstand voltage (250/2500 micro second) dry and wet | |
| - | between line terminals and ground | ± 1050 kV peak |
| - | between terminals with circuit breaker/ isolator open | 900 kVp impulse on one terminal and 345 kVp power frequency voltage of opposite polarity on other terminal |
| 3) | One minute power frequency dry and wet withstand voltage | |
| - | between line terminals and ground | 520 kV rms |

| | | |
|---|---|---|
| - | between terminals with circuit breaker/ isolator open | 610 kV rms |
| Corona extinction voltage (kV rms) with Circuit Breaker/ Isolator in all positions. | | 320 (min.) |
| Max. radio interference voltage (micro volts) for frequency between 0.5 MHz and 2 MHz at 266 kV rms. in all positions. | | 1000 |
| Min. Creepage distance | | |
| i) | Phase to ground (mm) | 10500 |
| ii) | Between CB Terminals (mm) | 10500 |
| Phase to phase spacing | | 7000 / 6000 mm (As applicable) |
| Seismic acceleration | | 0.3 g horizontal |
| Thermal Rating of Auxiliary contacts | | 10 A at 220 V DC |
| Breaking Capacity of auxiliary contacts | | 2 A DC with circuit time constant not less than 20 ms. |
| System neutral earthing | | Effectively Earthed |

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

For other technical parameters refer specification for circuit breaker and isolator

**B) FOR 420 KV CT/CVT/SA**

| | |
|---|---|
| Rated voltage ( kV, rms) | 420 |
| Rated frequency (Hz) | 50 |
| No. of Poles | 1 |
| Design ambient temperature (ºC) | 50 |

Rated Insulation levels:

1) Full Insulation levels:

| | | |
|---|---|---|
| - | between line terminals and ground | ± 1425 kV peak |
| - | for arrester housing | ± 1425 kV peak |

2) Switching impulse withstand voltage (250/2500 micro

second) dry and wet

| | | |
|---|---|---|
| - | between line terminals and ground | ± 1050 kV peak |
| - | for arrester housing | ± 1050 kV peak |

3) One minute power frequency dry and wet withstand voltage

| | | |
|---|---|---|
| - | between line terminals and ground | 630 kV rms |
| - | for arrester housing | 630 kV rms |

| | |
|---|---|
| Corona extinction voltage (kV rms) for CT/CVT | 320 (min.) |
| Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 266 kV rms (Micro volts) | 1000 for CT/CVT<br>500 For SA |
| Min. Creepage distance:- Phase to ground (mm) | 10500 |
| Seismic acceleration | 0.3g horizontal |
| Partial discharge:- | |
| for arrester at 1.05 COV | Not exceeding 50 pc. |
| for CT/CVT | Not exceeding 10 pc |
| System neutral earthing | Effectively earthed |

For other parameters refer Specification for instrument Transformer and Surge Arresters.

**C) FOR 245 KV CIRCUIT BREAKER AND ISOLATOR**

| | |
|---|---|
| Rated voltage kV ( rms) | 245 |
| Rated frequency (Hz.) | 50 |
| No. of Poles | 3 |
| Design ambient Temperature (ºC) | 50 |

Rated insulation levels:

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

| | | |
|---|---|---|
| - | Between line terminals and ground | ± 1050 kV peak |
| - | between terminals with circuit breaker open | ± 1050 kV peak |
| - | between terminals with isolator open | ± 1200 kV peak |

2) One minute power frequency dry and wet withstand voltage

| | | |
|---|---|---|
| - | Between line terminals and ground | 460 kV (rms) |
| - | between terminals with circuit breaker open | 460 kV (rms) |

| | | |
|---|---|---|
| - | between terminals with isolator open | 530 kV (rms) |

Max. radio interference voltage (microvolt) 1000
for frequency between 0.5 MHz and 2 MHz
at 156 kV rms in all positions of the equipments.

Minimum creepage distance:-

| | |
|---|---|
| Phase to ground (mm) | 6125 |
| Between CB Terminals (mm) | 6125 |
| System neutral earthing | Effectively earthed |
| Seismic acceleration | 0.3g horizontal |
| Rating of Auxiliary contacts | 10 A at 220 V DC |
| Breaking capacity of Auxiliary Contacts | 2 A DC with circuit time constant of not less than 20 ms. |
| Phase to phase spacing (mm) | 4500 |

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

For other parameters refer specification for circuit breaker and isolator

**D) FOR 245 kV CT/CVT/SA**

| | |
|---|---|
| Rated voltage kV (rms) | 245 |
| Rated frequency (Hz.) | 50 |
| No. of Poles | 1 |
| Design ambient temperature temperature(ºC) | 50 |

Rated insulation levels:

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

| | | |
|---|---|---|
| - | Between line terminals and ground | ± 1050 kV peak |
| - | For arrester housing | ± 1050 kV peak |

2) One minute power frequency dry and wet withstand voltage

| | | |
|---|---|---|
| - | Between line terminals and ground | 460 kV (rms) |
| - | for arrester housing | 460 kV (rms) |

Max. radio interference voltage (microvolt) 1000 for CT/CVT
for frequency between 0.5 MHz and 2 MHz 500 for SA
at 156 kV rms in all positions of the equipments.

Minimum creepage distance:-

| | |
|---|---|
| Phase to ground (mm) | 6125 |

| | |
|---|---|
| System neutral earthing | Effectively earthed |
| Seismic acceleration | 0.3g horizontal |
| Partial discharge for:- | |
| - Surge arrester at 1.05 COV | Not exceeding 50 pc. |
| - for CT/CVT | Not exceeding 10 pc. |

For other parameters refer Specification for instrument Transformer and Surge Arresters.

**E) FOR 72.5 KV ISOLATOR**

| | |
|---|---|
| Rated voltage kV (rms) | 72.5 |
| Rated frequency (Hz.) | 50 |
| Nos. of Poles | 3 |
| Design ambient temperature (ºC) | 50 |

Rated insulation levels:

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

| | |
|---|---|
| - Between line terminals and ground | ± 325 kV peak |
| - between terminals with Isolator open | ± 375 kV peak |

2) One minute power frequency dry and wet withstand voltage

| | |
|---|---|
| - Between line terminals and ground | 140 kV (rms) |
| - between terminals with Isolator open | 160 kV (rms) |

| | |
|---|---|
| Minimum creepage distance:- | |
| Phase to ground (mm) | 1813 |
| Seismic acceleration | 0.3g horizontal |
| Rating of Auxiliary contacts | 10 A at 220 V DC |
| Breaking capacity of Auxiliary Contacts | 2 A DC with Circuit time constant of not less than 20 ms. |
| Phase to Phase spacing (mm) | 2000 |

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

**F) SYSTEM PARAMETER**

| S.No. | Description of Parameters | 400 kV System | 220 kV System | 132 kV System | 33 kV System |
|---|---|---|---|---|---|
| 1. | System operating voltage | 400 kV | 220 kV | 132 kV | 33 kV |

| | | | | | |
|---|---|---|---|---|---|
| 2. | Rated frequency | 50 Hz | 50 Hz | 50 Hz | 50 Hz |
| 3. | No. of phase | 3 | 3 | 3 | 3 |
| 4. | Rated Insulation level | | | | |
| i) | Full wave impulse withstand voltage (1.2/50 micro sec.) | 1550kVP | 1050kVP | 650kVP | 170 kVP |
| ii) | Switching impulse withstand voltage (250/2500 micro sec.) dry and wet | 1050kVP | - | - | - |
| iii) | One minute power frequency dry and wet withstand voltage (rms) | 630 kV | 460 kV | 275kV | 80 kV |
| 5. | Corona extinction voltage | 320 kV | 156kV | 105kV | - |
| 6. | Max, radio interference voltage for frequency between 0.5 MHz and 2MHz at 320 kV rms for 400 kV system and 156 kV rms for 220 kV system & 92 kV rms for 132 kV system | 1000micro-Volt | 1000micro Volt | 500 micro Volt | - |
| 7. | Minimum creepage distance | 25mm/kV (10500mm) | 25mm/kV (6125mm) | 25mm/kV (3625mm) | 25mm/kV (900mm) |
| 8. | Min. clearances | | | | |
| i) | Phase to phase | 4200mm (for Rod-conductor configuration | 2100mm | 1300mm | 320mm |
| | | 4000mm (for conductor ï conductor confituration) | | | |
| ii) | Phase to earth | 3500mm | 2100mm | 1300mm | 320mm |
| iii) | Sectional clearances | 6500mm | 5000mm | 4000mm | 3000mm |
| 9. | Rated short circuit current for1 se. duration | 40 kA | 40 kA | 31.5kA | 25kA |
| 10. | System neutral earthing | Effectively earthed | Effectively earthed | Effectively earthed | Effectively earthed |

Note:- The insulation and RIV levels of the equipments shall be as per values given in the respective chapter of the equipments.

## 45.0 A C R O N Y M S

| | |
|---|---|
| MVA | Mega Volt Ampere |
| MW | Mega Watt |
| kVA | Kilo Volt Ampere |
| kV | Kilo Volt |
| Cu. m | Cubic meter |
| Deg. C | Degrees Centigrade |
| mm. | Millimetre |
| cm. | Centimetre |
| dm. | Decimetre |

| | |
|---|---|
| km. | Kilometre |
| g. | Grams |
| kg. | Kilogram |
| V | Volts |
| I | Current |
| Hz | Hertz |
| DC | Direct Current |
| AC | Alternate Current |
| ONAN | Oil Natural Air Natural |
| ONAF | Oil Natural Air Forced |
| HV | High Voltage |
| IV | Intermediary Voltage |
| LV | Low Voltage |
| dB | Decibel |
| kA | Kilo Amperes |
| Sec. | Seconds |
| Amps. | Amperes |
| kVp. | Kilo volts peak |
| kVrms. | Kilo volts root mean square |
| kW | Kilo watt |
| Max. | Maximum |
| Min. | Minimum |
| UTS | Ultimate Tensile Strength |
| QAP | Quality Assurance Plan |
| ACSR | Aluminum Conductor Steel Reinforced |
| AAAC | All Aluminum Alloy Conductor |
| HP | Horse Power |
| ppm. | Parts Per Million |
| OLTC | On Load Tap Changer |
| WTI | Winding Temperature Indicator |
| OTI | Oil Temperature Indicator |
| LA/SA | Lightning Arrester/ Surge Arrester |
| LOI | Letter of Intent |
| CIF | Cost including Insurance & Freight |
| CIP | Carriage Insurance Paid |
| SF6 | Sulphur Hexa Flouride |
| TRV | Transient Recovery Voltage |
| CTD | Capacitor Tripping Device |
| ICU | Individual Compressor Unit |
| NO | Normally Open |
| NC | Normally Close |
| sq.mm Al. Cable | Square millimeter Aluminium cable |
| sq.mm Cu. Cable | Square millimeter Copper cable |
| MS Flat | Mild Steel Flat |
| C | Close |
| O | Open |
| HRC | High Rupturing Capacity |
| PVC | Poly Vinyl Chloride |
| p.f | Power factor |
| CT | Current transformer |

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|---|---|
| NCT | Neutral Current Transformer |
| TEFC | Totally enclosed fan cooled |
| P.U. | Per Unit |
| ISO | Indian Standard Organization |
| CB | Circuit Breaker |
| Auto | Automatic |
| kg./Sq.mm | Kilogram per square centimeter |
| HMI/MMI | Human/ Men Machine Interface |
| IED | Intelligent Electronic Devices |
| BCU | Bay Control Unit |
| BPU | Bay Protection Unit |
| SAS | Substation Automation System |
| GPS | Geographic positioning System |
| SCADA | Supervisory control and Data Acquisition |

**ANNEXURE-V2-P2-1**
**CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST**

1. **General:**

Unless otherwise stipulated, all 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%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400 kV, 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 noisel 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 and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. 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%, 115% and 130%. 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 energized connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

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 at least 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 Purchaserôs 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 Purchaserôs inspector if, in his opinion, it will not prejudice other test.

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) Measurement 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 micro volts in each direction.

f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

**ANNEXURE-V2-P2-2**

## SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test on the complete equipment shall be carried out alongwith supporting structure.

The bidder shall arrange to transport the structure from his Supplierôs premises / RVPN sites for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Purchaser. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the Purchaser.

**ANNEXURE-V2-P2-3**

## LIST OF SPECIFICATIONS

## GENERAL STANDARDS AND CODES

Indian Electricity Rules

| | |
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| IS-5, 1994 | Colors for Ready Mixed Paints and Enamels. |
| IS-335, 1993 | New Insulating Oils. |
| IS-617,1991 | Aluminium and Aluminium alloy ingots and Castings for General Engineering Purposes. |
| IS-1448(P1to P145) | Methods of Test for Petroleum and its Products. |
| IS-2071 (P1toP3) | Methods of High Voltage Testing. |
| IS-12063-1987 | Classification of degrees of protection provided enclosures of electrical equipment. |
| IS-2165 | |
| P1:1997 (Reaffirmed 1991)<br>P2:1983 (Reaffirmed 1991) | Insulation Coordinaltion |
| IS-3043 (Reaffirmed 1991) | Code of Practice for earthing |
| IS-6103 (Reaffirmed 1990) | Method of Test for Specific Resistance (Resistivity) of Electrical Insulating Liquids. |
| IS-6104 (Reaffirmed 1991) | Method of Test for Interfacial Tension of Oil against Water by the Rind Method |
| IS-6262 (Reaffirmed 1991) | Method of tests for power factor and di-electric constant of electrical insulating liquids. |
| IS-6792 (1992) | Method for determination of electric strength of insulating oils. |
| IS-5578:1983 | Guide for marking of insulated conductors |
| IS-11353:1985(Reaffirmed 1991) | Guide for uniform system of marking & identification of conductors & apparatus terminals. |
| IS-8263 (Reaffirmed 1990) | Methods for Radio Interference Test on High voltage insulators. |
| IS-9224 (Part 1,2&4) | Low voltage Fuses |
| IEC-60 (Part 1 to P4) | High Voltage Test Techniques |
| IEC-117 | Graphical Symbols |
| IEC-156, 1963 | Methods for the Determination of the Electrical Strength of Insulation Oils. |
| IEC-270, 1989 | Partial Discharge Measurements. |
| IEC-376 | Specification and Acceptance of New Sulphur Hexafloride. |
| IEC-437,1973 | Radio Interference Test on High Voltage Insulators. |
| IEC-506,1975 | Switching Impulse Tests on High Voltage Insulators. |
| IEC-507,1991 | Artificial Pollution Tests on High Voltage Insulators to be used on |

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| | AC system. |
| IEC-694,1996 | Common Specification for High Voltage Switchgear & Control gear Standards. |
| IEC-815,1986 | Guide for the Selection of Insulators in respect of Polluted Conditions. |
| IEC-865(1994) (P1 &P2) | Short Circuit Current-Calculation of effects. |
| ANSI-C.1/NFPA.70 | National Electrical Code |
| ANSI-C37.90A | Guide for Surge Withstand Capability (SWC) tests |
| ANSI-C63.21<br>C63.3<br>C36.4 | Specification for Electromagnetic Noise and<br>Field Strength Instrumentation 10 KHZ to 1 GHZ |
| ANSI-C68.1 | Techniquest 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 land Equipment No. 61 Light Gray. |
| NEEMA-107 T | Methods of Measurements of RIV of High Voltage Apparatus. |
| NEEMA-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-Z299.1-1978th | Quality Assurance Program Requirements. |
| CSA-Z299.2-1979th | Quality Control Program Requirements. |
| CSA-Z299.3-1979th | Quality Verification Program Requirements |
| CSA-Z299.4-1979th | Inspection Programme Requirements. |

TRANSFORMERS AND REACTORS

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| IS:10028(Part2&3) | Code of practice for selection, installation & maintenance of Transformers (P1:1993),(P2:1991).(P3:1991) |
| IS:2026(PartP1 to P4) | Power Transformers |
| IS-3347 (Part 1 to Part 8) | Dimensions for Porcelain transformer Bushings for use in lightly polluted atmospheres. |
| IS:3639 (1991) | Fittings and Accessories for Power Transformers |
| IS:6600(1991) | Guide for Loading of Oil immersed Transformers. |
| IEC-76(Part 1 to Part5) | Power Transformers |
| IEC-214 (1989) | On-Load Tap-Changers. |
| IEC-289(1988) | Reactors. |
| IEC-354 (1991) | Loading Guide for Oil Immersed power transformers. |
| IEC-551 (1995) | Determination of Transformer and Reactor Sound Levels. |
| ANSI-C571280 | General requirements for Distribution, Power and Regulating Transformers. |
| ANSI-C571290 | Test Code for Distribution, Power and Regulation Transformers. |
| ANSI-C5721 | Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA. |
| ANSI-C5792 | Guide for Loading oil immersed power transformers upto and including 100 MVA with 55 deg C or 65 deg. C Winding Rise |
| ANSI-CG,IEE-4 | Standard Techniques for high voltage testing. |

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| NEEMA-TR.1 | Transformers, Regulators and Reactors. |
| CIRCUIT BREAKERS | |
| IEC-56 (1987) | High Voltage Alternating Current Circuit Breakers. |
| IEC-427 (1989) | Synthetic Testing of High Voltage alternating current circuit breakers. |

**CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITORS VOLTAGE TRANSFORERS.**

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| IS:2705-1992(P1toP4) | Current Transformers. |
| IS:3156-1992(P1toP4) | Voltage Transformers. |
| IS-4379 (1981) (Reaffirmed 1992) | Identification of the Contents of Industrial Gas Cylinders. |
| IEC-185 (1987) | Current transformers. |
| IEC-186 (1987) | Voltage Transformers. |
| IEC-358 (1990) | Coupling capacitors and capacitor dividers. |
| IEC-44-4 | Instrument Transformers: Measurement of Partial Discharges. |
| IEC-481(1974) | Coupling Devices for power line carrier systems. |
| ANSI-C5713 | Requirements for Instrument transformers |
| ANSI-C5716 | Terminology and test code for current limiting reactors. |
| ANSIC92.2 | Power Line Coupling Voltage Transformers |
| ANSI-C93.1 | Requirements for Power Line Carrier Coupling Capacitors. |
| Bushing | |
| IS-2099(1992) | Bushings for Alternating Voltages above 1000 V |
| IEC-137(1995) | Insulated Bushings for Alternating Voltage above 1000 V. |
| SURGE ARRESTERS | |
| IS-3070 (PART2)(1993) | Lightning arresters for alternating current systems: Metal oxide lightning arrestors without gaps |
| IEC 99-4 | Metal oxide surge arrestors without gaps. |
| ANSI-C62.1 | IEE Standards for Surge Arresters for AC Power circuits |
| NEMA-LA 1 | Surge Arresters |
| CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS | |
| IS-722, IS-1248, IS-3231,3231(P-3) | Electrical relays for power system protection |
| IS:5039 (1991) | Distributed pillars for Voltages not Exceeding 1000 Volts. |
| IEC-68.2.2(1994) | Basic environmental testing procedures Part 2 : Test B: Dry heat |
| IEC-529 (1989) | Degree of Protection provided by enclosures |
| IEC-158(upto P3-1985) | Low voltage Control gear: Contactors |
| IEC-439 (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. |
| IS:8623 (Part 1 to 3 :1993) | Specification for Switchgear & Control Assemblies |
| NEMA-AB | Moulded case Circuit and Systems |
| NEMA-CS | Industrial Controls and Systems |
| NEMA-PB-1 | Panel Boards |

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| 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-129(1992) | Alternating Current Disconnectors(Isolators) and Earthing switches. |
| IEC-265 (Part 1 1994) Part 2: 1994) | 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 |
| TELECOMMUNICATION AND LINE TRAPS | |
| | Indian Electricity Rules as amended up-to-date |
| IS-8792(1994) | Line traps for AC power system |
| IS-8793(1978) | Methods of tests for line traps. |
| IS-8997(1991) | Coupling devices for PLC systems. |
| IS-8998 (1991) | Methods of test for coupling devices for PLC systems. |
| IEC-353(1989) | Line traps for A.C.power systems |
| IEC-481(1974) | Coupling Devices for power line carrier systems. |
| IEC-495 (1993) | Single side board power line carrier terminals. |
| IEC-683 (1980) | Planning of (single Side-Band) power line carrier systems. |
| CIGRE | Tele protection report by Committee 34 & 35 |
| CIGRE | Guide on power line carrier 1979. |
| CCIR | International Radio Consultative Committee |
| CCITT | International Telegraph & Telephone Consultative Committee |
| EIA | Electric Industries Association |
| PROTECTIN AND CONTROL EQUIPMENT | |
| IEC-51: (P1 to P9) | Recommendations for Direct Acting indicating analog electrical mesuring instruments and their accessories. |
| IEC-255 (Part 1 to Part 23) | Electrical Relays. |
| IEC-297 (P1 to P4 :1995) | Dimensions of mechanical structures of the 482.6 mm (19 inches) series. |
| IEC-359 (1991) | Expression of the performance of electrical & electronic measuring equipment |
| IEC-387 (1992) | Symbols for Alternating ï Current Electricity meters. |
| IEC-447 (1993) | Man machine interface (MMI) ï Actuating principles. |
| IEC-521 (1988) | Class 0.5, 1 and 2 alternating current watt hour metres. |
| IEC-547 (1985) | 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. |

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| ANSI-C37.2 | Relays and relay systems associated with electric power apparatus |
| ANSI-C39.1 | Requirements for electrical analog indicating instruments. |
| MOTORS | |
| IS-325(1991) | Three phase induction motors |
| IS-4691 (1991) | Degree of protection provided by enclosure for rotating electrical machinery. |
| IEC-34 (P1 to P19 : 1995) | Rotating electrical machines |
| IEC-Documents 2 (Central Office) | Three phase induction motors |
| NEMA-MGI | Motors and Generators |
| Electronic equipment and components | |
| MIL-21B<br>MIL-833<br>MIL-2750 | |
| IEC-68 (P1 to P5) Environmental testing | |
| IEC-326 (P1 to P2) Printed Boards | |
| MATERIAL AND WORKMANSHIP STANDARDS | |
| IS-1363 (P1 to P3 1992) | Hexagon headbolts, screws and nuts of product grade C. |
| IS-1364 (P1 to P5 1992) | Hexagon head bolts, screws and nuts of products grade A and B. |
| IS-3138 (1991) | Hexagonal Bolts and Nuts (M42 to M150) |
| ISO-898 | Fasteners: Bolts, screws and studs |
| ASTM | Specification and tests for materials. |
| CLAMPS & CONNECTORS | |
| IS-5561 (1992) | Electric power connectors. |
| NEMA-CC1 | Electric Power connectors for substation` |
| NEMA-CC3 | Connectors for Use between aluminium or aluminium Copper Overhead Conductors. |
| BUS HARDWARE AND INSULATORS | |
| IS:2121 (1991) | Fittings for Aluminum and steel cored aluminum conductor for overhead power lines. |
| IS-731 (1991) | Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V. |
| IS-2486 (P1 to P4) | Insulator fittings for overhead power lines with a nominal voltage greater than 1000 V. |
| IEC-120 (1984) | Dimensions of Ball and Socket Couplings of string insulator units. |
| IEC-137 (1995) | Insulated bushings for alternating voltages above 1000 V. |
| IEC-168 (1994) | Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V. |
| IEC-233 (1988) | Tests on Hollow Insulators for use in electrical equipment. |
| IEC-273 (1990) | Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000 V. |
| IEC-305 (1995) | Insulators for overhead lines with nominal voltage above 1000 V ï Ceramic or glass insulator units for a.c. systems characteristics of String Insulators Units of the cap and pin type. |
| IEC-372 (1984) | Locking devices for ball and socket couplings of string insulator units: dimensions and tests. |
| IEC-383 (P1 and P2 1993) | Insulators for overhead lines with a nominal voltage above 1000 V. |

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| IEC-433 (1980) | Characteristics of string insulator units of the long rod type |
| IEC-471 (1977) | 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-C29.2 | For insulators, wet-process porcelain and toughened glass suspension type |
| ANSI-C29.8 | For wet-process porcelain insulators apparatus, cap & pin 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 | |
| IS-2678 (1992) | Dimensions & tolerances for Wrought Aluminium and Aluminium Alloys drawn round tube |
| IS-5082(1991) | Wrought Aluminium and Aluminium Alloy Bars, Rods, Tubes and Sections for Electrical purposes. |
| ASTM-B 230-82 | Aluminium 1350 H19 Wire for electrical purposes |
| ANSI-C 29.9 | Wet Process Porcelain Insulators Apparatus Post type |
| ASTM-B 231-81 | Concentric ï lay ï stand, aluminium 1350 conductors. |
| ASTM-B 221 | Aluminium ï Alloy extruded bar, rod, wire, shape. |
| ASTM-B 236-83 | Aluminium bars for electrical purpose (Bus-bars) |
| ASTM-B 317-83 | Aluminium Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors) |
| BATTERIES AND BATTERIES CHARGER | |
| IEC-86 (P1 to P3 : 1995) | Primary batteries |
| NEMA-1B1 | Definition and precautionary labels for lead-acid industrial storage batteries |
| NEMA-1B4 | Determination of ampere hour and watt hour capacity of lead-acid industrial storage batteries for stationary service. |
| NEMA-1B5 | Life testing of lead-acid industrial storage batteries for stationary service |
| NEMA-PV3 | Safety code for semiconductor Power converters |
| NEMA-PV5 | Constant potential type electric utility (Semi-conductor static Converter) battery chargers |
| NEMA-R-12 | General ï purpose and communication battery chargers |
| 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 generation stations and substations. |
| WIRES AND CABLES | |
| ASTMB-2863 | Measuring the minimum oxygen concentration to support candle like combustion of plastics (Oxygen index). |
| IS-694(1990) | PVC insulated cables for working voltages up-to and including 1100 Volts. |
| IS-1255 (1991) | Code of practice for installation and maintenance of power cables, up-to and including 33 kV rating. |
| IS-1554 (P1 and P2: 1988) | PVC insulated (heavy duty) electric cables (part1) for working voltage up-to and including 1100 V. |
| | Part (2) for working voltage from 3.3 kV up to and including 11 kV. |

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| IS:2982 | Copper Conductor in insulated cables |
| IS-3961 (P1 to P5 1991) | Recommended current ratings for cables. |
| IS-3975 (1992) | Mild steel wires, formed wires and tapes for armouring of cables. |
| IS-5831 (1991) | PVC insulating and sheath of electric cables. |
| IS-6380 (1991) | Elastometric insulating and sheath of electric cables. |
| IS-7098 (1988) | Cross linked polyethylene insulated PVC sheathed cables for working voltage up-to and including 1100 Volts. |
| IS-7098 (1988) | Cross linked polyethylene insulated PVC sheathed cables for working voltage from 3.3 kV up-to and including 33 kV. |
| IS-8130 (1991) | Conductors for insulated electrical cables and flexible cords. |
| IS-1753 | Aluminium Conductors for insulated cables |
| IS-10418 | Specification for drums for electric cables. |
| IEC-96 (Part to P4) | Radio Frequency cables. |
| IEC-183(1990) | Guide to the selection of High Voltage Cables. |
| IEC-189 (P1 to P7 1989) | Low frequency cables and wires with PVC insulation and PVC sheath. |
| IEC-227 (P1 to P7 1995) | Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750 V. |
| IEC-228 (1993) | Conductors of insulated cables. |
| IEC-230 (1996) | Impulse tests on cables and their accessories. |
| IEC-287 (P1 to P3 1995) | Calculation of the continuous current rating of cables (100% load factor). |
| IEC-304 (1982) | Standard colours for insulation for low frequency cables and wires. |
| IEC-331 (1970) | Fire resisting characteristics of Electric cables. |
| IEC-332 (P1 to P3 1992) | Tests on electric cables under fire conditions. |
| IEC-502 (1994) | Extruded solid dielectric insulated power cables for rated voltages from 1 kV up-to 30 kV. |
| IEC-754 (P1 and P2:1991) | Tests on gases evolved during combustion of electric cables. |
| NEMA-WC1 | Asbestos and Asbestos ï varnished cloth and asbestos Thermo plastic insulated wire and cable. |
| NEMA-WC2 | Steel armour and associated covering for impregnated paper insulated cables. |
| NEMA-WC3 | Rubber insulated wire and cable for transmission and distribution of electrical energy. |
| NEMA-WC5 | Thermo plastic insulated wire and cable for the transmission and distribution of electrical energy. |
| NEMA-WC7 | Cross linked thermo setting polyethylene insulated wire and cable for the transmission and distribution of electric energy. |
| NEMA-WC8 | Ethylene-propylene-rubber-insulated wire and cable for the transmission and distribution of electrical energy. |
| NEMA-W67 | Cross-linked-thermo setting polyethylene. |
| (IPCEA, S-66-402) | Insulated wire and cable for the transmission and distribution of electrical energy. |
| IPCEA S-61-402 | Thermoplastic insulated wire and cable for the transmission and distribution of electrical energy. |
| ASTMD-2843 | Standard test methods for density of smoke from burning or decomposition of plastics. |
| IEEE-48 | Pot heads |
| IEEE-383 | Standards for type tests of IE class of electrical cables, field splicers |

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| | and connection for nuclear power generating stations. |
| AIR CONDITIONING AND VENTILATION | |
| IS-659 (1991) | Safety code for air conditioning |
| IS-655 (1991) | Metal air ducts |
| IS-1391 (P1 and P2: 1992) | Room air conditioners |
| IS-6272 (1991) | Industrial Cooling fans |
| ASHRAE | American society of heating, refrigerating and air conditioning engineers. |
| AMCA | Air moving and conditioning association |
| SMACNA | Sheet metal and air conditioning contractors national association. |
| GALVANIZING | |
| IS-209 (1992) | Zinc Ingot |
| IS-2629 (1990) | Recommended Practice for Hot-Dip galvanizing on iron and steel. |
| IS-2633 (1992) | Methods for testing uniformity of coating of zinc coated articles. |
| ASTM-A-123 | Specification for zinc (Hot Galvanizing) coatings, on products Fabricated from rolled, pressed and forged steel shapes, plates, bars and strips. |
| ASTM-A-153 | Specification for Zinc Coating ( Hot Dip) on Iron and steel hardware. |
| ASTM-A-239 | Test method for locating the Thinnest Spot in a Zinc (Galvanised) Coating on Iron or Steel articles by the preece test (Copper sulfated dip) |
| ASTM-A-121-77 | Zinc coated (Galvanized) steel barbed wire. |
| PAINTING | |
| IS-6005 (1991) | Code of practice for phosphating of iron and steel. |
| ANSI-Z551 | Gray finishes for industrial apparatus and equipment. |
| SSPC | Steel structure painting council. |
| FIRE PROTECTION | |
| Fire protection manual issued by tariff advisory committee (TAC) of India. | |
| NFPA | National fire protection association. |
| NBFU | National board of the underwriters. |
| IS-554(1990) | Dimensions for pipe threads where pressure tight joints are required on the threads. |
| IS-638 (1993) | Sheet rubber jointing and rubber inserting jointing. |
| IS-778 (1990) | Copper alloy gate, globe and check valves for water works purposes. |
| IS-780 (1990) | Sluice valves for water-works purposes (50 to 300 mm size) |
| IS-1536 (1993) | Centrifugally cast (Spun) iron pressure pipes for water, gas and sewage. |
| IS-1538 (1993) | Cast iron fittings for pressure pipes for water gas and sewage. |
| IS-1703 (1989) | Copper alloy bar valves (horizontal plunger type) for water supply fittings. |
| IS-2379 (1990) | Colour code for identification of pipe lines. |
| IS-2643 (P1 to P3 1990) | Dimensions for pipe threads for fastening purposes. |
| IS-2685(1992) | Code of practice for selection, installation and maintenance of sluice valves. |
| IS-2906 (1990) | Sluice valves for water works purposes (350 to 1200 mm size). |
| IS-3589(1991) | Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter). |
| IS-4038 (1990) | Foot valves for water works purposes. |

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|---|---|
| IS-4927(1992) | Unlined flax canvas hose for fire fighting. |
| IS-5312 (P1 and P2: 1991) | Swing check type reflux (non-return) valves |
| IS-13095 (1991) | Butterfly valves for general purposes |
| STEEL STRUCTURES | |
| IS-228(1992) | Method of Chemical Analysis of pig iron, cast iron and plain carbone and low alloy steels. |
| IS-802 (P1 to 3 : 1991) | Code of practice for use of structural steel in overhead transmission line towers. |
| IS-806 (1991) | Code of practice for use of steel tubes in general building construction. |
| IS-808 (1991) | Dimensions for hot rolled steel beam, column channel and angle sections. |
| IS-814 (1991) | Covered electrodes for manual arc welding of carbon of carbon manganese steel. |
| IS-816 (1992) | Coce of Practice for use of metal arc welding for general construction in mild steel. |
| IS-817 (1992) | Code of practice for training and testing of metal arc welders. Part 1 : Manual Metal arc welding. |
| IS-875 (P1 to P4 : 1992) | Code of practice for design loads (other than earthquake) for buildings and structures. |
| IS-1161 (1990) | Steel tubes for structural purposes. |
| IS-1182 (1991) | Recommended practice for radiographic examination of fusion welded butt joints in steel plates. |
| IS-1363 (P1 to P3 (1992) | Hexagonal head bolts, screws & nuts of products grade C. |
| IS-1364 (1992) | Hexagonal head bolts, screws and nuts of product grades A and B. |
| IS-1367 (P1 to P18 1992) | Technical supply condition for threaded steel fasteners. |
| IS-1599 (1991) | Methods for bend test. |
| IS-1608 (1991) | Method for tensile testing of steel products. |
| IS-1893 (1991) | Criteria for earthquake resistant design of structures. |
| IS-1978 (1990) | Line pipe. |
| IS-2062 (1992) | Steel for general structural purposes. |
| IS-2595 (1991) | Code of practice for Radiographic testing. |
| IS-3063 (1991) | Single coil rectangular section spring washers for bolts, nuts and screws. |
| IS-3664 (1993) | Code of practice for ultrasonic pulse echo testing by contact and immersion methods. |
| IS-7205 (1991) | Safety code for erection of structural steel work. |
| IS-9595 (1992) | Recommendations for metal arc welding of carbon and carbon managese steel. |
| 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 | Specification of structural steel. |
| ASTM-A47 | Specification for malleable iron castings. |
| ASTM-A143 | Practice for safeguarding against embilement of Hot Galvanized structural steel products and procedure for detaching embrilement. |
| 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 vandium steel. |
| ASTM-A572 | Specification for High strength low alloy colombium 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 | |
| IS-1239 (Part 1 and 2: 1992) | Mild steel tubes, tubulars and other wrought steel fittings. |
| IS-3589(1991) | Electrically welded steel pipes for water, gas and sewage. |
| IS-6392 (1988) | Steel pipe flanges. |
| 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-A 106 | 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 fitting. Class 25, 125, 250 and 800. |
| ANSI-B16.3 | 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 lock nuts with pipe threads. |
| ANSI-B16.25 | Butt welding ends |
| ANSI-B18.1.1 | Fire hose coupling screw thread. |
| ANSI-B18.2.1 | Inch series square and hexagonal bolts and screws. |
| ANSI-B18.2.2 | Square and hexagonal nuts |
| ANSI-B18.21.1 | Lock washers |
| ANSI-B18.21.2 | Plain washers |
| ANSI-B 31.1 | Power Piping |

| | |
|---|---|
| ANSI-B36.10 | Welded and seamless wrought steel pipe |
| ANSI-B36.9 | Stainless steel pipe |
| OTHER CIVIL WORKS STANDARDS | |
| IS-269(1989) | 33 grade ordinary portland cement. |
| IS-2721 (1991) | Galvanized steel chain link fence fabric. |
| IS-278(1991) | Galvanized steel barbed wire for fencing. |
| IS-383 (1991) | Coarse and fine aggregates from natural sources for concrete. |
| IS-432 (P1 and P2 1989) | Mild steel and medium tensile steel bars and hard-dawn steel wire for concrete reinforcement. |
| IS-456 (1991) | Code of practice for plain and reinforced concrete. |
| IS 516 (1991) | Method of test for strength of concrete. |
| IS-800 (1991) | Code of practice for general construction in steel. |
| IS-806 (1991) | Steel tubes for structural purposes. |
| IS-1172 (1993) | Basic requirements for water supply, drainage and santitation. |
| IS-1199 (1991) | Methods of sampling and analysis of concrete |
| IS-1566 (1989) | Hard dawn steel wire fabric for concrete reinforcement. |
| IS-1742(1980) | Code of Practice for Building drainage. |
| IS-1785(1989) | Plain hard drawn steel wire for prestressed concrete. |
| IS-1786(1990) | High strength deformed steel bars and wires for concrete reinforcement. |
| IS-1811(1990) | Methods of sampling Foundry sands. |
| IS-1893(1991) | Criteria for earthquake resistant design of structures. |
| IS-2062 (1992) | Steel of general structural purposes. |
| IS-2064 (1993) | Selection, installation and maintenance of sanitary appliances code of practices. |
| IS-2065 (1993) | Code of practice for water supply in buildings. |
| IS-2090 (1989) | High tension steel bars used in prestressed concrete. |
| IS-2140 (1991) | Standard galvanized steel wire for fencing. |
| IS-2470 (P1 & P2 1990) | Code of practice for installation of septic tanks. |
| IS-2514 (1991) | Concrete vibrating tables. |
| IS-2645 (1992) | Integral cement water proofing compounds. |
| IS-3025 (Part 1 to Part 48, 1994) | Methods of sampling and test (Physical and chemical ) for water and waste water. |
| IS-4091 (1987) | Code of practice for design and construction of foundations for transmission line towers and poles. |
| IS-4111 (Part 1 to P5 1993) | Code of practice for ancillary structures in sewage system. |
| IS-4990 (1993) | Plywood for concrete shuttering work. |
| IS-5600 (1991) | Sewage and drainage pumps. |
| NATIONAL BUILDING CODE OF INDIA 1970 | |
| USBR E12 | Earth Manual by United States Department of the interior Bureau of Reclamation. |
| ASTM-A392-81 | Zinc/coated steel chain link fence fabric. |
| ASTM-D1557-80 | Test for moisture-density relation of soils using 10 lb ( 4.5 Kg.) Ramer and 18-in (457 mm) Drop. |
| ASTM-D1586 | Penetration Test and Split-Barrel |
| (1967) | Sampling of Soils. |
| ASTM-D2049-69 | Test method for Relative Density of Cohesionless Soils |

| | |
|---|---|
| ASTM-D2435 | Test method for Unconsolidated, (1982)<br>Untrained strengths of Cohesive Soils in Triaxial Compression. |
| BS-5075 | Specification for accelerating Part-I Admixtures, Retarding Admixtures and Water Reducing Admixtures. |

ACSR MOOSE CONDUCTOR

| Indian Standard | Title | International Standard |
|---|---|---|
| IS:6745 (1990) | Methods for Determination of Mass of zinc coating on zinc coated Iron and steel Articles | BS:443-1969 |
| IS:8263 (1990) | Methods for Radio Interference Test on High Voltage insulators | IEC:437-1973<br>NEMA:107-1964<br>CISPR |
| IS-209 (1992) | Zinc Ingot | BS:3436-1961 |
| IS:398 (1992) | Aluminium Conductors for Overhead Transmission Purposes | IEC:209-1966<br>BS:215 (Part-II) 1970 |
| Part V (1992) | Aluminium conductors galvanized steel reinforced extra high voltage (400 kV and above) | IEC:209-1966<br>BS:215 (Part-II) 1970 |
| IS:1778-1980 | Reels and Drums for Bare Conductors | BS:1559-1949 |
| IS:1521 (1991) | Method for Tensile Testing of steel wire | ISO/R89-1959 |
| IS:2629(1990) | Recommended practice for Hot dip galvanizing on iron and steel. | |
| IS:2633 (1992) | Method for Testing Uniformity of coating of zinc Coated Articles. | |
| IS:4826 (1992) | Hot dip galvanised coatings on round steel wires. | ASTMA-472-729 |
| GALVANISED STEEL EARTHWIRE | | |
| IS:1521 (1991) | Method for Tensile Testing of Steel Wire | ISO/R:89-1959 |
| IS:1778 (1980) | Reels and Drums for Bare Conductors | |
| IS:2629 (1990) | Recommended practice for Hot Dip galvanizing on iron and steel. | |
| IS:2633 (1992) | Methods for testing Uniformity of Coating of Zinc Coated Articles | |
| IS:4826(1992) | Hot dip galvanized coatings on Round Steel Wires. | ASTM:A 475-72 a<br>BS:443-1969 |
| IS:6745 (1990) | Method for Determination of mass of Zinc Coating on Zinc coated Iron and Steel Articles. | BS:443-1969 |
| IS:209 (1992) | Zinc ingot | BS:3463-1961 |
| IS:398 (Pt.I to P5 1992) | Aluminium Conductors for overhead transmission purposes. | BS:215 (Part-II) |

Lighting Fixtures and Accessories

| | | |
|---|---|---|
| (i) | IS:1913 | General and safety requirements for electric lighting fittings |
| (ii) | IS:3528 | Water proof electric lighting fittings. |
| (iii) | IS:4012 | Dust proof electric lighting fittings. |
| (iv) | IS:4013 | Dust tight proof electric lighting fittings. |

| | | |
|---|---|---|
| (v) | IS:10322 | Industrial lighting fittings with metal reflectors. |
| (vi) | IS:10322 | Industrial lighting fittings with plastic reflectors. |
| (vii) | IS:2206 | (Well glass lighting fittings for use under ground in mines ( non flame proof type) |
| (viii) | IS:10322 | Specification for flood light. |
| (ix) | IS:10322 | Specification for decorative lighting outfits. |
| (x) | IS:10322 | Luminaries for street lighting |
| (xi) | IS:2418 | Tubular fluorescent lamps. |
| (xii) | IS:9900 | High pressure mercury vapour lamps. |
| (xiii) | IS:1258 | Specification for Bayonet lamp fluorescent lamp. |
| (xiv) | IS:3323 | Bipin lamp holder tubular fluorescent lamps. |
| (xv) | IS:1534 (Part-I) | Ballasts for use in fluorescent lighting fittings. |
| (xvi) | IS:1569 | Capacitors for use in fluorescent lighting fittings. |
| (xvii) | IS:2215 | Starters for fluorescent lamps. |
| (xviii) | IS:3324 | Holders for starters for tubular fluorescent lamps. |
| (xix) | IS:418 | GLS lamps. |
| (xx) | IS:3553 | Water tight electric fittings. |
| (xxi) | IS:2713 | Tubular steel poles |
| (xxii) | IS:280 | MS wire for general engg. purposes. |

Conduits, Accessories and Junction Boxes

| | | |
|---|---|---|
| (1) | IS:9537 | Rigid steel conduits for electrical wiring. |
| (2) | IS:3480 | Flexible steel conduits for electrical wiring. |
| (3) | IS:2667 | Fittings for rigid steel conduits for electrical wiring. |
| (4) | IS:3837 | Accessories for rigid steel conduits for electrical wiring. |
| (5) | IS:4649 | Adapters for flexible steel conduits. |
| (6) | IS:5133 | Steel and Cast iron boxes. |
| (7) | IS:2629 | Hot dip galvanizing of Iron & steel. |

Lighting Panels

| | | |
|---|---|---|
| (1) | IS:13947 (Part 1 to 5) | LV Switchgear and Control gear. |
| (2) | IS:8828 | Circuit breakers for over current protection for house hold and similar installations. |
| (3) | IS:5 | Ready mix paints. |
| (4) | IS:2551 | Danger notice plates. |
| (5) | IS:2705 | Current transformers. |
| (6) | IS:9224 (Part-2) | HRC cartridge fuse links for voltage above 650 V. |
| (7) | IS:5082 | Wrought aluminium and Al. alloys, bars, rods, tubes and sections for electrical purposes. |
| (8) | IS:8623 | Factory built Assemblies of Switchgear and Control Gear for voltages up to and including 1000 V AC and 1200 V DC |
| (9) | IS:1248 | Direct Acting electrical indicating instruments. |

Cables:

| | | |
|---|---|---|
| (1) | IS:694 | PVC insulated cables for working voltages up-to and including 1100 volts. |

Electrical Installation

| | | |
|---|---|---|
| (1) | IS:1293 | 3 pin plug |
| (2) | IS:371 | Two to three ceiling roses. |
| (3) | IS:3854 | Switches for domestic and similar purposes. |
| (4) | IS:5216 | Guide for safety procedures and practices in electrical work. |
| (5) | IS:732 | Code of practice for electrical wiring installation (system voltage not exceeding 650 Volts.) |
| (6) | IS:3043 | Code of practice for earthing. |
| (7) | IS:3646 | Code of practice of interior illumination part II & III. |
| (8) | IS:1944 | Code of practice for lighting of public through fares. |
| (9) | IS:5571 | Guide for selection of electrical equipment for hazardous areas. |
| (10) | IS:800 | Code of practice for use of structural steel in general building construction. |
| (11) | IS:2633 | Method of Testing uniformity of coating on zinc coated articles. |
| (12) | IS:6005 | Code of Practice for Phosphating iron and steel. |

(13) INDIAN ELECTRICITY ACT

(14) INDIAN ELECTRICITY RULES

**ANNEXURE- V2-P2-4**

## LIST OF DRAWINGS/DOCUMENTS

1. Single Line Diagram
2. Electrical Layout ï Plan and Sections
3. DSLP Calculation and drawing
4. Earthmat Design
5. Short circuit Force and Critical Span Calculations
6. Busbar Design calculations
7. Cantilever Strength calculations
8. Design calculation for Sag ï Tension stringing chart
9. GTP and drawings for Bus-Post Insulator
10. Tension/suspension string insulator and Hardware Assembly GTP and drawing
11. Structure Layout (Plan & Section) drawing
12. Soil Investigation Report

**13. Circuit Breakers**

- GA drawing
- GTP
- Type test Reports

**14. CTs & CVTs**

- GA drawing
- GTP
- Type test Reports

**15. Surge Arrestors**

- GA drawing
- GTP
- Type test Reports

**16. Isolators**

- GA drawing
- GTP
- Type test Reports

**17. Control and Relay Panels**

- GTP and technical literature
- Type test report of Relays/Relays/Equipments

**18. PLCC**

- GTP and technical literature, Type Test Reports of Panels

**19. Civil Works**

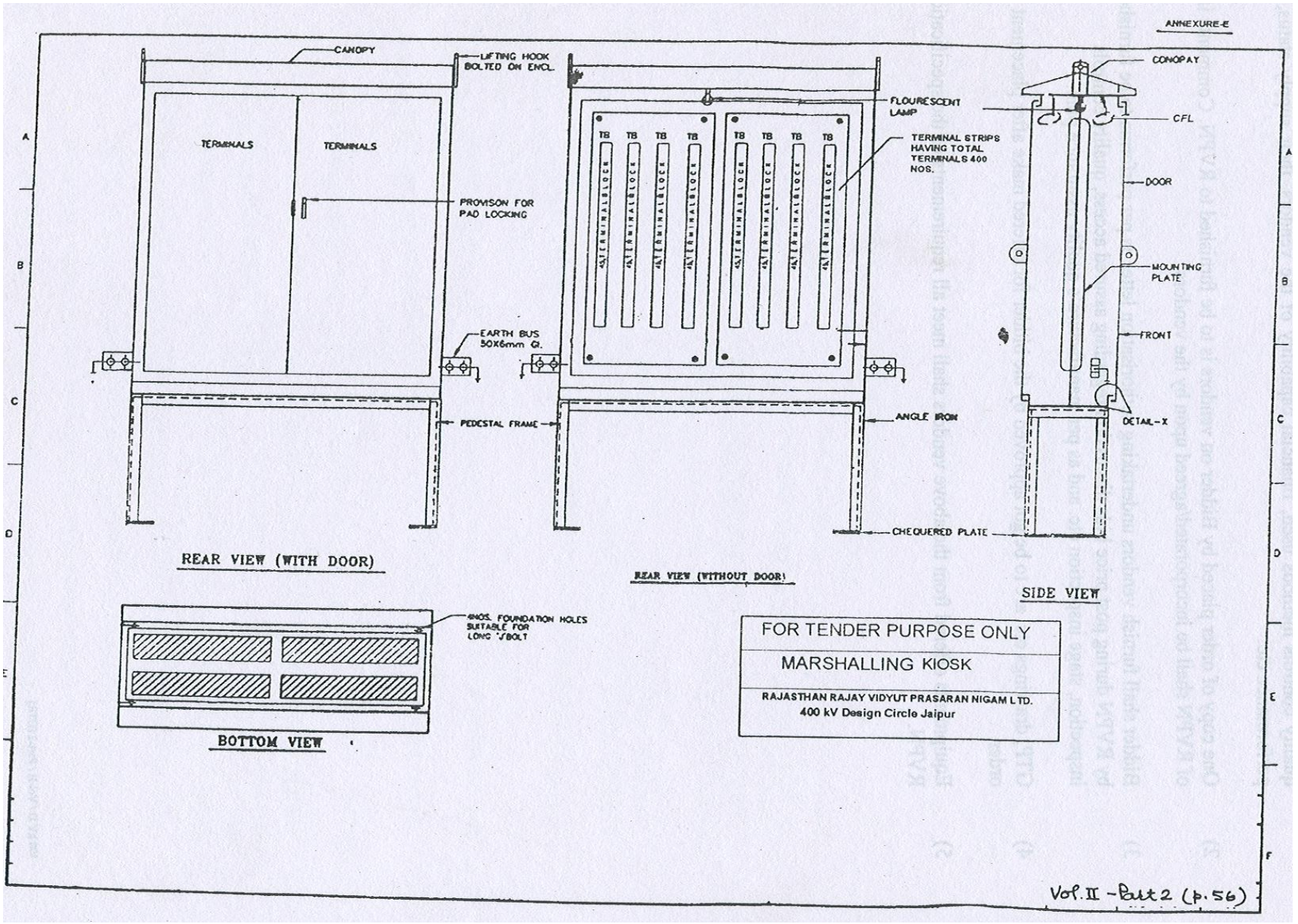
- **Control Room Building**

  Structure Design, Foundation Design & Drg., Plinth Beam Design & Drg. and column Design & Drg. Up to G.F. Level

- Auto transformer & Shunt Reactor foundation design/drawings

- Tower foundation design/drawings.

**NOTE:** The list of drawings/ documents mentioned above is a standard list. Some of the items may not be applicable and need not to be referred for a particular substation package.


ANNEXURE-E
CANOPY
LIFTING HOOK BOLTED ON ENCL.
TERMINALS
TERMINALS
PROVISON FOR PAD LOCKING
EARTH BUS 50X6mm GI.
PEDESTAL FRAME
FLOURESCENT LAMP
TERMINAL STRIPS HAVING TOTAL TERMINALS 400 NOS.
TB
4 TERMINAL BLOCK
ANGLE IRON
CHEQUERED PLATE
CONOPAY
CFL
DOOR
MOUNTING PLATE
FRONT
DETAIL-X
REAR VIEW (WITH DOOR)
REAR VIEW (WITHOUT DOOR)
SIDE VIEW
4NOS. FOUNDATION HOLES SUITABLE FOR LONG 'J'BOLT
BOTTOM VIEW
FOR TENDER PURPOSE ONLY
MARSHALLING KIOSK
RAJASTHAN RAJAY VIDYUT PRASARAN NIGAM LTD.
400 kV Design Circle Jaipur
Vol. II - Part 2 (p. 56)

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

# CONTROL & RELAY PANEL

**Part- 3**
**(Section-I)**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-3 (Section-I)**
**(Vol. II)**
**CONTROL & RELAY PANEL**

**INDEX**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**Annexure- V2P3(Sec.I) -1: Technical particulars for bushing current transformer of Reactor & NGR**
**Annexure- V2P3(Sec.I) -2: Technical particulars for bushing current transformer of Auto-Transformer**

**PART-3 (Vol. II)**
**Section-I**

**Technical Specification for Control & Relay Panel**

## 1.0 SCOPE

1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection & testing before supply, delivery and erection, testing & commissioning at site of control & relay panels ( Applicable for Sub-Station with Automation System), GPS based time synchronizing equipment, Event Logging and Disturbance Recording, Disturbance to fault locating etc., for 400 / 220 /33 kV Substation with complete with all fittings, wirings, accessories, associated equipment and mandatory spares specified herein which are required for efficient and trouble free operation as specified hereunder.

1.2 The integration/interfacing of the C&R panels to be supplied as above with the existing panels/arrangement in terms of matching with the panels, inter panel wiring, extension of D.C./A.C. supplies, inter-locking /inter-tripping, synchronizing etc. shall be in the bidderôs scope.

1.3 It is not the intent to specify completely herein all the details of the design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation up to the bidderôs guarantee, in a manner acceptable to the Purchaser, who will interpret the meanings of drawings and specifications and shall have the power to reject any work or material which, in his judgment, is not in accordance therewith. The offered equipment shall be complete with all components (hardware as well as software), necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidderôs supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

## 2.0 STANDARDS

2.1 The Relays, associated components and enclosures shall conform to the latest issues of Standards as given below, except to the extent explicitly modified in the specification.

| Standards | Title |
|---|---|
| IS-1248 | General requirements of indicating and integrating meters. |
| IS-2705 | Current transformers |
| IS-4201 | Application guide for current transformers. |
| IS-2419 | Dimensions of panel mounting and indicating and recording instruments. |
| IS-3156 | Potential Transformers |
| IS-3043 | Code of practice of earthing. |
| IS-8530 | MDI |
| IS-11426 | Ac precision KWH meter of class 0.5 for testing purposes. |
| IS-13010 | Energy meters. |
| IS-9224 | Energy meters. |
| IS-3202 | Climatic proofing for electrical equipment. |
| IS-345 | Code for wiring numbers. |
| IS-6005 | Code of practice for phosphate, Iron and steel. |

| | |
|---|---|
| IS-6875 | Control switches (LV switches device for control and auxiliary circuits) |
| IS-1554 | PVC insulated cable up to and including 1000V |
| IS-5578 | Marking of insulated conductors. |
| IS-2147 | Degrees of protection provided by enclosures for low voltage switchgear and control gear. |
| IS-5 | Colors for ready mix paints. |
| IS-722, IS-1248 IS-3231,3231 (p-3) | Electrical relay for power system Protection |
| IEC-255 (Part1 to Part23) | Electrical Relays |
| ANSI-C37.1 | Relays, Station control etc. |
| ANSI-C37.2 | Manual and automatic station control, supervisory and associated telemetering equipment |
| ANSI-C37.2 | Relay and relay system associated with electric power apparatus |
| IS-5039 | Distribution pillars for voltages not exceeding 1000 Volts |
| IEC-68.2.2 | Basic environmental testing procedures Part2:TestB:Dry heat |
| IEC-529 | Degree of Protection Provided by enclosures |
| IEC-158 (upto p3) | Low voltage control gear controls |
| IEC-439 (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 | Component for electric Equipment |
| IS-8623 (P1 to 3) | Specification for switchgear and control assemblies. |
| NEMA-AB | Molded case circuit and systems. |
| NEMA-CS | Industrial controls and systems. |
| NEMA-PB-1 | Panel Boards. |
| NEMA-SG-5 | Low voltage power circuit breaker. |
| NEMA-SG-3 | Power switchgear assemblies. |
| NEMA-SG-6 | Power switching equipments. |
| NEMA-5E-3 | Motor Control centers. |

2.2 In case equipment conforms to other International Standards, which ensure equivalent or better performance than that specified under clause 2.0, then the English version of such Standards or the relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately in additional information schedule.

## 3.0 PRINCIPAL PARAMETERS

3.1 Relay panels for 400 & 220 kV systems shall be as per requirement of single line diagram enclosed in the specification.

3.2 CT & CVT Details: -

3.2.1 The detail of secondary windings of current transformers and CVT to be used for protection schemes and metering etc. are as per the respective specification of the equipment enclosed.

3.2.2 Bushing CTs in Auto-Transformer / shunt Reactor are to be provided and their details are given at Annexure I & II.

**4.0 GENERAL TECHNICAL REQUIREMENTS**

4.1. CONSTRUCTION FEATURES

4.1.1 Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from bottom of the panel. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built-in locking facility or will be provided with pad-lock.

4.1.2 Relay panels shall be of simplex type design as indicated**. However simplex / duplex Control & Relay panels with corridor shall be provided to match the type of panels at the remote ends**. It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective / control schemes is properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions. No price increase at a later date on this account shall be allowed.

4.1.3 Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IS:2147.

4.1.4 Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

4.1.5 All doors, removable covers and panels shall be gasketed all around with synthetic rubber gaskets Neoprene / EPDM generally conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

4.1.6 Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, reivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.

4.1.7 Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels / insert plates. Anti vibration strips made of shock absorbing materials which shall be supplied by the contractor, shall be placed between panel & base frame.

4.1.8 Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel / station through a flexible braided copper conductor rigidly.

4.1.9 Relay panels of modern modular construction would also be acceptable.

4.2.0 MOUNTING

4.2.1 All equipments on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush.

4.2.2 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

4.2.3 The Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others (including owner) which are to be mounted in his panel in accordance with the corresponding equipment manufacturerôs drawings. Cut outs, if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

4.2.4 No equipment shall be mounted on the doors.

4.3 PANEL INTERNAL WIRING

4.3.1 Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally.

4.3.2 All wiring shall be carried out with 650V grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of the mult-stranded copper conductor used for internal wiring shall be as follows :-

- All circuits except current transformer circuits and voltage transfer circuits meant for energy metering ï one 1.5 sq.mm per lead.
- All current transformer circuits : one 2.5sq.mm per lead.
- Voltage transformer circuit (for energy meters ) : Two 2.5mm sq. per lead.
- 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), Gray for DC (Negative).

4.3.3 All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.

4.3.4 Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

4.3.5 Wire termination shall be made with solderless crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engrave core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

4.3.6 Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

4.3.7 Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.

4.4 TERMINAL BLOCKS

4.4.1 All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 650V grade and have 10 Amps. Continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

4.4.2 Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

4.4.3 At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

4.4.4 Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side.

- AII CT & PT circuits : minimum of two of 2.5mm sq. Copper.
- AC/DC Power Supply Circuits : One of 6mm Sq. Copper.
- All other circuits : minimum of one of 2.5 mm Sq. Copper.

4.4.5 There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150 mm.

4.4.6 Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

4.4.7 All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included in the scope of supply.

4.5. PAINTING

4.5.1 All sheet steel work shall be phosphated in accordance with the IS:6005 ñCode of practice for phosphating iron and steelò.

4.5.2 Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

4.5.3 Rust and scale shall be removed by pickling with dilute acid followed by washing with running water rinsing with a slightly alkaline hot water and drying.

4.5.4 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

4.5.5 The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be ñflash driedò while the second coat shall be stoved.

4.5.6 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. The exterior colour of paint shall be of a slighity different shade to enable inspection of the painting.

4.5.7 A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.

4.5.8 In case the bidder proposes to follow any other established painting procedure like electrostatic painting, the procedure shall be submitted for RVPNôs review and approval.

4.6.0 NAME PLATES AND MARKING

4.6.1 All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold nameplates shall be provided for circuit / feeder designation.

4.6.2 All front mounted equipment shall also be provided at the rear with individual name plates energraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

4.6.3 All relays and other devices shall be clearly marked with manufacturerôs name, manufacturerôs type, serial number and electrical rating data.

4.6.4 Name Plates shall be made on non-rusting metal or 3 ply lamicold. Name plates shall be black with white engraving lettering.

4.6.5 All the panels shall be provided with name plate mounted inside the panel bearing P.O. No. & Date, Name of the Substation & feeder and reference drawing number.

4.7. MISCELLANEOUS ACCESSORIES

4.7.1 Plug Point : 240V, Single phase 50 Hz, AC socket with switch suitable to accept 5 Amps and 15 amps pin round standard Indian plug. Shall be provided in the interior of each cubicle with ON-OFF switch.

4.7.2 Interior Lighting : Each panel shall be provided with a fluorescent lighting fixture rated for 240Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.

4.7.3 Switches and Fuses : Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective

clearance of sub-circuit faults. MCBs shall confirm to IS:13947. Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. However voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS:13703 mounted on plug-in type fuse bases. Fuse carrier base as well as MCBs shall have imprints of the fuse órating and voltageô.

4.7.4 Space Heater ; Each panel shall be provided with a space heater rated for 240V, single phase, 50 Hz Ac supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

4.8. EARTHING

4.8.1 All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25x6 sq. mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc. for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

4.8.2 Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of contractor.

4.8.3 All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The colour code of earthing wires shall be green.

4.8.4 Looping of earthing connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. Earthing may be done in such a manner that no circulating current shall flow in the panel.

4.8.5 VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

4.8.6 An electrostatic discharge point shall be provided in each panel connected to earth bus via 1 Mega Ohm resistor.

5.0 **RELAY**

5.1 All relays shall conform to the requirements of IS:3231/IEC-60255 /IEC 61000 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.

**5.2** IEC-61850 standards are well defined with various functionalities, conformance testing etc. It is not the intention of the specification to mention any specific laboratory, **however certificate of KEMA / Own testing simulator having facilities accredited by KEMA / UCA shall be acceptable.**

5.3 All protective relays shall be in draw out or plug in type / modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractorôs scope of supply.

5.4 All AC operated relays shall be suitable for operation at 50 Hz, AC voltage operated relays shall be suitable for 110 Volts CVT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

5.5 The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs on contacts as required to complete the scheme and the contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay coils and contacts, including spare contacts.

5.6 All protective relays, auxiliary relays and timers except the lock out relays and interlocking relays specified shall be provided with self-reset type contacts. All protective relays and timers shall be provided with externally hand reset positive action operation indicators with inscription. All protective relays which do not have built in hand reset operation indicators shall have additional auxiliary relays with operating indicators (Flag relays) for this purpose. Similarly, separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as buchholtz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.

5.7 Timers shall be solid state type. Pneumatic timers are not acceptable. Short time delays in terms of milliseconds may be obtained by using copper slugs on auxiliary relays. In such case it shall be ensured that the continuous rating of the relay is not affected. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided to the extent possible.

5.8 No control relay which shall trip the power circuit breaker when the relay is de-energised shall be employed in the circuits.

5.9 Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

5.10 Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured :

a) The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.

b) Seal-in-unit shall obtain adequate current for operation when one or more relays operate simultaneously.

c) Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the DC supply Voltage is minimum.

d) Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s), but also the relevant initiation signals to other scheme functions. (e.g. initiate signals to the circuit breaker failure function, reclosing function etc.) and the alarm output signals.

e) Two methods of seal-in are required, one based on the measurement of AC current catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).

f) For the current seal-in method, the seal-in shall be maintained until the circuit breaker opens, at which time the seal-in shall reset and the seal-in method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for singe and three pole tripping.

g) Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping. Trip-circuit seal-in shall not take place under sub-harmonic conditions (e.g. reactor ring down).

5.11 All protective relay and alarm relay shall be provided with one extra isolated pair (one NO & NC) of contacts wired to terminals exclusively for future use.

5.12 The setting ranges of the relays offered, if different from the ones specified, shall also be acceptable if they meet the functional requirements.

5.13 Any alternative/additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/additional equipment shall lie with the Purchaser.

5.14 The bidder shall include in his bid a list of installations where the relays quoted have been in satisfactory operation.

5.15 All relays and their drawings shall have phase indications as R-Red, Y-Yellow, B-Blue, N- Neutral.

5.16 For numerical relays used, the scope shall include the following;

i) Necessary software and hardware alongwith laptop to up / down load the data / from the relay from / to the laptop. The supply of laptop is covered under this scope.

ii) The relay shall have suitable communication facility to connect substation LAN on IEC 61850 as defined in the section-II ñSubstation Automation Systemò.

## 6.0 TRANSDUCERS AND ENERGY METER

### 6.1 Transducers

6.1.1 Transducers (Telemetry/Data communication application) shall in general conform to IEC 681-1.

6.1.2 The transducers shall be suitable for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.

6.1.3 The input to the transducers will be from substation current & potential transformers. The output shall be in milli ampere DC proportional to the input & it shall be possible to feed the output current directly to the telemetry terminal or indicating instruments.

6.1.4 The transducer characteristic shall be linear through out the measuring range.

6.1. 5 The transducer characteristic shall be load independent.

6.1. 6 The input & output of the transducer shall be galvanically isolated.

6.1.7 The transducer shall derive its auxiliary supply from the quantity to be measured without need for any external auxiliary supply.

6.1.8 Each transducer shall be housed in a separate compact case and have suitable terminals for inputs and outputs.

6.1.9 The transducers shall be suitably protected against transient high peaks of voltage & current.

6.1.10 The transducers shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 120% of the rated input current as applicable.

6.1.11 The voltage, frequency & current transducers shall have an output of 0-10mA and the active and reactive power transducer shall have an output of 10-0-10mA.

6.1.12 The response time of the transducers shall be less than 1 second.

6.1.13 The accuracy class of transducers shall be 1.0 or better for voltage/current transducer, 0.5 or better for watt/VAR transducer and 0.2 better for frequency transducer.

6.1.14 The transducers shall have allow AC ripple on output less than 1%.

6.1.15 The transducer shall be suitable for load resistance of 1000-1500.

6.1.16 The transducer shall have dual output.

6.2 The following type of energy meters will be arranged by RVPN.

1. AC HT Static inter utility availability base tariff TVM Class 0.2 s for EHV system
2. AC HT Static Trivector Meter TOD type class 0.2 s
3. AC HT Static Trivector Meter TOD type 0.5s.

The contractor shall provide cutout with mounting arrangement and wiring for installation of these energy meters on the relay panels as per details furnished/approved during detailed engineering by the purchaser.

## 7.0 PROTECTION SCHEMES

All main protective relays, to be provided, shall be numerical type. Bidders should offer most reliable numerical relays.

## 7.1 REACTOR PROTECTION

7.1.1 Numerical Differential Protection shall

a) be triple pole type
b) have operational time less than 25 milli-seconds at 5 times setting.
c) be tuned to system frequency
d) have current setting range of 10 to 40% of 1 Amp. Or a suitable voltage setting range.
e) be high impedance / biased differential type.
f) be stable for all external faults

7.1.2 High Impedance Differential (Circulating Current) Protection:- This differential protection shall be based on circulating current principle using high impedance differential relay of numerical type IEC 61850 compliant.

The relay shall:-

a) provide separate indication for each phase.
b) high speed circulating current type.
c) have current setting of 10-50% in minimum step of 10%
d) tuned to supply frequency and reject harmonics.
e) provided with continuously adjustable stabilizing resistance.
f) suitably protected against high voltages by suitable non-linear resistance.
g) have alarm and trip output contacts.
h) high impedance differential relay shall not be part of any other relay.

7.1.3 Restricted earth fault protection Relay shall

a) be single pole and numerical type.
b) be of current / voltage operated high impedance type.
c) have a current setting of 10-40% of 1 amp/ have a suitable voltage setting range.
d) be tuned to system frequency.
e) have a suitable non-linear resistor to limit the peak voltage to 1000 volts.

7.1.4 Numerical Back up impedance protection Relay shall

a) be triple pole type, with faulty phase identification /indication.
b) be single step polarized ómhoô distance / impedance relay suitable for measuring phase to ground and phase to phase faults.
c) have adequate ohmic setting range to cover at least 60% of the impedance of the reactor and shall be continuously variable.
d) have an adjustable characteristic angle of 30-80 degree.

e) have a definite time delay relay with a continuously adjustable setting range of 0.2-2.0 seconds.

f) include VT failure relay which shall block the tripping during VT fuse failure condition.

## 7.2 TRANSMISSION LINE PROTECTION

7.2.1 The protection scheme offered shall be suitable for 400 and 220kV three phase lines.

7.2.2 The line protection relays are required to protect and clear the faults with reliability, selectively for all type of faults under all system conditions in the shortest possible time to ensure system stability.

7.2.3 The maximum fault current could be as high as 40 kA but the minimum fault current could be as low as 20% of rated current of CT secondary. The starting & measuring relays characteristics should be satisfactory under these extremely varying conditions.

7.2.4 The protection schemes shall co-ordinate with the carrier schemes.

7.2.5 The protective relays shall be suitable for use with capacitor voltage transformers having non-electronic damping and transient response as per IEC.

7.2.6 The Main-I and Main-II protection schemes of the transmission line shall be of different makes, based on different principle/algorithm of operation to avoid the common mode failures.

7.2.7 The scheme shall be provided with following protection functions for each of the transmission lines.

i) Main-I: Numerical full scheme distance protection for use with PLCC scheme (permissive under-reach and over-reach blocking) and have facility for connecting to substation control system/SCADA.

ii) Main-II: Numerical full scheme distance protection for use with PLCC scheme (permissive under-reach and over-reach blocking) and have facility for connecting to substation control system/SCADA.

iii) Back-up Directional Over current and Earth fault protection (Numerical type) with non-directional facility.

iv) Auto reclosing scheme either inbuilt in both Main-I & Main-II or one common separate scheme

v) Independent Local breaker back up protection (Not included in any other scheme).

vi) LBB Relay shall not be part of any other relay.

7.2.8 The detailed specifications of the above line protection scheme is given here under:-

(i) Main-I & Main-II: These protections

Shall be numerical type & modular in construction

Shall be non-switched type with separate zone measurements for all phase to phase and phase to ground faults. Zone switching to extend the reach of the measuring elements also not allowed.

Shall be high speed full scheme distance relay for three phase systems to clear all type of line faults within the set reach of the relay.

Shall have stepped time-distance characteristics and three independent zones (zonal 1, Zone 2 and Zone3)

Shall have mho or quadrilateral or other suitably shaped characteristics for zone1, zone2, zone3.

The relay shall have an adjustable characteristics angle setting range of 30 to 75 degree or shall have independent resistance (R) and reactance (X) setting.

Shall have two independent continuously variable time setting range of 0 to 3 seconds for zone-2 and 0 to 5 second for zone-3.

Shall have resetting time of less than 55 miliseconds or lower (including the resetting time of trip relays).

Shall have facilities for offset features with adjustable 10-20% of zone-3 setting.

Shall have variable residual compensation.

Shall have memory circuits with defined characteristics in all three phases to ensure correct operations during close-up 3-phase faults and other adverse conditions and shall operate instantaneously when circuit breaker is closed to zero volt 3 phase fault.

The resistive reach shall be separately settable for phase-phase and phase-ground faults for each zone.

It shall also have a facility to store different settings suitable for different configurations to cater for mutual coupling on account of multi circuit line conditions.

have the following built in features

Power swing Block ï which blocks tripping during power swing conditions and have suitable setting range to encircle the distance protection described above.

Fuse failure protection shallï .

monitor all the three fuses of CVT and associated cable against open circuit.

Inhibit trip circuits on operation and initiate annunciation.

Have an operating time less than 7 miliseconds.

Remain inoperative for system earth faults.

Weak end infeed and current reversal logic.

Stub protection

1. Phase selection features for single pole auto-reclosure & cross country faults

Power system monitoring in terms of

Broken conductor detection

Overload

be suitable for single and three phase tripping.

shall have following maximum operating time(including trip relay time, if any) under given set of conditions and with CVT being used on line(With all filters included).

| | | |
|---|---|---|
| 1 | Source to Impedance Ratio(SIR) | 4 |
| 2 | Relay setting(Ohms) | 10&2 |
| 3 | Fault Location | 50% |
| 4 | Fault Resistance(Ohms) | 0 |
| 5 | Maximum operating time(m.sec) | 40 for all faults |

The scheme shall be suitable for various overreaching, under-reaching and blocking communication schemes.

The Scheme shall be provided with continuous self supervision features along with self diagnostic feature.

The scheme shall provide the user with complete information on at least latest 5 disturbances. Facility for retrieving this information remotely shall be possible.

Service values of voltage alongwith phase angle, current alongwith phase angle, frequency, active power and reactive power shall be available. Pre-fault and fault values of currents and voltages must be available for fault analyzing purposes. Facility to have remote communication for the purpose of parameterization and reading service values should be possible with suitable software and hardware.

Shall have suitable number of potential free contacts for carrier aided Tripping, Auto reclosing, Event Logging, Disturbance recorder & data acquisition system.

The scheme shall have built-in event recorder, which can record at least 100 events with the time resolution of 1 msec.

The scheme shall have capability to time synchronize with the external GPS signal.

The scheme shall have adequate serial and fibre optic communication ports for communication. The ports shall be used for configuration of the relay and disturbance data monitoring from local/remote and for the purpose of communicating to substation SCADA. All the necessary software and hardware required for remote configuration and for disturbance analysis shall be in the scope of the supplier.

The local and remote communications shall be as per internationally acceptable IEC 61850 protocols.

The scheme shall be provided with a front mounted menu driven human-machine-interface and/or local front port for local parameterization with suitable security provisions for unauthorized access to settings.

Shall have a continuous current rating of two times of rated current. The voltage circuit shall be capable of operation at 1.2 times rated voltage. The relay shall also be capable of carrying a high short time current of 70 times rated current without damage for a period of 1 sec.

Shall be provided with necessary self reset type trip duty contacts for completion of the scheme (minimum number of these trip duty contacts shall be four per phase) either through built in or through separate high speed trip relays. Making capacity of these trip contacts shall be 30 Amps. For 0.2 seconds with an inductive load of L/R > 10 milliseconds. If separate high speed trip relays are used, the operating time of the same shall not be more than 10 milliseconds.

(ii) AUTO RECLOSING RELAY: This shall

i) have single phase and three phase reclosing facilities with selectable single shot type.

ii) have continuously variable single phase dead time range of 0.1-2 seconds.

iii) have a continuously variable three phase dead timer range of 0.1 ï 2 seconds.

iv) have a continuously variable reclaim timer range of 5-60 seconds.

v) have a logic from which single phase and three phase auto reclosure mode can be selected. Alternatively, the mode of auto reclosing can be selected through programming.

vi) have facilities for selecting check synchronizing or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.

vii) have priority circuit to closing of both circuit breakers in case one and half breaker arrangements to allow sequential closing of breakers.

viii) Continuous self supervision feature

ix) Inputs to the auto-reclosure for breaker ready signal and breaker status.

x) Work in co-ordination with a check synchronizing function.

(iii) Back-up Directional over Current and Earth fault Protection Scheme: This shall,

have three over current and one earth fault elements(s) which shall be either independent or composite unit(s).

shall be numerical type.

shall include necessary CVT fuse failure relays for alarm purposes.

Directional over current relay (with facility of non-directional):

have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting.

Have a variable setting range of 50-200% of rated current.

Have a characteristic angle of 30/45 degree lead.

Include hand reset flag indicators or LEDs

Directional Earth fault relay(with facility of non-directional):

.Have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times.

Have a variable setting range 20-80% of rated current.

Have characteristic angle of 45/60 degree lag.

Include hand reset flag indicator or LEDs

Include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay.

(iv) LINE OVER VOLTAGE PROTECTION

This shall monitor all three phases.

Have two independent stages.

Have an adjustable setting range of 100-170% of rated voltage with an adjustable time delay range of 1 to 60 seconds for the first stage.

Have an adjustable setting range of 100-170% of rated voltage with a time delay of 100-200 milli seconds for the second stage.

Be tuned to power frequency.

Provided with separate operation indicators (flag target) for each stage relays.

Have a drop-off to pick-up ratio greater than 95%.

Provide separate out-put contacts for each ôPhaseô and stage for breaker trip relays, event logger and other scheme requirements

(v) CIRCUIT BREAKER PROTECTION:

1. The protection scheme shall be so designed that if any circuit breaker fails to trip in the event of a fault, then after a short time delay, all the circuit breakers connected to the points or bus sections to which faulted circuit breaker is connected will be tripped. In case of failure of transformer breaker on any side of the transformer, breaker on other sides of the transformer shall be tripped. Number of circuit breakers so tripped may ultimately be as high as 8 for outer 420 kV breakers and 2 for central 420 kV breaker. On 220kV side, breaker shall be tripped through respective bus bar protection zone and tripping relays necessary for initiating tripping of breakers of existing buses of 220kV substation shall be provided.
2. LBB Protection: This shall,

be independent triple pole type.

Have on operating time of less than 15 ms.

Have a resetting time of less than 15 ms.

Have two O/C & One E/F elements

Have a setting range of 50-200% of rated current for phase over current & 20-80% for earth fault.

Have a continuous thermal withstand of two times rated current irrespective of the setting.

Shall have timer with continuous adjustable setting range of 0.1-1 seconds.

Have necessary auxiliary relays to make a comprehensible scheme.

Shall be arranged to get individual initiation from the corresponding phase of main protections of line for each over current / earth fault element. However, common three phase initiation is acceptable for other protections.

(vi) DISTURBANCE RECORDING: The disturbance recording function shall have following features:

shall be able to record continuously and will have 8 analogue inputs and 32 digital inputs.

shall have a scan rate of 1 KHz or better.

It should be possible to trigger the recorder from any analogue inputs (Over and/or Under Voltage / Current) and on any digital input.

shall have provision to accept external signals for triggering.

shall have adjustable pre-fault and post fault time settings.

Total recording time shall be 20 sec

(vii) FAULT LOCATING: The fault location function shall;

a) be microprocessor based type
b) be ñOn-Lineò type
c) be suitable for breaker operating time of 2 cycles.
d) have built in display unit
e) the display shall be directly in percent of line length or Kilometers without requiring the further calculations.
f) have an accuracy of 3% or better for the typical conditions defined for operating timings measurements of distance relay.
g) The above accuracy should not be impaired under the following conditions:
h) Presence of remote end infeed
i) Predominant D.C. component in fault current
j) High fault arc resistance
k) Severe CVT Transients.
l) shall have mutual zero sequence compensation unit for fault locator to be used on double circuit lines.

(viii) SYNCHRONIZING/ENERGISATION: Synchro-check function and dead bus / dead line charging shall:

have a time setting continuously variable between 0.5-5 seconds. With a facility of additional 10 seconds.

have a response time within 200 milliseconds with the timer disconnected.

have a phase angle setting not exceeding 35 degrees.

have a voltage difference setting not exceeding 10%.

have function to measure the bus and line voltages and their comparison to high and low threshold values before initiating output.

## 7.3 TRANSFORMER PROTECTION

7.3.1 Numerical transformer Differential Protection: The Main-I and Main-II protection scheme for the transformers shall be of different makes, based on different principle / algorithm of operation to avoid the common modes failures. The relay (s) shall

a) be triple pole type, with faulty phase identification/ Indication

b) have an operating time not greater than 30 milli seconds at 5 times setting
c) have three instantaneous high set over-current units
d) have an adjustable bias setting range of 20-50%
e) be suitable for rated current of 1 Amp.
f) have second harmonic or other inrush proof features and also should be stable under normal over fluxing conditions. Magnetizing inrush proof feature shall not be achieved through any intentional time delay e.g use of timers to block relay operation or using disc operated relays
g) have an operating current setting of 15% or less
h) include necessary separate interposing current transformers for angle and ratio correction or have internal feature in the relay to take care of the angle & ratio correction
i) shall have continues self monitoring and diagnostic feature
j) have a disturbance recording feature to record graphic form of instantaneous values of current in all three windings in nine analog channels during faults and disturbances for the pre fault and post fault period. The disturbance recorder shall have the facility to record the following external digital channel signals apart from the digital signals pertaining to differential relay.

    1. REF protection operated
    2. HV breaker status (Main and tie)
    3. LV breaker status
    4. Bucholtz /OLTC Bucholtz alarm / trip
    5. WTI/OTI/PRD alarm/trip of transformer

k) be acceptable with built in features of definite time over load protection (alarm) relay provided the technical requirements of these relays specified under the relevant clauses are met.

7.3.2 High Impedance Differential (Circulating Current) Protection:- This differential protection shall be based on circulating current principle using high impedance differential relay of numerical type IEC 61850 compliant.

The relay shall:-

i) provide separate indication for each phase.
ii) high speed circulating current type.
iii) have current setting of 10-50% .
iv) tuned to supply frequency and reject harmonics.
v) provided with continuously adjustable stabilizing resistance.
vi) suitably protected against high voltages by suitable non-linear resistance.
vii) have alarm and trip output contacts.
viii) high impedance differential relay shall not be part of any other relay.

7.3.3 Over Fluxing protection Relays shall

a) Operate on the principle of voltage to frequency ratio and shall be phase to phase connected.

b) Have inverse time characteristics, matching with transformer over fluxing withstand capability curve.
c) Provide an independent óalarmô with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of v/f between 100% to 130% of rated values.
d) Tripping time shall be governed by v/f Vs. time characteristics of the relay.
e) Have a set of characteristics of various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at v/f values of 1.4 and 1.5 times, the rated values respectively.
f) Have an accuracy of operating time, better than ± 10%.
g) Have a resetting ratio of 95 % or better.

7.3.4 Numerical Restricted Earth Fault Protection shall

a) Be single pole type
b) Be of current / voltage operated high impedance type
c) Have a current setting range of 10-40% of Amp. Have a suitable voltage setting range.
d) Be tuned to the system frequency.

7.3.5 Numerical Back-up Over Current and Earth fault protection scheme with high set features.

a) Shall have three over current and one earth fault element(s) which shall be either independent or composite units(s).
b) The schemes shall include necessary VT fuse failure relays for alarm purposes.
c) Over current relay shall

- Have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current.
- Have low transient, over reach high set instantaneous unit of continuously variable setting range 500-2000% of rated current.
- Have a characteristic angle of 30/45 degree lead.
- Include hand reset flag indicators or LEDs.

d) Earth fault relay shall

- Have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current.
- Have low transient, over reach high set instantaneous unit of continuously variable setting range 200-800% of rated current.
- Have a characteristic angle of 45 / 60 degree lag.
- Include and reset flag indicators or LEDs
- Include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay.

7.3.6 Transformer overload Protection Relay shall

a) Be of single pole type
b) Be of definite time over current type
c) Have on set of over current relay element, with continuously adjustable setting range of 50-200% of rated current.

d) Have one adjustable time relay for alarm having setting range of 1 to 10.0 seconds, continuously.
e) Have a drop-off / pick up ratio greater than 95%.
f) Be acceptable as built in feature of numerical transformer differential relay.

7..3.7 TRIPPING RELAY: High speed tripping relay shall,

i) Be instantaneous (operating time not to exceed 10 milli second)
ii) Reset within 20 milliseconds.
iii) Be D.C. operated
iv) Have adequate contacts to meet the requirement of scheme, other function like auto-reclose relay, LBB relay as well as cater to event logging.
v) Be provided with operation indicators for each element/coil.

7.3.8 FLAG RELAYS: These shall have,

i. Hand reset flag indication
ii. Have minimum two contacts (NO or NC or combination as required) for each relay.

7..3.9 TRIP CIRCUIT SUPERVISION RELAY:

i. The relay shall be capable of monitoring the heathiness of each ópháseô trip coil and associated circuit of circuit breaker during óONô and óOFFô conditions.
ii. The relay shall have adequate contacts for providing connections to alarm and event logger.
iii. The relay shall have time delay on drop-off of not less than 200 milliseconds and be provided with operation indications for each phase.

7.3.10 DC SUPPLY SUPERVISION RELAY:

i. The relay shall be capable of monitoring the failure of D.C. Supply to which, it is connected.
ii. It shall have adequate potential free contacts to meet the scheme requirements.
iii. The relay shall have a ótime delay on drop off of not less than 100 milliseconds and be provided with operation indicator/flag.

## 7.4 BUSBAR PROTECTION:

7.4.1 Numerical bus bar protection for 400kV one and half breaker scheme shall be provided as two zone scheme

7.4.2 Numerical bus bar protection for double main & transfer switching scheme (Refer single line diagram) for 220kV shall be provided as four zone scheme.

7.4.3 Each Bus Bar protection scheme shall

a) Have maximum operating time up to trip impulse to trip relay for all types of faults of 25 milli seconds at 5 times setting value.
b) Operate selectively for each bus bar.
c) Give hundred percent security up to 40 kA fault level upto 40 kA for fault level for 400 kV and 220 kV.

d) Incorporate continuous supervision for CT secondary against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate an alarm.
e) Not give false operation during normal load flow in bus bars.
f) Incorporate clear zone indication.
g) Be of phase segregated and triple pole type
h) Provide independent zones of protection (including transfer bus if any).
i) Include individual high speed electrically reset tripping relays for each feeder
j) Be transient free in operation
k) Include continuous DC supplies supervision.
l) Not cause tripping for the differential current below the load current of heavest loaded feeder. Bidder shall submit application check for the same.
m) Shall include necessary CT switching relays wherever CT switching is involved and have CT selection incomplete alarm.
n) Include protection ôIN / OUTô switch for each zone.
o) Shall include trip relays, CT switching relays (if applicable), auxiliary CTs(if applicable) as well as additional power supply modules, input modules etc. as may be required to provide a bus bar protection scheme for the complete bus arrangement ie. For all the bay or breakers under this specification as per the single line diagram for substation.
p) Have through fault stability against CT saturation.

7.4.4 The busbar protection schemes is already provided at the 400 kV GSS where the bay works are to be carried out under this project. The existing busbar protection schemes at 400kV GSS Bikaner is mentioned below for the bidderôs reference:

| S. No. | Name of Substation | Type/ Make of Busbar Protection/ Schemes (**2Nos.**) are provided on the 400 kV Side | Type/ Make of Busbar Protection/ Scheme (**1No.**) is provided on the 220 kV Side |
|---|---|---|---|
| 1. | 400 kV GSS Barmer & Akal-1 | M/s. Areva make integrated Busbar Protection Central Unit (Model- MICOM -P741) and Peripheral Unit (PU) (Model- MICOM -P743) | M/s. Areva make integrated Busbar Protection Central Unit (Model- MICOM -P741) and Peripheral Unit (PU) (Model- MICOM -P743) |

## 8. DISTANCE TO FAULT LOCATOR FEATURE :

a) be electronic or microprocessor based type.
b) be ôOn-lineô type
c) be suitable for breaker operating time of 2 cycles
d) have built-in display unit
e) the display shall be directly in percent of line length or kilometers without requiring any further calculations.
f) have an accuracy of 3% or better for the typical conditions defined for operating timings measurement of distance relays.
g) The above accuracy should not be impaired under the following conditions :

- Presence of remote end infeed.
- Predominant DC component in fault current.
- High fault arc resistance

- Severe CVT transients.

h) shall have mutual zero sequence compensation unit if fault locator is to be used on double circuit transmission line.

i) built in features of line distance relay is acceptable provided the requirements of above clauses are met.

## 9.0 TIME SYNCHRONISATION EQUIPMENT

9.1 The Time Synchronization equipment shall receive the co-ordinated Universal Time (UTC) transmitted through Geo Positioning Salellite System (GPS) and synchronise equipments to the Indian Standard Time in a substation.

9.2 Time Synchronisation equipment shall include antenna, all special cables and processing equipment etc.

9.3 It shall be compatible for synchronization of Event Loggers, Disturbances recorders and SCADA at a substation through individual port or through Ethernet realized through optic fibre bus.

9.4 Equipment shall operate up to the ambient temperature of 50 degree centigrade and 100% humidity.

9.5 The synchronization equipment shall have 2 micro second accuracy. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, & temperature variations, propsagation & processing delays etc.)

9.6 Equipment shall meet the requirement of IEC 60255 for storage and operation.

9.7 The system shall be able to track the satellites to ensure no interruption of synchronization signal.

9.8 The output signal from each port shall be programmable at site for either one hour, half, hour, minute or second pulse, as per requirement.

9.9 The equipment offered shall have six (6) output ports. Various combinations of output ports shall be selected by the customer, during detailed engineering from the following :

- Voltage signal : Normally 0-5 V with 50 milli seconds minimum pulse duration. In case any other voltage signal required, it shall be decided during detailed engineering.
- Potential free contact (Minimum pulse duration of 50 milli seconds)
- IRIG-B
- RS232C

9.10 The equipment shall have a periodic time correction facility of one second periodicity.

9.11 Time synchronization equipment shall be suitable to operate from 220V DC or 110V DC as available at Substation.

9.12 Equipment shall have real time digital display in hour, minute, second (24 hour mode) and have a separate time display unit to be mounted on the top of control panels having display size of approx. 100mm height.

## 10.0 EVENT LOGGING

i) The event logging function shall be part of BCU/BPU and will be used to record open and close states of switchyard equipment, relays and changes of alarms.
ii) The equipment is used to record changes in digital events. When such changes occur in display in HMI as well as print out on printer should result.
iii) The printout of the events shall contain at least the station identification, date & time ( in hour, minutes, seconds & milliseconds) , event number and event description (at least 40 characters).s

## 11.0 CONFIGURATION OF CONTROL & RELAY PANELS :-

(a) 400/220kV TRANSFORMER PROTECTION PANEL

The Protection panel for Transformer shall consist of the following.

| S.No. | Description of the relays / items | HV side | MV / LV side |
|---|---|---|---|
| 1. | Main-I Numerical differential Protection Relay (IEC-61850 Compliant) | 1Set | NIL |
| 2. | Main-II Numerical differential Protection Relay (IEC-61850 Compliant) | 1Set | NIL |
| 3. | High impedance differential (Circulating current ) Relay (IEC-61850 Compliant) | 1Set | NIL |
| 4. | Over flux protection Relay (IEC-61850 Compliant) | NIL | 1Set |
| 5. | Restricted earth fault Protection Relay (IEC-61850 Compliant) | 1 No. | NIL |
| 6. | Directional backup Over-Current & E/F relay with non directional high set feature (IEC-61850 Compliant). | 1 set | 1set |
| 7. | Transformer overload Protection Relay(IEC-61850 Compliant). | 1Set | NIL |
| 8. | Tertiary protection Neutral displacement Relay (IEC-61850 Compliant) | NIL | 1Set |
| 9. | CVT selection relays as per scheme requirement | LOT | LOT |
| 10. | Three phase trip relays | 2Nos. | 2Nos. |
| 11. | Flag relays, auxiliary Relays, timers etc. as per scheme requirements including transformer alarms and trip functions viz WTI/OTI/Buchholtz etc. | LOT | LOT |
| 12. | Cut out & wiring with TTB for Energy Meter. | 1Set | 1Set |

| | | | |
|---|---|---|---|
| 13. | Local Breaker failure Protection Relay (IEC-61850 Compliant) | 1Set | 1Set |
| 14. | Any other items | LOT | LOT |

**Note:- All Relays mentioned above shall not be part of any other Relay.**

(b) 400 /220 kV LINE PROTECTION PANEL:

| S.No. | Description of the relays / items | 400kV | 220kV |
|---|---|---|---|
| 1. | Main-I Numerical Distance Protection Relay (IEC-61850 Compliant) | 1 Set | 1 Set |
| 2. | Main-II Numerical Distance Protection Relay (IEC-61850 Compliant) | 1 Set | 1 Set |
| 3. | Over Voltage Protection Relay (IEC-61850 Compliant) | 1 Set | NIL |
| 4. | Disturbance Recorder (If in built in Main-I & II then no need to provide separately). | 1 Set | 1 Set |
| 5. | Distance to fault Locator (If in built in Main-I & II then no need to provide separately). | 1 Set | 1 Set |
| 6. | 3 Phase Trip Relays | 2 Nos. | 2 Nos. |
| 8. | Under voltage relay for isolator/earth switch | 2 Nos. | 2 Nos. |
| 9. | Directional Back-up Over Current & E/F protection Relay (IEC-61850 Compliant) | Built in features of item No. 1 & 2 above | Built in features of item No. 1 & 2 above |
| 10. | Auto Reclosure Relay (IEC-61850 Compliant) | | |
| 11. | Local Breaker Failure Protection Relay (IEC-61850 Compliant) | 1Set | 1Set |
| 12. | Auxiliary Relays, Flag relay, Timers, Test blocks, Test Handles | 1 LOT as per Scheme Requirements | 1 LOT as per Scheme Requirements |
| 13. | Cut out and wiring with TTB for energy meter. | 1 Set | 1Set |
| 14. | Any other items | LOT | LOT |

**Note:- All Relays mentioned above shall not be part of any other Relay.**

(c) 400 kV BUS Bar Protection Panel :

| | | |
|---|---|---|
| 1. | Bus Bar Protection Scheme having one no. central unit and 16 nos. peripheral units (PU) considering all existing and future dia of 400kV Switchyard designed for one & half breaker scheme (IEC-61850 | 1 Set. |

| | | |
|---|---|---|
| | Compliant). | |
| 2. | Any other items | Lot |

**Note:- All Relays mentioned above shall not be part of any other Relay.**

(d) 220 kV BUS Bar Protection Panel :

| | | |
|---|---|---|
| 1. | Bus Bar Protection Scheme having one no. central unit and 22 nos. peripheral units (PU) considering all existing and future bays of 220kV Switchyard designed for double main and transfer bus scheme with sectionalizer (IEC-61850 Compliant). | 1 Set. |
| 2. | Any other items | LOT |

**Note:- All Relays mentioned above shall not be part of any other Relay.**

(e) 400 kV Shunt reactor Relay Panel:

| | | |
|---|---|---|
| 1. | Differential Protection Relay (IEC-61850 Compliant). | 1Set |
| 2. | High impedance differential (Circulating current ) Relay (IEC-61850 Compliant) | 1Set |
| 3. | Restricted Earth fault Protection Relay (IEC-61850 Compliant). | 1Set |
| 4. | Back up impedance Protection Relay (IEC-61850 Compliant) | 1 Set |
| 5. | Three Phase trip relays (Only for Bus Reactor) | 2 No. |
| 6. | DC Supervision Relay | LOT |
| 7. | CVT selection relay as per scheme requirement. | LOT |
| 8. | Flag relays, Auxiliary Relays, Timers as per Scheme requirements including reactor alarms and trip function viz WTI/OTI/Buchholtz etc. | 1 LOT |
| 9. | Local Breaker Failure Protection Relay (IEC-61850 Compliant) | 1Set |
| 10. | Any other items | LOT |

**Note:- All Relays mentioned above shall not be part of any other Relay.**

(f) 400 kV Simplex Tie breaker & Common relay panel

| S.No. | Description | With A/R | Without A/R |
|---|---|---|---|
| 1. | Local Breaker Failure Protection Relay (IEC-61850 Compliant) | 1Set | 1Set |
| 2. | DC supply supervision relay | 2Nos. | 2Nos. |
| 3. | Trip Circuit supervision relay | 6Nos. | 6Nos. |
| 4. | Auto Reclose Relay with check synchronizing and dead line charging relay (IEC-61850 Compliant) | 1Set | NIL |
| 5. | Flag relays, aux relays, timers, trip relays as per scheme requirements | LOT | LOT |
| 6. | Cut out and wiring with TTB for energy meter. | 1 No. for IMPORT & EXPORT | 1 No. for IMPORT & EXPORT |
| 7. | Any other items | LOT | LOT |

**Note:- All Relays mentioned above shall not be part of any other Relay.**

(g) 220 kV Relay Panel for Bus Coupler:-

| S.No, | Description | Qty. |
|---|---|---|
| 1. | Local Breaker Failure Protection Relay (IEC-61850 Compliant) | 1Set |
| 2. | Non Directional Over current & Earth fault Relay (IEC-61850 Compliant) | 1Set |
| 3. | DC supply supervision relay, Trip circuit supervision relay, Flag relays, Aux. Relays, Timers, Trip Relays, Multiplication Relays etc. as per scheme requirements. | LOT |
| 4. | Any other items | LOT |

**Note:- All Relays mentioned above shall not be part of any other Relay.**

(h) 220 kV Relay Panel for Sectionalizer:-

| S.No, | Description | Qty. |
|---|---|---|
| 1. | Local Breaker Failure Protection Relay (IEC-61850 Compliant) | 1Set |
| 2. | Non Directional Over current & Earth fault Relay (IEC-61850 Compliant) | 1Set |
| 3. | DC supply supervision relay, Trip circuit supervision relay, Flag relays, Aux. Relays, Timers, Trip Relays, Multiplication Relays etc. as per scheme requirements. | LOT |
| 4. | Any other items | LOT |

**Note:- All Relays mentioned above shall not be part of any other Relay.**

(i) 220 kV Relay Panel for Transfer Bus Coupler:-

| S.No, | Description | Qty. |
|---|---|---|
| 1. | Local Breaker Failure Protection Relay (IEC-61850 Compliant) | 1Set |
| 2. | Non Directional Over current & Earth fault Relay (IEC-61850 Compliant) | 1Set |
| 3. | DC supply supervision relay, Trip circuit supervision relay, Flag relays, Aux. Relays, Timers, Trip Relays, Multiplication Relays etc. as per scheme requirements. | LOT |
| 4. | Any other items | LOT |

**Note:- All Relays mentioned above shall not be part of any other Relay.**

## 12 TYPE TESTS

12.1 The following type tests shall be conducted on the protective relays, fault locator, Disturbance recorder and Event Logger.

a) Insulation tests as per IEC 60255-5
b) High frequency disturbance test as per IEC 60255-4 (Appendix-E) class III (not applicable for electromechanical relays)
c) Fast transient test as per IES 1000-4, III (not applicable for electromechanical relays)
d) Relay characteristic, performance and accuracy test as per IEC 60255.

Steady state characteristics and operating time.
Dynamic characteristics and operating time for distance protection relay and current differential protection relays.
For Disturbance recorder and Event Logger only performance test is intended under this item.
g) Tests for thermal and mechanical requirements as per IEC -60255-6.
h)Tests for rated burden as per IEC 60255-6
i)Contact performance test as per IEC 60255-0-20 (not applicable for Event logger, Distance to fault locator and Disturbance recorder)

Steady state & Dynamic characteristics tests on the relays (distance protection relays and current differential protection relays), as type test, shall be carried out based on general guide lines specified in CIGRE committee 34 report on simulator/network analyzer/PTL.

12.2 All the equipments offered shall be fully type tested as per the relevant standards. The bidder must furnish two sets of type test reports along with bid, in respect of the equipment (of the type and design offered) type tested in an independent test laboratory or at manufacture's work. However, the test for IEC-61850 compliance shall have to be got done at a Govt. / Govt. approved / ILAC recognized independent laboratory. These type tests must not have been conducted earlier then seven years for

the date of opening of bid. Bids without type test reports will be treated as non-responsive.

However, the purchaser reserves the right to demand repetition of some or all the type tests in presence of purchaserôs representative. For this purpose, the bidder should indicate unit rates for carrying out such type test.

12.3 Routine/Acceptance tests

The following tests shall be got conducted in presence of purchaserôs representative.

12.3.1 Checking of wiring of circuits and their continuity.
12.3.2 One minute 2 kV insulation withstand test at 50 cycles on all equipments on the panels and wiring.
12.3.3 Insulation resistance of complete wiring with all equipments
12.3.4 Checking the operation of protection schemes, instruments and meters.
12.3.5 Tolerance on test results- The tests shall be conducted as per relevant ISS.

Test at site- The purchaser reserves the right to conduct all tests on control & relay panels after arrival at site and the contractor shall guarantee test certificate figures under actual service conditions.

## 13 INSPECTION

(i) The purchaser shall have access at all times to the works and all other places of manufacture where the relay and protection panels, digital clock, etc ate being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplierôs work, raw material, manufacture of all the accessories and for conducting necessary tests as detailed herein.
(ii) The suppliers shall keep the purchaser informed in advance of the time of staring and of the progress of manufacture of equipment in its various stages so that arrangement could be made for inspection.
(iii) No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.
(iv) The acceptance of any quantity of equipment shall in no way relieve the supplier of its responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection if such equipment are later found to be defective.

## 14 QUALITY ASSURANCE PLAN

14.1 The bidder shall invariably furnish following information along with his offer, failing which the offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

(i) Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw material in the presence of supplierôs representative, copies of test certificates.
(ii) Information and copies of test certificates as in (i) above in respect of bought out items.
(iii) List of manufacturing facilities available.

(iv) Level of automation achieved and list of areas where manual processing exists.

(v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

(vi) Special features provided in the equipment to make it maintenance free.

(vii) The bidder should have adequate facilities to carryout accurately all required tests during manufacturing and routine/ acceptance tests as per relevant ISS/IEC standards at the final and routine/acceptance. The supplier will ensure that all testing/measuring instruments/ apparatus are calibrated at regular periodicity from reputed test house as per relevant standards and a certificate of testing authority is made available to purchaserôs inspector at the time of inspection. Such calibration certificates, in any case shall not older than one year on the date of such tests.

(viii) List of testing instrument and apparatus along with their last date of calibration, available with the Bidder for testing of equipment specified and test plan limitation, if any, vis-à-vis the type, special, acceptance and routine tests testing during manufacture specified in the relevant standards. These limitations shall be very clearly brought out in ñSchedule of Deviationsò.

14.2 The supplier shall within 30 days of placement of order, submit the following information to the purchaser.

(i) Name of the raw material as well as bought out accessories and the name of sub-suppliers selected from those furnished along with the offer.

(ii) Type test certificates of the raw material and bought out accessories.

(iii) Quality Assurance Plan (QAP) with hold points for purchaserôs inspection. The QAP and purchaserôs hold points shall be discussed between the purchaser and the supplier before the QAP is finalized.

14.3 The supplier shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the fully assembled equipment.

## 15 DOCUMENTATION

### 15.1 MANDATORY SPARES AND OPTIONAL ITEMS

The supplier shall necessarily include in his tender an item wise price list of various protection schemes, relays, meters, accessories and other optional items used in the manufacture of C&R panels offered by him to facilitate ordering of spares as well as to make suitable adjustment in prices on account of subsequent additions/deletions of any of these items. The tender without such price list is likely to be ignored.

### 15.2 DRAWINGS

In addition to any other drawing which the tenderer may like to enclose, to explain the merits of his proposal, the following drawings shall be enclosed with the tender in quadruplicate.

i) Principal dimensional details of each panel.

ii) Front and rear views with instruments relays and devices positions marked.

iii) Elementary diagrams of all metering, protection, annunciation and other circuits.

iv) Feeder protection scheme.

v) Local breaker backup protection scheme.

vi) Bus bar protection scheme upgradation, wherever required.
vii) Auto reclose scheme.
viii) Shunt Reactor biased differential protection scheme.
ix) Shunt Reactor REF protection scheme.
x) Shunt Reactor over fluxing protection scheme.
xi) NGR protection scheme.
xii) Distance to fault locator scheme.
xiii) Disturbance recorder scheme and GA drawings.
xiv) Marshalling kiosks GA drawings.

The tenderer shall be responsible for any discrepancies / errors or omissions in the drawings and other particulars approved by the purchaser or not. In the event of order 5 sets of such drawings would be supplied for each S/S.

15.3 ILLUSTRATED AND PRINTED LITERATURE

Four copies of each of the descriptive and printed literature in respect of all the ammeters, voltmeters, selector switches, watt meters, VAR meter, energy meters, power factor meter, control switches, relays etc., proposed to be used shall be supplied along with the tender. A descriptive note indicating the salient points of the scheme offered shall also accompany each copy of the tender. In the event of an order, 3 sets of complete literature as well as operating / maintenance instruction manuals shall be supplied for each sub-station and another three sets to purchaser for other use.

15.4 TEST REPORTS

i) Two copies of type test reports shall be furnished to the purchaser within one month of conducting the tests. One copy will be returned duly certified by purchaser to the supplier within three weeks thereafter and on receipt of the same supplier shall commence with the commercial production of the concerned material.
ii) Two copies of acceptance tests reports shall be furnished to the purchaser. One copy will be returned duly certified by the purchaser and only thereafter the materials shall be dispatched.
iii) All records of routine test reports shall be maintained by the supplier at its works for periodic inspection by the purchaser.
iv) All test report for tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

## 16.0 **PACKING AND FORWARDING**

16.1 The loose equipment shall be packed in creates suitable for vertical/horizontal transport as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbol. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

16.2 Each consignment shall be accompanied by a detailed packing list containing the following information:

i) Name of the consignee.
ii) Details of consignment
iii) Destination.
iv) Total weight of consignment
v) Sign showing upper/lower side of the crate.
vi) Handling and unpacking instruction.
vii) Bill of material indicating contents of each package.

The supplier shall ensure that the packing and bill of material are approved by the purchaser before dispatch.

## 17 CO-ORDINATION

i) Auto Transformer and Shunt Reactor shall be supplied by other supplier in the other package, Contractor and supplier of panels shall be responsible for preparing complete wiring diagrams and cable schedule including the control circuits of Transformer, shunt reactor, RVPN supplied energy meters, other associated equipments of various manufacturers under this contract and shall also undertake to mount and wire any equipment received loose from other suppliers.

ii) The feeder protection schemes proposed to be provided shall be co-ordinated with the existing protection schemes, wherever asked for, shall be suitably co ordinated with the existing , protection at the various sub stations other co-ordination work if required, will also be done without any extra cost by the supplier of control and relay board.

iii) The supplier shall be solely responsible to propose/select the suitable carrier frequency for carrier aided protection schemes, meeting the requirement of our existing systems and arrange allocation of frequency from the wireless advisor, Govt. of India. All relays/associated equipments shall be supplied as per frequency finally approved / allocated by the wireless advisor Govt. of India accordingly.

**ANNEXURE-V2P3(Sec.I) -1**

DETAILS OF BUSHING CURRENT TRANSFORMER OF REACTOR AND NGR FOR PROTECTION AND METERING PURPOSE

| | | Shunt Reactor (on each phase connection) | | Neutral Reactor | |
|---|---|---|---|---|---|
| | | Line side | Neutral side | Line side | Earth side |
| Ratio | Core 1 | 200/1A | 200/1A | 200/1A | 200/1A |
| | Core 2 | 200/1A | -- | | |
| | Core 3 | 200/1A | 2000-1000-500/1A | | |
| | Core 4 | 200/1A | -do- | | |
| Minimum knee point voltage or burden and accuracy class | | | | | |
| | Core 1 | 200V Class PS | 200V Class PS | 200V Class PS | 200V Class PS |
| | Core 2 | 200V Class PS | Suitable for WTI being supplied | | |
| | Core 3 | 200V Class PS | 1000-500 250V Class PS | | |
| | Core 4 | 10VA Class 1.0 | -do- | | |
| Maximum CT Resistance | | | | | |
| | Core 1 | 1 ohm | 1 ohm | 1 ohm | 1 ohm |
| | Core 2 | 1 ohm | -- | | |
| | Core 3 | 1 ohm | 10-5-2.5 ohm | | |
| | Core 4 | -- | -do- | | |
| Application | | | | | |
| | Core 1 | Reactor Differen-tial | Reactor Differen-tial | Restric-ted Earth Fault | Restric-ted Earth Fault |

| | | | | |
|---|---|---|---|---|
| Core 2 | Restric-ited Earth Fault | Temp. indicator (on one phase only) | -- | -- |
| Core 3 | Reactor Backup | Line Protection (Main-I)/ Tzone differential Protn./spare | | |
| Core 4 | Metering | Line Protection (Main-II)/ Tzone differential Protn./spare | | |

**ANNEXURE V2P3(Sec.I) -2**

TECHNICAL PARTICULARS FOR TRANSFORMER BUSHING CURRENT TRANSFORER

| S.No. | | | | |
|---|---|---|---|---|
| 1. | Rated system voltage kv (rms) | 420 | 245 | 36 |
| 2. | Rated frequency Hz | 50 | 50 | 50 |
| 3. | Number of cores | Two | Two | Two |
| 4. | Rated primary current, Amps | 1250 | 1250 | 1250 |
| 5. | Rated secondary current | 1 | 1 | 1 |
| 6. | Rated continuous thermal current, Amps. | 120 % rated current | | |
| 7. | Rated transformation ratio | 1250/1 | 1250/1 | 1250/1 |
| 8. | Accuracy class | PS | PS | PS |
| 9. | Minimum knee point voltage, volts | 1000 | 1000 | 1000 |
| 10. | Maximum magnetization current at guaranteed knee point voltage, mA | 60 | 60 | 60 |
| 11. | Maximum secondary winding resistance at 75 deg. C, ohms. | 2.5 | 2.5 | 2.5 |
| 12. | Rated short time thermal current for second, kA rms. | 40 | 40 | 40 |
| 13. | Rated dynamic current kA (peak) | 100 | 100 | 100 |

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**SUBSTATION AUTOMATION SYSTEM**
**Part-3 (Section-II)**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-3 (Vol. II) (Section-II)**

# SUBSTATION AUTOMATION SYSTEM

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## SECTION : SUBSTATION AUTOMATION SYSTEM

### 1.0 GENERAL

1.1 The substation automation system shall be offered from a manufacturer who must have designed, manufactured, type tested, installed and commissioned substation automation system which must be in satisfactory operation on atleast 1No.of EHV substation of 400 kV or above voltage level (each having total bays not less than 5 years) in India for last 5 (five) years as on the date of bid opening.

1.2 The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipment from remote control center (RC) as well as from local control center.

The SAS shall contain the following main functional parts :

i. Bay control intelligent Electronic Devices (IED s) for control and monitoring.

ii. Station Human Machine Interface (HM)

iii. Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.

iv. Gateway for remote control via industrial grade hardware (to RCC) through IEC 60870-5-101 Protocol.

v. Gateway for remote supervisory control (to RSCC), the gateway should be able to communicate with RSCC on IEC 60870-S-101) protocol. The specific protocol to be implemented shall be handed over to successful bidder. It shall be the bidderôs responsibility to integrate his effected system with existing RSCC system for exchange of desired data. The exact IO point shall be decided during detailed engineering.

vi. Remote HMI

vii. Peripheral equipments like printers, display units, key boards, Mouse etc.

1.3 It shall enable local station control via a PC by means of human machine interface (HMI) and control software package, which shall contain an extensive range of supervisory control and data acquisition (SCADA) functions.

1.4 It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. An architecture drawing for SAS is enclosed.

1.5 The communication gateway shall facilitate the information flow with remote control centers. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection and monitoring functions.

### 2.0 SYSTEM DESIGN

#### 2.1 General system design

The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions as given in Section Project.

The system shall be of the state of the art suitable for operation under electrical environmental present in Extra high voltage substations, follow the latest engineering practice ensure long

term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The offered SAS shall support remote control and monitoring from Remote Control centers via gateways.

The system shall be designed such that personnel without any background knowledge in Mocroprocessor based technology are able to operate the system. The operator interface shall be intuitive such that operting personnel shall be able to operate the system easily after having received some basic training.

The system shall incorporate the control, monitoring and protection functions specified self-monitoring signaling and testing facilities, measuring as well as memory functions, event recording and evaluation of disturbance records.

Maintenance, modification of extension of components may not cause a shutdown of the whole substation automation system. Self monitoring of components modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

**Bidder shall offer the Bay level unit (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer bay mimic alongwith relay and protection panels and PLCC panels (described in other sections of technical specifications) housed in air-conditioned Kiosks suitably located in switchyard and station HMI in Control Room Building for overall optimization in respect of cabling and control room building.**

## 2.2 System architecture

The SAS shall be based on a decentralized architecture and on a concept of bay-oriented distributed intelligence.

Functions shall be decentralized, object-oriented and located as close as possible to the process.

The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels i.e. in a station i.e. a bay level.

In bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands. The IEDs should be directly connected to the switchgear without any need for additional interposition or transducers.

Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fibre optic cables, thereby guaranteeing disturbance free communication. The fiber optic cables shall be run in G.1 conduit pipes. Data exchange is to be realized using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure.

The communication shall be made in 1+1 mode, excluding the links between individual bay IEDs to switch, such that failure of one set of fibre shall not affect the normal operation of the SAS. However, it shall be alarmed in SAS. Each fibre optic cable shall have four (4) spare fibres.

At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.

Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels i.e. RCC station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.

The station level contains the station-oriented functions which cannot be realized at bay level e.g. alarm list or event list related to the entire substation gateway for the communication with remote control centre.

The GPS time synchronizing signal (as specified in the section relay and protection) for the synchronization of the entire system shall be provided.

The SAS shall contain the functional parts as described in para 1.2 above.

2.3 **Functional Requirements**

The high voltage apparatus within the station shall be operated from different places.

Remote control centers

Station HM

Local bay controller IED (in the bays)

Operation shall be possible by only one operator at a time

The operation shall depend on the conditions of other functions, such as interlocking synchrocheck etc. (see description in Bay level control functions).

2.3.1 Select before execute

For security reasons the command is always to be given in two stages, selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

2.3.2 Command supervision

Bay station interlocking and blocking

Software interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

In addition to software interlocking hardwired interlocking are to be provided for

a) Bus Earth switch interlocking
b) Transfer Bus interlocking (if applicable)

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.

2.3.3 Run Time Command cancellation

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time the command should get cancelled.

2.3.4 Self-supervision

Continuous self-supervision function with self diagnostic feature shall be included.

2.3.5 User configuration

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built in functions and signals shall be possible both locally and remotely.

It shall also be possible to interconnect and derive input and output signals, logic functions using built in functions, complex voltage and currents. additional logics (AND gates or gates and timers, multi activation of these additional functions should be possible)

The functional requirement shall be divided into following levels

a) Bay ( a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer ) Level functions.

b) System level functions.

## 3.1 **Bay level functions**

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level.

- Bay control functions including data collection functionality.
- Bay protection functions

Separate IEDs shall be provided for bay control function and bay protection function.

### 3.1.1 Bay Control functions

#### 3.1.1.1. Overview

Functions

(I) Control mode selection
(ii) Select before execute principle
  (i) Interlocking and blocking
  (ii) Double command
(III) Synchrocheck , Voltage selection
(IV) Run Time Command cancellation
(V) Transformer tap changer control (for power transformer bays)
(VI) Operation counters for circuit breaker and pumps
(VII) Hydraulic pump / air compressor control and runtime supervision
(viii) Operating pressure supervision
(IX) Display of interlocking and blocking
(X) Breaker position indication per phase
(XI) Alarm annunciation
(XII) Measurement display
(XIII) Local HMI (local guided, emergency mode)
(XIV) Interface to the station HMI
(XV) Data storage for at least 200 events
(XVI) Extension possibilities with additional I/Os inside the unit or via fibreioptic communication and process bus

3.1.1.2 Control mode selection

Bay level Operation :

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation bay control unit allows the safe operation of all switching devices via the bay control IED.

EMERGENCY Operation

It shall be possible to close or open the selected Circuit Breaker with ON or OFF push buttons even during the outage of bay IED.

REMOTE mode

Control authority in this mode is given to a higher level (Remote Control Centre) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

3.1.1.3 Synchronism and energizing check

The synchronism and energizing check functions shall be bay oriented and distributed to the bay control and / or protection devices. These features are

(I) Settable voltage, phase angle and frequency difference.

(II) Energizing for dead line- live bus, live line-dead bus or dead line-dead bus with no synchro-check function.

(III) Synchronising between live line and live bus with synchro-check function.

Voltage selection

The voltages relevant for the Synchrocheck functions are dependent on the station topology i.e on the position of the circuit breakers and / or the isolator. The correct voltage for synchroniaing and energizing is derived from the auxiliary switches of the circuit breakers, the isolator and earthing switch and shall be selected automatically by the bay control and protection IEDs.

3.1.1.4 Transformer tap changer control.

Raise and lower operation of OLTC taps of transformer shall be facilitated through bay controller IED.

3.1.2 **Bay protection function**

3.1.2.1 General

The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices as per section Relay and Protection.

IEDs shall be connected to the communication infrastructure for data sharing and meet the real time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

Event and disturbance recording function

Each IED should contain an event recorder capable of storing at least 200 time lagged events. This shall give alarm if 70% memory is full. The disturbance recorder function shall be as detailed in section C&R.

## 3.2 System level functions

### 3.2.1 Status supervision

The position of each switchgear e.g circuit breaker, isolator, earthing switch, transformer tap changer etc. shall be supervised continuously. Every detected change of position shall be immediately displayed in the single line diagram on the station HMI screen recorded in the event list and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.

The switchgear positions shall be indicated by two auxiliary switches normally closed (NC) and normally open (NO) which shall give ambivalent signals. An alarm shall be initiated if these positon indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

The SAS shall also monitor the status of substation auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analogue values shall be monitored and recorded through this IED.

### 3.2.2 Measurements

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W) reactive power (VAR) frequency (Hz) and the rms values for voltage (U) and current (I) shall be calculated.

The measured values shall be displayed locally on the station HMI and in the control center. The abnormal values must be discarded. The analogue value shall be updated every 2 seconds.

Threshold limit values shall be selectable for alarm indications.

### 3.2.3 Event and alarm handling

Events and alarms are generated either by the switchgear by the control IEDs or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time tagged with a time resolution of 1 ms.

### 3.2.4 Station HMI

#### 3.2.4.1 Substation HMI Operation

On the HMI the object has to be selected first in case of a blocking or interlocking conditions are not met the selection shall not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction and the appropriate control execution button shall be pressed in order to close or open the corresponding object.

Control operation from other places (e.g Remote) shall not be possible in this operating mode.

#### 3.2.4.2 Presentation and dialogues

General

The operator station HMI shall be a redundant with hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks or keyboard commands.

The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen there shall be a printout of alarms or events in an event log.

An acoustic alarm shall indicate abnormalities and all unacknowledged alarms shall be accessible from any screen selected by the operator.

The following standard pictures shall be available from the HMI.

(I) Single line diagram showing the switchgear status and measured Values.
(II) Control dialogues with interlocking and blocking details. The control dialogue shall tell the operator whether the device operation is permitted or blocked.
(III) Measurement dialogues
(IV) Alarm list, station / bay oriented
(V) Event list station / bay oriented
(VI) System status

3.2.4.3 **HMI design principles**

Consistent design principles shall be adopted with the HMI concerning labels colours dialogues and fonts. Non-valid selections shall be dimmed out

The object status shall be indicated using different status colours for

(I) Selected object under command
(II) Selected on the screen
(III) Not updated, obsolete values, not in use or not sampled.
(IV) Alarm or faulty state
(V) Warning or blocked
(VI) Updated blocked or manually updated
(VII) Control blocked
(VIII) Normal state

3.2.4.4 **Process status displays and command procedures.**

The process status of the substation in terms of actual values of currents, voltage, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap changers shall be displayed in the station single line diagram.

In order to ensure a high degree of security against undesired operation a õselect before executeò command procedure shall be provided. After the selection of a switch, the operator shall be able to recognize the selected device on the screen, and all other switchgear shall be blocked As communication between control center and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the execution of the command the operated switching symbol shall flash until the switch has reached its new position.

The operator shall be in a position to execute a command only, if the switch is notblocked and if no interlocking condition is going to be violated. The interlocking statements shall be checked by the interlocking scheme implemented at bay and station level.

After command execution the operator shall receive a confirmation that the new

Switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

3.2.4.5 **System supervision & display**

The SAS system shall be comprehensively self monitored such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a fully status in a system supervision display. The display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links and printers at the station level etc.

3.2.4.6 **Event list**

The event list shall contain events that are important for the control and monitoring of the substation.

The event and associated time (with 1 ms resolution) of its occurrence has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or section of it.

A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer for at least one month. The information shall be obtainable also from a printed event log.

The Chronological event list shall contain :

i) Position changes of circuit breakers, isolators and earthing devices.
ii) Indication of protective relay operations.
iii) Fault signals from the switchgear
iv) Indication when analogue measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measure.

Loss of communication

Filters for selection of a certain type of group of events shall be available. The filters shall be designed to enable viewing of events grouped per

i) Data and time
ii) Bay
iii) Device
iv) Function e.g. trips, protection operations etc.
v) Alarm class

3.2.4.7 **Alarm list**

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control center. The alarm list shall substitute a conventional alarm tableau, and shall constituted an evaluation of all station alarms. It shall contain unacknowledged alarm and persisting faults. The date and time of occurrence shall be indicated.

The alarm list shall consist of a summary display of the present alarm situation. Each alarm shall be reported on one line that contains.

i) The date and time of the alarm
ii) The name of the alarming object.
iii) A descriptive text
iv) The acknowledgement state.

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state alongwith an audiable alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, Unacknowledged and cleared, Acknowledged and persistent).

Filters for selection of a certain type or group of alarms shall be available as for events.

3.2.4.8 **Object picture**

When selecting an object such as a circuit breaker or isolator in the single line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like

i) Type of blocking
ii) Authority
iii) Local / remote control
iv) RSCC / SAS control
v) Errors
vi) Shall be displayed etc.

3.2.4.9 **Control dialogues**

The operator shall give commands to the system by means of mouse click located on the single line diagram. It shall also be possible to use the keyboard for command activation. Data entry is performed with the keyboard. Dedicated control dialogues for controlling at least the following devices shall be available.

i) Breaker and disconnector
ii) Transformer tap-changer

3.2.5 **User authority levels**

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus) within a certain user authorization group. Each user shall then be given access rights to each group of objects e.g.

i) Display only
ii) Normal operation (e.g. open / close of switchgear)
iii) Restricted operation (e.g. by passed interlocking)
iv) System administrator

For maintenance and engineering purpose of the station HMI, the following authorization level shall be available.

i) No engineering allowed
ii) Engineering configuration allowed
iii) Entire system management allowed.

The access rights shall be defined by passwords assigned during the log in procedure . Only the system administrator shall be able to add /remove users and change access rights.

3.2.6. **Reports**

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise.

Trend reports

i) Day (mean, Peak)
ii) Month (mean, peak)
iii) Semi annual (mean, peak)
iv) Year (mean, peak)

Historical reports of selected analogue Values

i) Day (at 15 minutes interval)
ii) Week
iii) Month
iv) Year

It shall be possible to select displays values from the database in the process display on-line Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.

Following printouts shall be available from the printer and shall be printed on demand.

i) Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.

ii) Weekly trend curves for real and derived analogue values.

iii) Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.

iv) Provision shall be made for logging information about breaker status like number of operation with date and time indications.

v) Equipment operation details shift wise and during 24 hours.

vi) Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Position, temperature and status of pumps and fans for transformers.

vii) Printout on adjustable time period as well as on demand system frequency and average frequency.

viii) Reports in specified formats which shall be handed over to successful bidder.

3.2.7 **Trend display (historical data)**

It shall be possible to illustrate all types of process data as trends ï input and output data, binary and analogue data. The trends shall be displayed in graphical form as column of curve diagrams with a maximum of the trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum of difference) on line in the window. It shall also be possible to change the update intervals on line in the picture as well as the selection of threshold values for alarming purposes.

3.2.8 **Automatic disturbance transfer**

All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording system shall be automatically uploaded (event triggered of once per day) to a dedicated computer and be stored on the hard disc.

3.2.9 **Disturbance analysis**

The PC based work station shall have necessary software to evaluate all the required information for proper fault analysis.

3.2.10 **IED Parameter softing**

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters of the activation of parameter sets shall only be allowed after entering a password.

3.2.11 **Automation sequences**

The available automatic sequences in the system should be listed and described (e.g. sequences related to the bus transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences.

3.3. Gateway

3.3.1 Communication Interface

The substation Automaton System shall have the capability to support simultaneous communications with multiple independent remote master stations.

The Substation Automation System shall have communication ports as follows :-

a) Two ports for Remote Control Centre
b) Two ports for Regional System Coordination Centre (RSCC)

The communication interface to the SAS shall allow scanning and control of defined points within the substation automation system independently for each control center. The substation automation system shall simultaneously respond to independent scans and commands from employerõs control centers (RCC & RSCC). The substation automation system shall support the use of a different communication data exchange rate (bits per second) scanning cycle, and / or communication protocol to each remote control center. Also, each control centreõs data scan and control commands may be different for different data points within the substation automation systemõs database.

3.3.2 Remote Control Centre Communication Interface

Employer will supply communication channel between the Substation Automation System and the remote control center. The communication channels provided by Employer will consist either of power line carrier microwave, optical fibre, VSAT or leased line, the details of which shall be provided during detailed Engineering.

3.3.3 Interface equipment

The contractor shall provide interface equipment for communicating between Substation Automation System and Remote Control Center and between Substation Automation system and Regional System Coordination Centre (RSCC). However, the communication channels available for this purpose are specified in section project.

In case of PLCC communication any modem supplied shall not require manual equalization and shall include self test features such as manual mark / space keying, analogue loop back and digital loop back. The modems shall provide for convenient adjustment of output level and receive sensitivity. The modem should be stand alone complete in all respects including power supply to interface the SAS with communication channel. The configuration of tones and speed shall be programmable and maintained in non volatile memory in the modem. All necessary hardware and software shall also be in the scope of bidder except the communication link along with communication equipment between substation control room and Remote Control Centre.

3.3.4 Communication Protocol

The communication protocol for gateway to control center must be open protocol and shall support IEC 60870-5-101 and IEC 61850 for all levels of communication for sub-station automation such as Bay to station HMI, gateway to remote station etc.

## 4.0 SYSTEM HARDWARE :

4.1 Redundant Station HMI, HMI view Node, Remote HMI and Disturbance Recorder Work station:

The contractor shall provide redundant station HMI in hot standby mode.

It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components. Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space.

1. Storage of all analogue data (at 15 minutes interval ) and digital data including alarm event and trend data for thirty (30) days.
2. Storage of all necessary software.
3. 20 GB space for ownerôs use.

Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

### 4.1.1 HMI (Human Machine Interface)

The VDU shall show overview diagrams ( Single Line Diagrams) and complete details of the switchgear with a colour display. All event and alarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning device. The user interface shall be based on Windows concepts with graphics and facility for panning, scrolling, zooming, decultering etc.

### 4.1.2 Visual Display Units / TFT's (Thin Film Technology)

4.1.2.1 The contractor shall provide three display units one for station HMI one for redundant HMI and one for DR work station. These shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 21ò diagonally in size and capable of colour graphic displays.

The display shall accommodate resolution of 1280 X 1024 pixesl.

The HMI shall be able to switch the key board and cursor positioning device as unit among all the monitors at a consol vis push button or other controls.

4.1.2.2 The contractor shall also provide Rear Projection MIMIC Display (LVS) having 3x2 Matrix (Size of each block shall be 67 inch diagonally with SXGA resolution) with all necessary accessories / item, software, hardware, mounting arrangement etc required for satisfactory operation. The video wall shall be suitable for flat as well as curved background of control room wall and shall be decided during detailed engineering.

4.1.3 **Printer**

It shall be robust & suitable for operation with a minimum of 132 characters per line. The printing operation shall be quiet with a noise level of less than 45 db suitable for location in the control room. Printer shall accept and print all ASCII characters via master control computer units interface.

The printer shall have in-built testing facility. Failure of the printer shall be indicated in the Station HMI. The printer shall have an off line mode selector switch to enable safe maintenance. The maintenance should be simple with provisions for ease of change of print head, ribbon changing, paper insertion etc.

All printers mounted in the control room shall be provided with a separate printer enclosure each. The enclosure shall be designed to permit full enclosure of the printers at a convenient level. Plexiglas window shall be used to provide visual inspection of the printers and ease of reading. The printer enclosures shall be designed to protect the printers from accidental external contact & each should be removable from hinges at the back and shall be provided with lock at the front.

All reports and graphics prints shall be printed on laser printer. One dot matrix printer shall be exclusively used for hourly log printing.

All printers shall be continuously on line.

4.1.4 **Mass Storage Unit**

The mass storage unit shall be built in to the Station HMI. All operational measured values and indications shall be stored in a mass-storage unit of CD ROM / DVD ROM with 700 MB or more capacity. The unit should support at least Read (48x), Write (24x) and Re-write (10x) operations with Multi Session capability. It should support ISO 9660. Rocknage and file system. It should support formatting and use under the operating provided to station HMI. The monthly back up of data shall be taken on disc. The facility of back up of data shall be inherent in the software.

4.1.5 **Switched Ethernet Communication Infrastructure :**

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS. The bidder shall keep provision of 100% spare capacity for employer use. One switch shall be provided to connect all IEDs in one diameter of each 765 and 400 kV yard and for two bays of 220 kV yard to communication infrastructure.

4.2 **Bay level unit**

The bay unit shall use industrial grade components. The bay level units, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select before operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation

commands from station HMI and control center. The bay unit shall have the capability to store all the data for at least 24 hours.

One no. bay level unit shall be provided for supervision and control of each 400 and 220 kV ( a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer). The bay level unit shall be equipped with analogue and binary inputs / outputs for handling the controls status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit / local bay mimic panel with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.

The bay level unit shall meet the requirement for withstanding electromagnetic interfence according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

### 4.2.1 **Input / output (I/O modules)**

The I/O modules shall form a part of the bay level unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear. The measured values of voltage and current shall be from the secondaries of instruments transformers. The digital input shall be acquired by exception with 1 ms resolution Contact bouncing in digital inputs shall not be assumed as change of state.

## 4.3 **AIR-CONDITIONED KIOSK**

The Air-conditioned kiosk offered shall house Bay level units, bay mimic, relay and protection panels. PLCC panels etc. One each for a diameter in 400 kV / 220 kV substation and for two bays in 220 kV level. In case of incomplete diameter the kiosk shall have necessary space for accommodating the future bay IEDs. The layout of equipment / panel shall be subject to Ownerôs approval. The Kiosk shall be provided with fire alarm system with at least two detectors and it shall be wired to SAS. The detailed specification / requirement of kiosk building shall be as per clause No. 17.0 (C) of volume-III (Tech. Specification for Civil Works) of the specification. The air conditioner provided in Kiosk shall be controlled and monitored from substation automation system. One additional kiosk for each voltage level. If required, shall be provided for housing bus bar protection panels at suitable location in switchyard.

## 4.4 **EXTENDIBILITY IN FUTURE**

Offered substation automation system shall be suitable for extension in future for additional bays. During such requirement, all the drawings and configurations alarm / event list etc. displaced shall be designed in such a manner that its extension shall be easily performed by the employer. During such event normal operation of the existing substation shall be unaffected and system shall not require a shutdown. The contractor shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analogue variable alarm list, event list, modify interlocking logics etc for additional bays / equipment which shall be added in future.

# 5.0 **SOFTWARE STRUCTURE**

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance modification of an extension of components of any feeder may not force a shunt down of the parts of the system which are not affected by the system adaptation.

5.1 **Station level software**

Human machine interface (HMI)

The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing engineering and system configuration. The system shall be easy to use to maintain and to adapt according to specific user requirements-System shall contain a library with standard functions and applications.

5.2 **Bay level software**

5.2.1 System software

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software alongwith hardware shall be capable of automatically synchronsing with the remaining system without an manual interface. This shall be demonstrated by contractor during integrated system test.

5.2.2 Application software

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of a library. The application software within the control / protection devices shall be programmed in a functional block language.

5.2.3 Network Management System

The contractor shall provide a network management system software for following management functions

a) Configuration Management
b) Fault Management
c) Performance Monitoring

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR work station and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any fault in the monitored devices. The NMS shall

a) Maintain performance, resources usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.

b) Maintain a graphical display of SAS connectivity and device status.
c) Issue alarms when error conditions occurs.
d) Provide facility to add and delete addresses and links.

5.2.4 The Contractor shall provide each software in two copies in CD to load into the system in case of any problem related with Hardware / communication etc.

6.0 **TESTS**

The Substation Automation System offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV sub-station equipment installed in sheltered area in the outdoor switchyard and specified ambient conditions.

6.1 **Type Tests**

6.1.1 Control IEDs and Communication Equipment :

a) Power Input :

i) Auxiliary Voltage
ii) Current Circuits
iii) Voltage Circuits
iv) Indications

b) Accuracy Tests :

i) Operational Measured Value
ii) Currents
iii) Voltages
iv) Time resolution

c) Insulation Tests

i) Dielectric Tests
ii) Impulse Voltage withstand Test

d) Influencing Quantities

i) Limits of operation
ii) Permissible ripples
iii) Interruption of input voltage

e) Electromagnetic Compatibility Test

i) 1 MHz burst disturbance test
ii) Electrostatic Discharge Test
iii) Radiated Electromagnetic Field Disturbance Test
iv) Electrical Fast transient Disturbance Test
v) Conducted Disturbances Tests induced by Radio Frequency Field
vi) Magnetic Field Test
vii) Emission (Radio interference level) Test
viii) Conducted Interference Test

f) Function Test

i) Indication
ii) Commands
iii) Measured value Acqusition
iv) Display indications

g) Environmental tests

i) Cold temperature

ii) Dry Heat
iii) Wet Heat
iv) Humidity (Damp heat Cycle)
v) Vibration
vi) Bump
vii) Shock

6.2 **Factory Acceptance Tests**

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IEDs applicable type test certificates shall be submitted.

The manufacturing phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified as far as site conditions can be simulated in a test lab. If the FAT comprises only a certain portion of the system for practical reason, it has to be assured that this test configuration contains at least one unit of each and every type of equipment incorporated in the delivered system.

If the complete system consists of parts from various suppliers or some parts are already installed on site, the FAT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT)

6.3 **Integrated Testing**

The integrated system tests shall be performed as detailed in subsequent clauses as per following configuration

Redundant Station HMI, DR work station, two switches (i.e. for two diameter) alongwith all IEDs for the Dia and printers.

All other switches for complete sub-station as detailed in section project shall be simulated as needed.

6.3.1 Hardware Integration Tests

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests.

6.3.2 Integrated system Tests

Integrated system tests shall verify the stability of the hardware and the software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period. The integrated system test shall ensure the SAS is free of improper interactions between software and hardware while the system is operating as a whole.

6.4 **Field Tests**

The field tests shall completely verify all the features of SAS hardware and software.

## 7.0 SYSTEM OPERATION

### 7.1 Substation operation

7.1.1 Normal Operation

Operation of the system by the operator from the remote RCC or at the substation shall take place via industry standard HMI (Human Machine interface) sub system consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse)

The coloured screen shall be divided into 3 fields

i) Message field with display of present time and date
ii) Display field for single line diagrams
iii) Navigation bar with alarm / condition indication.

For display of alarm, annunciation, lists of event etc. a separate HMI view node shall be provided.

All operations shall be performed with mouse and / or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the command field (i.e operator prompting). For control actions, the switchgear (i.e. circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys. The switching element selected shall then appear on the background that shall be flashing in a different colour. The operator prompting shall distinguish between.

Prompting of indications e.g. fault indications in the switchgear and
Prompting of operational sequences e.g. execution of switching operations.

The summary information displayed in the message field shall give a rapid display of alarm / message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described more faulty.

Each operational sequence shall be divided into single operation steps which are initiated by means of the function keys / window command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicted by comments in the message field and must not be executed.

The offer shall include a comprehensive description of the system. The above operation shall also be possible via Windows based system by mouse.

## 8.0 POWER SUPPLY

Power for the substation automation system shall be derived from substation 220 V DC system. Inverter of suitable capacity shall be provided for station HMI and its peripheral devices e.g. printer etc. in the event of Power failures, necessary safeguard software shall be built for proper shutdown and restart.

## 9.0 DOCUMENTATION

The following documents shall be submitted for employerôs approval during detailed engineering

a) System Architecture Drawing
b) Hardware Specification
c) Sizing Calculations of various components
d) Response Time Calculation
e) Functional Design Document

The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported and of similar look / feel. All CAD drawings be provided in dxt format.

- List of Drawings
- Substation automation system architecture
- Block Diagram
- Guaranteed technical parameters, functional design specification and guaranteed availability and reliability
- Calculation for power supply dimensioning
- I/O Signals lists
- Schematic diagrams
- List of Apparatus
- List of Labels
- Logic Diagram (hardware & software)
- GA of kiosk and GTP
- Control Room Layout
- Test Specification for Factory Acceptlance Test
- Product Manuals
- Assembly Drawing
- Operatorôs Manual
- Complete documentation of implemented protocols between various elements
- Listing of software and loadable in CD ROM
- Other documents as may be required during detailed engineering

Two sets of hard copy and Four sets of CD ROM containing all the as built documents / drawings shall be provided.

## 10.0 TRAINING, SUPPORT SERVICES, MAINTEANCE AND SPARES

### 10.1 Training

Contractor personnel who are experienced instructors and who speak understandable English shall conduct training. The contractor shall arrange on its own cost all hardware training platform required for successful training and understanding in India. The Contractor shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. These materials shall be sent to employer at least two months before the scheduled commencement of the particular training course. Class materials including the documents sent before the training courses as well as class handouts, shall become the property of employer. Employer reserves the right to copy such materials but for in house training and use only. Hand-on training shall utilize equipment identical to the being supplied to Employer

For all training courses, the travel (e.g. airfare) and per-diem expenses will be borne by the participants.

The Contractor shall quote training prices individually for each of the courses as indicated in BPS.

Employer will have the option to cancel any or all- training courses. In the case of cancellation the rate quoted against the respective course will not be paid to the Contractor.

The schedule, location and detailed contents of each course will be finalized during employer and contractor discussions.

10.2 **Computer System Hardware Course**

A computer system hardware course shall be offered but at the system level only. The training course shall be designed to give employer hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure, the hardware, perform preventive, maintenance run diagnostic programs and communicate with contract maintenance personnel. The following subjects shall be covered.

a) **System Hardware Overview :- Configuration of the system hardware**

b) Equipment Maintenance :- Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system e.g. processors, auxiliary memories, LANs routers and printers, configuration of all the hardware equipments.

c) System Expansion :- Techniques and procedures to expand and add equipment such as loggers, monitors and communication channels.

d) System Maintenace :- Theory of operation and maintenance of the redundant hardware configuration, failover hardware, configuration control panels and failover switches maintenance of protective devices and power supplies.

e) Subsystem Maintenace :- Theory of design and operation maintenance techniques and practies, diagnostic procedures and (where applicable) expansion techniques and procedures. Classes shall include hands ï on training for the specific subsystems that are part of employerÕs equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be taught in detail.

f) Operational Training :-Practical training on preventive and corrective maintenance of all equipment including use of special tools and instruments. This training shall be provided on Employer equipment or on similarly configured systems.

10.3 **Computer System Software Course**

The contractor shall provide a computer system software course that covers the following subjects.

a) System Programming:-Including all applicable programming languages and all stand alone service and utility packages provided with the system. An introduction to software architecture, effect of tuning parameters (OS software, Network software, database software etc. ) on the performance of the system.

b) Operating system :- Including the user aspects of the operating system , such as program loading and integrating procedures, scheduling management, service and utility functions and system expansion techniques and procedures.

c) System Initialization and Failover :- Including design, theory of operation and practice.

d) Diagnostics :- Including the execution of diagnostic procedures and the interpretation of diagnostic outputs.

e) Software Documentation :- Orientation in the organization and use of system software documentation.

f) Hands-on Trainings One week with allocation computer time for trainee performance of unstructured exercises and with the course instructor availability for assistance as necessary.

10.4 **Application Software Course**

The Contractor shall provide a comprehensive application software courses covering all applications including the database and display building course. The training shall include :

a) Overview :- Block diagrams of the application software and data flows programming standards and program interface conventions.

b) Application Functions:- Functional capabilities, design and major algorithms, associated maintenance and expansion techniques.

c) Software Development :- Techniques and conventions to be used for the preparation and integration of new software functions.

d) Software Generation :- Generation of application software from source code and associated software configuration control procedures.

e) Software Documentation :- Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.

f) Hands-on-Training:- One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.5 **Requirement of training**

The contractor shall provide training for two batches for two weeks each for following courses

| S.No. | Name of Course |
|---|---|
| 1. | Computer System Hardware |
| 2. | Computer System Software |
| 3. | Application Software |

11.0 **MAINTENANCE**

11.1 Maintenance Responsibility during the Guaranteed Availability period

During Guaranteed Availability Period, the Contractor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational.

12.0 **RELIABILITY AND AVAILABILITY**

The SAS shall be designed so that the failure of any single component, processor or device shall not render the system unavailable. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning.

- Mechanical and electrical design.
- Security against electrical interference (EMI)
- High quality components and boards

- Modular, well-tested hardware
- Thoroughly developed and tested modular software
- Easy-to-understand programming language for application programming.
- Details graphical documentation and application software.
- Built in supervision and diagnostic functions
- Security

  - Experience of security requirements.
  - Process know-how
  - Select before execute at operation
  - Process status representation as double indications.

- Distributed solution
- Independent units connected to the local are network
- Back-up functions.
- Panel design appropriate to the harsh electrical environment and ambient conditions.
- Panel grounding immune against transient ground potential rise.

Outage Terms

1) Outage

The state in which substation automation system or a unit of SAS is unavailable for Normal Operation as defined in the clause 7.1 due to an event directly related to the SAS or unit of SAS. In the event, the owner has taken any equipment / system other than Sub-station Automation System for scheduled / forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

2) Actual outage duration (AOD)

The time elapsed in hours between the start and the end of an outage. The time shall be counted to the nearest ¼ of an hour. Time less than ¼ of an hour shall be counted as having duration of ¼ of an hour.

3) Period Hours (PH)

The number of hours in the reporting period in a full year the period hour are 8760h (8784h for a leap year)

4) Actual Outage hours (AOH)

The sum of actual outage duration within the reporting period.

AOH = × AOD

5) Availability

Each SAS shall have a total availability of 99.98% i.e. the ratio of total time duration minus the actual outage duration to total time duration.

12.1 **Guarantees Required.**

The availability for the complete SAS shall be guaranteed by the Contractor. Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total substation automaion system as a whole after commissioning of total sub-station Automation system The test shall verify the reliability and integrity of all sub-systems. Under these

conditions the test shall establish an overll availability of 99.98%. After the lapse of 1000 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test, the contractor shall rectify the problem and after rectification, the 1000 Hours period start after such rectification, If test object has not been met the test shall continue until the specified availability is achieved.

The contractor has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability criterion the test is considered to be completed successfully. After that the system shall be taken over by the employer and then the guarantee period shall start.

## 13.0 SPARES

### 13.1 Consumables

All consumables such as paper cartridges shall be supplied by the contractor till the SAS is taken over by the owner.

### 13.2 Availability Spares

In addition to mandatory spares as listed in section project for SAS, the bidder is required to list the spares, which may be required for ensuring the guaranteed availability during the guaranteed availability period. The final list of spares shall form part of scope of supply and accordingly the price thereof shall be quoted by the bidder and shall be considered in the evaluation of the bids. During the guaranteed availability period, the spare parts supplied by the Contractor shall be made available to the Contractor for usage subject to replenishment at the earliest. Thus, at the end of availability period the inventory of spares with the Employer shall be fully replenished by the Contractor. However, any additional spares required to meet the availability of the system (which are not a part of the above spares supplied by the Contractor) would have to be supplied immediately by the contractor free of cost to the Employer.

## 14.0 LIST OF EQUIPMENTS

Quantity of equipments shall be decided by bidder in order to achieve guaranteed reliability and availability as declared by bidder.

1) Station HMI
2) Redudant Station HMI (in Hot - stand by mode)
3) HMI View Node
4) Bay level units along with bay mimic
5) Disturbance Recorder Work Station (Maintenance HMI)
6) Colour Laser Printer (A-3) 1 No. (For Reports & Disturbance records)
7) Dot Matrix Printer (one each for alarms and log sheets)
8) All interface equipment for gateway to RCC and RSCC
9) Communication infrastructure between bay level unit, Station HMI, Printers, gateways, redundant LAN etc. as required.
10) Remote workstation including HMI and alongwith one printer.
11) SAS Panel with all associated equipments for installed in control room.
12) SAS Panel for each Ethernet Switch with all associated equipments installed in each Kiosk/sub control room.
13) Rear Projection MIMIC Display (LVS) having 3x2 Matrix (Size of each block shall be 67 inch diagonally with SXGA resolution) with all necessary accessories / item, software, hardware, mounting arrangement etc
14) Any other equipments as necessary.

Basic Monitoring Requirements are :

- Switchgear status indication
- Measurements (U.I.P.O.I)
- Event
- Alarm
- Winding temperature of transformers & reactors
- Ambient temperature
- Status and display of 415 LT system 220 V & 48 V DC system
- Status of display of fire protection system and air-conditioning system.
- Acquisition of all counters in PLCC panels through potential free contacts from PLCC or independently by counting the receive / send commands.
- Acquisition of alarm and fault record from protection relays.
- Disturbance records.
- Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.
- Tap position of transformer

List of inputs

The list of input for typical bays in as below :-

Analogue inputs

i) For line

| | |
|---|---|
| Current | R phase |
| | Y phase |
| | B phase |
| Voltage | R-Y phase |
| | Y-B phase |
| | B-R phase |

ii) For transformer /; reactor

| | |
|---|---|
| Current | R phase |
| | Y phase |
| | B phase |

WTI (for transformer and reactor)
Tap position ( for transformer only)

iii) For TBC and Bus coupler

| | |
|---|---|
| Current | R phase |
| | Y phase |
| | B phase |

iv) Common

a) Voltage for Bus-I, Bus-II and Transfer bus wherever applicable.

| | |
|---|---|
| Voltage | R-Y phase |
| | Y-B phase |
| | B-R phase |

b) Frequency for Bus-I and Bus-II

c) Ambient temperature (switchyard)

d) LT System

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. Voltage R-Y, Y-B, B-R of Diesel Generator
iv. Current from LT Transformer-I
v. Current from LT Transformer-II
vi. Current from Diesel Generator
vii. Voltage of 220 V DCDB-I
viii. Voltage of 220 V DCDB-II
ix. Current from 220V Battery Set-I
x. Current from 220 V Battery Set-II
xi. Current from 220 Battery Charger-I
xii. Current from 220 V Battery Charger-II
xiii. Voltage of 48 V DCDB-I
xiv. Voltage of 48V DCDB-II
xv. Current from 48V Battery Set-I
xvi. Current from 48V Battery set-II
xvii. Current from 48 kV Battery charger-I
xviii. Current from 48 V Battery charger-II

Digital Inputs

The list of inputs for various bays / system is as follows :

1. Line bays

i. Status of each pole of CB, Isolator, Earth Switch
ii. CB trouble
iii. CB Operation / closing lockout
iv. Pole discrepancy optd
v. Trip coil faulty
vi. LBB optd
vii. Bus bar protn. Trip relay optd
viii. Main bkr auto recloser operated
ix. Tie / transfer auto recloser operated
x. Air lockout
xi. Tie / Transfer bkr a/r lockout
xii. Direct trip ï I /II sent
xiii. Direct trip-I / II received
xiv. Main I / II blocking
xv. Main I/II inter trip send
xvi. Main I / II inter trip received
xvii. O/V Stage-I operated
xviii. O/V State-II operated
xix. Fault Locator faulty
xx. Main- I / II CVT fuse fail
xxi. Main -I Protn trip
xxii. Main II Protn Trip
xxiii. Main-I PSB Alarm
xxiv. Main -I Sotf trip
xxv. Main -I R-PH trip
xxvi. Main ï I Y-PH trip

xxvii. Main I-B ph Trip
xxviii. Main -I Start
xxix. Main I / II carrier aided trip
xxx. Main I/II fault in reverse direction
xxxi. Main I / II Zone 2 trip
xxxii. Main I/II Zone-3 trip
xxxiii. Main I/II weak end infeed optd
xxxiv. Main PSB alarm
xxxv. Main II Sotf Trip
xxxvi. Maing II R-PH Trip
xxxvii. Main II Y-PH trip
xxxviii. Main II B-PH trip
xxxix. Main-II start
xl. Main-II aided trip
xli. Main I/II fault in reverse direction
xlii. Back-up o/c Optd
xliii. Back-up e/f optd
xliv. 220 V DC1/II source fail
xlv. Speech channel fail
xlvi. PLCC protection channel-I FAIL
xlvii. PLCC Protection Channel-II FAIL

2. Transformer bays

i. Status of each pole of CB, Isolator, Earth switch
ii. CB trouble
iii. CB operation / closing lockout
iv. Pole discrepancy optd
v. Trip coil faulty
vi. LBB optd
vii. Bus bar protn trip relay optd
viii. REF optd
ix. DIF OPTD
x. OVERFLUX ALARM (MV)
xi. OVERFLUX TRIP (MV)
xii. OVERFLUX ALARM (HV)
xiii. OVERFLUX TRIP (HV)
xiv. HV BUS CVT 1/2 FUSE FAIL
xv. MV BUS CVT 1/2 FUSE FAIL
xvi. OTI ALARM / TRIP
xvii. PRD OPTD
xviii. OVERLOAD ALARM
xix. BUCHOLZ TRIP
xx. BUCHOLZ ALARM
xxi. OLTC BUCHOLZ ALARM
xxii. OLTC BUCHOLZ TRIP
xxiii. OIL LOW ALARM
xxiv. Back-up O/C (HV) optd
xxv. Back up E / F (HV) optd
xxvi. 220 V DC-I /II source fail
xxvii. TAP MISMATCH
xxviii. GR-A PROTN OPTD
xxix. GR-B PROTN OPTD
xxx. Back-up o/c (MV) optd
xxxi. Back-up e/f (MV) optd

3. Transformer bays

viii. Status of each pole of CB, Isolator, Earth switch
ix. CB trouble
x. CB operation / closing lockout
xi. Pole discrepancy optd
xii. Trip coil faulty
xiii. LBB optd
xiv. Bus bar protn trip relay optd
xv. REF OPTD
xvi. DIF OPTD
xvii. HV BUS CVT FUSE FAIL
xviii. OTI / ALARM /TRIP
xix. PRD OPTD
xx. BUCHLOZ TRIP
xxi. BUCHLOZ ALRAM
xxii. OIL LOW ALARM
xxiii. Back-up impedance relay
xxiv. 220 V DC- I/II source fail
xxv. GR-A PROTN OPTD
xxvi. GR-B PROTN OPTD

4. Bus bar Protection

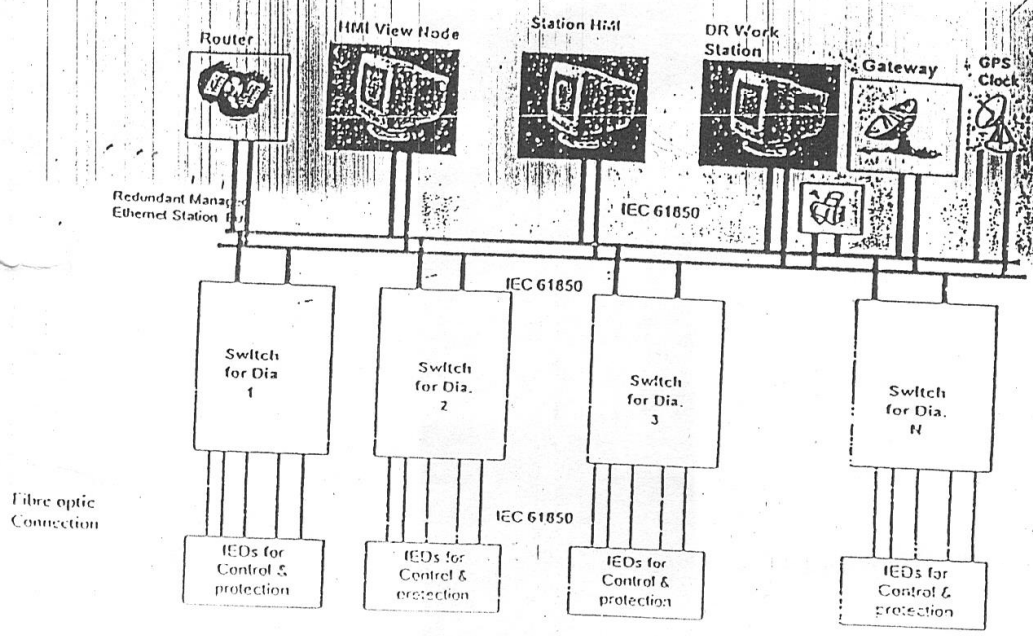
i. Bus bar Main-I trip
ii. Bus bar main-II trip
iii. Bus bar zone-I CT open
iv. Bus bar Zone-II CT open
v. Bus transfer CT sup. Optd
vi. Bus transfer bus bar protn optd
vii. Bus protection relay fail

5. Auxiliary System

i. Incomer-I On / Off
ii. Incomer ï II ON / OFF
iii. 415 V Bus-I/II U/V
iv. 415 V bus coupler breaker on/ off
v. DG set bkr on/off
vi. Alarm / trip signals as listed in Section DG set
vii. LT transformer-I Bunchloz Alarm and trip
viii. LT Transformer-II Buncholz Alarm & Trip
ix. LT Transformer-I WTI alarm & trip
x. LT Transformer-II WT1 Alarm & trip
xi. LT Transformer-I OTI Alarm & trip
xii. LT transformer-II OTI Alarm & trip
xiii. PLCC exchange fail
xiv. Time synch. Signal absent
xv. Alarm/trip signals as listed in Section Battery and Battery charger
xvi. 220 V DC-I earth fault
xvii. 220 V DC-II earth fault
xviii. Alarm / trip signals as listed in Section. Fire protection system

The exact number and description of digital inputs shall be as per detailed engineering requirement. Apart from the above mentioned digital inputs, minimum of 200 inputs shall be kept for NIGAM use in future.

# TYPICAL ARCHITECTURAL DRAWING OF SUBSTATION AUTOMATION SYSTEM




Note:

1. The redundant managed bus shall be realized by high speed optical bus using industrial grade components and shall be as per IEC 61850.
2. The IEDs and switches for each of the dia. of 400kV shall have separate kiosk. For 220kV yards, IEDs for two bays can be housed in one Kiosk along with its switch.
3. Inside the sub-station, all connections shall be realized as per IEC 61850 protocol.
4. For gateway, it shall communicate with Remote Supervisory Control Centre (RSCC) on IEC 60870-5-101 protocol.
5. The substation Remote Control Centre (RCC) shall communicate on IEC 60870-5-101 protocol.
6. The printer as required shall be connected to station bus directly and can be managed either from station HMI, HMI view node or disturbance recorder work station.

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

# CIRCUIT BREAKER

**Volume-II**
**Part-4**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

## PART-4 (Vol. II)

## Technical Specification for Circuit Breaker

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## Part-4 (Vol. II)

## Technical Specification for Circuit Breaker

### 1.0 SCOPE :-

1.1 This specification covers design, engineering, manufacture, assembly, routine testing, inspection and testing before supply, packing, forwarding and delivery erection, testing and commissioning at site of 420 kV and 245kV, 3 pole, SF6 gas filled outdoor circuit breakers alongwith terminal connectors, mounting, structures, all the accessories and auxiliary equipment and mandatory spares and maintenance equipment specified herein required for their satisfactory operation in various sub-stations of the State as specified here under.

1.2 It is not the intent to specify completely here all the details of design and construction of the circuit breakers. However, the breakers shall conform in all respects to the high standard of engineering design and workmanship and shall be capable of performing in continuous commercial operation upto the Bidderôs guarantee in a manner acceptable to the Purchaser who will interpret the meanings of drawings and specifications and shall have power to reject any material which in his judgement is not in accordance therewith. The circuit breakers offered shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of the Bidder irrespective of whether they are superficially brought out in this specification and / or in the commercial order or not.

### 2.0 STANDARDS :-

2.1 The circuit breakers covered by this specification shall comply with the requirements of the latest edition of IEC publication No.56 or IS Specification No.2516 except where stated otherwise in the specification.

2.2 Pressure vessels for unit system shall be designed and manufactured as per any of the following standards :-

1. IS : 2825
2. BS : 5500
3. ASME : Section 6 Division 1.

2.3 The high pressure cylinder in which SF6 gas is transported and stored at site shall comply with the requirements of the following standards :-

1. IS : 4379
2. BS : 7285
3. Indian Boiler Regulations

2.4 The terminal clamps (connectors) shall conform to the provision of IS: 5561.

2.5 Galvanisation on ferrous parts of equipment, bolts, nuts, screws, pins, washers etc. shall conform to IS:2629.

2.6 Sulphur Hexafluoride Gas (SF6) shall conform to provision of IEC Publication 376.

2.7 Induction motors shall conform to IS:325.

2.8 Marking & identification of insulated conductors and apparatus terminals shall conform to IS:5578 & 11353.

2.9 The porcelain bushings shall conform to IS:2099 and IEC:137.

2.10 Equipment and material conforming to alternative internationally recognised standards which ensures a quality equal to or better than as per the Indian Standards shall also be acceptable. In that case, the salient points of difference between the standard adopted and those prescribed in this specification shall be clearly brought out in the bid and a copy of the applicable standard (s) in English language, if other than ISS, shall also be enclosed by the tenderer with his offer.

## 3.0 SERVICE CONDITONS :-

3.1 Climatic conditions :-

The breakers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

| | | |
|---|---|---|
| 1. | Maximum ambient temperature, °C. | 50 |
| 2. | Minimum ambient air temperature in shade ºC. | (-) 5ºC. |
| 3. | Maximum daily average ambient temperature, °C. | 45 |
| 4. | Maximum yearly weighted ambient temperature, °C. | 35 |
| 5. | Average No. of thunder storm days per annum | 40 days. |
| 6. | Average No. of months of tropical monsoon condition per annum | 4 |
| 7. | Maximum relative humidity | 100%. |
| 8. | Minimum relative humidity | 10% |
| 9. | Height above mean sea level | Less than 1000 M |
| 10. | Dust storms are liable to occur in the period from | March to July. |
| 11. | Maximum wind load | 195 Kg./$M^2$. |
| 12. | Seismic level<br>Horizontal acceleration | 0.3 g. |
| 13. | Average annual rainfall (mm) | 10 to 100cm. |

Moderately hot and humid tropical climate, conducive to rust and fungus growth.

3.2 Auxiliary Power Supply :-

Auxiliary electrical equipment shall be suitable for operation on the following supply system.

(a) Power Devices (like drive motors) 415 Volts, 3 phase, 4 wire, 50 Hz, neutral grounded A.C. Supply.

(b) D.C.Alarm, control and Protective devices. 220 Volts DC, undergrounded 2 wire.

( c) Lighting 240 V, single phase, 50 Hz AC supply.

Each of the forgoing supplies shall be made available by the purchaser at the terminal point for each circuit breaker for operation of accessories and auxiliary equipment. Bidderôs scope include supply of interconnecting cables, terminal boxes etc.. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over the entire range of voltages.

| | |
|---|---|
| A.C. Supply | Voltage + 10%; Frequency ± 5% |
| D.C. Supply | -15% to + 10% |

## 4.0 PRINCIPLE PARAMETERS (Circuit Breaker)

### 4.1 Circuit breakers shall have rating as specified below :-

| | | | |
|---|---|---|---|
| i. | Rated Voltage, kV rms | 420 | 245 |
| ii. | Rated Frequency, Hz | 50 | 50 |
| iii. | System Neutral Earthing | Effectively earthed. | Effectively earthed. |
| iv. | Type of quenching medium | SF6 | SF6 |
| v. | Rated continuous current at design ambient temp. (A) | 2000 | 2000 |
| vi. | Number of poles | 3 | 3 |
| vii. | Installation | Outdoor | Outdoor |
| viii. | Service Condition | As per Clause 3.0 | As per Clause 3.0 |
| ix. | Temperature rise | As per Clause 6.25 | As per Clause 6.25 |
| x. | Rated short circuit current | | |
| | a) RMS value of the A.C. Component, kA | 40 | 40 |
| | b) The percentage DC component shall correspond to minimum operating time | As per IEC 62271-100 | As per IEC 62271-100 |
| xi. | Rated short circuit making current, kA peak | 100 | 100 |
| Xii | First pole to clear factor | 1.3 | 1.3 |
| xiii. | Rated duration of short circuit, (second). | 1 | 1 |
| Xiv | Total break time for any current upto the rated breaking current with limiting conditions of operating coil voltage and operating and quenching media pressure (not more than), ms. | 50 | 50 |
| xv. | Closing time, ms (max.) | 150 | 150 |
| xvi. | Difference in the instants of closing / opening of contacts at rated control voltage and the rated operating quenching media pressure ï Not more than | | |
| | a) Within a pole, ms | 2.5 | 5 |
| | b) Between poles, ms | 3.33 | 10 |
| Xvii | Standard values of rated transient recovery voltage for terminal faults | | |
| | Rated voltage U, kV | 420 | 245 |
| | First ref. voltage U1, kV | 446 | 260 |
| | Time co-ordinate T1, µs | 223 | 130 |
| | TRV peak value Uc, kV | 624 | 364 |
| | Time co-ordinate t2, µs | 669 | 390 |
| | Time delay td, µs | 2 | 2 |
| | Voltage Co-ordinate u1, kV | 223 | 130 |
| | Time co-ordinate td, µs | 114 | 67 |
| | Rate of rise µ1 /t1, kV / µs | 2.0 | 2.0 |
| Xviii | Rated characteristics for short line faults | | |
| | a) Standard values of transient recovery voltage of the supply circuit for short line fault. | | |
| | U, kV | 420 | 245 |
| | U1,kv | 343 | 200 |
| | t1, µs | 171 | 100 |

| | | | |
|---|---|---|---|
| | U c, kV | 480 | 280 |
| | t 2, µs | 513 | 300 |
| | td, µs | 2.0 | 2.0 |
| | Uo, kV | 171 | 100 |
| | t 1, µs | 88 | 52 |
| | U1 / t 1, kV / µs | 2.0 | 2.0 |
| | b) Standard values of rated line characteristics for short line fault | Rated Surge impedance Z (ohm) / Rated peak factor K / RRRV Factor S (kV/ms kA) | |
| | | 450 / 1.6 / 0.2 | |
| | c) Standard values of transient recovery voltage for out of phase breaking | | |
| | U, kV | 420 | 245 |
| | u1, kV | 686 | 400 |
| | t 1, us | 445 | 260 |
| | uc, kV | 857 | 500 |
| | t 2, µs | 1335 | 780 |
| | u1 / t1, kV/ us | 1.54 | 1.54 |
| xix. | Standard values of prospective transient recovery voltage for test duties as per IEC | As per IEC 62271-100 | As per IEC 62271-100 |
| xx. | Rated operating duty cycle | 0-0.3sec.-CO-3Min-CO(Where óOô stand for opening and óCô stand for closing). | 0-0.3sec.-CO-3Min-CO(Where óOô stand for opening and óCô stand for closing). |
| xxi. | Auto Reclosing | Suitable for single & three phase | Suitable for single & three phase |
| xxii. | Rated insulation level under heavy pollution conditions | | |
| | A. 1.2 / 50 microsecond lightning impulse withstand voltage, kV (Peak).<br>a) to earth | 1425 | 1050 |
| | b) across the open circuit breaker voltage supplied to<br>- one terminal, lightning impulse, kV (Peak).<br>- opposite terminal, power frequency, kV (Peak). | 1425<br>345 | 1050<br>As per IEC 62271-100 |
| | B) 250/2500 microsecond switching impulse withstand voltage | | |
| | a) to earth, kV (Peak) | 1050 | As per IEC 62271-100 |
| | b) across the open circuit breaker voltage applied to :-<br>- one terminal lightning, impulse, kV (Peak)<br>- opposite terminal, power frequency, kV (peak) | 900<br>345 | As per IEC 62271-100<br>As per IEC 62271-100 |
| | C) Power frequency withstand, voltage | | |
| | a) to earth, kV (rms) | 520 | As per IEC 62271-100 |
| | b) across terminals of one circuit breaker, kV (rms) | 610 | As per IEC 62271-100 |
| xxiii. | Rated line charging current breaking capacity (* at temporary power frequency over voltage as high as 1.5 p.u. without restrikes, Amps). | 600 (*) | As per IEC 62271-100 |
| xxiv. | Small inductive current interrupting capacity | Any value from 0.5 A to 10A, without switching over voltage exceeding 2.3 p.u. | Any value from 0.5 A to 10A, without switching over voltage exceeding 2.3 p.u. |
| xxv. | Operating mechanism | Pneumatic, mechanical or Hydraulic, Anti-pumping and trip free, with the failure of AC power, it shall be possible to operate the breaker for one OCO operation with the energy contained in the operating mechanism. | Pneumatic, mechanical or Hydraulic, Anti-pumping and trip free, with the failure of AC power, it shall be possible to operate the breaker for one OCO operation with the energy contained in the operating mechanism. |

| | | | |
|---|---|---|---|
| xxvi. | Radio interference voltage at 266 kV (rms) for 420 kV breakers. | Not exceeding 1000 microvolts (both in closed and open conditions.) | Not exceeding 1000 microvolts (both in closed and open conditions.) |
| xxvii. | Corona Extinction voltage, kV (rms) | 320 | 156 |
| xxviii. | Partial discharge level | As per IEC 62271-100 | As per IEC 62271-100 |
| xxix. | Creepage distance, mm | | |
| | a) Phase to earth | 10500 | 6125 |
| | b) Across terminals | 10500 | 6125 |
| xxx. | Rated supply voltage of closing and opening devices and auxiliary circuit. | i) 220 V D.C.<br>ii) 240 V. A.C.<br>50 Hz single phase.<br>iii) 415 V. AC 50 HZ, three phase. | i) 220 V D.C.<br>ii) 240 V. A.C.<br>50 Hz single phase.<br>iii) 415 V. AC 50 HZ, three phase. |
| xxxi. | Number of auxiliary contacts. | 10 NO and 10 NC on each pole. Continuous current rating 10 A D.C. Breaking capacity shall be minimum 2 Amp. With circuit time constant less than 20 m.s. at 220 V.D.C. | 10 NO and 10 NC on each pole. Continuous current rating 10 A D.C. Breaking capacity shall be minimum 2 Amp. With circuit time constant less than 20 m.s. at 220 V.D.C. |
| xxxii. | a) Number of Trip coils | 2 per pole if series elements are used along with trip coil, they are to be thoroughly tested for reliability. | 2 per pole if series elements are used along with trip coil, they are to be thoroughly tested for reliability. |
| | b) Number of closing coil per pole | One | One |
| xxxiii. | a) SF6 characteristics | As per Annex-I | As per Annex-I |
| | b) SF6 gas cylinder | Seamless cylinder to be used. | Seamless cylinder to be used. |
| xxxiv. | Noise level of the equipment | Not exceeding 140 dB. | Not exceeding 140 dB. |
| xxxv | Rated terminal load | 100 kg. static | |
| xxxvi | Clearances, mm | | |
| | a) Minimum Phase to phase clearance in air | 4000 | 2700 |
| | b) minimum phase to ground clearance in air | 3500 | 2300 |
| | c) Minimum ground clearance between lowest part of insulator and earth | 2500 | 2500 |
| xxxvii | Pole to pole spacing to be maintained in switchyard | 7000 / 6000 | 4500 |

## 5.0 GENERAL TECHNICAL REQUIREMENTS

5.1 Circuit breakers shall comprise three identical single pole units linked together electrically, pneumatically or electro-hydraulically. Each breaker pole shall have its associated mechanism box. Common operating shaft for all the three poles shall not be acceptable.

5.2 Base plate & support structure and foundation bolts for circuit breakers and control cabinets, terminal connectors shall be in the scope of supply.

5.3 Exposed live parts shall be placed high enough above ground to meet the requirements of local safety codes.

5.4 All similar parts particularly removable ones shall be interchangeable with one another.

5.5 Circuit breakers shall be single pressure SF6 type.

5.6 Design and construction of the circuit breaker shall be such that there is minimum possibility of gas leakage and ingress of moisture. There should not be any condensation of SF6 gas on internal insulating surface of the circuit breaker.

5.7 In the interrupter assembly there shall be filters to eliminate SF6 decomposition products and moisture. The details and operating experience with such filters shall be brought out, in additional information schedule.

5.8 Each pole shall form an enclosure filled with SF6 independent of the two other poles, the pressure of each pole shall be monitored and regulated by individual Density Monitor (Indicating type) and pressure switches. Double ñOò ring seals / sealing rings with test holes for leakage test of the internal seal shall be provided on each static joint. The density monitor shall meet the following requirements:-

i) It shall be possible to dismantle the density monitor for checking / replacement without draining the SF6 gas by using suitable interlocked non-return coupling.

ii) The monitor shall damp the pressure pulsation while filling the gas in service so that the flickering of the pressure switch contacts does not take place.

iii) A pressure indicator shall be provided.

iv) The alarm and trip setting shall be provided such that advance warning can be given for low pressure below the acceptable level and after alarm; the breaker shall open, if the pressure fails below pre-determined value.

5.9 Material used in the construction of circuit breakers shall be such as fully compatible with SF6.

5.10 The position of vents, diaphragms and pressure relief devices shall be so arranged to minimise danger to the operators in the event of gas or vapour escaping under pressure.

5.11 Sufficient SF6 gas shall be provided to fill all the circuit breakers installed plus an additional 20% of the quantity to compensate for losses in non-returnable cylinders, names of the suppliers of SF6 for future requirements shall be indicated in the bid. The pressure loss in the breaker shall not be more than 1% per year under normal conditions.

5.12 The control circuit shall have two source of DC control supply of 220V (One for closing circuit & Trip circuit ï I and other for Trip circuit ï II). Separate & independent control of SF6 pressure switches & air pressure switches shall be incorporated for lock out circuit for DC source-1 and DC source-2. Pole discrepancy circuit shall be prepared for DC-1 & DC-2 independently using 2 Nos. pole discrepancy relays.

5.13 The compressorôs motor power supply circuit shall have AC supply source-1 and source -2 with auto supply change over scheme.

## 6. 0 DATA REQUIREMNTS

6.1 The circuit breakers shall be totally restrike free under all duty conditions and shall be capable of performing specified duties without opening resistors.

6.2 The circuit breakers shall meet the duty requirements for any type of fault location, for line charging and dropping when used on an effectively grounded system and perform make and break operations as per stipulated duty cycles satisfactorily.

6.3 The circuit breakers shall be capable of :-

i) Interrupting the steady and transient magnetising current corresponding to 420 kV class transformers of 315 MVA rating.

ii) Interrupting line charging current as given in Clause 4.0, ñPrinciple parametersò of this specification with a temporary over-voltage as high as 1.5 p.u. without restricts and without use of opening resistors.

iii) Clearing short line faults (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.

iv) Breaking inductive currents of 0.5 to 10A without switching over-voltage exceeding 2.3 p.u. for 420 kV circuit breakers.

v) Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.

6.4 The critical current which gives the longest arc duration at lockout pressure of extinguishing media and the arc duration shall be indicated.

6.5 The breakers shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges. The breakers shall also withstand the voltage specified in Clause 4.0 ñPrincipal Parametersò of this specification.

6.6 **TOTAL BREAK TIME OF BREAKER**

6.6.1 Each breaker shall be capable of completely interrupting all phases or only one phase of a 50 Hz three phase circuit when faulted by any type of fault, upto 100 percent of rated short circuit at rated maximum voltage or related required capabilities in the specified time of 50 ms. For proving the total break time (vide clause 4.1 ï xiv above) duties 1, 2, 3, 4, 5 and SLF shall be considered and out of phase switching duty shall be discarded. The opening time and arcing times shall be obtained from Oscillographic records showing the most severe switching conditions as per IEC: 56. The total break time shall be obtained by adding opening time and maximum arcing time of a breaker.

6.6.2 Opening time of a breaker is a defined as the interval between the instant it receives a trip signal and parting of first contact to open in the slowest pole. However, for assigning a symmetrical breaking capacity, shortest opening time (i.e. the shortest time between partings of contacts in the fastest pole) shall be considered.

6.6.3 When single phase test data are used, the total break time obtained from the addition of opening time and maximum arcing time will be reduced by 1/10 cycle for symmetrical currents and 1/5 cycle for asymmetrical currents.

6.7 **MAKE BREAK TIME :-**

6.7.1 Make break time is defined as the interval of time between the initiation of current flow in the first pole of the main circuit during a closing operation and the end of the maximum arcing time during the subsequent opening operation. It is assumed that the tripping circuit of the circuit breaker is energised one half cycle after the current begins to flow in the main circuit during making.

6.8 **RATED OPERATING DUTY CYCLE**

6.8.1 Three minutes interval in rated operating duty cycle (vide clause 4.1 ï xx) indicate the maximum time in which breaker auxiliary scheme to be brought to the normal operating condition. Breakers can operate for the subsequent co-operation if the auxiliaries come to operating condition at a time interval of less than 3 minutes. No special timer will be provided to block the co-operation for three minutes.

6.8.2 The breaking current value, for the following duty is to be indicated by the bidder. 0-0.0 sec. ï CO ï 0.0 sec. indicates that no intentional delay is provided between opening and next closing operation i.e. setting of time delay relay as 0.0 sec.. However, this will include the inherent delay of the circuit breaker. The breaker shall be able to interrupt the fault current without the provision of opening resistors across the contacts.

6.8.3 Any device required to furnish as a current or voltage limiter or to damp out oscillation or restrikes prior to complete interruption of current shall have a life expectancy not less than that of the rest of breaker as a whole.

6.9 **CONTACTS**

6.9.1 All making and breaking contacts shall be sealed and free from atmospheric effects. The contacts shall be permanently under pressure of SF6 gas.

6.9.2 If multi-break interrupters are used, those shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculation in support of the same shall be furnished along with the bid. Thermal and voltage withstands of the grading elements shall be adequate for the service conditions and duty specified.

6.9.3 Main contacts shall be the first to open and the last to close so that burning and wear of main contacts shall be minimum.

6.9.4 Arcing contacts shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. If there are no separately mounted arcing contacts, then the main contacts shall be easily accessible for inspection and replacement.

6.9.5 Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise which may cause pitting or welding.

6.9.6 Contacts shall be adjustable to allow for wear, easily replaceable and shall have a minimum of moveable parts and adjustment to accomplish these results.

6.9.7 Tip of arcing and main contacts shall be silver plated or have a tungsten alloy tipping.

6.9.8 Current carrying contact surfaces shall be silver plated.

6.9.9 Diagrams showing contacts in the following position shall be furnished along with the bid :-

i) Closed position.
ii) Arc initiation position.
iii) Full arcing position.
iv) Arc extinction position.
v) Open position.

## 6.10 SUPPORT INSULATOR AND HOUSING

6.10.1 Porcelain used in manufacture of support insulators / housing shall be homogenous, free from cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

6.10.2 Glazing of the porcelain shall be of uniform, free from blisters, burrs and similar other defects. Porcelain support housing shall be designed to have ample insulations, mechanical strength and rigidity for the conditions under which they will be used. All insulator housing of identical rating shall be interchangeable.

6.10.3 Puncture strength shall be greater than the dry flashover value. When operating at normal rated voltage, there shall be no electric discharge between the conductors and porcelain parts which would cause corrosion or injury to conductors, insulators or supports by the formation of sub-stances produced by chemical action. No radio disturbances will be caused by the insulation support / housing when operating at the normal rated voltage and shall also be free from external and internal corona.

6.10.4 Insulator supports / housing shall satisfactorily withstand the insulation level, specified for circuit breakers in this specification. The external insulator supports / housing shall have dielectric strength as specified above under heavy pollution conditions.

## 6.11 SUPPORT STRUCTURES

6.11.1 The support structures if required, shall be of tubular or lattice type and will be supplied with breaker. The price of these support structures shall be included in the price of the equipment and the same shall be separately indicated clearly in the bid. The bidder shall submit design calculations, fabrication / detailed drawings of the requisite supporting structures suitable for the equipment being offered. In addition, the bidder shall specify the loads which shall be transmitted to the equipment foundation under most adverse operating conditions of the

equipment. Foundation bolts (with nuts) shall also be supplied with the structures. The criteria for design of the supporting structures are given at Annexure ï III.

## 6.12 OPERATING MECHANISM – GENERAL REQUIREMENT

6.12.1 Circuit breaker shall be operated by either pneumatic mechanism or spring charged mechanism or hydraulic mechanism or alternate operating mechanism can be quoted. The merits for the type of alternative operating mechanism proposed or operating mechanism deviating from that specified shall be stated in the tender.

6.12.2 The operating mechanism shall be suitable for high speed reclosing. It shall be anti-pumping and trip free (as per IEC definition) electrically and either mechanically or pneumatically under every method of closing (except during manual closing of breaker for maintenance). A latch checking switch shall be provided on mechanically trip free mechanism to prevent reclosure before the breaker latches have reset.

6.12.3 There shall be no objectionable rebound and the mechanism shall not require any critical adjustment. It shall be strong, rigid, positive and fast in operation.

6.12.4 The operating 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 operated closing devices.

6.12.5 A mechanical indicator shall be provided to show open and close positions of breaker. It shall be located in a position where it will be visible to a man standing on the ground. An operation counter at 1000-1300 mm level shall also be provided. The counter reading shall be visible from the ground even with the mechanism housing closed.

6.12.6 Closing coil and trip coil shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. If additional elements are introduced in the trip coil circuit, their successful operation for similar applications on outdoor breakers shall be clearly brought out in the appropriate schedule. In the absence of adequate details, the offer is likely to be rejected.

6.12.7 Working parts of the mechanism shall be of 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.

6.12.8 Operating mechanism shall normally be operated by remote electrical control. Electrical tripping shall be performed by trip coils. provision shall be made for local electrical control ó Local/Remoteô selector switch and close and trip push buttons shall be provided in the breaker control cabinet.

6.12.9 For the purpose of tripping, two electrically independent trip circuits along with separate trip coils shall be provided.

6.12.10 Provision shall be made on the circuit breaker for attaching operation analyser to perform the speed test after installation of circuit breaker at site to record contact travel against- time, instant of insertion and removal of resistor with respect to energisation and to measure opening time of all interrupters, simultaneously.

6.12.11 The bidder shall furnish, along with the bid, curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and pneumatic / hydraulic pressure.

6.12.12 The operating mechanism shall be such that the main poles shall close simultaneously. Should the settings of the breaker poles being not the same during closing all three poles shall tirp simultaneously on appropriate electrical pneumatic command. An out of step relay shall be supplied with each breaker to trip the breaker in case of pole discrepancy after pre set time and to give a remote pole discrepancy after pre set time and to give a remote pole discrepancy trip indication.

6.12.13 The circuit breaker operating mechanism shall incorporate an electrically achieved positive acting antipumping feature to prevent the circuit breaker from relcosing after automatic opening when the initiating closing devices, is set in the position of closing. Necessary antipumping relay shall be included in the scope of supply.

## 6.13 SPRING OPERATING MECHANISM

6.13.1 The spring operating mechanism shall have adequate energy stored in the operating springs to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

6.13.2 The mechanism shall be capable of performing the rated operating duty cycle of 0-0.3 sec.-C 0-3 min-CO as per IEC :56.

6.13.3 The spring charging motor shall not take more than 30 sec. for fully charging the closing springs. The provision shall be made for automatic charging of the closing springs as soon as they are discharged in a closing operation and indication there of shall be provided in local control cabinet. For this the mechanism shall be such that the charging of the springs by the motor does not inter-act with the operation of the breaker.

6.13.4 The motor shall be adequately rated to carry out a minimum of 10 close and open operations continuously. Also provision shall be made to protect the motor against over-loads.

6.13.5 In case of failure of power supply to the springs charging motor, the mechanism shall be capable of performing one sequence of 0-0.3 sec. ï CO operation.

6.13.6 Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of the closing springs when the breaker is already in the closed position. Provision shall also be made to prevent a closing operation to be carried out when the springs are partially charged.

6.13.7 Facility shall be provided for manual charging of the closing springs.

6.13.8 Closing operation of breaker shall compress the opening springs so that breaker is ready for tripping.

## 6.14 HYDRAULIC OPERATING MECHANISM

6.14.1 The hydraulic operating mechanism shall be a complete and self contained unit without requiring any external source of energy except electric supply. The hydraulic system shall consist namely of operating unit with cylinder (s), a set of actuating valves, nitrogen gas accumulators (to supply the energy instantaneously), oil pump (to charge the controls for performing various operations) and motor etc.

The hydraulic mechanism shall meet the following requirement:-

1. In case of failure of AC supply, the energy stored in the accumulator shall be sufficient for 2 CO operation with initial pressure equal to lowest pressure of auto reclose duty plus pressure drop for one close operation of the breaker.
2. The energy stored shall be sufficient for 0-0.3 sec.-CO-3 min CO sequence operation of breaker and the accumulator charging time for restoring pressure shall be so short as to meet further operating sequence as per IEC.
3. Hydraulic mechanism shall be provided with satiable safe guards or lockout arrangement to prevent operations below the specified minimum operating pressure. The closing lock out pressure shall be such that an opening operation is possible after the breaker is closed.
4. The hydraulic oil used in the mechanism shall be capable of retaining its properties from minus 50ºC to 50ºC so that operation of the breaker is possible throughout the specified ambient temperature range.

5. The mechanism shall have a comprehensive pressure monitoring and control system to regulate the operating pressure at all times automatically and give electrical indication in local as well as remote control board in case of loss of hydraulic pressure, loss of $N_2$ gas in accumulator etc..
6. The mechanism shall be so designed that in the event of pressure loss in the hydraulic system the breaker contacts remain in the particular and position.
7. The hydraulic mechanism shall be provided with the hand pump for an emergency operation of the breaker.

## 6.15 NEUMATIC MECHANISM

6.15.1 The pneumatic operating mechanism shall consist of pilot or auxiliary and main valves for closing and opening operations of the circuit breaker. The pilot valves shall be suitable of operations either electrically by electrical solenoids or by local control push buttons. The accessories shall include an intake filter stop valve, non return valve, drain valve, breaker position indicator, auxiliary contacts, operation counter, space heater, a set of terminal blocks etc..

6.15.2 The operating mechanism shall also include necessary monitoring and safety interlocks such as pressure gauge with electrical alarm contacts for low / high pressure signals, pressure switch for low pressure lock out for closing, opening and auto reclosing operations and a safety valve. The closing and auto reclosing lock out pressure shall be such that the breakers shall be above to open immediately after closing or reclosing operation as the case may be. Provision shall exist for both local and remote electrical operation of the breaker. The mechanism shall be provided with anti-pumping feature.

6.15.3 The compressed air store din the local air receiver shall be sufficient to carry out atleast 2 CO operations and the charging time to restore the pressure shall be sufficiently short to complete the rated operating sequence viz. 0-0.3 sec.-CO-3 Min-CO.

6.15.4 The operating mechanism shall be suitable for the rated operating sequence viz. 0-0.3 sec.-CO-3 minï CO with lowest pressure recommended for make up.

6.15.5 The compressed air mechanism shall be capable of operating the circuit breaker under all duty conditions with the air pressure immediately before operation between 85% and 105% of the rated supply pressure. The make / break time at this supply pressure shall be exceed the specified make / break time within any value of trip coil supply voltage as specified. The operating mechanism shall be such that it shall not be possible for any leakage of air from the pneumatic equipment to build up a pressure in the closing cylinder.

6.15.6 All compressed air cabinets and connections especially those between ceramic and metallic components shall be completed gas tight for pressure upto 1.5 times the rated pressure for breaker operation. Any gasket used for these joints shall have a long life under climatic conditions specified. Necessary arrangements for draining the condensed moisture from the lower points in the pneumatic system shall be incorporated.

## 6.16 GENERAL REQUIREMENT OF COMPRESSOR SYSTEM

**(a)** The unit compressor system of the breaker shall consist of one compressor which shall charge local air receiver vessel of each of three core of the SF6 circuit breaker either directly or through main receiver vessel located outdoor near the breaker. The plant shall be provided with static absorption filter, automatic regenerating type, to ensure dry air. The compressor shall be capable of charging the compressed air receivers to the rated breaker operating pressure from atmospheric pressure in short time. The bidder shall, indicate clearly in the bid the charging time of the receivers starting from atmospheric conditions. All pressure vessels

shall be equipped with safety valves. Bids offering in adequate compressor plant will be rejected. Bidders shall furnish calculations to prove adequacy of the plant offered by them.

**(b) Compressor:-**

The Compressor shall be multi-stage machine with two or more cylinders and shall be Designed for continuous duty at the maximum working pressure and shall be designed for continuous duty at the maximum working pressure and shall preferably be of air cooled design. The compressor shall be complete with its air filter and silencer so as to give a noise free service.

**c) Driving Motors :-**

The Driving motor shall be three phase squirrel cage machine of totally enclosed, fan cooled design meant for outdoor service.

**d) Air Receivers :-**

The air receivers shall be fabricated according to the valid pressure vessel codes and shall also fulfil the stipulations of the relevant welding codes. Each air receiver shall be either hot dip galvanised both inside and outside or hot dip galvanised on outside and painted on inner side. Air receiver shall be fitted with a drainage cock for the condensate water. The anti-corrosive primer and paint used shall be compressed air and water resistant. These properties of the primers / paints shall be elaborated in the bid. All pipe connections shall be tested together with the receiver. After fabrication the receivers shall be relieved of fabrication stresses. Each air receiver shall be provided with an inspection hole of suitable size and base plates and rating plate.

**e) Safety Valves:-**

Safety valves shall be provided after each compression stage of compressor and on the air receivers. Each safety valve equipped with easing mechanism, shall be capable of being set at correct opening and closing pressure and an arrangement shall be provided to seal it against unauthorised interference.

**f) Selector Switches:-**

A selector switch with the text ôAuto-off-handõ shall be provided for the compressor. This switch shall be mounted on the local control panel.

**g) Manual starting of compressor:-**

For manual starting of compressor, two push buttons one each for ôStartõ and ôStopõ shall be provided. A push button once pressed shall continue the appropriate operation unless the other push button is pressed for reversing the previous operation.

**h) Motor Protection:-**

Motor starters with thermal overload release shall be provided as a safety precaution against over heating of driving motors. Motor must have single phase and reverse phase sequence protection.

i) **Control cubicle :-**

The selector switches, start / stop push buttons, etc. for the compressor shall be flush mounted on a self supporting 3 mm thick sheet steel cubicle having hinged doors on the front and back. The cubicle shall be dust and vermin proof and shall be provided with approved type of illumination arrangements and appropriate number of terminals on a terminal board. Inside of the control panel shall be painted with white glossy enamel paint whereas the outside shall be finished with glossy enamel paint of approved shade. The selector switch pressure and other accessories mounted on the front of the control panel shall be provided with an approved type of label to indicate the purpose of equipment. Cubicle shall be complete in all respect including small wiring. Suitable space heaters complete along with rotary switch shall also be provided in the control cubicle.

j) **Pressure Gauges:-**

Pressure gauge shall be provided with suitable number of contacts so as to sound an alarm in the control room when the pressure in the air receivers falls below or rises above the recommended values. The pressure gauges shall have dial working in $Kg/Cm^2$.

k) **Pressure Switches:-**

Two or more pressure switches having different pickup values shall be provided on compressed air plant. These pressure switches shall have suitable number of contacts to enable automatic working of the compressor.

## 6.17 LOCAL CONTROL CABINET

6.17.1 Control cabinet shall be sheet steel enclosed and shall be dust, water and vermin proof. Sheet steel used shall be atleast 3.0 mm thick and properly braced to prevent webbing.

6.17.2 The enclosure of the control cabinets shall provide a degree of protection of not less than IP : 55 (as per IS:2147).

6.17.3 Control cabinets shall be of free standing floor mounting type.

6.17.4 Control cabinets shall be provided with double hinged doors with padlocking arrangement. The doors shall be provided on front and rear side.

6.17.5 All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. Louvers shall have screens and filters .The screens shall be of fine wire mesh made of brass or GI wire.

6.17.6 Cable entries shall be from bosom, suitable removable cable gland plate shall be provided on the cabinet for this purpose. Necessary number of cable glands shall be supplied fitted up on this gland plate cable glands shall be screw on type and made of brass.

6.17.7 All sheet steel work shall be degreased, pickled posphated and then applied with two coats of zinc chromate primer and two coats of finishing synthetic enamel paints, both inside and outside. The colour of the finishing paint shall be light gray in accordance with shade No.697 of IS : 5.

6.17.8 Suitable heaters shall be mounted in the cabinet to prevent condensation. Heaters shall be controlled by differential thermostat so that that cubicle temperature is always maintained approximately 10ºC above the outside air temperature. ON/OFF switch and fuse shall be provided. Heater shall be suitable for 240 VAC supply voltage.

6.17.9 The terminals shall be so staggered that the connection of external cable to any terminal block should be possible without disturbing the rest of the connections. The terminal block arrangement shall be such as to provide easy accessibility to all conductor terminations. The

terminal blocks to be provided shall be fully enclosed with removable covers and made of moulded non-inflammable plastic material with boxes and barriers moulded integrally.

6.17.10 Each block shall have washer and binding screws for external circuit wire connection, a white marking strip for circuit identification and moulded plastic cover. All terminals shall be clearly marked with identification numbers of letter to facilitate connection to external wiring.

6.17.11 The arrangements shall be in such that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

6.17.12 The cabinet shall be complete with all the necessary wiring. All wiring in the housing shall be stranded and the insulation shall be vermin proof. The insulation shall be non inflammable. All the control or indication circuits shall be wired upto the terminal block.

6.17.13 Each terminal block shall be suitable to accommodate 2x6 $mm^2$ size copper conductor. The control cabinet shall have one light point with control switch. The control cabinet shall have suitably rated switches to enable the control supply to the breaker, to be cut off from the mechanism housing.

6.17.14 The control cabinet shall accommodate following accessories:-

a) Mechanical ON / OFF indicator.
b) Selector switches for local / remote electrical control with a neutral position.
c) Operation counters to register the number of break operation.
d) Control switches for local electrical operation.
e) Control knob for local pneumatic / hydraulic or local mechanical operation in case of failure of supply (including pressure switches, valves, locks, pressure gauges etc.).
f) Anti pumping devices.
g) Indicating lamps for ‘ON’ ‘OFF’ and other indications, as specified.
h) Switched contactors and fuses for controlling AC and DC supplies.
i) A power plug and light point.
j) SF6 gas density detector.
k) SF6 feeding valve with protector.
l) All other equipment / parts required for compressed spring operation pneumatic operation / hydraulic operation of the breaker.
m) A terminal board with adequate number of numbered terminals.
n) Cable glands for various power and control cables.
o) A rating and diagram plate.

6.17.15 Each breaker pole shall have its mechanism box placed near the circuit breaker pole.

## 6.18 CABLE BOX / CABLE GLANDS

6.18.1 Cable box and cable glands for terminating the multi-core control cables shall be provided wherever required. These shall be mounted in accessible position, clear of the floor level so that the cable connection with terminal block can be made easily.

## 6.19 INTERLOCKING

6.19.1 Necessary interlocks to prevent the closing, opening, reclosing of breaker under low gas and or low air / hydraulic / spring pressure shall be provided and alarm in centralised control room will be initiated.

6.19.2 It is proposed to electrically interlock the dis-connectors associated with the circuit breaker so that they may not open / close, when breaker is closed etc. The details of switchyard safety interlocking scheme shall be furnished to the successful tenderer. All accessories required on breaker side for satisfactory operation of the scheme will be deemed to have been included in the scope of supply of this specification.

## 6.20 TERMINAL CONNECTOR AND EARTHING TERMINALS

6.20.1 All 420 kV Circuit Breaker shall be provided with flexible terminal connectors suitable to receive on 4ò I.P.S. (114.3 mm) aluminium pipe or twin / Quad Moose conductors or twin tarantulla conductors. Clamps shall be designed adequately to take care of any bimetallic effect. The clamps shall conform to the provision of IS:5561 and shall have corona extinction voltage, radio interference voltage and short circuit current withstand capability equal to that of circuit breaker, specified at clause 2.4. Terminal pads shall have silver plating of atleast 50 microns thickness. The height of terminal be such that centre line of terminal connector is 8.0 m above ground level for 420 kV breaker.

6.20.2 Two nos. grounding terminals, for connection to the purchaserôs ground mat riser shall be 75x8 mm MS plate.

## 6.21 CONTROL CONNECTION AND WIRING

6.21.1 All connections and wiring shall be suitable for tropical atmosphere.

6.21.2 Apparatus box connections shall be insulated and shall be neatly and securely fixed to the panel. All box wiring shall be of a suitable self extinguishing type and shall be run in porcelain or non-rusting metal cleats of the limited compression type.

6.21.3 Where conduits are used, the runs shall be laid with suitable falls and the lowest parts of the run shall be external to the boxes. All conduit runs shall be adequately drained and ventilated. Conduits shall not be run at or below ground level.

6.21.4 Where 415 Volts connections are taken through junction boxes or marshalling boxes they shall be adequately screened and ñ415 VOLTS DANGERò notices must be affixed to the outside of the junction boxes or marshalling boxes.

6.21.5 All box wiring shall be in accordance with relevant IS or BS. All wires on apparatus box and all multicore cables shall have ferrules which shall bear the same number on both ends.

6.21.6 Ferrules shall be of white insulating material and shall be provided with glossy finish to prevent adhesion. They shall be clearly and durably marked in black and shall not be affected by damp or oil. Ferrule numbering shall be in accordance with relevant IS or BS. The same ferrule number shall not be used on wires in different circuits on the same apparatus box. Strapled wires shall be terminated with tinned (not soldered) ross Courtney or other suitable claw washers, separate washers being used for each wire. The size of the washers shall be suited to the size of wire terminated. Wiring shall in general be accommodated on the sides of the box and wires for each circuit shall be separately grouped. Wires shall not be jointed or teed between terminal points. Wherever practicable all circuits in which the voltage exceeds 125 volts shall be kept physically separated from the remaining wire. The function of each circuit shall be marked on the associated terminal boards.

6.21.7 Where apparatus is mounted on the box all metal cases shall be separately earthed by means of copper wire or strip having adequate cross section.

6.21.8 Multicore cable tails shall be so bound that each wire may be traced without difficulty to its cable.

6.21.9 All terminal boards shall be suitably mounted to give easy access to terminations and to enable ferrule numbers to be read without difficulty.

6.21.10 Terminal board rows shall be spaced adequately and not less than 100 mm apart to permit convenient access to wires and terminations.

6.21.11 Terminal boards shall be so placed with respect to the cable crutch (at a minimum distance of 200 mm) as to permit satisfactory arrangement of multicore cable tails.

6.21.12 Terminal boards shall have pairs of terminals for incoming and outgoing wires. Insulating barriers shall be provided between adjacent connections. The height of the barriers and the spacing between terminals shell be such as to give adequate protection while allowing easy access to terminals.

6.21.13 Insulating covers of self extinguishing material preferably transparent shall be provided on terminal boards on which connections for circuits with a voltage greater than 125 volts are terminated.

6.21.14 Labels shall be provided on the fixed portion of the terminal boards. No live metal shall be exposed at the back of the terminal boards. All fuses shall be of the cartridge type. Fuses and links shall be labelled.

## 6.22 RATING PLATE

6.22.1 A circuit breaker and its operating device shall be provided with a whether and corrosion proof rating plate (s) marked with technical particulars etc. including the following :-

a) Manufacturerôs name or trade mark by which it may be readily identified.
b) Serial number of type designation, making it possible to get all the relevant information from the manufacturer.
c) Year of manufacture.
d) Rated voltage.
e) Rated Insulation level.
f) Rated frequency.
g) Rated normal current.
h) Rated short circuit breaking current.
i) Rated duration of short circuit.
j) First pole to clear factor.
k) Rated auxiliary DG supply voltage of closing and opening devices.
l) Rated pressure of SF6 for operation and interruption.
m) Rated pressure of air / hydraulic mechanism for operation and interruption.
n) Rated supply voltage and frequency of auxiliary circuits.
o) Rated cut of phase breaking current.

6.22.2 The coils of operating devices shall have a reference mark permitting the date to be obtained from the manufacturer.

6.22.3 The rating plate shall be about 1000-1300 mm above ground level so that it is visible in position of normal device and installation.

## 6.23 METAL PARTS

6.23.1 All ferrous parts of equipment shall be heavily hot dip galvanised, bolts, nuts, screws, pins, washers etc. used in the equipment shall also be galvanised. The galvanised should conform to IS: 2629-1966.

6.23.2 All current carrying parts shall be of non-ferrous metal or alloys and shall be designed to limit sharp points, edges and sharp faces.

## 6.24 GUARANTEED AND OTHER TECHNICAL PARTICULARS

6.24.1 The tenderer shall furnish all the guaranteed and other technical particulars as called for in Schedule ï óAô for 420 kV circuit breakers. Particulars which are subject to guarantee shall be clearly, marked with asterisk (*). Any other particulars considered necessary by the tenderer may also be given in addition to those listed in Schedule - óAô Tender lacking in supply of requisite information as called for may be rejected as incomplete.

## 6.25 Temperature Rise Limits:-

6.25.1 The temperature rise on any part of equipment shall not exceed the maximum temperature rise specified below under the conditions specified in test clauses. The permissible temperature rise indicated is for a maximum ambient temperature of 50ºC. If the maximum ambient temperature rises, permissible values shall be reduced accordingly.

| S.No. | Nature of the part or No. of the liquid | Maximum value of | |
|---|---|---|---|
| | | Temperature | Temp. rise at a max. ambient air temp. not exceeding 50ºC. |
| 1. | Contacts in air.<br>silver faced copper, copper alloy or aluminium alloy (see notes (i) & (ii)) | 105 | 55 |
| | Bare copper or tinned aluminium alloy | 75 | 25 |
| 2. | Contacts in oil : | | |
| | silver faced copper, copper alloy or aluminium alloy (see notes (ii)) | 90 | 40 |
| | Bare copper or tinned aluminium alloy | 80 | 30 |
| 3. | Terminals to be connected to external conductors by screws or bolts silver faced (see note iii) | 105 | 55 |
| 4. | Metal parts acting as springs | (see note iv) | (See note iv) |
| 5. | Metal parts in contacts with insulation of the following classes | | |
| | Class Y : (for non-impregnated materials) | 90 | 40 |
| | Class A : (for materials immersed in oil or impregnated) | 100 | 50 |
| | Class E : in air | 120 | 70 |
| | in oil | 100 | 50 |
| | Class B : in air | 130 | 80 |
| | in oil | 100 | 50 |
| | Class F : in air | 155 | 105 |
| | in oil | 100 | 50 |
| | Enamel : Oil base | | |
| | Synthetic. in air | 120 | 70 |
| | Synthetic. in oil | 100 | 50 |
| 6. | Any part of metal or of insulating material in contact with oil except contacts. | 100 | 50 |
| 7. | Oil | 90 | 40 |

**Notes :-**

i) When applying the temperature rise of 55ºC care should be taken to ensure that no damage is caused to the surrounding insulating materials.

ii) The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test. Otherwise, the contacts shall be regarded as ñbareò.

iii) The values of temperature and temperature rise are valid whether or not the conductor connected to the terminals is silver-faced.

iv) The temperature shall not reach a value where the elasticity of the material is impaired. For pure copper, this implies a temperature limit of 75ºC.

**7.0 TESTS:-**

7.1 Each circuit breaker with operating mechanism gear and air receivers and support shall comply with the type and routine tests as per the IEC :56 (1987 / latest) unless specified otherwise in this clause.

7.2 The bidder shall furnish, for the circuit breaker being offered, one copy of certificate of all type tests. Type tests reports for short circuit making and breaking test shall be the test conducted at rated frequency of 50 Hz. In case of order, the type test not in conformity with this clause shall be conducted at test laboratory of international repute in the presence of purchaserôs representative without any extra cost.

7.3 All routine tests as per IEC:56 (1987) shall be conducted in the presence of purchaserôs representative unless waived off and their reports shall be submitted and got approved by the purchaser prior to despatch of the equipment.

7.4 Reports for routine tests in respect of associated equipment e.g. compressor, air receiver, meters, instruments, pressure switches, relays, piping etc. as per the latest edition of relevant IS or IEC publication or any equivalent authoritative standard shall be supplied by the tenderer in the event of an order. The reports should be approved by the purchaser prior to despatch of the equipment.

7.5 **Type Tests:-**

| | | |
|---|---|---|
| 7.5.1 | Mechanical Test | Clause 6.10.1 of IEC:56 (1987) |
| 7.5.2 | Temperature rise test | Clause 6.3 of IEC:56 (1987) |
| 7.5.3 | Dielectric tests on circuit breaker | |
| 7.5.3.1 | Lightning impulse test | Cl.6.1.6 (a) of IEC : 56 (1987) |
| 7.5.3.2 | Switching impulse test (for 420 kV CB only) | Cl.6.1.6 (b) of IEC : 56 (1987) |
| 7.5.3.3 | Power frequency voltage test | Cl.6.1.7 of IEC : 56 (1987) |
| 7.5.3.6 | Tests on Auxiliary & control circuit | Cl.6.1.10 of IEC : 56 (1987) |
| 7.5.4 | Radio interference voltage test. | As per procedure specified at Annexure ï III. |
| 7.5.5 | Corona extinction voltage test. | As per procedure specified at Annexure ï III. |
| 7.5.6 | Making and breaking test | Cl.5 to 8 of IEC ï 56 (4) ï 1972. |
| 7.5.7 | Basic short circuit test duties for terminal faults | Cl.6.106 of IEC : 56 (1987) |
| 7.5.8 | Seismic withstand test | DIN 40046 |
| 7.5.9 | Critical current test | Cl. 6.107 of IEC :56 (1987). |

| | | |
|---|---|---|
| 7.5.10 | Short line fault test | Cl. 6.109 of IEC :56 (1987). |
| 7.5.11 | Short line current test | Cl. 6.5 of IEC :56 (1987). |
| 7.5.12 | Out of phase closing test | Cl. 6.110 of IEC :56 (1987). |
| 7.5.13 | Line charging current breaking test (test voltage for 420 kV CB shall be 1.4 p.u. instead of 1.2 p,u. as per Cl.15.7 of IEC-56 (4) | As per Cl. 15 of IEC :56 (4) - 1972. |
| 7.6 | **ROUTINE TEST** | |
| 7.6.1 | Power frequency voltage dry tests on the main circuit | Cl.7.1 of IEC:56 (1987). |
| 7.6.2 | Measurement of resistance of the main circuit | Cl.7.3 of IEC:56 (1987). |
| 7.6.3 | Voltage test on control and auxiliary circuit | Cl.7.2 of IEC:56 (1987). |
| 7.6.4 | Mechanical operating tests | Cl.7.101 of IEC:56 (1987). |

7.7 **SITE TESTS:-**

Tests to be conducted at site will be as under:-

1. Voltage tests on control and auxiliary circuits.
2. Measurement of resistance on the main circuit.
3. Mechanical operating tests.
4. Test to prove the Clause 4.1 (xvi) (b) of this specification.
5. Measurement of the capacitance if used.
6. Measurement of closing resistor value.
7. Speed curve test. Speed curve shall be obtained with the help of a suitable operation analyser to determine breaker contact movement during opening, closing, autoreclosing and trip free operation under normal as well as limiting operating conditions (control voltage pneumatic pressures etc.). The tests shall show the speed of contact 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.

7.8 All vessels and accessories which operate under pressure shall be tested according to relevant standards and six sets of copies of test certificate incorporating the following minimum information shall be submitted:-

i) Description of item.
ii) Supplier / manufacturerôs name.
iii) Serial Numbers.
iv) Date of manufacture and tests
v) Drawing number.
vi) Material composition.
vii) Working and design pressures.
viii) Details of tests carried out and reference standards.
ix) Test results.
x) Identification mark.
xi) Name and seal of approval of testing authority.

7.9 **TESTS ON SF6**

The bidders shall submit test report for the following tests as per IEC ï 376 before the supply / despatch of the gas :-

| | | |
|---|---|---|
| i) | Toxity Test | Cl.22 |
| ii) | Water content and Condensation temp. | Cl.23, 24, 25 & 26. |
| iii) | Carbon tetra fluoride Oxygen & Nitrogen | Cl. 27, 28,29,30 & 31. |
| iv) | Hydrolysable fluoride | Cl.32,33,34, 35, 36 & 37. |
| v) | Acidity | Cl. 38, 39, 40 41 & 42. |
| vi) | Oil content | Section ï 13. |
| vii) | Break down voltage | |

7.10 **LEAKAGE TEST**

7.10.1 The tenderer is required to furnish Gas Leakage Test Report along with the bid. In case of single ó0ô rings leakage test shall be carried out in presence of the purchaserôs representative.

**8.0 INSPECTION**

8.1 The inspection may be carried out by the purchaser at any stage of manufacture. The supplier shall grant free access to the purchaserôs representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the purchaser shall to relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective. The supplier shall keep the purchaser informed in advance, about the manufacturing programme so that arrangement can be made for inspection. Atleast fifteen (15) days advance intimations shall be given for the readiness of the equipment for inspection.

8.2 The purchaser reserves the right to insist for witnessing the acceptance / routine testing of the bought out items.

8.3 No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

8.4 Should the inspection be waived by the purchaser, such waiver shall not relieve the supplier in any way from his contractual obligations.

**9.0 ADDITIONAL DATA TO BE FURNISHED ALONGWITH THE OFFER**

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) Method of checking the healthiness of voltage distribution devices (condensers) provided across the breaks at site.
d) 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.
e) The effect of non-simultaneity between contacts within a pole or between poles and also how it is covered in the guaranteed total break time.
f) Sectional view of non-return couplings if used for SF6 pipes.
g) Details and type of filters used in interrupter assembly and also the operating experience with such filters (for SF6 CB).

h) Details on 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 condition of SF6 within a circuit breakers after a period of service particularly with regard to moisture contents of the gas.

iii) The precise procedure to be adopted by maintenance personnel for handling equipment who are exposed to the products of arcing in SF6 gas, so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be furnished for suitable protective clothing, methods of disposal of circuit breaker cleaning utensils and other relevant matter.

i) A complete catalogue on operation analyser satisfying all the requirements stipulated in this specification.

j) The bidder shall furnish along with the bid, curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and pneumatic / hydraulic pressure.

k) Field test report in case of CB meant for reactor switching duty.

l) All duty requirements shall be proved with the support of adequate test reports to be furnished along with the bid failing which the bid is likely to be rejected.

## 10.0 DRAWINGS, MANUALS AND CATALOGUES:-

10.1 In addition to any other drawings, which the tenderer may like to supply, four copies of the following drawings and literature shall be submitted with the tender for the purpose of preliminary study :-

a) General outline drawings showing dimensions net and shipping weights, quantity of insulating gas, air receiver capacity, lifting dimensions for maintenance etc. of circuit breaker and its local control panel.

b) Sectional views showing the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts, etc..

c) Short circuit oscillogram and type test reports for similar type of breakers.

d) Descriptive literature for circuit breakers.

10.2 After receipt of the order, the successful tenderer will be required to furnish three sets of the following drawings for approval:-

a) General outline drawings showing dimensional front, side elevation and plan of circuit breaker and its local control panel, incorporating terminal load, impact load, wind force and weights, etc. for design of foundation.

b) Sectional view drawings.

c) Assembly and sub-assembly drawings of the breakers, arcing chambers, contacts, operating mechanism etc.

d) Detailed drawing of operating mechanism.

e) Piping diagram.

f) Detailed dimension drawings and assembly of the unit air compressor system / hydraulic operating device.

g) Foundation plans including weights of various components, impact loadings, terminal load, wind force & position of centre of gravity.

h) Wiring diagram showing the local and remote control scheme of the breaker, including alarms, indicating devices, instruments, space heaters etc..

i) Drawing of terminal connectors.
j) Outline dimensional drawing and schematic drawing of SF6 gas filling, evacuation and refilling equipment.
k) Drawing of SF6 gas density monitor.
i) Drawing of SF6 gas leak detector.
m) Master packing list.
n) PERT Chart.

10.3 10 copies of operation, maintenance and erection manuals shall be supplied one month prior to the despatch of equipment. The manuals shall be bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the equipment. The manuals shall include amongst other things the following particulars :-

a) Marked erection and prints identifying the components of the equipment with assembly drawings.
b) Detailed dimensions, assembly and description of the equipment and accessories.
c) Precautions to be adopted in the handling of SF6 gas.
d) List of spare parts.

## 11.0 TEST REPORTS:-

i) Four copies of type test reports shall be furnished to the purchaser. One copy will be returned duly certified by the purchaser to the supplier within three weeks thereafter and on receipt of the same, supplier shall commence with the commercial production of the concerned material.
ii) Four copies of acceptance test reports shall be furnished to the purchaser. One copy will be returned, duly certified by the purchaser and only thereafter-wards shall be material be despatched.
iii) All records of the routine test reports shall be maintained by the supplier at this works for periodic inspection by the purchase.
iv) All test reports of tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

## 12.0 MICROPROCESSOR BASED POINT OF WAVE CONTROLLER FOR CIRCUIT BREAKER (WHERE EVER APPLICABLE / REQUIRED)

The energisation / de-energization of shunt reactors may mainly be required as per the system requirements resulting in more numbers of manual operations. In such cases, use of point of wave controller with the circuit breaker will be beneficial for reducing transients, improving power quality and ensuring less fatigue, insulation failure, stresses and longer life for the connected equipments. The intended use of this controller is to control the planned switching of shunt reactor so as to minimize the impact of transients, in rush currents and re-ignition. The relevant supporting information / features for its selection are as under:-

12.1 General Information

a. Circuit Breaker Operation shall be Single Pole type.
b. Both Opening and Closing Operations required through Controller.

c. Shunt Reactor is of 400 kV (Rated 420 kV), 50 MVAR, Gapped Core, 5 Limbed Construction type along with 145 kV (Rated Voltage), 0.045 MVAR Neutral Grounding Reactor grounding.
d. System Voltage: 400 kV and Frequency: 50 Hz.
e. Substation Configuration: Breaker & Half Scheme.
f. The POW provides to drive 3 close coils and 6 trip coils suitable for one closing and two trip circuits.

12.2 The Microprocessor based Point of Wave Controller shall have following general features:

a. Power Supply Consumption: 48-250C AC/DC<4VA
b. Ambient Temperature: 0 to 55ºC.
c. Operating Command Duration: 48-250C DC, 0.15-2S.
d. Measurement for Reference Voltage, Current and Voltage Start Detectors with suitable ranges / ratings shall be provided.
e. Cross Sectional Area of Connecting Leads: < 4 Sq.mm
f. Adaptive Controller for compensation to systematic variation in operating lines, the stored / recorded values shall also be used for breaker condition monitoring.
g) Necessary compensation for variation in ambient temperature and auxiliary voltage variation shall also be provided for exact timing / operation.
h) The point of Wave Controller shall be suitable for installation in electrically hostile environment of 400 kV Switchyard and shall comply with the relevant IEC standards for Electrical Immunity and Emissions.

12.3 The necessary accessories, software etc. suitable for satisfactory intended operation shall also be supplied by the contractor. The Point of wave Controller alongwith accessories etc. as mentioned above shall be supplied, installed, tested and commissioned by contractor as per manufacturerôs standard practices. The overall scheme / arrangement of such controllers on circuit breakers and their co-ordination in the 400 kV bay shall be engineered / designed by the contractor.

**13.0 PACKING AND FORWARDING:-**

The loose equipment shall be packed in the suitable crates so as to withstand handling during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing and handling. The easily damageable materials shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost. Each consignment shall be accompanied by a detailed packing list containing the following information:-

a) Name of the consignee.
b) Details of the consignee.
c) Destination.
d) Total weight of consignment.
e) Sign showing upper / lower side of the crate.
f) Handling and unpacking instructions.

g) Bill of material indicating contents of each package and spare material.

The supplier shall ensure that the packing list and bill of material are approved by the purchaser before despatch.

## 14.0 QUANTITY AND DELIVERY REQUIREMENT:-

i) This is set out in else-where of this specification.

ii) The scope of supply shall include a supply of 2.5% extra-quantity of bolts, nuts, washers, split pins, cotter pins and such other small loose items free of cost.

**SCHEDULE 'A'**

## SCHEDULE OF GUARANTEED AND OTHER TECHNICAL PARTICULARS (*INDICATE GUARANTEED PARTICUALRS)

| | | |
|---|---|---|
| 1. | Makerôs name and country of manufacture | |
| 2. | Manufacturerôs Type, Designation. | |
| 3. | Applicable Technical Standards. | |
| 4. | Rated voltage, kV | |
| 5. | Rated frequency, Hz | |
| 6. | Number of poles | |
| 7. | Class (Outdoor / Indoor) | |
| 8.* | Rated normal current Amps. | |
| | *a) at 50ºC ambient temperature, Amps.<br>*b) at reference ambient temperature of 40ºC. | |
| 9. | Rated short circuit breaking current.<br>* a) rms value of AC component.<br>* b) Percentage D C component.<br>*c) Assymetrical breaking current. (including Dc component).<br>d) It is possible to increase the rupturing capacity at a later date. | |
| 10. | Rated operating duty cycle. | |
| 11. | Rated short circuit making current. | |
| 12. | First pole to clear factor. | |
| 13. | Rated transient recovery voltage for terminal faults. | |
| 14. | Rated characteristics for short line faults. | |
| 15. | Maximum line charging current breaking capacity and corresponding over voltage recorded during test. kA<br>a) On line side, kV<br>b) On supply side, kV. | |
| 16. | Maximum breaking capacity under phase opposition conditions, kA. | |
| 17. | Rated small inductive breaking current with corresponding switching surge over voltage, kA-P.U. | |
| 18. | Reactor loaded transformer interrupting capacity and corresponding switching surge over voltage, kA-P.U. | |
| 19. | Capacity for interrupting inrush current of transformers & the corresponding over voltage, Amps.-P.U. | |
| 20. | Maximum cable, charging breaking current, and over voltages recorded during test, kA :-<br>a) on supply side, kV. | |

| | | |
|---|---|---|
| | b) On line side, kV. | |
| 21. | Maximum (single) capacitor bank breaking current and corresponding over voltages recorded, during test, kA.<br>a) On supply side, kV.<br>b) On line side, kV. | |
| 22 | Data on restriking voltage<br>100% 60% 30% 10 %<br>Capacity capacity capacity capacity<br>a) Amplitude factor.<br>b) Phase factor.<br>c) Natural frequency.<br>d) Rate of rise of restriking voltage. | |
| 23. | a) Is circuit breaker restrike free<br>b) Means adopted if any to check the voltage rise. | |
| 24. | Rated duration of short circuit, Sec. | |
| 25. | Short time current ratiagn for the following duration<br>a) For one second, kA (rms)<br>b) For three seconds, kA (rms). | |
| 26. | Maxim. Arcing time under any duty condition with limiting conditions of voltage and pressure, ms. | |
| 27. | Maximum Break time, ms<br>a) At 100% rated breaking current, ms.<br>b) At 50% rated breaking current, ms.<br>c) At 25% rated breaking current, ms.<br>d) At 10% rated breaking current, ms.<br>e) At lowest fault current, ms. | |
| 28. | Maximum closing time, ms | |
| 29. | Total make break time (maximum), ms | |
| 30. | Minimum reclosing time at rated interrupting capacity from the instant of trip coil energisation, ms | |
| 31. | Minimum dead time for :-<br>a) Three phase reclosing.<br>b) One phase reclosing.<br>c) Limits of adjustment of dead time for three phase reclosing.<br>d) Limits of adjustment of dead time for one phase reclosing. | |
| 32. | Latching Current, Amp. | |
| 33. | No. of breaks in series per pole. | |
| 34. | Length of contact travel, mm. | |
| 35. | Total length of break per pole, mm. | |
| 36. | Speed of contact travel :-<br>a) At tripping, metre, sec.<br>b) At closing, metre / sec. | |

| | | |
|---|---|---|
| 37. | Type of device, if any, used to obtain uniform voltage distribution between breaks (where No. of breaks are more than one). | |
| 38. | Recovery voltage distribution between breaks in percentage of rated voltage for :-<br>a) Single line to ground fault.<br>b) Interruption of short lines.<br>c) Switching off an unloaded transformer. | |
| 39. | Type of main contacts. | |
| 40. | Type of arcing contacts and / or arc control contacts. | |
| 41. | Material of :<br>a) Main contacts.<br>b) Arcing contacts.<br>c) Whether contacts are silver plated.<br>d) Minimum thickness of silver coating<br>e) Contact pressure, Kg / mm Sq.<br>f) Terminals. | |
| 42. | Difference in the instant of closing opening of contacts :-<br>a) Within a pole, ms.<br>b) Between poles, ms. | |
| 43. | a) Coronas inception voltage, kV (rms)<br>b) Corona extinction voltage, kV (rms.) | |
| 44. | Maximum temperature, rise for :-<br>a) Main contacts over ambient temperature of 50ºC, ºC.<br>b) Terminals to be connected to the external conductors, ºC. | |
| 45. | Dry one minute power frequency withstand test voltage for complete circuit breaker :-<br>a) Between line terminal & ground objects (breaker closed), kV (rms).<br>b) Between terminals with breaker contacts open, kV (rms). | |
| 46. | 1.2 / 50 microsecond wave impulse withstand test voltage for complete circuit breaker ;-<br>a) Between line terminal and ground (breaker closed), kV (peak).<br>b) Across terminals with circuit breaker contacts open ï<br>- One terminal lightning impulse, kV (Peak).<br>- Opposite terminal power frequency, kV (Peak). | |
| 47. | Dry & wet 250/2500 micro second switching impulse withstand voltage. | |

| | | |
|---|---|---|
| | i) Between line terminal and grounded objects (Breaker closed), kV (Peak).<br>ii) Between terminal with circuit breaker contacts open ï<br>- One terminal switching impulse, kV (Peak).<br>- Opposite terminal power frequency, kV (Peak). | |
| 48. | Radio interference voltage for circuit breaker with a voltage of 266 kV and 155 kV (420 and 245 kV circuit breakers respectively).<br>*a) 0.5 MHz.<br>b) 1.0 MHz<br>c) 1.5 MHz<br>d) 2.0 MHz | |
| 49. | Clearance<br>a) Between phase (live parts), mm.<br>b) Between line parts & earth, mm.<br>c) Live parts to ground level (section clearance), mm. | |
| 50. | Whether the circuit breaker is fixed trip or trip free. | |
| 51. | a) Normal voltage of closing coils, volts.<br>Pick up range, volts. | |
| 52. | a) Rated voltage of tripping coil and range of pick up value, volts.<br>b) Number of tripping coils provided. | |
| 53. | Normal power consumption at rated voltage for :-<br>a) Trip coil, watts.<br>b) Closing coil, Watts. | |
| 54. | Number of auxiliary contacts per pole provided for purchaserôs use :<br>a) NO<br>b) NC<br>c) Adjustable. | |
| 55. | Rated voltage of auxiliary contacts, volts. | |
| 56. | Current capacity of auxiliary contacts, volts.<br>a) Continuous, Amps.<br>b) Breaking, Amps. | |
| 57. | Whether auxiliary contacts silver plated, Yes / No. | |
| 58. | a) Breaking capacity at the rate of 50% of rated supply voltage of closing / opening device.<br>b) 50% of rated pressure of operating mechanism. | |
| 59. | Qty. of SF-6 gas required for each pole of | |

| | | |
|---|---|---|
| | circuit breaker, Kgs. | |
| 60. | Limits of pressure of SF-6 at which breaker operate correctly, Kg./CM Sq. | |
| 61. | Number of operations after which SF-6 gas replacement is necessary.<br>a) At fully rupturing capacity.<br>b) At 50% of rated rupturing capacity.<br>c) At 10% of rated rupturing capacity.<br>d) At rated current. | |
| 62. | Number of operations after which main and auxiliary contacts replacement is necessary :-<br>a) At fully rupturing capacity.<br>b) At 50% of rated rupturing capacity.<br>c) At 10% rated rupturing capacity.<br>d) At rated current. | |
| 63. | Number of operations at rated current after which routine inspection of breaker is necessary. | |
| 64. | Number of operations at full reputing capacity after which routine inspection of breaker is necessary. | |
| 65. | Supporting Insulation column / units<br>(Dataôs for one unit and completes column to be furnished).<br>a) Make & Type<br>b) Numbers per pole<br>c) Descriptive pamphlet No.<br>d) Weight, Kg.<br>e) Transport dimensions, mm.<br>f) One minute dry power frequency withstands, kV (rms).<br>g) Flash over voltage, kV.<br>h) Full wave impulse withstands voltage, kV (peak).<br>i) Switching surge withstand voltage, kV (Peak).<br>j) Corona extinction voltage, kV.<br>k) Cree page distance, total & Protected, mm<br>l) Permissible safe cantilevers strength, Kg. | |
| 66. | Type of operating mechanism for<br>a) Closing.<br>b) Opening. | |
| 67. | Rated pressure and limits of pressure of operating mechanism, Kg/cm Sq. | |
| 68. | Pneumatic operating mechanism (type) | |

| | | |
|---|---|---|
| | a) Rated operating pressure, Kg. / Cm2.<br>b) B) Range of operating pressure for ï<br>i) Closing.<br>ii) Opening.<br>c) Air consumption at rated pressure for<br>i) Closing, M3.<br>ii) Opening, M3.<br>iii) Close ï Open, M3.<br>d) Number of local air receiver per breaker and capacity of each local air receiver, M3.<br>e) Time required for filling the air receiver to its rated pressure from atmospheric pressure, minute.<br>f) Design pressure of air receiver, Kg/CM Sq.<br>g) Number of closing opening operations possible without charging the air receiver.<br>h) Arrangement provided for preventing the operation of breaker with in-sufficient air pressure.<br>i) Compressor :-<br>i) Make and type.<br>ii) No. of cylinders.<br>iii)Number of compression stages.<br>iv) Compression pressure after each stage.<br>v) Whether compressor is provided with its own filter, if so five type and make.<br>vi) Piston displacement in terms of free air in litres / minutes.<br>vii) Effectively delivered air in litres per hr / at atmospheric pressure.<br>viii) Maximum pressure.<br>ix) Horse power of driving motor.<br>x)<br>a) Make and type of the driving motor.<br>b) Class of insulation.<br>xi) Whether thermal overload protection provided with motor starter.<br>xii) Safety valves settings :-<br>1. Lower pressure stage blows at.<br>2. Intermediate pressure blows at<br>3. H.P.Stage blows at | |

| | | |
|---|---|---|
| | xiii) Temperature rise of compressor while working at full load at ambient of 50ºc.<br>xiv) Type of cooling.<br>xv) Whether centrifugal type unloader valve provided on the compressor.<br>xvi) Pressure settings of :<br>1. Safety valve on local storage receiver.<br>2. compressor starts at<br>3. Compressor cuts off at<br>4. Low pressure alarm setting for local storage receivers.<br>xvii) Local air receivers. :-<br>1. Volume in litres.<br>2. Test pressure.<br>3. Charging time of receivers starting from atmospheric condition.<br>j) Pressure reducer (where applicable)<br>1. Number of pressure reducers.<br>2. Secondary pressure.<br>3. Range within which the secondary pressure can be adjusted.<br>4. Safety valve on secondary side blow at.<br>k) Compressed air piping :-<br>a) Material.<br>b) B) Inner and outer diameter in mm.<br>c) Working pressure in Kg./Cm. Sq. | |
| 69. | Spring charged mechanism :<br>a) Rating of motor, volts, Amps. H.P.<br>* b) Time required for charging the closing spring, specs.<br>c) Number of CO operations possible after failure of auxiliary supply.<br>d) Whether indication for spring charged condition provided in central control cabinet, Yes / No. | |
| 70. | Hydraulic operating mechanism :-<br>a) Rated pressure of oil in operating cylinder, Kg. / CM 2.<br>b) Limits of operating pressure, Kg/CM. Sq.<br>c) Specification of oil and quantity required per breaker, litters.<br>d) Number of CO operations possible after loss of hydraulic pressure.<br>e) Details of arrangement to prevent change of position of breaker in the event of loss of hydraulic pressure.<br>f) Details of monitoring arrangement for | |

| | | |
|---|---|---|
| | hydraulic pressure. | |
| 71. | Overall Dimensions, mm<br>a) Weight, mm<br>b) Width, mm<br>c) Length, mm | |
| 72. | Weight of :-<br>a) Each pole, Kg.<br>b) Complete breaker, Kg. | |
| 73. | Impact loading for foundation design, Kg. | |
| 74. | Noise level, dB<br>a) AT breaker location<br>b) at 8 M<br>c) at 10 M<br>d) at 40 M | |
| 75. | a) Details of supporting structures (Attach drawing)<br>b) State whether hot dip galvanised or painted. | |
| 76. | a) Details of central control cabinet (Attach drawing)<br>b) State whether cabinet is hot dip galvanised or painted. | |
| 77. | SF-6 Gas Density monitor whether provided, Yes / No. (Give drawing & descriptive literature) and the quantity provided per breaker. | |
| 78. | a) Seismic withstand level<br>b) Special arrangements, if any made to take care of seismic force. | |

SIGNATURE OF TENDERER
NAME
STATUS
WHETHER AUTHORISED ATTORNEY OF THE TENDERING COMPANY.

NAME OF THE TENDERING FIRM.

PLACE :
DATE :

**ANNEXURE - I**

## SPECIFICATION AND ACCEPTANCE OF NEW SULPHUR HEXA FLORIDE GAS

| | | | |
|---|---|---|---|
| 1. | Physical | Colourless, odourless, non-toxic and non-flammable. | |
| 2. | Density at 20ºC and 1 bar | 6.08 g / ltr. | |
| 3. | Electric Strength | 2 1/2 times that of Nitrogen. | |
| 4. | Compatibility | Up to temperature of about 180ºC its compatibility with material used in electrical construction is similar to that of Nitrogen. | |
| 5. | Toxic impurities | SF-6 gas shall comply with the requirements of the test as per Clause 22 of IEC-376-1971. | |
| 6. | Impurities | SF-6 shall not contain more than the maximum allowable quantities of impurities give below | |
| | | Impurity of group of impurities | Maximum permitted concentration mass by mass |
| | | CF4 | 0.05% |
| | | Oxygen + Nitrogen (Air) | 0.05% |
| | | Water | 1.5 ppm |
| | | Acidity expressed as HF | 0.3 ppm |
| | | Hydrolysable fluorides expressed as HF | 1.0 ppm |
| | | Oil content | Substantially free from oil |
| 7. | Standard sizes of cylinders | 4,5, 10, 20, 40, 80, 150 and 500 litres. | |
| 8. | Preferred sizes of cylinders | 10 and 40 litres. | |
| 9. | Test pressure of cylinder | According to gas cylinder rules 1981 and to comply with IS: 7285/1974. | |
| 10. | Maximum filling ratio for tropical country. | -do- | |

**ANNEXURE – II**

**CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TESTS :-**

1. **General**

Unless otherwise stipulated, all 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 failing power frequency voltage and by measurement of radio influence voltage (RIV).

2. **Test Levels**

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the breaker specifications at Sl..No. 4.1 (xxv) and 4.1 (xxvi), respectively.

3. **Test methods for RIV**

3.1 RIV tests shall be made according to measuring circuit as per International sub-committee on Radio Interference Publication 1-1972 second edition. The measuring circuit shall preferably be tuned to frequency within 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 micro-volts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standards publication NO.107-1964 except as otherwise so 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 serves of tests to ensure that there is no variation in ambient noise level. If variation is present, the low ambient noise level will form basis for measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipments unless otherwise specified. The specified RIV test voltage for 420 kV system is listed in the detailed specification together with maximum RIV level of 500 micro volts with CB open / close position, when CBôs is phase to ground rms voltage of 266 kV.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authority.

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.
However, RIV test method may be followed as per IEC 56/4-1975.

4. **Test methods for visible corona extinction Voltage Test**

The purpose of this test is to determine the corona extinction voltage of apparatus and connectors. 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 voltages, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of test voltage and maintained there for five minutes. The voltage will then be decreased slowly until all visible corona disappears. The voltage will then be raised slowly again to the same maximum voltage. This procedure shall be repeated at least 4 times with corona extinction voltage for purposes of determining compliance with the specifications 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%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. Atleast 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 conations as determined from direct observation. Photographs shall be taken from above and below the level of connectors so as to show corona on bushing, insulators and all parts of energised connectors. The photograph shall be framed such that test object, essentially fills the frame with no cut off.

4.1 The test voltage 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 photograph of the test object atleast four photographs shall be taken of the complete test assembly showing relative position of all the test equipment and test objects. These four photographs shall be taken from their points equally spaced around the test arrangement to show its feature 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 purchaserôs 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 tests shall be carried out with the same test set up and as little time difference between tests as possible. No modifications on treatment of the sample between tests will be allowed. Simultaneously RIV and visible corona extinction voltage testing may be permitted at the complete discretion of purchasers inspector, if in his opinion, it will not be prejudice to other test.

**5. Test Records**

In addition to the information previously mentioned and the requirements specified as per CIS PR or NEMA 107-1964 the following data shall be included in the test reports.

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 measure RIV passes through 100 microvolts in each direction.

f) Inception and extinction of visual corona for each of the four tests required shall be recorded.

**ANNEXURE – III**

## CRITERIA FOR THE DESIGN OF SUPPORTING STRUCTURE:-

### 1. MATERIALS

1.1.1 The structure member shall be of structural steel conforming to IS : 226 ï 1962 amended up to date.

1.1.2 The rolled steel flats, plates, bolts, nuts and spring washers used for the construction of structures shall be of mild steel, and shall not inferior in strength and quality to the requirements of tests as laid in latest IS: 226.

1.1.3 Steel tubes, used for fabricating the structure shall conform to the requirements of Section IV of IS:1161-1979 of Y St. 240 grade. Sizes of steel tubes shall be as per table 1 of IS: 1161 ï 1979 however where higher thickness is required, outside diameter shall be as given in said table.

1.1.4 Tubular structure ends shall be provided with top bottom plates welded to tube so as to prevent inner surface of tube from being exposed to atmosphere. Holes provided to facilitate air venting during galvanising shall be plugged to prevent ingress of moisture.

1.1.5 Any material made from steel of inferior quality and specifications will not be excepted by the purchaser and shall have to be removed and replaced by the contractor at his own cost.

### 1.2 FACTOR OF SAFETY

Factor of safety for the design of structural members of steel shall be 2.0 under normal conditions and 1.5 for severe conditions. For members under tension, factor of safety shall be on elastic limit and for members under compression it shall be on crippling load. Above factor of safety shall also be applicable for over turning.

### 1.3 LOADING UNDER NORMAL CONDITIONS:-

Loading under normal conditions shall be as under:-

a) Longitudinal load
Longitudinal force plus wind force on complete assembly, its base and supporting structure, accessories mounted on the structure.

b) Transverse Load:-
Transverse terminal load due to wind force on bus bars, force due to deviation of component force, if any plus wind pressure on complete assembly, its base and supporting structure and accessories mounted on the structure.

c) Vertical load
Weight of complete assembly / equipment, its base, its supporting structure and accessories mounted on it plus 300 Kg. per pole to represent weight of a man with tools.

d) Wind Load :-
Wind load on complete assembly / equipment its accessories and fittings etc. shall be determined from the figures of wind pressure given in Schedule ï A. Wind Load on structures etc. shall be taken as under:-

| | | |
|---|---|---|
| i) | On flat surface | 95 Kg./Cm2 |
| ii) | On circular surface | 122 Kg./Cm2 |
| iii) | On bus bar | 122 KG/Cm2. |

e) Torsional, vibrational and other forces appearing while closing and opening operation shall be added to the force at (a), (b) and (c) above.

f) For the purpose of item (a) (b) & (c) forces exerted on the supporting structures when the equipment contact is in open positing or in closed position shall be determined and higher figures shall be adopted for the purpose of design.

g) Any force exerted on compete assembly equipment, its base and supporting structure due to temperature variation specified in Schedule ï A shall be considered in above forces.

**1.4 Forces under severe conditions**

These forces shall consist of earthquake forces specified in Clause 3.1, on equipment, structures and jumper connection and short circuit forces (including forces exerted due to their thermal effects) on assembly and jumper connection for a three phase fault at the terminals of equipment. Short circuit shall be at such an instant of voltage wave form that resultant repulsive / attractive forces on the equipment are maximum. For this purpose symmetrical short circuit current at the location of equipment be taken as specified. Short circuit forces shall be considered as acting simultaneously with either (1) earthquake forces and forces at 1.3 without wind or (2) forces at 1.3 with wind, whichever is severer.

1.5 Design, fabrication and permissible stresses of the steel tubular structures shall be as per IS : 806 and IS: 800 amended up to date.

1.6 The minimum thickness of steel tube, stiffeners, base and top plate shall b3 5 mm. No bolt less than 16 mm diameter shall be used. The difference between outer diameter of base / top plate and pitch circle diameter of bolt holes shall be atleast 3 times the diameter of bolt.

1.7 Earthing Facilities

To facilitate making of earthing connection, 75 x 12 mm thick flat shall be welded at site at two points on to the legs of each structure. The supplier shall keep this in view while designing the supporting structure of each pole. Earthing pads of size 75 x 75 mm with 2 holes of 17.5mm dia shall be provided on two diagonal legs of the supporting structure.

## 2. BOLTS, NUTS AND WASHERS

2.1 All joints in the structure shall be made with bolts, nuts and spring washers. The steel used for the bolts and nuts must be class ï I tested quality, conforming to the requirement of IS: 1369 ï 1967. Bolt head and nuts shall be hexagonal and bolts and nuts threaded to whit worth standard. Nuts and bolts of the same size shall be interchangeable.

2.2 Spring washers not less than 3 mm thick shall be provided under all nuts, spring washer shall conform to IS: 3063-1965 and plane washers shall conform to IS: 2016-1967.

2.3 The allowable shearing strength of bolt section employed in design of supporting structure is for unthreaded shanks of nominal diameter. Accordingly, the portion of bolt shank which

bears against jointed members must be unthreaded to ensure full shear strength. It is the responsibility of the tenderer to assess the correct length of the unthreaded portions of the shanks required for different joints and to arrange supplied of bolts and nuts, accordingly that can be fully tightened with washer of standard thickness under the nut. All bolts shall project through corresponding nuts, but such projection shall be exceed 10 mm and shall not be less than 6 mm.

2.4 The quantity of bolts, nuts and spring washes of various sizes to be supplied along with each consignment of the fabricated steel structure shall be 5 percent in excess of the actual quantity required to complete the structure. No extra cost shall be charged by the supplier for the excess quantity of bolts, nuts and washers so supplied with each consignment and all consignments taken as a whole.

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**ISOLATORS**
**Volume-II**
**Part-5**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-5 (Vol. II)**

# Technical Specification for Isolators

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**PART-5 (Vol. II)**

# Technical Specification for Isolators

## 1.0 SCOPE

1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site FOR destination of 420 kV and 245 kV Motor Operated Isolators/ Isolator-cum-earthing switches alongwith insulators, with all fittings, accessories, associated equipment and mandatory spares specified herein which are required for efficient and trouble free operation as specified hereunder.

1.2 It is not the intent to specify completely herein all the details of the design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation upto the Bidder's guarantee, in a manner acceptable to the Purchaser, who will interpret the meanings of drawings and specifications and shall have the power to reject any work or material which, in his judgment, is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

## 2.0 STANDARDS

The Isolators /Isolators-cum-earthing switches and associated accessories shall conform to the latest issues of standards as given below, except to the extent explicitly modified in the specification.

| Indian Standard No. | Title | International & Internationally recognized Standard |
|---|---|---|
| IS-9921 (Pt.I to V) | Isolators | IEC 129 |
| IS-1554 (Pt.I) | PVC cables (FRLS type) BS 6346 | IEC Pub.502-1 |
| IS-375 | Marking arrangement for switchgear bus-bars main connections & auxiliary wiring | |
| IS-5561 | Power Connectors | |
| IS-2544 | Post Insulators | |
| IS-5350 (Pt II & III) | Outdoor cylindrical Post | |
| IS-1573 | Electro plated of zinc on iron & steel | |

| | | |
|---|---|---|
| IS-4759 | Hot dip zinc coating on structural steel and other allied product. | |
| IS-1822 | Motor Starters. | |
| IS-6875 (Pt.I&III) | Control switches | IEC 337 1A,1B,2A |
| IS-2633 | Method of testing weight, thickness and uniformity of coating on hot dipped galvanised articles. | 1970 ASTM Part 3 |
| IS-2147 | Degree of protection provided by enclosures for low voltage switch-gear & control gear. | |
| IS-2629 | Recommended practice for hot dip galvanising of iron & steel. | |

2.1 In case equipment conforms to other International Standards which ensure equivalent or better performance than that specified under clause 2.0 then the English version of such standards or the relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately in additional information schedule.

3.0 **SERVICE CONDITIONS:**

3.1 Climatic Conditions:

The Isolators/Isolators cum earthing switches to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions:

| | | |
|---|---|---|
| i) | Location | In state of Rajasthan |
| ii) | Maximum ambient air temperature ( deg C) | 50 deg C |
| iii) | Minimum ambient air temperature (deg C) | (-)5 deg C |
| iv) | Average daily ambient air temperature (deg C) | 45 |
| v) | Max. yearly weighted ambient temperature. | 35 deg C |
| vi) | Maximum Relative Humidity (%) | 100 % |
| vi) | Max. altitude above mean sea level (Metres) | Varies from 61 Mts. to 815 Mts |

| | | |
|---|---|---|
| vii) | Average annual rainfall (mm) | 15 cm to 100 cm |
| viii) | Max. wind pressure (Kg/Sq.mt) | 195 |
| ix) | Isoceraunic level (days/year) | 4 Months (June to Sep) |
| x) | Seismic level (Horizontal Acceleration) | 0.3 g |

NOTE : Hot and humid tropical climate, conducive to rust and fungus growth. The climatic conditions are also prone to wide variations in ambient conditions. Smoke is also present in the atmosphere. Heavy Lightning also occurs during June to October.

3.2 Auxiliary Power Supply

Auxiliary electrical equipment shall be suitable for operation on the following supply system:

| | | |
|---|---|---|
| a) | Power Devices (Like drive motors) | 415 V, 3 Phase 4 wire 50 HZ, neutral grounded AC supply. |
| b) | D.C. Alarm, control and protective device | 220 V DC, 2 wire. Sub-stationwise exact details shall be furnished to the successful Bidder. |

Each of the foregoing supplies shall be made available by the Purchaser at the terminal point for each Isolator for operation of accessories and auxiliary equipment. Bidders scope include supply of interconnecting cables, terminal boxes etc. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over entire range of voltages.

i) AC supply: Voltage ± 10% frequency ± 5%
ii) DC supply: (-)15% to +10%

4.0 **PRINCIPAL PARAMETERS (Isolator)**

**The isolator covered in this specification shall meet the technical requirements listed below:**

| | | |
|---|---|---|
| **a**. Highest system Voltage, kV | 420 | 245 |
| **b**. System Neutral Earthing | -------Efficitively earthed----- | |
| **c**. Rated Voltage Um, kV(rms) | 420 | 245 |
| **d**. Rated frequency, Hz. | 50 | 50 |
| **e**. No. of Poles | 3 | 3 |
| **f**. Rated normal current, Amp. | 2000 | 2000 |
| **g**. Installation | Outdoor | Outdoor |
| **h**. Rated insulation level: | | |

I) 1.2/50 microsecond lightening impulse withstand voltage of positive & negative polarity.

| | | | |
|---|---|---|---|
| | i) To earth and between poles | 1425 kV(rms) | 1050 |
| | ii) Across the open Isolator, voltage applied to : | | |
| | - One terminal lightening impulse (kV-Peak) | 1425 | 1200 |
| | - Opposite terminal power frequency (kV-Peak) | 240 | NIL |
| II) | 250/2500 microsecond switching impulse withstand voltage (Positive & Negative Polarity) | | |
| | i) To earth ( kV-Peak) | 1050 | - |
| | ii) Across open isolator voltage applied to: | | |
| | - One terminal switching impulse (kV-Peak) | 900 | - |
| | - Opposite terminal power frequency (kV-Peak) | 345 | - |
| III) | One minute power frequency withstand voltage(dry & wet) | | |
| | i) To earth ( kV-rms ) | 520 | 460 |
| | ii) Across terminals of open isolators, kV rms | 610 | 530 |
| **i.** | i)Rated short time current rating, kA | 40 | 40 |
| | ii) Rated duration of short circuit current, seconds. | 1 | 1 |
| **j.** | Rated peak short circuit current, kA (Peak) | 100 | 100 |
| **k.** | Special requirements: | | |
| | i) Rated magnetising current/ capacitive current make/ break capacity of Isolator. | 0.7 Amps. | 0.5 Amp. |
| | ii) Isolator may be required to make or break normal current when no significant change in voltage across the terminals of each pole of the isolator occur on account of make or break operation. | ( only manufacturing Guarantee) | |
| **l.** | Temperature rise | As per IS:9921(Part-II) above ambient temperature of 50°C. | |
| **m**. | Radio interference level at 1.1 Um _/3 rms phase to ground, max. | 1000 Microvolts both in open & close position | - |
| **n.** | Corona Extinction voltage, kV rms | 320 | - |
| **o.** | Operating time of Isolator | 12 seconds or less | 12 second or less |
| **p.** | Maximum phase to phase spacing (for design purpose) | 7000 / 6000 mm | 4500mm |
| **q**. | i) Rating of auxiliary contacts | 10 Amps. at 220 volts. | |
| | ii) Breaking Capacity. | 2 Amps. DC with time constraint of less than 20ms | |

**PARTICULARS OF INSULATORS**

| | | |
|---|---|---|
| **r.** Rated voltage | 420 KV | 245 kV |
| I) Creepage distance, mm | | |
| i) Total | 10500 | 6125 |
| ii) Protected | Atleast 50% of total creepage distance. | |
| II) Dielectric Strength. | | |
| i) Minimum one minute power frequency withstand voltage, kV, rms | 610 | 460 |
| ii) Minimum impulse withstand voltage, kV Peak. | 1425 | 1050 |
| iii) Minimum Switching surge withstand voltage. | 1050 | - |
| iv) Minimum discharge voltage with ring, kV rms | 320 | - |
| v) Max. RIV at 1.1 Um -/3 kV, rms. | 1000 Micro Volts | 1000 micro volts |
| III) Minimum cantilever strength | 800 Kg. | 800 kg. |

5.0 **GENERAL TECHNICAL REQUIREMENTS**

5.1 420 kV and 245 kV Isolators / Isolators cum earthing switch shall be of single centre break type having two rotating insulator posts per pole as well as horizontal double break type having one rotating insulator post per pole (for line). The blades shall open and close in a horizontal plane. Each 420 kV three pole isolating switch shall consist of three identical single isolating pole unit and earthing switches linked together electrically and each 245kV isolator shall consists of requisite number of poles linked together mechanically and shall be suitable for uright parallel motion. Isolating poles of centre break type isolators cum earthing switch shall rotate at least $90^{o}$ from their fully closed position to fully open position.

5.1.1. In fully open position of the isolators cum earthing switches, the break shall be distinct and clearly visible from ground level.

5.1.2 The phase to phase spacing and phase to ground clearance for 420 kV and 245kV Isolators shall be 7000 / 6000 mm and 8000 mm; and 4500 mm and 5500 mm respectively.

5.2 **GENERAL REQUIREMENTS**

5.2.1 The reliability of operation of the Isolators / Isolators cum earthing switches shall not be effected by heat, humidity, rain or dust. Design of isolators shall permit easy maintenance and replacement of parts.

5.2.2 The Isolators are not required to operate under load conditions but may be called upon to make and break capacitive current of bushings, busbar connections and capacitive voltage transformers specified at Clause 4.0 above and round shall make/break, the load currents, when no significant change in voltage across terminals of each pole of the isolator occurs, when its poles are closed/opened (e.g.

after closing the bus coupler and closing and opening of bus selector isolators to transfer load from one bus to another).

5.2.3 Isolator-cum-earthing switches, besides meeting the requirement for Isolator shall also meet those for earthing switches, as provided for, in this specification. Earthing switches shall have only manual operation.

5.2.4 Design of the Isolators and associated earthing switches shall be such so as to provide positive control of blades in all positions with minimum mechanical stress on insulators. Fixed guides shall be provided so that proper seating of contacts shall be obtained even when blade is out of alignment by 25mm, in either direction.

5.2.5 Isolators/Isolators cum earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the system in their closed position. They shall be constructed such that they do not open under the influence of short circuit current.

5.2.6 Arrangement of arcing contact (Interrupting device + copper braided flexible) which should make before and open after main contact of isolator.

5.2.7 Isolators/Isolators-cum-earthing switches shall have the rating and insulation level as given in Clause 4.0 above.

5.3 **EARTHING SWITCHES**

5.3.1 For Isolator-cum-earthing switch, the earthing switch shall be integral part of Isolators. Earthing switch shall consist of one or two earthing blade(s) per pole as per requirement of the Isolators. The earthing blades shall normally rest against the frame when the corresponding isolators are in closed position. The earthing blades shall be capable of being fitted on either side of centre break Isolator. An independent manual operating handle and geared mechanism with auxiliary contacts shall be provided for each earthing switch.

5.3.2 Each earthing switch shall be designed to withstand electro-dynamic stresses due to the rated short time current and rated peak withstand current and the current carrying capacity of earthing switch for these currents shall be same as that of the isolating switch.

5.3.3 A flexible braid with a connector, suitable for above short circuit current shall be provided on the hinged end of the earthing blades for connection to the Isolator Structure and also to the station grounding grid mat of iron ( Flats of size 100x 12 mm). The exact size of the grounding mat shall be intimated to the successful bidder.

5.3.4 The earthing switch shall be constructional interlocked with the isolator so that earthing switches can be operated only when the isolator is open and vice-versa. Besides this, an interlock will be provided which will make electrical operation of Isolator in operative before E.S. is opened. This interlock will remain in operation till E.S. remain closed.

5.3.5 The earth blades in the Isolators shall be of vertical and lift fork type for easy make and break operation. The plane of movement and final position of earth switch shall be such that adequate electrical clearance are obtained from adjacent live parts.

5.3.6 The Isolators shall be so designed that addition of earth switches on one or both sides shall be possible at future date.

5.4 **INSULATORS**

5.4.1 The polycone / solid core (cylindrical type) 400 kV Post Insulators (bottom having 8 Nos. 18 mm dia plain fixing holes preferably at 300 mm PCD and top having 4 Nos. 16 mm dia tapped holes at 127 mm PCD) and 220 kV Post insulators (bottom having 4 Nos. 18 mm dia drilled holes at 184 mm PCD and top having 4 Nos. 16 mm dia tapped holes at 127 mm PCD) with bending strength of 8000 Newton and 8000 Newton resectively shall be used for isolators. The bidder shall design the Isolator and earthing switch metallic, base and elevating structure suiting to support Polycone/solid core Post Insulators having technical particulars given above and as detailed at clause No. 4.0.

5.4.2 **GENERAL REQUIREMENT OF POST INSULATORS**

The porcelain of post insulator shall be of high dielectric, mechanical and thermal strength and shall be ivory white, non porous, free from internal stresses, blisters, laminations, voids, foreign matters, imper-fections or other defects which might in any way render it unsuitable, as insulator shells. Porcelain used shall be un-effected by climatic conditions, ozone, acids, alkalis, zinc or dust. The porcelain shells shall be made by wet process. These shall be clean, dense, homogeneous and shall be fired to a complete and uniform verification so that glaze does not depend upon insulation. The glaze shall be smooth, uniform and of chocolate brown colour. The glaze shall cover completely all exposed porcelain parts of the insulation and shall have a bright luster, smooth surface, a good performance under extreme weather conditions of tropical climate and shall be dust-resistant. The glaze shall not crack or chip due to ageing under normal service conditions or while handling during transit or erection. The glaze shall have the same co-efficient of expansion as the porcelain body, through out the working temperature range. The porcelain shells shall posses the qualities, best adopted to insulators for service at extra high voltage.

5.4.3 **CEMENT**

Cement used in the construction of Insulators shall be 'Portland' cement which shall not cause cracks due to expansion or loosening due to contraction and must have high compressive and sheering strength and be free from change in volume due to ageing and temperature change. The thickness of cement shall be kept as small and even, as possible and proper care shall be taken to correctly centre and locate the individual parts, during cementing. The cement shall not give rise to chemical reaction with metal fittings. Cement used shall be of high quality, durable and shall have high strength. The material employed for cementing various cones and sealing material, used to prevent ingress of moisture etc. between cones shall be indicated. Cement and sealing material used shall be same as in used by the bidder's collaborators if any. The cement used shall be indicated in bid with years of satisfactory performance.

5.4.4 **HARDWARES**

All metal fittings of insulators shall be of drop forged steel or heat treated malleable cast iron and should have excellent mechanical properties such as strength, toughness and high corrosion resistance and free from corona formation. All raw materials used for disc insulator units/ post insulator stacks shall conform to relevant standards. All ferrous parts of insulator fittings shall be hot dip galvanised and spring washer, wherever used, shall be electro galvanised.

5.4.5 **DESIGN FEATURE OF INSULATORS**

The Design of post insulator stack shall be such that all stresses due to expansion or

contraction in any part of the insulator, under rapid temperature fluctuations, while in service, shall not lead to deterioration. Flat surfaces and corners shall be avoided. Porcelain shall not engage directly with hard metal and all in contact with cement shall be coated with a layer of chemically neutral and suitable shielding material or paint which shall act as a cushion and lubricant for the slight relative expansion and contraction of the parts.

5.4.5.1 Post insulator unit shall have antilog type skirt. The total creepage distance of post insulator stacks shall be 25 mm per kV(rms) of highest system voltage.

5.4.5.2 All studs, nuts, bolts spring and plane washers etc. for post insulator stack, to be used for interconnecting various units and fixing of post insulator to base/isolator and of accessories on top shall be supplied with the post insulator with 2.5% extra. Length of the same may be taken as 2 1/2 times the thickness of bottom flange/threaded portion on top. Exact length will be conveyed while approving the drawing.

5.4.5.3 Design of the insulators shall ensure ample insulation, mechanical strength and rigidity for satisfactory operation under site condition. The design shall also ensure that the losses caused by capacitive current or conduction through dielectric are minimum and that the leakage due to moist and dirty insulator surface is least. Corona extinction voltage of post insulator stacks shall not be less than 320 kV (rms) for 400 kV.

5.4.5.4 **Locking Device**

Security clips for use with ball and socket coupling and split pins for use with cotter bolts, shall be made of phosphor-bronze. The security clip shall comprise humpback type split pin in accordance with IEC recommendation publication No. 371-1971 or relevant IEC. The legs of the security clips, shall spread after installation to prevent withdrawal from the socket. The locking devices should be resilient corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device, being displaced accidentally or being rotted when in position. Under no circumstances shall the locking device allow separation of insulator units or fittings.

5.4.5.5 **SPECIFIC REQUIREMENTS OF POST INSULATOR STACKS**

400 kV and 220 kV polycone type post insulator stacks shall be solid core type, complete with all fittings. The post insulator stacks shall have not more than 2 to 3 post insulators per stack. Its top metallic shall have 4 Nos. 16 mm dia tapped bolt holes at pitch circle diameter of 127 mm for fixing grading rings and post insulator clamps etc. The post insulator stacks shall be mounted on supporting structure/isolators.. The successful tenderer shall however supply the design data for post insulator stacks and fittings ( i.e. weight, cantilever strength & wind force) to purchaser for the design of supporting structure.

5.4.5.6 The Isolators, metallic shall be bolted to the metal parts of insulators thus making the replacement of damaged insulator easy.

5.4.5.7 All studs, nuts, bolts, spring and plain washers ( required for fixing isolator on to the base and mounting insulators on to the isolator) shall be supplied with the isolators with 2.5% extra. The tenderer shall indicate the dimensions for bottom flange on which the supporting insulators is to be mounted.

5.6 **OPERATING RODS**

5.6.1 The length of the operating rod will be such that the height of the manual operating handle above ground may vary from 1200 mm to 1300 mm. The tenderer may form his bid on the basis of above mentioned dimensions and bay bus height of 8 meter and 5.5 meter respectively for 420 kV and 245kV Isolators/Isolators-cum-earthing switch. No variation in price shall be allowed.

5.6.2 The tenderer shall also state the maximum free length of the operating rod for which no intermediate coupling and bearing arrangements are needed. Where, longer lengths necessitate such arrangement, price of the same should be included in quoted unit price of respective isolator.

5.6.3 The operating rod of earthing switch shall have handle with insulation layer so that the electro static voltage on the handle from bus bar may not cause shock to the operator.

5.6.4 The isolator and earthing switches including their operating parts shall be such that they can not be dislodged from their open or closed positions by gravity, wind pressure, vibrations, earthquakes, reasonable shocks or accidental touching of the connecting rods of the operating mechanism. The manual operating mechanism shall be of robust construction, conveniently located for operation and easy operation by a single person.

5.6.5 The isolators shall be so constructed that the switch blade will not fall to the closed position if the operating shaft gets disconnected.

## 5.7 COUNTER BALANCING OF BLADES/CONTACTS

5.7.1 Counter balancing springs or any other suitable arrangement shall be provided for counter balancing the isolator blades so as to prevent impact at the end of their travel both on opening and closing of the isolators. The material used shall be made of a non-rusting alloy.

The operating mechanism shall include a device, or circuit to store an 'Open' or 'Close' command until it is fully executed. After execution of a command, concerned coils/circuits shall get de-energised positively to prevent their burn outs.

## 5.8 BASE

5.8.1 Supply of each of single pole isolator and earthing switch shall include the base on which the insulator stack shall be mounted with their bearings. The tenderer shall indicate fixing details of the base which is to be mounted on the supporting structure. Fixing material ( i.e. bolts, nuts, washers and spring washers etc.) for installation of the base to the supporting structures shall also be included in the scope of supply. The base shall be rigid and self supporting and shall require no guying or cross bracing. Two independent 8 mm thick earthing plates of size 75 x 75 mm shall be provided on the base for bolting the ground mat ( flat of 100 x 12 mm size ).

5.8.2 The position of moving contact system ( main blades) of each of the isolator and earthing switch shall be indicated by a mechanical indicator at the lower end of the vertical rod or shaft. The indicator shall be of metal and shall be visible from ground level.

## 5.9 OPERATING MECHANISM AND CONTROL

5.9.1 Each three pole isolator shall have remote electrical control from the control room, as well as local electrical control in switch yard. The control circuitry shall be on 220 V D.C. The operating mechanism shall be equipped with local/manual operating device intended for emergency operation of isolator by an operator when electrical operation is in operative. It shall be possible to padlock the manual operating handle both in open and closed position of the switches. Additional electro magnetic type of interlock shall be provided on the manual operating handle and door of control cubicle so as to prevent the operation of isolator manually and locally when the corresponding circuit breaker is in closed position. Suitable interlocks shall be provided such that during manual operation, electrical operation shall be automatically rendered in-operative, by interrupting the supply of power. Earthing switches shall be suitable for local/manual operation by separate operating mechanism.

5.9.2 Pole discrepancy relay to give a remote discrepancy alarm and bulb indication shall be supplied with each three pole isolator whose poles are not mechanically ganged. The control schematics shall be such that in case of pole discrepancy, it will be feasible to reverse the close operation or to give open command automatically/manually. The bulb indicator will continue to glow till pole discrepancy conditions exist.

The isolator shall be provided with positive continuous control through out the entire cycle of operation. The operating pipes and rods shall be provided with universal type interlocking mechanism assembly on both side to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing/opening. They shall also be capable of withstanding all torsional and bending stresses due to operation of the isolator.

5.9.3 It shall not be possible, after final adjustment has been made, for any part of the mechanism to be displaced at any point in the travel sufficient enough to allow improper functioning of the isolator when the isolator is opened or closed at any speed. All holes in cranks, linkages etc., having moving pins shall be drilled to accurately fit so as to maintain minimum amount of slack and lost motion in the entire mechanism.

5.9.4 All the items of driving mechanism including, fixing bolts, all brackets, angles or other members necessary for attaching the operating mechanism to the isolator supporting structure shall be supplied as an integral part of isolator. Rust proof pins and ball or roller type bearings shall be supplied.

5.9.5 Each rotating insulator shall be supported on tapered thrust type ball bearings. These shall be protected from the weather by means of covers and grease retainers. Bearings pressure shall be kept low to ensure long life and ease of operation.

5.9.6 Control Cabinets shall be of sheet steel. It shall be dust, water and vermin proof. Sheet steel used shall be at least 3 mm thick and shall be properly braced to prevent wobbling. The cabinet shall be spray painted with special zinc rich paint.

5.9.7 The enclosures of the control cabinets shall provide a degree of protection of not less than IP 55 ( as per IS 2147) and shall be such that no rain water enters the control cabinet.

5.9.8 Control cabinets shall be mounted on Isolator structure with free standing floor mounting or mounted on isolator structure with handle at a height of about 1200 mm to 1300 mm from the ground level.

5.9.9 Control cabinet doors shall be securely hinged and fitted with lockable handle

engaging the door closing mechanism of the cabinet at, atleast 3 positions ( i.e. top, middle and bottom).

5.9.10 All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. Louvers, shall have screens and filters. The screen shall be of fine wire mesh made of brass or G.I. wires.

5.9.11 Cable entries shall be from bottom. Suitable removable cable gland plate shall be provided on the cabinet for the purpose. Necessary number of cable glands shall be supplied and fitted on to this gland plate. Cable glands shall be screw-on-type and made of brass. Their size shall be intimated by the purchaser.

5.9.12 Suitable space heaters shall be mounted in the cabinet to prevent condensation. Heater shall be suitable for 240 V A.C., 50 Hz supply.

5.9.13 The cabinet shall be fitted with 1100 V grade barrier type of terminal blocks. The control wiring shall be carried out with a minimum 2.5 mm squire copper wire of 1100 V grade insulation. The auxiliary wiring with auxiliary device shall be capable of withstanding a test voltage of 2 kV per minute.

5.9.14 The terminal blocks to be provided shall be fully enclosed with removable covers and made of molded, non inflammable plastic material with boxes and barriers molded integrally. Such block shall have washers and binding screws for external circuit wire connections, a white marking strip for circuit identification and molded plastic covers. All terminals shall be clearly marked with identification number or letters to facilitate connection to external wiring.

5.9.15 The terminals shall be so staggered that the connection of external cable to any terminal block should be possible without disturbing the rest of the connections. The terminal block arrangement shall be such as to provide maximum accessibility to all conductor terminations. Any arrangement preventing ready access to other terminal screws shall not be accepted.

5.9.16 The arrangements shall be such that it is possible to safely connect or disconnect terminals on live circuits and replace links when the cabinet is live.

5.9.17 All control and secondary circuits shall be wired completely and up to the terminal blocks in the control cabinet.

5.9.18 All auxiliary contacts of the isolator shall be wired upto terminal blocks.

5.9.19 At least 20% spare terminals shall be provided over and above the number required.

5.9.20 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 the operation of the isolator from local or remote position. Remote operation shall be through spring return to neutral type control switches.

5.9.21 Provision shall be made in the control cabinet to disconnect power supply to prevent local/remote power operation.

5.9.22 Lamp for ON and OFF indication shall also be provided in Motor control Mechanism.

5.10 **CONTROL**

5.10.1 All the equipment for satisfactory remote operation of the isolating switches, such as control switches, local/remote operation selector switches, ON/OFF, pole

discrepancy and indicating lights etc. which are to be mounted on the control board to be installed inside the purchaser's control room shall be detailed but not included in the scope of supply. The control circuit shall be so arranged that necessary inter locks with associated breaker and earthing switch can be incorporated in it. The provision for these inter locks shall be suitable for providing:-

1. Interlock in close command only.
2. Interlock in open command only.
3. Interlock for close as well open command in :-
   a) Electric supply for the operating mechanism.
   b) Separate electric supply from centralised control room.

5.11 **AUXILIARY SWITCHES**

5.11.1 All isolators and earthing switches shall be provided with 220 Volts, D.C. auxiliary switches for their remote indication on the control board, electrical interlocking, with other equipment and isolator's control schematics. The shaft operating the auxiliary switch should preferably be directly coupled to the shaft of rotating post insulator.

5.11.2 Each auxiliary switch of isolator/isolator and earthing switch shall have pairs of normally open, normally closed, and make before break silver plated copper contacts. Number of such contacts/ways for isolator will be 8 Nos. 'NO' and 8 Nos. 'NC' and 4 Nos. make before break contacts and those for earthing switches will be 8 Nos. 'NO' and 8 Nos. 'NC' per pole. The auxiliary contacts shall be accessible even when the isolator is live and signaling for open will not take place unless moving contacts have fully separated.

5.11.3 All connection from the auxiliary switches shall be brought out on a terminal block. The auxiliary switches shall be housed in weather proof and dust proof housing with cable terminating box/gland provided beneath auxiliary switch housing for multi core control cables. Provision shall be kept for adding more auxiliary switch contacts, if required, at a later date. Separate, auxiliary switches shall be provided for isolator and earthing switches of isolator-cum-earthing switch. The auxiliary switches shall conform to the relevant provision of latest edition of IEC:129 or IS:9921 and IS:6875 (Pt.I & Pt. III). The capacity of each contact of these switches shall not be less than 10 ampere continuous DC with breaking current of 2 A at 220 V DC with circuit time constant of 20 ms.

5.11.4 It shall be possible to change normally closed contacts into normally open contacts and vice-versa at site.

5.11.5 CT leads of busbar protection may be routed through the auxiliary switches of bus isolators. The auxiliary switches shall be suitable for withstanding the voltages in C.T. circuits( i.e. 4 kV rms to ground) under all operating conditions.

5.11.6 Signaling of the closed position shall not take place unless it is certain that the movable contact will reach a position in which the rated normal current, the peak withstand current and the short time withstand current can be safely carried.

5.11.7 The tenderer shall give details of arrangements provided for protecting the auxiliary switches against accidental arcing from the main circuit.

5.12 **MECHANICAL INTERLOCKS**

5.12.1 All isolators and earthing switches shall be provided with padlocking castel key locks to permit locking of isolators and earthing switches in both fully open and fully closed position. All locks shall be provided with two ordinary keys and in addition a master key shall also be provided.

5.12.2 The isolating switches shall be so designed that the opening/closing operation of isolator does not take place when the corresponding earth switch or interlocking isolator is in operating stroke.

5.12.3 The operation of isolating and earthing switch of isolator-cum-earthing switch, shall be mechanically inter-locked so that following requirements are fulfilled for remote/local, electrical/manual operation.

a) It shall be possible to close the earthing switch only when isolating switch is in fully open position.

b) It shall be possible to close the isolating switch only when the earthing switch is fully open.

Besides this, electromagnetic type interlocks shall also be provided, so that:-

i) Local operation of isolating switch is not possible when corresponding circuit breaker is in closed position or in operating stroke and ;

ii) Operation of earthing switch is possible only when line is dead i.e. when there is no supply from line, CVTs/CTs. Necessary contractors/relays shall be in the scope of supply of supplier.

5.12.4 Interlocking arrangement shall be generally fail safe type. For failure, of control voltage or any component of interlocking device/scheme shall remain operative. The electrical interlocking scheme shall operate on 220 Volts D.C.

5.13 **BEARINGS**

5.13.1 All bearings in the current path except those specially designed as high pressure contacts should be shunted by flexible copper conductors of adequate cross section which in no case shall be less than 50 sq.mm. The tenderer may submit detailed calculations in support of the size of the flexible copper conductor offered. Bearing housing shall be weather proof. Facilities shall be provided for easy lubrication of the bearings. The rotating insulator stacks shall have tapered roller bearing at both ends of the shaft. and shall be accessible for dismantling in the field. Bearings shall be filled with first fillings of lubricants which shall be long lasting in nature.

5.13.2 Nipples for servicing shall be provided at accessible location.

5.14 **CONTACTS AND TEMPERATURE RISE**

5.14.1 All isolators/Isolators cum earthing switch shall have heavy duty, self aligning and high pressure type contacts of modern design. the male and female contacts shall be of robust construction and made of hard drawn electrolytic copper having silvered surface of ample cross section ( not less than 25 microns) and the same will not flake/peal off during service condition. the isolator blades shall be of aluminum alloy

tube. The various parts shall be finished to ensure inter changeability of similar components. The design of their assemblies shall ensure:-

i) Electro dynamic withstand ability during short circuit without any risk of repulsion of contacts.
ii) Thermal withstand ability during short circuit.
iii) Constant contact pressure even if the live parts of the insulator stack are subject to stresses upto rated mechanical load due to variation in length of bus bars either because of temperature variation of transverse force due to wind, short circuit etc.
iv) Wiping action during closing and opening.
v) Self alignment, assuring closing of the switch without minor adjustment.

5.14.2 Earthing switch shall have a suitable fixed contact assembly on the main isolator and moving contact. Their contacts too shall be fabricated from electrolytic copper, and their design shall meet requirement as stated above and shall ensure discharging of residual charge on the disconnected line without any damage/pitting of its contacts.

5.14.3 Earthing switches of each 245kV three pole isolator cum earthing switch will have three poles of earthing switches linked mechanically. Earthing switches of each 420 kV three pole earthing switch shall be made of 3 single poles of earthing switches.

5.14.4 The reference ambient temperature in shade is to be taken as per Clause 3.0 above. The maximum temperature attained by any of the isolating switch of isolator and isolator-cum-earthing switches, when in service under continuous full load conditions and exposed continuously to the direct rays of the Sun and the air having maximum temperature of $50^{o}$C ( as per Clause 3.0) shall not exceed the permissible limits as given in Table-4 of IS:9921 (Part-II) 1982 less $10^{o}$C ( i.e. difference between maximum ambient temperature and reference temperature of $40^{o}$C.)

5.15 **TERMINAL CONNECTORS**

5.15.1 The current carrying capacity of the clamps shall not be less than the current rating of the isolators for the ambient temperature specified in this specification. Their terminal connectors suitable for 114.2 mm outer dia tube shall however be suitable for 2500 Amps.( at $75^{o}$C and without solar heating). The clamps shall be so designed that they shall be free from corona emission and satisfied the requirement of specified corona extinction voltage.

5.15.2 The clamps body shall be of high conductivity and high strength aluminum alloy, free from copper. The bolts and nuts shall be of high tensile, non corrosive, fungus resistant material. Aluminium alloy phosphor bronze or galvanised iron may be used as required by the clamps design. Bolting pressure shall be well distributed. Washer shall be used to provide constant pressure under thermal cycling conditions so as to maintain a low contact resistance. Contact surfaces shall be finished and protected against galvanic action and oxidation. The supplier shall quote for the jointing compound recommended to be applied to the aluminium contact surfaces before bolting the clamps.

5.15.3 The unit rate for the following types of bimetallic terminal connector shall be quoted. The exact quantity and the type of terminal connector would be indicated to the successful tenderer.

i) Terminal connector for 420 kV Isolators suitable for horizontal/vertical take off and for twin / Quad ACSR Moose at 450 mm spacing. The particulars of ACSR Moose conductors have been given in Annexure-II.

ii) Terminal connectors for 245 kV isolators suitable for horizontal / vertical take off and for AAC Tarantulla Conductor at 300 mm spacing.

iii) Expansion joint type terminal connector for 420 kV suitable for Aluminium Alloy tube ( O.D. ranging from 114.2 mm to 116.5 mm). The terminal connector shall take 25 mm expansion.

5.15.4 Terminal connectors for 420 kV Isolators shall have corona extinction voltage of not less than 320 kV rms and maximum R.I.V. of 1000 micro volts at 266 kV. The Corona extinction voltage of terminal connectors of 245kV isolator shall not be less than 155kV rms. Terminal connectors shall conform to type and routine tests as per IS:5561.

5.15.5 To avoid galvanized corrosion, copper alloy or bimetallic liner of minimum 4 mm thickness cast integral with aluminum body shall be preferred.

## 5.16 METAL PARTS AND WORKMANSHIP

5.16.1 The successful tenderer shall assume full responsibility for co-ordination and adequate design of isolators/earthing switch. All material used in the construction of the equipment shall be of the appropriate class, well finished and of approved design and make. All similar parts should be accurately finished and will be interchangeable.

5.16.2 The live parts shall be designed to eliminate sharp points, edges and other corona producing surfaces. If this is impracticable, adequate corona shields shall be provided.

5.16.3 Special attention shall be paid to give tropical treatment to all equipments as it will be subjected during service to extremely severe exposure to atmospheric moisture. All metal parts shall be made of non rusting, non-coroding metals. Current carrying parts shall be of non-ferrous metal or alloy. Bolts screws and pins shall be provided with lock washerôs, keys or equivalent locking facilities, if provided on current carrying parts, shall be made of copper silicon alloy or equivalent. All castings except for current carrying parts shall be of malleable cast iron or cast steel. No grey cast iron shall be used in the manufacture of any part of the isolators. Isolator/Isolators-cum-earthing switches shall be designed such that no lubrication of any part is required except at very in-frequent intervals.

5.16.4 The Zinc coating shall not flake or loosened from the steel when struck squarely with a chisel faced hammer. The spring washers will be electrolytic ally galvanised.

## 5.17 MOTOR OPERATING MECHANISM

5.17.1 The control schematics of motor operating mechanism shall actuate 3 pole group operated switches or individual drive switches to operate the electric motor in proper direction. There will be additional contacts, which will switch on power supply to motor on receipt of open/close command. The operating mechanism shall be capable of providing a quick, simple and effective operation. The design shall be such that a minimum energy is required for the operation.

5.17.2 The motor mechanism shall be connected to the isolator torsional control through a suitable coupling assembly. Suitable means to limit over travel shall be provided and stated in the tender.

5.17.3 The motor operated mechanism shall be suitable for operation from AC 50 Hz power supply. Motor shall be direct on line starting type conforming to IS:325. Gear drive assemblies shall be suitable for operating the isolator with minimum of energy. The motor enclosure shall conform to IP-55. The motor shall develop stalled torque equal to atleast 2.5 times the torque required to operate the isolator.

5.17.4 Emergency manual operation shall be provided to enable operation of isolator in case of power failure. During manual operation of isolator power operation shall be in-operative. Arrangement shall be made to padlock the emergency handle when not in use.

5.17.5 Limit switches for motor control shall be fitted on the isolator shaft, within the cabinet, to sense 'Open and Close' positions of the isolator to cut off the power supply to the motor at appropriate instant. The control schematics shall be such that in case of stalling of motor power supply to motor, it shall be automatically tripped after the predetermined time and shall remain tripped till restored by the operator. Indication for such auto tripping shall be provided in local as well as remote control cabinet. The motor shall be provided with single phase preventes, short circuit protection and over load protection.

5.17.6 A quick acting electro mechanical brake shall be provided on higher speed shaft.

5.18 **ASSEMBLY**

Isolators shall be completely assembled at the works to ascertain that all parts fit properly.

6.0 **TESTS :**

6.1 Type Tests:

6.1.1 All the Isolators/Isolator cum earthing switches ,shall be fully type tested as per Clause 3.0 and special test as per clause 3.7 & 3.8 of IS 9921 PT-IV for voltage described in clause 4.0 above and Corona extinction voltage test and RIV test for 420 kV Isolators only as detailed below. In case the equipment of the type and design offered, has already been type tested, the Bidder shall furnish four sets of the type test reports along with the offer. The purchaser reserves the right to demand repetition of some or all the type tests in the presence of Purchaser's representatives. For this purpose the Bidder may quote unit rates for carrying out each type test. For any change in the design/type already type tested and the design/type offered against this specification the Purchaser reserves the right to demand repetition of tests without any extra cost.

6.1.2 During type tests the disconnector shall be mounted on support structure or equivalent support structure and installed with its own operating mechanism to make the type tests representative. Drawing of equivalent support structure and mounting arrangements shall be furnished for Purchaser's approval before conducting the type tests.

6.1.3 The type tests shall be conducted on the disconnector alongwith approved insulators and terminal connectors.

6.1.4 Mechanical endurance test shall be conducted on the main switch as well as earth switch of one disconnector of each type.

6.1.5 **CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TESTS**

6.1.5.1 **General**

Unless otherwise stipulated, all 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 interface voltage(RIV).

6.1.5.2. **Test Levels**

The test voltage levels for measurement of external RIV and for Corona extinction voltage are as listed in Clause 4.0 above.

6.1.5.3 **Test Methods for RIV**

RIV tests shall be made according to measuring circuit as per International Sub-Committee on Radio Interference Publication 1-1972 Second Edition. The measuring circuit shall preferably be tuned to frequency within 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 Micro-volts.

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

6.1.5.6 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 terminal.

6.1.5.7 Ambient noise shall be measured before and after each series of test to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipments unless otherwise specified. The specified RIV test voltage for 420 kV system is listed in the detailed specification together with maximum RIV level of 1000 micro-volts with CB open/closed position when CB is at phase to ground rms voltage of 266 kV.

6.1.5.8 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

6.1.5.9 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.

6.1.5.10 However, RIV test method may be followed as per IEC 56/4-1975.

6.1.5.11 **Test Methods for Visible Corona**

The purpose of this test is to determine the corona extinction voltage of apparatus and connectors. 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 on set and extinction voltages, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. The voltage will then be decreased slowly until all visible corona dis-appears. The voltage will then be raised slowly again to the same maximum voltage. This 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 specifications 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 condition, at all voltage steps i.e. 85%, 100%, 115% and 130%. 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 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 connectors so as to show corona on bushings, insulators and all parts of energised connectors. The photograph shall be framed such that test object, essentially, fills the farms with no cut off.

6.1.5.12 The test voltage 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.

6.1.5.13 In addition to photographs of the test object at least four photographs shall be taken of the complete test assembly showing relative position of all the test equipment and test objects. These four photographs shall be taken from 4 points equally spaced around the test arrangement to show its features from all sides. Drawings of 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 location by trial energisation of test object at a voltage which results in corona.

6.1.5.14 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV level.

6.1.5.15 However, both tests shall be carried out with the same test set up and as little time duration between tests as possible. No modifications on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the complete discretion of purchaser's Inspector if, in his opinion, it will not be prejudice other test.

6.1.5.16 **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 micro volts in each direction.

f) On set and extinction of visual corona for each of the four tests required shall be recorded.

6.2 **Acceptance and Routine Tests:**

6.2.1 All acceptance & routine tests as stipulated in the relevant standards shall be carried out by the supplier in the presence of purchaser's representative.

6.2.2 The separate routine test will be carried out on auxiliary contacts, motor operating mechanism, and control cabinet etc. in accordance with governing standards. These test taken together shall prove the compliance of routine test as per ISS. Galvanised, components shall be tested as per IS:2633.

6.2.3 Mechanical Operation Test (routine test) shall be conducted on disconnector (main switch and earth switch) at the Supplier's works.

6.2.4 Immediately after finalisation of the programme of type/acceptance and routine testing, the Supplier shall give sufficient advance intimation to the Purchaser to enable him to depute his representative for witnessing the tests.

6.3 Various tests listed in Annexure III on associated equipments of isolator shall be carried out in the presence of Purchaser's representative.

6.4 Test certificates of various items including but not limited to the following, shall be furnished at the time of routine tests.

a) Chemical analysis of copper alongwith a copy of excise duty certificate indicating genuine source of procurement of electrolytic grade copper.
b) Bearings.
c) Fasteners.
d) Universal/swivel joint coupling.
e) Insulators.
f) Motor
g) Gears
h) Auxiliary switch.
i) Limit switch.
j) Timer
k) Overload/single phase preventer relay.
l) Interlocking devices.
m) Terminal block.
n) Any other item.

7.0 **INSPECTION :**

i) The Purchaser shall have access at all times to the works and all other places of manufacture, where the dis-connectors, earth switches and associated equipment are

being manufactured and the Supplier shall provide all facilities for unrestricted inspection of the works, raw-materials, manufacturing of all the accessories and for conducting necessary tests as detailed herein.

ii) The Supplier shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.

iii) No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iv) The acceptance of any quantity of the equipment shall in no way relieve the Supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection if such equipments are later found to be defective.

8.0 **DRAWINGS**

All drawings shall conform to international standards organization (ISO) 'A' series of drawing sheet/Indian Standards Specification IS:656. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

8.1 **List of Drawings and Documents :**

The Bidder shall furnish four sets of following drawings alongwith his offer:

a) General outline and assembly drawings of the disconnector operating mechanism, structure, insulator and terminal connector.

b) Sectional views and descriptive details of items such of heights, phase coupling pipes, base plate, operating shaft, guides, swivel joint operating mechanism and its components etc.,

c) Loading diagram.

d) Drawings with structure for the purpose of type tests.

e) Name plate.

f) Schematic drawing.

g) Type test reports in case the equipment has already been type tested.

h) Test reports, literature, pamphlets of the bought out items and raw material.

8.2 The manufacturing of the equipment shall be strictly in, accordance with the approved drawings and no deviation shall be permitted without the written approval of the Purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the Supplier's risk.

8.3 Approval of drawings/work by Purchaser shall not relieve the Supplier of his responsibility and liability for ensuring correctness and correct interpretation of the latest revision of applicable standards, rules and codes of practices.

9.0 **INSTRUCTION MANUALS**

Twenty copies of the erection, operation and maintenance manuals in English be supplied for each type of dis-connector one month prior to despatch of the equipment. The manual shall be bound volumes and shall contain all drawings and information required for erection, operation and maintenance of the dis-connector including but not limited to the following particulars :

a) Marked erection prints identifying the component parts of the dis-connector as shipped with assembly drawings.

b) Detailed dimensions and description of all auxiliaries.

c) Detailed views of the insulator stacks, metallic, operating mechanism, structure, interlocks, spare parts etc.,

10.0 **NAME PLATE**

10.1 All Isolators/Isolators cum earthing switches shall be provided with a name plate giving all information (whether mandatory or optional) as prescribed in Table-1 of IS:9921(Part-V)-1985.

11.0 **PACKING AND FORWARDING**:

11.1 The equipment shall be packed in crates suitable for vertical/horizontal transport, as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The Supplier shall be responsible for any damage to the equipment during transit due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied by Supplier without any extra cost.

11.2 Each consignment shall be accompanied by a detailed packing list containing the following information:

a) Name of the consignee.
b) Details of consignment.
c) Destination.
d) Total weight of consignment.
e) Handling and unpacking instructions.
f) Bill of material indicating contents of each package.

11.3 The Supplier shall ensure that the packing list and bill of material are approved by the Purchaser before despatch.

**ANNEXURE-I**

**SYSTEM PARTICULARS**

A) Electrical System Data:

| | | |
|---|---|---|
| a) System Voltage (kV rms) | 400 | 220 |
| b) Max. voltage (kV rms) | 420 | 245 |
| c)Lightning impulse withstand voltage (kVp) | 1425 | 1050 |
| d) Power frequency withstand voltage (wet) (kVp) | 520 | 460 |
| e) Short circuit level (kA rms) | 40 | 40 |
| f) Earthing system | Effectively earthed | |

**ANNEXURE-II**

## PARTICULARS OF ACSR Moose Conductor

| | | |
|---|---|---|
| 1. | Type of Conductor | ACSR Moose |
| 2. | Stranding and wire diameter<br>Aluminum<br>Steel | <br>54/3.53 mm<br>7/3.53mm |
| 3. | Overall diameter | 31.77 mm |
| 4. | Calculated equivalent area of aluminum | 528.5 $mm^2$ |
| 5. | Approximate total weight | 2004 Kg./Km |
| 6. | Calculated resistance at max. 20$^oC$ | 0.05552 Ohm/Km. |
| 7. | Direction as lay | Right hand lay |

## PARTICULARS OF AAC TARANTULLA Conductor

| | | |
|---|---|---|
| 1. | Type of Conductor | AAC Tarantulla |
| 2. | Stranding and wire diameter<br>Aluminum<br>Steel | <br>37/5.23 mm |
| 3. | Overall diameter | 36.61 mm |
| 4. | Calculated equivalent area of aluminum | 778.0 $mm^2$ |
| 5. | Approximate total weight | 2197 Kg./Km |
| 6. | Calculated resistance at max. 20$^oC$ | 0.0367 Ohm/Km. |
| 7. | Direction as lay | Right hand lay |

**ANNEXURE-III**

## LIST OF TESTS TO BE CARRIED OUT ON OTHER EQUIPMENTS

| S. No. | Name of the Test | Standard to which it Conforms |
|---|---|---|
| 1. | Tests on insulators | IS:2544<br>IEC:168 |
| 2. | Tests on terminal connectors | IS:5561 |
| 3. | Tests on galvanised components | IS:2633 |
| 4. | Stalled torque test on motor operating mechanism | At 110% of supply voltage |

## SCHEDULE OF GUARANTEED AND OTHER TECHNICAL PARTICULARS

| | | 420 kV | 245kV |
|---|---|---|---|
| 1. | Type, make and country of origin. | | |
| 2. | applicable standard | | |
| 3. | Maximum permissible continuous service voltage. | ....kV rms | |
| 4. | Rated Voltage | ....kV rms | |
| 5. | Rated frequency | ..... Hz. | |
| 6. | Number of Poles. | | |
| 7. | Minimum clearance in air in mm<br>i) Between phases<br>ii) Between live parts and earth<br>iii) Distance between terminals of same phase. | | |
| 8. | One minute dry & wet power frequency withstand test voltage for complete assembled isolator/isolator-cum-earthing switch. | | |
| | **a)** against ground.<br>**b)** *Across open contact | ....kV rms<br>....kV rms | |
| 9. | 250/2500 microsecond dry & wet switching impulse withstand test voltage for completely assembled isolator/isolator-cum-earthing switch without arcing horn. | | |
| | **a)** Between live parts and ground<br>**b)** Across the open terminals of the same phase.<br>(indicate the voltage applied during the test on other terminals not subjected to switching impulse for 420 kV isolators) | ...kVPeak+kVrms<br>..kVpeak+kVrms | |
| 10. | 1.2/50 microsecond lightning impulse withstand test voltage on completely assembled isolator/isolator-cum-earthing swh without arcing horn. | | |
| | **a)** Between live parts and ground<br>**b)** Across the open terminals of the same phase.<br>(indicate the voltage applied during the test on other terminals not subjected to switching impulse for 420 kV isolators) | ...kVPeak+kVrms<br>.. kVpeak+kVrms | |

| | | |
|---|---|---|
| 11. | Dry & wet flashover voltage to ground of completely assembled switch, without arcing horns for phase to ground across isolating distance. | |
| | **a)** Power frequency voltage, kV rms | |
| | **b)** 50% probability 1.2/50 micro-second lightning impulse voltage, kV Peak | |
| | **c)** 50% probability 250/2500 microsecond switching impulse voltage, kV Peak. | |
| 12. | Material and current density at the minimum cross section of switch blade | ...Amps/sq.mm. |
| 13. | Continuous current rating in Amps at.. | |
| | **a)** Reference ambient temperature of 40°C | ...Amps. |
| | **b)** Ambient temperature of 50°C | ...Amps. |
| 14. | Short time current ratings... | |
| | i) *For 1 second | ...kArms. |
| | ii) *For 3 second | ...kArms. |
| 15. | Rated peak short circuit current of.. | |
| | i) *Isolator | ...kA peak |
| | ii) *Earthing switch | ...kA peak |
| 16. | **a)** Maximum transformer magnetising current which can safely be interr-upted by the switch. | ...Amps. |
| | **b)** Maximum capacitive current/line charging current which/can be safely interrupted by the switch. | ...Amps. |
| 17. | Maximum current that can be safely interrupted between bus bar at same potential(connected by bus coupler) | ... Amps. |
| 18. | Thermal currents. | ...Amps. |
| 19. | Temperature rise corresponding to: | |
| | *a) Maximum continuous current rating at 50°C ambient temperature. | ...°C. |
| | *b) Short time current rating... | |
| | i) For 1 second | ...°C |
| | ii) For 3 second | ...°C |

20. Constructional details....
**a)** Number of insulator or stack required per pole.

21. Particulars of contacts Switch blade Moving Contacts
i) Type
ii) Material
iii) Surface treatment and thickness of surface coating in microns
iv) Contract area ...$CM^2$
v) Contact pressure ...$Kg/cm^2$

22. Total break length

23. Auxiliary contacts For Isolators/ For earthing pole switch

i) Total number of contacts.
ii) Number of 'Normally openô & Normally closed contacts.
iii) Number of make before break contacts.
*iv) Rated continuous current, Amps.(D.C.)
*v) Test Voltage, Volts.
*vi) Rated breaking current, Amps(D.C.)

24. Number of operations which the switch can withstand without deterioration of contacts.

*25 Number of times the switches can be operated without any need of inspection.

26. Safety factor taken into account while designing the isolators.

27. Type of mounting of isolators.

28. Whether terminal connectors provided and, if so, indicate the type of material used.

29. Weight of the single/three pole isolating switch.

a) Without earthing blade ... Kg.
b) With single earthing blade ... Kg.
c) With double earthing blade ... Kg.

30. Weight of the three pole, tandom connected isolating switch with single earthing blade.

31. Weight of base of isolator. ...Kg.

32. a) Actual dimension of isolator in mm.
b) Shipping dimension of the largest package in mm.
c) dimension of base in mm.

33. i) Opening time of the isolator.
ii) Closing time of the isolator

34. Whether separate operating mechanism provided for operation of isolator and earthing blades.

35. Torque required for operating Isolator.

36. *Rated Mechanical terminal load, Newtons

a) Rated longitudinal(or straight) mechanical terminal) load...
b) Rated transverse(or cross) mechanical terminal load...

37. Location and type of bearings.

38. Type of lubricant for bearings.

39. Specification of jointing compound.

40. Electrical & Mechanical inter-locks provided for close/open operation of isolators.

41. Electrical & Mechanical interlocking between isolating switch and earth switch.

42. Radio interference level of the isolator at 1.1 um _/3 kV rms micro volts.

43. Power required by D.C. interlocking coil at rated voltage.

44. Particulars of earthing switch Blade Contact
i) Type
ii) Material
iii)Whether protected by cover or open to atmosphere.

45. Particulars for Insulators
i) Make
ii) Type
iii) Size
a) Length
b) Diameter of shed
iv) Cantilever strength of stack
v) Weight
vi) Number of units per stack

vii) Bolt circle diameter top/bottom
viii)Creepage distance, mm....
*a) Total
*b) protected
x) Dry arcing distance
*xi)One minute dry power frequency withstand voltage ...kV rms
*xii)One minute wet power frequency withstand voltage ...kV rms
xiii)Corona extinction voltage ... kV
xiv)Lightening impulse withstand voltage. ... kV peak
xv)Switching impulse withstand voltage. ... kV
xvi)Compressive strength
xvii)Torsional strength
xviii)Cantilever strength upright
xix)Tensile strength
xx)Puncture voltage ... kV
xxi) Number and size of studs required for mounting metallics top to post insulator.
- Number & size of bolts, nuts required for fixing post insulator.
- Depth of threaded portion of top bolt PCD in mm.
- Thickness of base flange in mm.

46. Motor operating Mechanism
i) type
ii) Motor
a) Rating Voltage Current HP
b) Duty
iii) Type of stop for limit position offered.
iv) Details of arrangement for emergency local manual operation provided.

47. Space Heater.
a) Voltage Volts
b) Power consumption Watts

48. Reference drawing of isolators with and without earthing switch.

Signature:
Name:
Status

Whether authorised attorney of the tendering company

Name of the tendering company

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

# CAPACITIVE VOLTAGE TRANSFORMER
**Part-6**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

## PART-6 (Vol. II)

## Technical Specification for Capacitive Voltage Transformer

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## PART-6 (Vol. II)

### Technical Specification For Capacitive Voltage Transformer

**1.0 SCOPE :-**

1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply, packing, forwarding and delivery erection, testing and commissioning at site of 420 kV and 245kV Capacitive Voltage Transformer complete with all fittings, accessories, which are required for efficient and trouble free operation as specified hereunder.

1.2 It is not the intent to specify completely here all the details of design and construction of the equipments. However, the equipments shall conform in all respects to the high standard of engineering design and workmanship and shall be capable of performing in continuous commercial operation upto the Bidderôs guarantee in a manner acceptable to the Purchaser, who will interpret the meanings of drawings and specifications and shall have the power to reject any work or material which, in his judgement, is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of the Bidder irrespective of whether they are superficially brought out in this specification and / or in the commercial order or not.

**2.0 STANDARDS :-**

2.1 The Capacitive Voltage Transformers and associated accessories shall conform to the latest issues of standards as given below, except to the extent explicitly modified in the specification.

| Sl.No. | Indian Standard No. | Title | International & Internationally recognised standard |
|---|---|---|---|
| i. | IS-3156 Part (I to IV) | Capacitive voltage transformer | - |
| ii. | IS ï 8263 ï 1976 | Method for radio interference test on high voltage insulator | IEC 56 / 4 (1975) |
| iii. | - | Voltage Transformers | IEC 186-1968 |
| iv. | - | Voltage Transformer (First supplement to IEC-186-1969 | IEC-186A-1970 |
| v. | IS-9348-1979 | Coupling capacitors and capacitor dividers | IEC-358-1971 |
| vi. | - | Instrument transfer measurement of partial discharge | IEC-44 (4) ï 1980 |
| vii. | IS-9348-1979 | Coupling capacitor and capacitor divider | - |
| viii. | - | Report of committee for standardisation of the parameters and specification of major item of 400 kVS/S equipments and transmission line materials. | (June, ó84) with latest amendments, if any. |

2.2 In case equipment conforms to other International standards which ensure equivalent or better performance than that specified under Clause 2.0 then the English version of such standards or the relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately in additional information schedule.

**3.0 Climatic conditions :-**

The Capacitive Voltage Transformers and accessories shall be suitable for continuous satisfactory operation under the following Climatic conditions :-

| | | |
|---|---|---|
| 1. | Maximum ambient temperature, °C. | 50 |
| 2. | Minimum ambient air temperature in shade ºC. | (-) 5ºC. |
| 3. | Maximum daily average ambient temperature, °C. | 45 |
| 4. | Maximum yearly weighted ambient temperature, °C. | 35 |
| 5. | Average No. of thunder storm days per annum | 40 days. |
| 6. | Average No. of months of tropical monsoon condition per annum | 4 |
| 7. | Maximum relative humidity | 95%. |
| 8. | Minimum relative humidity | 10% |
| 9. | Height above mean sea level | Less than 1000 M |
| 10. | Dust storms are liable to occure in the period from | March to July. |
| 11. | Maximum wind load | 195 Kg./$M^2$. |
| 12. | Seismic level<br>Horizontal acceleration | 0.3 g. |
| 13. | Average annual rainfall (mm) | 10 to 100cm. |

Note :- Hot and humid tropical climate, conducive to rust and fungus growth. The climatic conditions are also prone to wide variations in ambient conditions. Smoke is also present in the atmosphere. Heavy lightning also occurs during June to October.

**3.1 AUXILIARY POWER SUPPLY :-**

3.1.1 Auxiliary electrical equipment shall be suitable for operation on the following supply system.

| | |
|---|---|
| (a) Power Devices<br>(like drive motors) | 415 Volts, 3 phase,<br>4 wire, 50 Hz, grounded A.C. Supply |
| (b) D.C.Alarm, control and protective device | 220 Volts DC, 2 wire. Sub-station-wise exact data shall be to furnished successful bidder. |

3.1.2 Each of the foregoing supplies will be made available by purchaser at one terminal point for each Capacitive Voltage Transformer for operation of its accessory and auxiliary equipment(s). Bidders scope shall include supply of interconnecting cables, terminal boxes etc. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over entire range of voltage.

3.1.3 The above power supplies are subject to the variations given below:-

| | |
|---|---|
| A.C. Supply | Voltage variation ± 10%<br>Frequency variation ± 5% |
| D.C. Supply | Voltage variation -15% to + 10% |

**4.0 PRINCIPLE PARAMETERS (CVT)**

**The capacitive Voltage Transformer shall meet the technical requirement listed below:-**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4.1 | Rated System Voltage | **420 kV (rms)** | | | **245 kV (rms)** | | |
| 4.2 | Rated frequency | 50 Hz | | | 50 Hz | | |
| 4.3 | No. of Phase | 3 | | | 3 | | |
| 4.4 | System neutral earthing | Effectively earthed. | | | Effectively earthed. | | |
| 4.5 | Installation | Outdoor | | | Outdoor | | |
| 4.6 | Service Conditions | As per clause 3.0 | | | As per clause 3.0 | | |
| | **Note :- Ambient temperature and pollution level to be specified by the user based on the local conditions.** | | | | | | |
| 4.7. | Number of secondary windings | 3 | | | 3 | | |
| 4.8 | a. Short circuit level KA (rms seconds) | 40 | | | 40 | | |
| | b. Rated duration of short circuit | 1 Sec. | | | 1 Sec. | | |
| 4.9 | Rated secondary voltage, burden, accuracy and utilisation for 420 kV & 245 Kv (rms) | | | | | | |
| | | Windings | | | Windings | | |
| | | I | II | III | I | II | III |
| | Rated Voltage (Volt) | 110 / ã3 | 110 / ã3 | 110 / ã3 | 110 / ã3 | 110 / ã3 | 110 / ã3 |
| | Rated Burden (VA) | 50 | 50 | 50 | 50 | 50 | 50 |
| | Accuracy | 3p | 3p | 0.2 | 3p | 3p | 0.2 |
| | Purpose | Main Ist protection | Main IInd protection | Metering | Main Ist protection | Main IInd protection | Metering |
| | **Note :- The accuracy of 0.2 on winding III should be maintained up to and including a total burden of 150 VA on all the three windings.** | | | | | | |

| | | | |
|---|---|---|---|
| 4.10 | Transformation ratio for all windings | 400 /0.11 | 220/0.11 |
| 4.11 | Rated total thermal burden (VA) | 300 | 300 |
| 4.12 | Temperature rise | As per Annx. III | As per Annx. III |
| 4.13 | Voltage factor | 1.5 for 30 seconds | 1.5 for 30 seconds |
| 4.14 | Rated insulation level | | |
| 4.14.1 | 1.2 / 50 microsecond impulse withstand voltage kV (Peak) | 1425 | 1050 |
| 4.14.2 | One minute dry power frequency withstand voltage kV (rms) | 630 | 460 |
| 4.14.3 | 250 / 2500 microsecond switching impulse withstand voltage kV (Peak) | 1050 | - |
| 4.15 | Standard reference range of frequency for which the accuracies are valid | 97% to 103% for protection and 99% to 101% for measurement. | 97% to 103% for protection and 99% to 101% for measurement. |
| 4.16 | Whether CVTs are suitable for carrier coupling | Yes. | Yes |
| 4.17 | Total capacitance | Pf 4400 + 10% to (-) 5% | Pf 4400 + 10% to (-) 5% |
| 4.18 | HIGH FREQUENCY CAPACITANCE | | |

| | | | |
|---|---|---|---|
| 4.18.1 | For the entire carrier frequency range | Within 80% to 150% of rated capacitance | Within 80% to 150% of rated capacitance |
| 4.18.2 | Equivalent series resistance over the entire carrier frequency range (ohms) | Less than 40. | Less than 40. |
| 4.19 | Stray capacitance and stray conductance of the low voltage terminal over entire carrier frequency range Microsiemens | Pf 300 + 0.5 Ocn (Cn is the rated capacitance).<br><br>50 | Pf 300 + 0.5 Ocn (Cn is the rated capacitance).<br><br>50 |
| 4.20 | One minute power frequency test | - | |
| 4.20.1 | Withstand voltage between low voltage terminal and earth terminal kV (rms) | 4 | 4 |
| | **Note : The test voltage shall be 10 kV (rms) if the low voltage terminal is exposed to weather.** | | |
| 4.20.2 | Withstand voltage for secondary winding kV (rms) | 3 | 3 |
| 4.21 | a. Minimum creepage distance mm | 10500 | 6125 |
| | b. Maximum protected creepage distance mm | 5250 | 3075 |
| 4.22 | Radio interference voltage at 266 kV (rms) & 155 kV (rms) for 420 kV & 245 kV CVT respectively. | Not exceeding 500 microvolts. | Not exceeding 500 microvolts. |
| 4.23 | Corona extinction voltage kV (rms) | 320 | - |
| 4.24 | Partial discharge level at rated voltage for capacitance divider | Picocoulombs less than 10 | Picocoulombs less than 10 |

## 5.0 GENERAL REQUIREMENTS :-

5.1.1 The capacitive voltage transformer shall be suitable for simultaneous use as a measuring unit as well as a coupling capacitor for the carrier transmission system for voice communication, carrier protective relaying transmission system for telemetering and telprinting service over one or more carrier channels in 40 to 500 KHz frequency range. For this purpose, the CVT shall be provided with an insulated low voltage terminal for connection to the H.F. coupling unit.

5.1.2 Each capacitive voltage transformer shall be suitable for connection directly to the Bus without the use of auxiliaries, such as isolating switches or fuses. The capacitors of the unit shall be so designed that application of lightning and switching impulse voltage of the magnitude specified in Clause 4.0 of this specification shall not damage the internal working of elements or cause a change in their electro-static capacitance.

5.1.3 An oil level indicator and a pressure relief device capable of releasing abnormal internal pressure may be provided.

5.1.4 The intermediate potential transformer shall be of the oil-immersed, self cooled design and shall be suitable for metering, relaying and synchronising services. The core of this transformer shall be made on non-ageing, cold rolled, laminated, electrical grade silicon steel having low hysteresis loss and high permeability so as to ensure high accuracy at normal as well as high over voltages. The primary winding shall be connected through reactor suitable for compensating any increase in the intermediate tapping point voltage at all loading upto the rated burden.

5.1.5 Damping device :- The capacitive voltage transformer shall be provided with a suitable device so that Ferro-resonance oscillations, due to saturation of iron core of transformer or due to any inductance connected in parallel with it and initiated by either over voltages on the network side or by opening of the short ï circuited primary or secondaries, are practically zero for no burden to rated burden. Oscillations of the secondary voltages which may rise as

a result of break down of primary voltage due to short circuits shall not effect the proper working of protective relays. The design of the compensating reactor and the intermediate potential transformer as well as of the damping device, inserted in the winding of intermediate transformer, shall be such that the phenomenon of Ferro resonance can not occur. This shall further conform to the provisions of Clause 6 of IS 3156.

5.1.6 Temperature rise :- Maximum temperature attained by any part of the equipment when in service at site under full load conditions, shall not exceed limits specified in Annexure ï III. The temperature rise at 1.2 times the rated primary voltage when applied continuously at rated frequency and rated burden shall not exceed the limit specified in Annexure ï III and the temperature rise at 1.5 times the rated primary voltage when applied for 30 seconds starting from the previous stable operating conditions at rated frequency and rated burden, shall not exceed the above temperature limit by more than 10ºC.

5.1.7 The capacitive voltage transformer shall be designed to meet the following requirements :-

i) Comparatively low specific voltage between capacitor foil.
ii) Low dielectric loss over a wide frequency band.
iii) Low variation of capacitance due to change of temperature.
iv) Very high natural frequency.
v) Corona free design to keep the noise level low.
vi) Low stray capacitance to ground to reduce the carrier frequency energy losses in the neighbourhood of carrier connection if provided at a later stage. The stray capacitance and the stray conductance of low voltage terminal in high frequency range shall not exceed 300 + 0.05 of rated capacitance picofarads and 50 micro siemens respectively.
vii) To withstand a steady high ï frequency current of at-least 1.0 amp (rms) (equivalent to a power to 4oo watts for a terminal resistance of 400 ohms) without any damages or deterioration.

5.1.8 The electromagnetic unit of the CVTs shall be designed to meet the following requirements in connection with protective relaying :-

i) These must transmit accurately sudden drops of primary voltage. The secondary output voltage following a short circuit on primary terminal shall decay within 1 cycle of rated frequency to a value less than 10% of peak value before short circuit.
ii) The measuring errors on the three phases of a set of CVTs should not differ appreciably and these should match in respect of accuracy.
iii) These must have a sufficiently low short circuit impedance as seen from secondary. The short circuit impedance as seen from secondary should not exceed 0.25 ohms.
iv) These shall be suitable for rapid reclosing service, both for single and three phase reclosing of 400 kV lines.

**5.2 ACCESSORIES :-**

The capacitive voltage transformers shall be provided with the accessories specified below. Any accessories considered necessary by the tenderer in addition to these shall also be provided and complete details thereof shall be furnished in the tender.

**5.2.1 Grading Rings :-**

Grading rings or other shielding arrangements may be provided for proper voltage distribution to ensure corona free operation of the capacitive voltage transformer for the specified corona extinction voltage.

**5.2.2 Voltage Arrestors :-**

Voltage arrestors connected across the capacitor potential device transformer unit to limit the voltage impressed on the electromagnetic transformer and the auxiliary or shunt capacitor when used, shall be provided.

**5.2.3 Terminal Connectors :-**

Capacitor Voltage Transformers shall be provided within appropriate number of solder less clamp type connector suitable to be connected to 4 ½ò IPS aluminium pipe or Twin / Quad ACSR Moose or AAC Twin Tarantulla. The connector shall conform to the provision of IS: 5561 (amended upto date).

**5.2.4 Grounding Terminal _-**

Two grounding terminals shall be provided on the tank of each capacitive voltage transformer on opposite side. The grounding conductor size shall be intimated to the successful tenderer.

**5.2.5 Secondary Terminals Box :-**

a) All secondary terminals of the CVT shall be brought out in a weather proof terminals box provided at one side of each voltage transformer for easy access.
b) The terminal box shall be hot dip galvanised.
c) The terminal box shall be provided with a removable cable gland plate at the bottom for mounting three cable glands suitable for 1100 V grade, steel wire armoured, PVC insulated, PVC sheathed 4 x 2.5 Sq.mm standard copper conductor control cables and one gland suitable for H.F. cable required for PLCC system. The cable glands shall be included within the scope of supply and shall be screw on type and made of brass.
d) The terminal box shall be provided with a door on the front so as to permit easy access to secondary terminals. The door shall be provided with locking arrangement and shall have suitable arrangement to prevent penetration of moisture and water into the terminal box.
e) The terminal box shall be provided with a terminal board. The terminal shall be so staggered that connection of external cable to any terminal block should be possible without disturbing the rest of the connections. The terminal block arrangement shall be such as to provide maximum accessibility to all conductor terminals.
f) The terminal block shall be fully enclosed with removable cover made of moulded, non-inflammable, plastic material with boxes.
g) The terminal block arrangements shall be such that it will be possible to connect or disconnect terminals on live circuits.
h) All terminals shall be clearly marked with identification number to facilitate connection to external box.

### 5.2.6 Cable Terminations :-

Conveniently located suitable glands for terminating multicore PVC control cable and cable box for H.F. cable, the necessary fasteners for installing the cable glands and cable boxes, shall be provided.

### 5.2.7 Secondary Fuses :-

Fuses of adequate capacity shall be provided in each secondary circuit in the secondary terminal box. The selection of fuses shall be done very carefully so as to protect the CVT efficiently. The rating, type and make of fuses provided shall be indicated in the tender. Each of the secondary winding shall be provided with duplicate fuses in the line (Phase) terminals. Other terminals will be provided with links.

### 5.2.8 External Insulation :-

a) The external insulation shall comprise of hollow single piece porcelain insulator which shall also serve as a housing or the main insulation and other internal parts of the CVT, Insulators shall be of high grade and homogeneous porcelain made by the wet process. The porcelain shall have glazing of uniform brown colour and shall comply with requirement of IS: 5621 ï 1970 in all respects. The skirt forms shall be carefully selected to achieve the necessary flashover distance and total / protected creep age distance as specified in Clause 4.0
b) All current carrying contact surfaces shall be tipped with silver plating and the silver plating shall not be les than one mil in thickness.
c) The porcelain housing shall have ample insulation, mechanical strength and rigidity for the condition under which they will be used at site and shall be designed to prevent accumulation of explosive gases and provide adequate oil circulation to remove internal heat.
d) There shall be no undue stressing of any part of the bushing due to temperature change and adequate means shall be provided to accommodate conductor expansion.
e) All metal parts shall be of high strength and hot dip galvanised as per IS 2633 (amended upto date). All current carrying parts shall be non-ferrous or alloys and shall be designed to eliminate sharp points, edges and sharp faces.
f) The porcelain housing shall be unaffected by atmospheric conditions e.g. weather, fumes, zone, acids, alkalis, dust and rapid change of air temperature. The stresses due to expansion and contraction in any part of the CVT shall not load to development of defects in the porcelain housing. The porcelain housing shall have high factor of safety against earthquake and other loads.
g) Fixing material / cement shall not enter into chemical action with the metal parts or cause fracture by expansion in service. Cement thickness shall be as small as possible and proper care shall be taken to centre and locate individual parts correctly during cementing.
h) Each porcelain housing shall have marked upon it the manufacturerôs name and such other marks as may be required to assist in the selection of representative batches for the purpose of sample testing.
i) Porcelain shall not engage directly with hard metal and where necessary, gasket shall be interposed between porcelain and the fittings. All porcelain clamping

surface in contact with gasket shall be accurately ground and shall be free of glaze.

j) Porcelain housing insulators shall be designed to facilitate natural cooling.

k) Each porcelain housing shall be provided with :-
   i) Oil level gauge visible from ground level and
   ii) Convenient means for sampling and drainage of oil from bottom.

l) The porcelain shall be so designed that when operating at highest system voltage specified, there will be no electric discharge between the conductors and porcelain which could cause corrosion or injury to conductors, insulators or supports by formation of sub-stances produced by chemical action.

m) The insulation of the porcelain shall be co-ordinated with that of the capacitive voltage transformers such that the flash over, if any, will occur external to the voltage transformer.

**5.3 RATING PLATE :-**

Each CVT shall be provided with a rusting and non-corroding rating plate inscribed on it, the following particulars:-

i) Manufacturerôs name and years of manufacture.
ii) Identification number.
iii) Rated capacitance.
iv) High frequency capacitance.
v) Primary capacitance.
vi) Secondary capacitance.
vii) Rated voltage in kV.
viii) Intermediate voltage in kV.
ix) Rated frequency in Hertz.
x) Temperature category.
xi) Rated insulation level.
xii) Rated output and corresponding accuracy class of secondary windings.
xiii) The use of each secondary winding and its corresponding terminals.
xiv) Rated voltage factor and corresponding rated time.
xv) Class of insulation.
xvi) Diagrams showing the terminal markings.

**5.4 INSULATING OIL :-**

The quantities of insulating oil for the first filling shall be stated in the tender. The oil shall conform to the requirement of IS 335-1993 (as amended upto date) and also with following specification of oil.

| Sl.No. | Characteristics | Requirements |
|---|---|---|
| 1. | Appearance | The oil shall be clear and transparent and free from suspended matter or sediments. |
| 2. | Density at 29.5 deg. C max. | 0.89 g / cm3. |
| 3. | Kinematic viscosity at 27 deg C. max. | 27 CST |
| 4. | Interfacial tension at 27 deg. C. | 0.04 N/m |

| | | |
|---|---|---|
| | min. | |
| 5. | Flashpoint (Min.) | 140 deg. C. |
| 6. | Pour point max. | -6 deg. C. |
| 7. | a) Neutralisation value (Total acidity) | 0.03 mg KOH/g. |
| | b) Inorganic acidity / alkalinity | NIL |
| 8. | Corrosive Sulphur (in terms of classification of copper strip) | Non ï corrosive. |
| 9. | Electric strength (break-down voltage) Min. | |
| | a) New unfiltered oil | 30 kV (rms) |
| | b) After filtration | 60 kV (rms), (if the above value is not attained, the oil shall be filtered). |
| 10. | Dielectric dissipation factor (tan delta) at 90 deg. C max. | 0.002 |
| 11. | Specific resistance (resistivity) | |
| | a) 90 deg. C. min. | 35 x $(10)^{12}$ ohm ï cm. |
| | b) at 27 deg. C. min. | 1500 x $(10)^{12}$ ohm ï cm. |
| 12. | Oxidation stability | |
| | a) Neutralisation value after oxidation, max. | 0.40 mg/KOH/g. |
| | b) Total sludge, after oxidation max. | 0.10 percent by weight. |
| 13. | Presence of oxidation inhibitors. | The oil shall not contain antioxidant inhibitors. |
| 14. | Water content, max. | i) New untreated oil ï 50 ppm.<br>ii) After treatment ï 15 ppm. |
| 15. | Aging characteristics after accelerated ageing (open beaker method with copper catalyst) | |
| | a) Resistivity | |
| | i) At 27 deg. C min. | 2.5 x $(10)^{12}$ ohm cm. |
| | ii) At 29 deg. C. Min. | 0.2 x $(10)^{12}$ ohm cm. |
| | b) Tan delta at 90 deg. C. max. | 0.2 (max.) |
| | c) Total acidity | 0.05 mg. / KOH/gm (max.). |
| | d) Sludge content percent by weight | 0.05 (max.). |

**6 TESTS :-**

a) The supplier shall carry out all type tests and routine tests on capacitive voltage transformers as per the relevant standard. Type tests shall be carried out on one capacitive voltage transformer and routine tests on all capacitive voltage transformers. If type tests are already carried out on capacitive voltage transformers of similar rating, copies of test reports shall be furnished alongwith bid. If the capacitive voltage transformer of particular rating is manufactured and supplied for the first time, all the type tests mentioned shall be carried out free of cost.

b) Special tests other than type and routine test, as agreed between purchaser and supplier shall also be carried out as per IS 3156 & 9348.

c) The charges for conducting each type test and special test shall be indicated separately in the Bid.

d) The pre-shipment checks to be carried out by the supplier are given under clause 7.0 ñInspectionò.

e) The requirements of site tests are also given in this clause.

**6.1 ROUTINE TESTS :-**

| | | |
|---|---|---|
| 6.1.1 | Verification of terminal markings of polarity | Clause No.8.2 of IS : 3156 (Part-I) ï 1992. |
| 6.1.2 | Power frequency test on primary winding | Clause 9.3 of IS: 3156 (Part-I) ï 1992. |
| 6.1.3 | Power frequency test on secondary winding | Clause 9.4 of IS: 3156 (Part-I) ï 1992. |
| 6.1.4 | Determination of error according to the requirement of the appropriate accuracy class | Clause 9.3 of IS: 3156 (Part-II) ï 1992. |
| 6.1.5 | Capacitance and loss angle measurement before and after voltage test | Clause 8.2 and 8.4 of IS: 9348 ï 1979. |
| 6.1.6 | Partial discharge test of capacitor dividers | Clause 8.11 of IS: 9348 ï 1979 |
| 6.1.7 | Oil leakage test | Clause 8.6 of IS ï 9348 ï 1979 |
| 6.1.8 | Terminal connectors shall conform to all routine and type test | As per IS : 5561 ï 1970. |

**6.2 TYPE TESTS**

| | | |
|---|---|---|
| 6.2.1 | Temperature rise test | Clause 9.2.1 of IS: 3156 (Part ï IV) ï 1978. |
| 6.2.2 | Lightning impulse withstand voltage test | Clause 9.2.2 of IS: 3156 (Part ï IV) ï 1978. |
| 6.2.3 | Switching impulse withstand voltage test | |
| | The test shall be performed in dry condition with voltage of positive polarity only and repeated in wet condition with voltage of both the positive and negative polarity using the standard 250 / 2500 microsecond switching impulse wave. The voltage applied during the test shall be 1050 kV (peak). 15 consecutive impulse shall be applied to the line terminal with the base of the CVT earthed. The CVT shall be considered to have passed the test successfully if no internal discharge occurs and if the number of discharges on external insulation to earth does not exceed two. | |
| 6.2.4 | FERRO ï resonance test | Clause 9.2.3 of IS: 3156 (Part ï IV) ï 1978. |
| 6.2.5 | Test for Accuracy | Clause 5 and 9.1 of IS: 3156 (Part ï III) ï 1978. |
| 6.2.6 | Transient response test | Clause 9.2.4 of IS: 3156 (Part ï |

| | | |
|---|---|---|
| | | IV) ï 1978. |
| 6.2.7 | Accuracy test over the standard frequency range | Clause 9.2.5 of IS: 3156 (Part ï IV) ï 1978. |
| 6.2.8 | High frequency capacitance and equivalent series resistance measurement | Clause 8.7 of IS: 9348 ï 1979. |
| 6.2.9 | Stray capacitance and stray conductance measurement of low voltage terminal | -do- |
| 6.2.10 | Determination of temperature coefficient | Clause No.8.12 of IS: 9348 ï 1979 |
| 6.2.11 | RIV and corona extinction voltage test | As per Annexure ï II. |

**6.2.12 TESTS ON ARRESTERS ON PRIMARY SIDE :-**

The protective arrester shall comply with the requirements of tests as per IS: 3070 (as amended upto-date) in case of non linear type arresters. Tests on arresters of some other type shall be carried out as per manufacturerôs standard practice. The details of tests in that case shall be given in the tender.

**6.3 TEST REPORTS**

A. Six (6) sets of certified test reports and oscillograms shall be submitted for approval prior to despatch of the equipment. The equipment shall be despatched only when all the required type and routine tests have been carried out and test reports have been approved by the purchaser.

B. Four (4) copies of the test reports for the tests carried out on the auxiliary apparatus shall be furnished to the purchaser for approval prior to despatch.

C. All auxiliary equipment shall be tested as per the relevant standard. Test certificate shall be submitted for bought out items.

**7 INSPECTION :-**

**7.1 GENERAL :-**

I) The purchaser shall have access at all times to the works and all other places of manufacture where the capacitive voltage transformers are being manufactured and the supplier shall provide all facilities for un-restricted inspection of the supplierôs works, raw materials, manufacture of all the accessories and for conducting necessary tests as detailed herein.

II) The supplier shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.

III) No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

IV) The acceptance of any quantity of equipment shall in no way relieve the supplier of its responsibility for meeting all the requirements of this specification and shall not prevent

subsequent rejection if such equipment are later found to be defective.

7.2 **INSPECTION PROGRAMME :-**

A) The supplier shall chalk out a detailed inspection testing programme for manufacturing activities for the various components. An indicative programme of inspection as envisaged by the purchaser is given below. This is not however intended to form a comprehensive programme as it is supplierôs responsibility to draw up and carry out such a programme duly approved by the purchaser.

a. Cost of inspection / tests shall be borne by the supplier.

b. Additional tests, if required, are deemed to be included in the scope of work.

c. Stages of inspection and purchaserôs participant would be defined and tied up at the time of award and of contract.

**8.0 DRAWINGS :-**

8.1 In addition to any other drawing (s) which the tenderer may like to supply, four sets of the following drawings and technical literature shall be submitted by the tenderer within thirty days of the receipt of order.

i) An outline drawing showing arrangement of the complete CVT.
ii) Drawing showing clearances from grounded objects at various heights of CVT.
iii) Details of line, intermediate, low voltage and earth terminals of CVT.
iv) Type test certificates for CVTs.
v) Descriptive literature for capacitive voltage transformers.

8.2 The tenderer shall furnish the drawings / particulars listed below for approval by the purchaser.

a) Dimensioned outline drawing showing plan, elevation, end view, shipping volume and weight of CVT.
b) Dimensioned drawing of CVT showing details of clamps and terminal connections.
c) Drawing showing details of the secondary terminals in secondary terminal box.
d) Complete foundation drawing of CVT showing spacing of holes for mounting on steel structures.
e) Drawing of name and rating plate with connection diagram.

**9.0 INSTRUCTION MANUALS :-**

At least six copies of operation, maintenance and erection manuals shall be supplied one month prior to the shipment of the equipment. The manuals shall be bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the equipment. The manuals shall include amongst other things the following particulars.

i) Marked erection prints identifying the components of the equipment, with assembly drawings.
ii) Detailed dimension, assembly and description of the auxiliaries.
iii) List of spare parts.

**10.0 GUARANTEED TECHNICAL PARTICULARS :-**

The tenderer shall furnish all the guaranteed technical particulars as called in for capacitive voltage transformer. Particulars which are subject to guarantee shall be clearly marked an asterisk (*). Any other particulars considered necessary by the tenderer may also be given in

addition to those listed in GTP. Tender, lacking supply of requisite information as called for, may be rejected as incomplete.

**11.0 TEST REPORTS :-**

i) Four copies of type test reports shall be furnished to the purchaser within one month of conducting the tests. One copy will be returned duly certified by purchaser to the supplier within three weeks thereafter and on receipt of the same supplier shall commence with the commercial production of the concerned material.

iii) Four copies of acceptance test reports shall be furnished to the purchaser. One copy will be returned duly certified by the purchaser and only thereafter the materials shall be despatched.

iv) All records of routine test reports shall be maintained by the supplier at its works for periodic inspection by the purchaser.

v) All test reports for tests conducted during manufacture shall be maintained by the suppler. These shall be produced for verification as and when requested for by the purchaser.

**12.0 PACKING AND FORWARDING :-**

12.1 The loose equipment shall be packed in the suitable crates so as to withstand handling during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing and handling. The easily damageable materials shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost.

12.2 Each consignments shall be accompanied by a detailed packing list containing the following information :-

a) Name of the consignee.
b) Details of the consignee.
c) Destination.
d) Total weight of consignment.
e) Sign showing upper / lower side of the crate.
f) Handling and unpacking instructions.
g) Bill of material indicating contents of each package and spare material.

The supplier shall ensure that the packing list and bill of material are approved by the purchaser before despatch.

**13.0 QUANTITY AND DELIVERY REQUIREMENT :-**

i) This is set out in else-where of this specification.

ii) The scope of supply shall include a supply of 2.5% extra-quantity of bolts, nuts, washers, split pins, cotter pins and such other small loose items free of cost.

**********

**ANNEXURE – I**

## (CAPACITIVE VOLTAGE TRANSFORMER)

SYSTEM PARTICULARS

ELECTRICAL SYSTEM DATA :-

| | | | |
|---|---|---|---|
| A. | System Voltage (kV rms) | 400 kV | 220 kV |
| B. | Max. voltage (kV rms) | 420 kV | 245 kV |
| C. | Normal frequency | 50 Hz ± 5%. | 50 Hz ± 5%. |
| D. | Temporary power frequency over voltage (Dynamic over voltage) | 1.9 PU decreasing to 1.5 PU phase to ground 420 / ã3 base after 1-2 cycle. | 1.9 PU decreasing to 1.5 PU phase to ground 245/ ã3 base after 1-2 cycle. |
| E. | Max. switching surge over voltage | Limited to 2.3 PU on 420 / x ã2 kV base / ã3. | Limited to 2.3 PU on 245 / x ã2 kV base / ã3. |

**ANNEXURE – II**

## CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TESTS :-

1. **General :-**

Unless otherwise stipulated, all 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 failing power frequency voltage and by measurement of radio influence voltage (RIV).

2. **Test Levels :-**

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the breaker specifications.

3. **Test methods for RIV :-**

3.1 RIV tests shall be made according to measuring circuit as per International sub-committee on Radio Interference Publication 1-1972 second edition. The measuring circuit shall preferably be tuned to frequency within 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 micro-volts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standards publication NO.107-1964 except as otherwise so 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 serves of tests to ensure that there is no variation in ambient noise level. If variation is present, the low ambient noise level will form basis for measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipments unless otherwise specified. The specified RIV test voltage for 420 kV system is listed in the detailed specification together with maximum RIV level of 500 micro volts with CB open / close position, when CBôs is phase to ground rms voltage of 266 kV.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authority.

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.
However, RIV test method may be followed as per IEC 56/4-1975.

4. **Test methods for visible corona extinction**

**Voltage Test**

The purpose of this test is to determine the corona extinction voltage of apparatus and connectors. 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 voltages, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of test voltage and maintained there for five minutes. The voltage will then be decreased slowly until all visible corona disappears. The voltage will then be raised slowly again to the same maximum voltage. This procedure shall be repeated at least 4 times with corona extinction

voltage for purposes of determining compliance with the specifications 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%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. Atleast 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 conations as determined from direct observation. Photographs shall be taken from above and below the level of connectors so as to show corona on bushing, insulators and all parts of energised connectors. The photograph shall be framed such that test object, essentially fills the frame with no cut off.

4.1 The test voltage 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 photograph of the test object atleast four photographs shall be taken of the complete test assembly showing relative position of all the test equipment and test objects. These four photographs shall be taken from their points equally spaced around the test arrangement to show its feature 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 purchaserôs 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 tests shall be carried out with the same test set up and as little time difference between tests as possible. No modifications on treatment of the sample between tests will be allowed. Simultaneously RIV and visible corona extinction voltage testing may be permitted at the complete discretion of purchasers inspector, if in his opinion, it will not be prejudice to other test.

5. **Test Records :-**

In addition to the informating previously mentioned and the requirements specified as per CIS PR or NEMA 107-1964 the following data shall be included in the test reports.

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 measure RIV passes through 100 microvolts in each direction.
f) Inception and extinction of visual corona for each of the four tests required shall be recorded.

**ANNEXURE – III**

## TEMPERATURE RISE LIMITS

| Sl.No. | Nature of the part or of the liquid | Temperature $^{o}$C | Maximum values of temperature rise at a maxm. Ambient air temp. not exceeding 50$^{o}$C |
|---|---|---|---|
| 1. | Contacts in Air | | |
| a. | Silver faced copper, copper alloy or aluminium ally (See notes I & ii) | 105 | 55 |
| b. | Bare copper or tinned aluminium alloy | 75 | 25 |
| 2. | Contacts in oil | | |
| a. | Silver faced copper, copper alloy or aluminium alloy (See notes ii) | 90 | 40 |
| b. | Bare copper or tinned aluminium alloy | 80 | 30 |
| 3. | Terminal to be connected to external conductors by screws of bolts | | |
| a. | Silver faced (See note iii) | 105` | 55 |
| b. | Bare | 90 | 40 |
| 4. | Metal parts acting as springs | (See note iv) | (See note iv) |
| 5. | Metal parts in contact with insulation of the following classes :- | | |
| | Class I (For non- impregnated materials) | 90 | 40 |
| | Class A for material immersed in oil on impregnated | 100 | 50 |
| | Class E in air<br>In oil | 120<br>100 | 70<br>50 |
| | Class B in air<br>In oil | 130<br>100 | 80<br>50 |
| | Class F in air<br>In oil | 155<br>100 | 105<br>50 |
| | Enamel :-<br>Oil base | <br>100 | <br>50 |
| | Synethetic in air | 120 | 70 |
| | Synethetic, in oil | 100 | 50 |
| 6. | Any part of metal or of insulating material in contact with oil, except contacts | 100 | 50 |
| 7. | Oil | 90 | 40 |

Notes :-

i) When applying the temperature rise of 55$^{o}$C, care should be taken to ensure that no damage is caused to the surrounding insulating materials.

ii) The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test.

iii) The values of temperature and temperature rise are valid whether or not the conductor connected to the terminals is silver faced.

iv) The temperature shall not reach a value where the elasticity of the materials is materials for pure copper, this impulses a temperature limit of 75$^{o}$C.

**ANNEXURE-IV**

## SCHDULE OF GUARANTEED TECHNICAL PARTICULARS FOR CVT

| A. | CAPACITIVE VOLTAGE TRANSFORMERS | |
|---|---|---|
| 1. | Name of manufacturer and country of origin | |
| 2. | Governing standard | |
| 3. | Service | |
| 4. | Rated voltage | KV |
| 5. | Capacitance | |
| | a. Primary Capacitance | PF |
| | b. Secondary Capacitance | PF |
| | c. Equivalent Capacitance | PF |
| 6. | a. Maximum secondary tap voltage whether CVT with max. secondary tap voltage employed in CVTs already supplied, if so, mention years of satisfactory operation. | Volts |
| 7. | a. Is CVT suitable for carrier coupling? | Yes / No. |
| | b. If, so the range of carrier frequency | KHz. |
| 8. | Natural frequency as coupling capacitor | KHz |
| 9. | Number of secondary windings | |
| 10. | Rated secondary voltage with tolerance to primary voltage of 400 / ã3 kV | |
| | a. Winding I | Volts |
| | b. Winding II | Volts |
| | c. Winding III | Volts |
| 11. | Rated secondary burden | |
| | a. Winding I | VA |
| | b. Winding II | VA |
| | c. Winding III | VA |
| 12. | Accuracy class (with ± 3% variation in system frequency of 50 Hz) | |
| | a. Winding I | |
| | b. Winding II | |
| | c. Winding III | |
| 13. | Temperature rise at 1.2 times rated voltage and rated burden after steady state conditions at normal rated voltage and burden. | $^{o}$C |
| 14. | Temperature rise at 1.5times rated voltage for 30 sec. | $^{o}$C |
| 15. | Rated total thermal burden | VA |
| 16. | a. One minute power frequency withstand dry test voltage | KV (rms) |
| | b. One minute power frequency withstand wet test voltage | KV (rms) |
| 17. | 1.2 / 50 microsecond impulse wave withstand voltage | KV (peak) |
| 18. | 250 / 2500 microsecond switching impulse withstand voltage | KV (peak) |
| 19. | One minute power frequency withstand voltage on secondaries | |
| | a. Winding I | KV (rms) |
| | b. Winding II | KV (rms) |
| | c. Winding III | KV (rms) |

| | | |
|---|---|---|
| 19. A. | One minute power frequency withstand voltage of LV terminal. | KV (rms) |
| 20. | Radio interference voltage at 266 kV. | Micro Volts. |
| 21. | Corona extinction voltage | KV |
| 22. | Partial discharge level | Pico cow lumens |
| 23. | Value of pressure for oil leakage test | KN/M2 |
| 24. | Value of stray capacitance and stray conductance in the carrier frequency range of 40 to 500 kHz. | Picofarads micro-siemens. |
| 25. | a. Total creep age distance | Mm |
| | b. Total projected creep age distance | Mm |
| 26. | Weight of oil and the standard to which it conforms | |
| | a. In capacitor unit | Kg. |
| | b. In electromagnetic unit | Kg. |
| 27. | Total weight | Kg. |
| 28. | Overall dimensions | Mm |
| 29. | Minimum centre to centre recommended spacing between CVTs | Mm |
| 30. | Clearance required from grounded equipment at various heights of CVTs | mm |
| 31. | Mounting flange dimensional details. | |
| 32. | Do the CVTs contain built in compensating reactor HF choke coil, voltage arresters and damping devices in PF portions | Yes / No. |
| 33. | Arrestors on capacitance tap. | |
| | i) Type | |
| | ii) Rated Voltage, KV | |
| | iii) Nominal discharge current, kA | |
| | iv) Power frequency spark over voltage | KV (rms) |
| | v) Power frequency reseal voltage | KV (rms) |
| | vi) Impulse spark over voltage | KVp |
| | vii) Residual voltage at nominal discharge current | KV (rms) |
| | viii) Series resistance in ohms if used | Ohms |
| | ix) Whether arrestors employed in CVT already supplied, if so year of satisfactory operation of above rating. | |
| 34. | Particulars of damping device, including its V/I characteristics and voltage rating and whether permanently connected on primary secondary side of electro-magnetic unit. | |

SIGNATURE OF TENDERER
NAME
STATUS
WHETHER AUTHORISED ATTORNEY OF
THE TENDERING COMPANY.

PLACE :
DATE :

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**CURRENT TRANSFORMER**
**Part-7**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**Part 7 (Vol. II)**

# Technical Specification for Current Transformer

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**Part 7 (Vol. II)**

# Technical Specification for Current Transformer

1.0 **SCOPE**

1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply and delivery at site, erection, testing and commissioning of 420kV & 245kV Current Transformer complete with all fittings, accessories, which are required for efficient and trouble free operation as specified hereunder.

1.2 It is not the intent to specify completely herein all the details of the design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation upto the Bidder's guarantee, in a manner acceptable to the Purchaser, who will interpret the meanings of drawings and specifications and shall have the power to reject any work or material which, in his judgment, is not in accordance therewith. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply irrespective of whether those are specifically brought out in this specification and/or the commercial order or not.

2.0 **STANDARDS:**

The current transformers and associated accessories shall conform to the latest issues of standards as given below, except to the extent explicitly modified in the specification.

| S.No. | Indian Standard No. | Title | International & Internationally recognised Standard |
|---|---|---|---|
| 1. | IS-2705 Part I to IV | Current Transformers | - |
| 2. | IS-5561 | Electric Power Connectors | - |
| 3. | IS-5621 | Hollow Insulators | - |
| 4. | IS-2633 | Testing of uniformity of Zinc coating | - |
| 5. | IS-8263 | Method for radio inter ference test | - |
| 6. | | High Voltage Techniques | IEC:60.973 |

| | | |
|---|---|---|
| 7. | Partial discharge measurements | IEC:270-1968 |
| 8. | Instrument transformers | IEC:44(4)-1980 |
| 9. | Recommendation contained in the report of committee for standardisation of parameter and specification of Major item of 400 kV sub-station equipments and Transmission line materials | June 1984 with latest amendments, if any. |

2.1 In case equipment conforms to other International standards which ensure equivalent or better performance than that specified under clause 2.0 then the English version of such standards or the relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately in additional information schedule.

## 3.0 SERVICE CONDITIONS:

### 3.1 Climatic Conditions

The Current transformers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions:

| | |
|---|---|
| i) Location | In state of Rajasthan |
| ii) Maximum ambient air temperature (deg C) | 50 deg C |
| iii) Minimum ambient air temperature (deg C) | -5 deg C |
| iv) Average daily ambient air temperature (deg C) | 45 deg C |
| v) Max. yearly weighted ambient temperature. | 35 deg C |
| v) Maximum Relative Humidity (%) | 100% |
| vi) Max. altitude above mean sea level (Meters) | Varies from 61 Mts. to 815 Mts. |
| vii) Average annual rainfall(cm) | 15 mm to 100 cm |
| viii)Max. wind pressure (kg/Sq.mt) | 195 |
| ix) Isoceraunic level (days/year) | 4 Months (June to Sept.) |

x) Seismic level (Horizontal Acceleration) 0.3 g

NOTE: Hot and humid tropical climate, conducive to rust and fungus growth. The climatic conditions are also prone to wide variations in ambient conditions. Smoke is also present in the atmosphere. Heavy Lightning also occurs during June to October.

3.2 **AUXILIARY POWER SUPPLY**

Auxiliary electrical equipment shall be suitable for operation on the following supply system:

| | |
|---|---|
| a) Power Devices (Like drive motors) | 415 V, 3 Phase 4 wire 50 Hz, neutral grounded AC Supply. |
| b) D.C. Alarm, Control and protective device | 220 V DC, 2 Wire. Sub Stationwise exact details shall be furnished to successful Bidder. |

Each of the foregoing supplies shall be made available by the Purchaser at the terminal point for each current transformer for operation of accessories and auxiliary equipment. Bidders scope include supply of interconnecting cables, terminal boxes etc. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over entire range of voltages.

i) AC Supply : Voltage ± 10% frequency ± 5%
ii) DC Supply : -15% to + 10%

4.0 **PRINCIPAL PARAMETERS (Current Transformer)**

**The Current transformers shall conform to the following specific parameters:**

| | | 420 kV | 245 kV |
|---|---|---|---|
| 4.1 | Rated System Voltage (Kv rms) | 420 | 245 |
| 4.2 | Rated frequency Hz | ------ 50 ------ | |
| 4.3 | System neutral earthing | --Effectively earthed-- | |
| 4.4 | Installation | ---------Outdoor---- | |
| 4.5 | Service conditions | --As per clause 3.0--- | |
| 4.6 | Number of cores | -------- 5-------- | |
| 4.7 | Rated Primary current A | -----2000-1000-500----- | |
| 4.8 | Rated secondary current A | -------- 1.0-------- | |
| 4.9 | Rated continuous thermal A | 120% of rated current for 2000/1A tap and 200% of rated current for lower ratio taps. | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 4.10 | Core Utilisation | Core I Main I Protec-tion | Core II Main II Protec-tion | Core III Metering Protec-tion | Core IV Busbar Protec-tion | Core V Busbar Protec-tion |
| 4.11 | Rated burden(VA) | - | - | 20 | - | - |
| 4.12 | Accuracy Class | PS | PS | 0.2s | PS | PS |
| 4.13 | Instrument secur-ity factors(ISF) | - | - | ‹5 | - | - |
| 4.14 | Minimum knee-point voltage (Volts) | | | | | |
| | 2000/1 tap | 4000 | 4000 | - | 2000 | 2000 |
| | 1000/1 tap | 2000 | 2000 | - | 1000 | 1000 |
| | 500/1 tap | 1000 | 1000 | - | 500 | 500 |
| 4.15 | Maximum Magnetisation current at guaranteed knee-point voltage (mA) | | | | | |
| | 2000/1 tap | 30 | 30 | - | 30 | 30 |
| | 1000/1 tap | 60 | 60 | - | 60 | 60 |
| | 500/1 tap | 120 | 120 | - | 120 | 120 |
| 4.16 | Maximum secondary winding resistance at 75 ₀ C (ohms) | | | | | |
| | 2000/1 tap | 10 | 10 | - | 10 | 10 |
| | 1000/1 tap | 5 | 5 | - | 5 | 5 |
| | 500/1 tap | 2.5 | 2.5 | - | 2.5 | 2.5 |
| 4.17 | Rated short time thermal current for 1 second kA (rms) | | | | 40 | 40 |
| 4.18 | Rated dynamic current kA (peak) | | | | 100 | 100 |
| 4.19 | Rated insulation level | | | | | |
| 4.19.1 | 12/50 microsecond ligh- tunning impulse withstand voltage | | | | kV (peak) 1425 | 1050 |
| 4.19.2 | 250/2500 microsecond switching impulse with stand voltage | | | | kV (peak) 1050 | - |
| 4.19.3 | One minute dry power frequency with stand voltage | | | | kV (rms) 630 | 460 |
| 4.20. | Power frequency over voltage withstand requ-irements for secondary windings | | | | As per Clause 7.4 & 7.5 of IS:2705(PartI) 1981. But for core I and II test voltage will be 10 kV (peak) for 1. Sec. | |
| 4.21. | Limits of temperature rise | | | | As per Clause 5.6.3 of IS: 2705 (Part I) -1981. | |

| | | | |
|---|---|---|---|
| 4.22 | Creepage distance mm | 10,500 | 6125 |
| 4.23 | Max. radio interference voltage at 266 kV (rms) | <500 microvolt | <500 microvolt |
| 4.24. | Visual Corona extinction Voltage KV (rms) | 320 | - |
| 4.25. | Partial discharge level | 10 picocoulombs | 10 picoco-ulombs |

5.0 **GENERAL TECHNICAL REQUIREMENTS:**

5.1.1 The CTs shall be of robust design tested quality and reliable in operation. Only pure high grade paper wound evenly under controlled conditions and impregnated with mineral oil under vacuum shall be used for the main insulation. The assembly of each CT shall be dried and filled with insulating oil of appropriate quality under high vacuum and hermetically sealed with or without inert gas to eliminate un desirable effect of moisture and oxygen on the internal insulation. No breather and/or drying chemicals shall be used in the design and construction of CTs.

5.1.2 The shape of external metal parts shall ensure that rain water runs off and there is no stagnation. All external surfaces shall be resistant to atmospheric corrosion either by the selection of suitable materials or by proper treatment such as hot dip galavanisation, zinc plating and passivation, enamel painted ever rust inhibitive coat of zinc chrome primer etc. Likewise the internal metal surfaces coming in contact with oil shall be given proper treatment unless the material used itself is oil resistant. Nuts, Bolt and washers to be used as fasteners shall be galvanised through out. No arcing horns are required with current transformers.

5.1.3 For current transformers open circuiting of secondary on load causes very high peak voltage which may exceed the insulation level of secondary circuit and can damage insulation. It is, therefore, suggested that some form of C.T. secondary circuit protection be provided for various cores of the C.T.s . Such protection should be able to detect open circuit and act in the following manner.

i) Short circuit the terminals of secondary windings in question or limit the voltage to a safe level.

ii) Provide a contact for annunciating this condition. This device shall not, however, maloperate during actual fault conditions and should therefore be capable of being set accordingly. Also this device shall be located as close to the C.T. terminals as physically possible.

5.2 **PRIMARY WINDINGS**

5.2.1 A Common/single primary associated with the several cores as specified at clause 4.0 shall be provided. The ends of the primary winding shall be taken out and connected to the main terminals at the top. The conductor material for the primary winding may be of electrolytic high conductivity copper strips or aluminium tube having area of cross section sufficient for the guaranteed short time as well as continuous thermal current ratings under site conditions. The winding may be wound type or hairpin type.

5.2.2 The tenderer may offer CTs having bar type primary with inverted arrangement of construction, if considered more appropriate.

5.2.3 The main insulation shall consist of paper and oil system and posses high mechanical strength, superior electrical withstand properties and good ageing qualities to ensure long trouble free life for the CTs. Winding shall have high mechanical strength for safety against short circuit stresses.

## 5.3 CORE AND SECONDARY WINDINGS

5.3.1 All the cores may be continuous without any air gap. All the protection cores shall be formed out of laminations of high grade, cold rolled, grain oriented silicon steel, whereas the Metering cores in which high accuracy at low ampere turns and low ISF are required, may be of Mu metal, or such other ferro magnetic material. The core material shall have low hysteresis loss and high permeability. The area of cross section of core and the flux densities at rated primary current and rated burden shall be consistent with the required characteristics of the CTs. The cores shall be carefully annealed and banded after they are wound to relieve the stress during winding.

5.3.2 The secondary winding shall be made of high conductivity electrolytic copper wire of suitable cross section. The copper wires shall have heavy enamel insulation which shall be immune to the effect of insulating oil. The winding shall be provided with paper insulation to enhance the reliability. The secondary winding shall be uniformly distributed on the total circumference of the core.

The different ratios specified at clause 4.0 shall be achieved by secondary taps.

## 5.4 EXTERNAL INSULATION:

5.4.1 The external insulation shall comprise of a hollow single piece prcelain insulator which shall also serve as a housing for the main insulation or other internal parts of the current transformers. Insulators shall be of high grade and homogeneous porcelain made by the wet process. The porcelain shall have hard glazing of uniform brown colour and shall comply with the requirements of IS:5621-1970 (amended upto date) in all respects. The skirt forms shall be carefully selected to achieve the necessary flashover distance and total/protected creepage distances as specified at clause 4.0.

5.4.2 The porcelain housing shall be unaffected by atmospheric conditions e.g. weather, fumes, ozone, acids, alkalies, dust and rapid change of air temperature, stresses due to expansion and contraction in any part of the current transformer shall not lead to development of defects in the procelain housing. The porcelain housing shall have high factor of safety against earthquake and other loads.

5.4.3 Fixing material/cement shall not enter into chemical action with the metal parts or cause fractures by expansion in service. Cement thickness shall be as small as posible and proper care shall be taken to locate individual parts correctly during cementing.

5.4.4 Each porcelain housing shall have mark upon of the manufacturer's name and such other marks as may be required to assist in the selection of representative batches for the purpose of sample testing.

5.4.5 Porcelain shall not engage directly with hard metal and where necessary gasket shall be interposed between porcelain and the fittings. All porcelain clamping surface in contact with gasket shall be accurately grounded and shall be free of glaze.

5.4.6 All porcelain housing shall be designed to facilitate adequate oil circulation to remove internal heat and to prevent accumulation of gases.

5.4.7 The Bushings shall be provided with:-

i) Oil level gauge visible from ground level and
ii) Convenient means for sampling and drainage of oil from bottom.

5.4.8 The insulation of porcelain housing shall be coordinated with that of the winding such that flashover, if any, shall occur external to the current transformer.

## 5.5 UPPER TANK

5.5.1 The upper tank shall be made of either light alloy having high strength or high quality steel which will serve as upper terminations and carry primary terminals and shall be fixed on the top of insulator shell. In case of inverted type arrangement, this tank shall also house the secondary windings. The primary terminals shall also house the secondary parts. The primary terminals shall be of substantial cross section, sturdy and suitable for mounting line terminal connectors as referred to in Clause No. 5.9 of this specification. One of the primary terminals shall be insulated from the tank and fitted with a bypass surge divertor to protect the internal insulation from unusual surge voltages.

5.5.2 This tank shall also serve as an expansion chamber or contain other suitable devices for absorbing the effects of temperature variations on oil. Likewise a pressure relief vent or other suitably built in features may be provide in the upper tank if considered necessary by the manufacturer for safety against abnormal pressure rise inside the CT.

## 5.6 LOWER TANK/BASE PLATE

5.6.1 The material used for the fabrication of the lower tank shall be mild steel of suitable thickness. The outer surface of the tank shall be given suitable treatment to make it resistant against atmospheric exposure. For this the tank should be preferably hot dip galvanised. It should be suitable for housing secondary unless the inverted type or insulator type of arrangement for the CTs is proposed by the tenderer. In the case of later type CT, the lower part shall be in the form of a base plate only.The base construction shall be suitable for upright mounting on raised steel structures and shall have fixed legs and lifting holes/lugs of adequate strength. Necessary provisions shall also be made on the lower tank/base plate for two independent earthing connections to the substation grounding system.

5.7 **TERMINAL BOX**

5.7.1 All the leads from the secondary windings shall be brought out near the bottom of CT and connected to heavy and dependable terminals in a lower voltage terminal box, which shall be fixed to the outer surface of the lower tank/base plate. The terminal box shall be made from the same material, as used for the lower tank and also treated similarly. It shall be of weather proof construction having a hinged door fitted with a locking arrangement. A diagram of terminal connections with various taps shall be mounted permanently on the inside of this door. A proper seal shall be provided all round the door to check the ingress of moisture in to the terminal box. The internal arrangement of the terminal box shall permit convenient handling of connections to the outgoing PVC insulated, steel wire or non-magnetic material armoured copper cables(s) entering from below. Inlet arrangement for the cable(s) to be provided shall be subject to approval by the purchaser. The secondaries of all CTs shall be fitted with shorting links in the terminal box before despatch from the factory.

5.8 **RATING PLATE**

5.8.1 Each Current Transformer shall be provided with a non rusting and non-corroding rating plate with all particulars marked indelibly in accordance with Clause 5.1 of IS: 2705 (Part-I)-1981 together with the following particulars. The rating plate shall be provided outside the terminal box.

i) The use of each winding and its terminal details.
ii) Class of insulation.
iii) Switching impulse withstand voltage.
iv) Diagram of connections.
v) Purpose (Measurement or protection), rated output at 0.95 p.f. lagging and rated class of accuracy of each secondary winding.
vi) Terminal numbering of each secondary winding.
vii) Rated instrument security factor in respect of winding meant for measurement and metering.
viii) Secondary winding resistance at 75 $^{o}$C
ix) Minimum knee point voltage.
x) Maximum exciting current at 50% of knee point voltage.
xi) Rated thermal current.

5.9 **TERMINAL CONNECTORS**

5.9.1 Each CT shall be provided with appropriate solder less, clamp type connectors suitable for 114.2 mm outer dia aluminium tubes with a spacing of 450 mm with/without expansion joints.

5.9.2 All castings for manufaturing terminal connectors shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

5.9.3 No part of the primary terminal shall be less that 10 mm thick.

5.9.4. All ferrous part shall be hot dip galvanised conforming to IS:2633 (amended upto date).

5.9.5 Bimetalic strips or sleeves of about 2 mm thickness shall be provided loose as part of the connectors.

5.9.6 Size of the primary terminals for which the connectors are suitable and rated current under site conditions shall be embossed/punched on each component of connector except hardware.

5.9.7 All current carrying parts of the connectors shall be designed and manufactured to have minimum contact resistance.

5.9.8 Connectors shall be designed to have corona Extinction Voltage and RIV level as specified at Clause 4.0 and shall conform to IS:5561 (amended upto date) in all respect.

5.9.9 Terminal connectors shall conform to type tests as per IS:5561 and shall be subject to routine tests in accordance with IS: 5561 (amended upto date).

5.9.10 Exact quantity and type of terminal connectors shall be intimated to successful bidder.

## 5.10 FITTINGS AND ACCESSORIES

5.10.1 A list of fittings and accessories whether specifically referred to in the text of the specification or not but required to be incorporated/supplied with the CTs is given below for ready reference.

i) Primary terminals.
ii) Terminal connectors for connections from line to the CT Primary.
iii) Oil level gauge.
iv) Pressure relief device.
v) Expansion chamber or other suitable type of device for absorbing variation in the volume of oil due to change of temperature of oil.
vi) Weather proof secondary terminal box fitted with hinged door and complete with terminal shorting links.
vii) Lifting lugs/holes.
viii) Fixing legs with bolts, nuts and washers for holding down the CTs on the supporting steel structures.
ix) Rating and coneection diagram plates.
x) Two earthing terminals in opposite directon on the lower tank. Grounding conductor shall be M.S. Flat of 75x8mm size.
xi) Oil filling plug and drain valve.

## 5.11 INSULATING OIL

5.11.1 The insulating oil to be used for the impregnation and for the first filling of current transformer shall generally conform to IS:335-1983 ( as amended upto dates ) and also with following specification of oil and there shall be practically no deterioration during service.

| S.No. | Characteristics | Requirement |
|---|---|---|
| 1. | Appearance | The oil shall be clear and transparent and free from suspended matter or sediments |
| 2. | Density at 29.5 deg C max. | 0.89 g/$cm_3$ |
| 3. | Kinematic viscosity at 27 deg C Max. | 27 CST |
| 4. | Interfacial tension at 27 deg C Min. | 0.04 N/m |
| 5. | Flashpoint (min.) | 140 deg C |
| 6. | Pour point, Max. | -6 deg C |
| 7. | a) Neutralization value(Total acidity) max. | 0.03 mg KOH/g |
| | b) Inorganic acidity/ alkalinity | NIL |
| 8. | Corrosive Sulphur (in terms of classification of copper strip) | Non-corrosive |
| 9. | Electric strength (breakdown voltage) Min | |
| | a) New unfiltered oil | 340 kV (rms) (if the above value is not attained, the oil shall be filtered) |
| | b) After filtration | 60 kV (rms) |
| 10. | Dielectric dissipation factor (tan delta) at 90 deg C Max. | 0.002 |
| 11. | Specific resistance (resistivity) | |
| | a) at 90 deg C Min | $35x(10)^{12}$ ohm-cm / |
| | b) at 27 deg C Min | $1500x(10)^{12}$ ohm -cm |
| 12. | Oxidation stability | |
| | a) Neutralisation value after oxidation, Max. | 0.40 mg/KOH/g |
| | b) Total sludge, after oxidation Max. | 0.10 per cent by weight . |
| 13. | Presence of oxidation inhibitors | The oil shall not contain antioxidant inhibitors |
| 14. | Water content, Max. | i) New untreated oil 50ppm<br>ii) After treatment 15ppm |
| 15. | Ageing characteristics after accelerated ageing | |

(open breaker method with copper catalyst)
a) Resistivity

| | |
|---|---|
| i) AT 27 deg C Min. | $2.5x(10)^{12}$ ohm cm |
| ii) AT 29 deg C Min. | $0.2x(10)^{12}$ ohm cm |
| b) Tan delta at 90 deg C. | 0.2 (Max.) |
| c) Total acidity | 0.05 mg/KOH/gm(Max.) |
| d) Sludge contain percent by weight | 0.05 (Max.) |

6.0 **TESTS:**

a. The supplier shall carry out all type tests and routine tests on current transformers as per the relevant standard. Type tests shall be carried out on one current transformer and routine tests on all current transformers. If type tests are already carried out on current transformers of similar rating, copies of test reports shall be furnished alongwith Bid. If the current transformer of a particular rating is manufactured and supplied for the first time, all the type tests mentioned shall be carried out free of cost.

b. Special tests other than type and routine test, as agreed between Purchaser and Supplier shall also be carried out as per IS: 2705 Part-I-1981.

c. The charges for conducting each type test and special test shall be indicated separately in the Bid.

d. The preshipment checks to be carried out by the Supplier are given under clause 7.0, "Inspection".

e. The requirements of site tests are also given in this clause.

6.1 **ROUTINE TESTS:**

6.1.1 245kV Current transformers shall comply with the requirement of routine test as per IS : 2705 and the following routine tests shall be carried out on 420 Kv Current Transformers:-

| | |
|---|---|
| i)Verification of terminal markings and polarity | IS:2705 (Part I)-1981 |
| ii)High voltage power frequency tests on primary winding. | IS:2705 (PartI)-1981 |

| | |
|---|---|
| iii)High voltage power freqncncy tests on secondary winding. | IS:2705 (PartII)-1981 (But for core I&II the power frequency test voltage will be 10 KV peak for 1 second) |
| (iv) Over Voltage interturn test | IS:2705 (PartI)-1981 (But for core I and II the over voltage will be 10 kv peak for 1 second. |
| v) Determination of errors accessories to the req-uirements of the appro-priate accuracy class | IS:2705 (PartIto IV) 1981 |
| vi) Partial discharge Test | As described hereunder |

**Partial Discharge Test**

The test circuit for the measurement of partial discharge shall be in accordance with sub-clause 4.2 of IEC:270-1968. The partial discharge test shall be carried out after all tests are completed. The applied voltage shall be raised to 437 kv (rms) and maintained for period greater than or equal to 10 seconds. The voltage shall then be reduced to measuring voltage of 266 kV (rms) phase to ground and maintained for a period greater than or equal to one minute. The
partial discharge level shall not exceed 10 picocoulombs.

6.2 **TYPE TEST**

6.2.1 245kV Current transformer shall comply with the requirement of type test as per IS-2705 and the 420 kV Current Transformers shall comply with the requirements of following type tests:-

| | | |
|---|---|---|
| i) | Short time current tests | As per IS:2705(Pt.I)-1981 |
| ii) | Temperature rise test | --------do---------- |
| iii) | Impulse Voltage withstand test | -do- |
| iv) | Radio Interference Voltage test | As per Annx. II |
| v) | Switching Impulse withstnad test | As discussed hereunder |
| vi) | Transient Response test | -do-- |
| vii) | Ageing test | -do-- |
| viii) | Corona Extinction Voltage test | As per Annex.II |

6.2.2 Switching Impulse Withstand Test

This test shall be carried out in accordance with IEC Publication-60(21)-1973. The test shall be performed in wet conditions with voltage of both positive and negative polarity using the standard switching impulse of 250/2500 micro second. Switching impulse voltage shall be applied on line terminal of complete CT with base of the CT earthed. The voltage applied during the test shall be 1050 kv (Peak) for 420 kV and fifteen prospective impulses of each polarity shall be applied. The CT shall be

considered to have passed the test successfully if no internal disruptive discharge occurs and if the number of disruptive discharge on the external insulation does not exceed two. If a disruptive discharge on external insulation accured during the last impulse applied, the CT under test shall be inspected in order to be sure that no permanent damage occurred. In case of doubt, additional impulse of the same polarity as that of the last impulse shall be applied and must be withstood.

6.2.3 Transient Response Test and Ageing Test

Procedure for the above tests shall be mutually agreed between the purchaser and tenderer.

6.3 **TEST REPORTS**

a. Six(6) sets of certified test reports and oscilograms shall be submitted for approval prior to despatch of the equipment. The equipment shall be despatched only when all the required type and routine tests have been carried out and test reports have been approved by the Purchaser.

b. Four(4) copies of the test reports for the tests carried out on the ancillary apparatus shall be furnished to the Purchaser for approval prior to despatch.

c. All auxiliary equipment shall be tested as per the relevant standard. Test certificate shall be submitted for bought out items.

7.0 **INSPECTION**

7.1 General

i) The purchaser shall have access at all times to the works and all other places of manufacture where the current transformers are being manufactured and the supplier shall provide all facilities for un restricted inspection of the Supplier's works, raw materials, manufacture of all the accessories and for conducting necessary tests as detailed herein.

ii) The supplier shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.

iii) No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iv) The acceptance of any quantity of equipment shall in no way relieve the Supplier of its responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection if such equipment are later found to be defective.

7.2 **INSPECTION PROGRAMME**

a. The supplier shall chalk out a detailed inspection testing programme for manufacturing activities for the various components. An indicative programme of inspection as envisaged by the Purchaser is given below. This is not however

intended to form a comprehensive programme as it is Supplier's responsibility to draw up and carry out such a programme duly approved by the Purchaser.
b. Cost of inspection/tests shall be borne by the Supplier.
c. Additional tests, if required, are deemed to be included in the scope of work.
d. Stages of inspection and Purchaser's participant would be defined and tied up at the time of award and of contract.

8.0 **DOCUMENTATION**

8.1 The following dimensional drawings/manuals, in addition to the other special characteristic drawing/literature shall be submitted, alongwith tenders in quardruplicate by the tenderers. In absence of these drawings tender shall be treated incomplete.

i) Out line dimensions drawing showing general arrangement and loading data of the CT.
ii) Drawing showing inside details of (vertical sectional view of CT)
iii) Drawing showing details of terminal connectors.
iv) Drawing showing details of mounting arrangement.
v) Drawing of connection diagrams showing the details of secondary terminals.
vi) Complete foundation drawing of the current transformer showing spacing of bolts for mounting steel structures.
vii) Test report of all type tests carried out on similar type of CT.
viii) Technical and descriptive literature explaining the details of the equpment
ix) Magnetisation curves for each of the secondaries of current transformers.

8.2 Within 30 days of the receipt of the order the contractor shall furnish drawings listed at clause 9.1.1 with all pertinent details for the approval by the purchaser. All drawings and literature shall be in English language and dimensions in Metric System.

8.3 **INSTRUCTION MANUALS**

At least six copies of operation, maintenance and erection manuals shall be supplied one month prior to the shipment of the equipment. The manuals shall be bound volumes and shall contain all the drawings and information required for erection, operation and maintenance of the equipment. The manual shall include amongst other things the following particulars:

i) Marked erection prints identifying the components of the equipment, with assembly drawings.
ii) Detailed dimension, assembly and description of the auxiliaries.
iii) List of spare parts.

8.4 **GUARANTEED TECHNICAL PARTICULARS**

That tenderer shall furnish all the guaranteed technical particulars as called for in Volume-2B. Particulars which are subject to guarantee shall be clearly marked an asterisk(*). Any other particulars considered necessary by the tenderer may also be given in addition to those listed Volume-2B. Tender lacking supply of requisite information as called for, may be rejected as incomplete.

9.0 **PACKING AND FORWARDING**:

9.1 The loose equipment shall be packed in crates suitable for vertical/horizontal transport as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The Supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbol. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied by Supplier without any extra cost.

9.2 Each consignment shall be accompanied by a detailed packing list containing the following information:

a) Name of the consignee
b) Details of consignment
c) Destination
d) Total weight of consignment
e) Sign showing upper/lower side of the crate.
f) Handling and unpacking instructions.
g) Bill of material indicating contents of each package

The Supplier shall ensure that the packing and bill of material are approved by the Purchaser before despatch.

**ANNEXURE-I**

**(Current Transformer)**

**SYSTEM PARTICULARS**

ELECTRICAL SYSTEM DATA:

| | | |
|---|---|---|
| A) System Voltage (kV rms) | 400 kV | 220kV |
| b) Max. Voltage (kV rms) | 420 kV | 245kV |
| c) Normal frequency | 50 Hz±5% | |
| d) Temporary Power Frequency over Voltage (Dynamic over voltage) | 1.9 PU decreasing to 1.5 PU phase to ground on 420/ _/3 base after 1-2 cycles | |
| e) Max. switching surge over Voltage - | limited to 2.3 PU on 420/ X _/2 KV base _____ _/3 | |

**ANNEXURE-II**

## CORONA AND RADIO INFLUENCE VOLTAGE (RIV) TEST

1. **General**

Unless otherwise stipulated, the 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 Influence Voltage (RIV).

2. **Test Levels**

The test voltage levels for measurement of external RIV and for Corona Extinction Voltage are listed respectively at item 4.23 and 4.24 of clause 4.0 of this specification.

3. **Test Method for RIV**

3.1 RIV test shall be made according to measuring circuit as per International sub-committee on Radio Interference Publication-1-1972 Second Edition. The measuring circuit shall preferably be tuned to frequency within 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 Micro Voltes.

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

3.3 In measurement of RIV, temporary additional external Corona shielding may be provided. In measurement 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 measurements. RIV levels shall be measured at increasing and decreasing voltages of 85% , 100%, 115% and 130% of the specified RIV test voltage for all equipments unless otherwise specified. The specified RIV test voltage for 420 KV system is listed in the detailed specification together with maximum RIV level of 500 microvolts with CB open/close position when CB is at phase to ground rms voltage of 266 KV.

3.5 The meeting instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authority.

3.6 The RIV measurement shall be made with a noise meter.

3.7 A calibration procedure of the frequency to which noise meter shall be tuned shall established the ratio of voltage at the high voltage terminal to voltage read by noise meter. However, RIV test method may be followed as per IEC: 56/4-1975.

4. **Test Methods for Visible Corona**

The purpose of this test is to determine the Corona extinction voltage of apparatus and connectors. 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 voltages, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. The voltage will then be decreased slowly until all visible corona disapperars. The voltage will then be raised slowly again to the same maximum voltage. This procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded at each time. The corona extinction voltage for purposes of determining compliance with the specifications 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%,115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. Atleast two views shall be photographed in each case using Panchromatic film with an ASA day light rating of 400 with an exposure of two minutes at 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 connectors so as to show corona on bushings, insulators and all parts of energised connectors. The photograph shall be framed such that test object, essentially, fills the frame with no cut off.

4.1 The test voltage 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. The photographs taken to corona sources in darkness shall be in exact register with reference
photographs with lights on. This exact register is to allow precise corona location from the photographic evidence.

4.2 In addition to photographs of the test object at least four photographs shall be taken of the complete test assembly showing relative position of all the test equipment and test objects. These four photographs shall be from 4 points equally spaced around the test arrangement to show its features from all sides. Drawings shall be provided of the laboratory and test set up locations which shall indicate camera positions and angles. The precise location of camera shall be approved by purchaser's Inspector, it being noted that trial energisation of test object at a voltage which results in corona may be necessary to determine the best camera locations before actual test is made.

4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV level.

4.4 However, both tests shall be carried out with the same test set up and as little time difference between tests as possible. No modifications on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the complete discretion of purchaser's Inspector if, in his opinion, it will not prejudice other test.

5.0 **TEST RECORDS**

In addition to information previously mentioned and the requirement specified as per CISPR or NEMA 107-1964 the following data shall be included in tests reports:-

a) Background noise before and after test.
b) Detailed procedure of application of test voltage.
c) Measurements of RIV levels expressed in microvolts at each levels.
d) Results and observations with regard to location and type of interference sources detected attach steps.
e) Test voltage shall be recorded when measure RIV passes through 100 microvolts in each direction.
f) On-set and extinction of visual corona for each of four tests required shall be recorded.

**ANNEXURE-III**

## TEMPERATURE RISE LIMITS

| S.No. | Nature of the part or of the liquid | Temperature deg. C | Maximum Values of Temperature rise at a max. ambient air temp. not exceeding $50_oC$ |
|---|---|---|---|
| 1. | Contacts in Air | | |
| a. | Silver faced copper, Copper alloy or aluminum alloy (See notes i & ii) | 105 | 55 |
| b. | Bare copper or tinned aluminium alloy. | 75 | 25 |
| 2. | Contacts in oil. | | |
| a. | Silver faced copper, Copper alloy or aluminium alloy (See notes ii) | 90 | 40 |
| b. | Bare copper or tinned aluminium alloy. | 80 | 30 |
| 3. | Terminal to be connected to external conductors by screws of bolts. | | |
| a. | Silver faced (see note iii) | 105 | 55 |
| b. | Bare | 90 | 40 |
| 4. | Metal parts acting as springs | (See note iv) | (See note iv) |
| 5. | Metal parts in contact with insulation of the following: classes: | | |
| | Class I (For non-impregnated Materials) | 90 | 40 |
| | Class A (For material immersed in oil or impregnated | 100 | 50 |
| | Class E in air | 120 | 70 |
| | in oil | 100 | 50 |
| | Class B in air | 130 | 80 |
| | in oil | 100 | 50 |
| | Class F in air | 155 | 105 |
| | in oil | 100 | 50 |
| | Enamel: Oil base | 100 | 50 |
| | Synethetic in air | 120 | 70 |
| | Synthetic, in oil | 100 | 50 |

| | | |
|---|---|---|
| 6. Any part of metal or of insulating material in contact with oil, except contacts. | 100 | 50 |
| 7. Oil | 90 | 40 |

NOTES:

i) When applying the temperature rise of 55 $_{o}$ C, care should be taken to ensure that no damage is caused to the surrounding insulating materials.

ii) The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test.

iii) The values of temperature and temperature rise are valid whether or not the conductor connected to the terminals is silver faced.

iv) The temperature shall not reach a value where the elasticity of the materials is materials for pure copper, this impulses a temperature limit of 75 $_{o}$ C.

**ANNEXURE-IV**

## SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR CTS (INFORMATION TO BE FURNISHED BY THE TENDERER WITH HIS OFFER)

| | | | | | | |
|---|---|---|---|---|---|---|
| 1. | Type | | | | | |
| 2. | Manufacturer's designation | | | | | |
| 3. | Rated Voltage | | | | | |
| 4. * | CT Characteristics | Secondary No. 1 | Secondary No. 2 | Secondary No. 3 | Secondary No. 4 | Secondary No. 5 |
| a) | Rated Primary Current | | | | | |
| b)* | Rated Secondary current | | | | | |
| c)* | Rated burden, VA | | | | | |
| d)* | Class of accuracy | | | | | |
| e)* | Minimum knee point voltage, volts | | | | | |
| f)* | Max. magnetising current, mA at knee point voltage. | | | | | |
| g)* | Max. resistance of secondary winding, ohms. | | | | | |
| 5.* | Short time thermal rating of primary for: a) One second, kA(rms) | | | | | |
| 6.* | Rated dynamic current of primary, kA | | | | | |
| | Flux density at knee point, (knee point) defined as the point at which a 10% increase in voltage produces a 50% increase in magnetisation current). $wb/cm_2$ | | | | | |
| 8. | Number of primary turns. | | | | | |
| 9. | Number of secondary turns. | | | | | |
| 10. | Core area cm Sq. | | | | | |
| 11. | Core length, (Average magnetic path), cms | | | | | |
| 12.* | Instrument security factor for the winding meant for measurement and metering. | | | | | |
| 13. | Type of primary winding. | | | | | |
| 14. | Rated continuous thermal current. | | | | | |
| 15.* | a) Temperature rise at rated wdg $_o$ Oil Explored continous thermal current over at top current max. ambient temperature at site oC carrying for parts ($_oC$). | | | | | |
| | b) Temperature rise at normal rating over max. ambient temperature at site for: | | | | | |
| 16*. | Total creepage distance,mm | | | | | |
| 17*. | Protected Creepage distance,mm | | | | | |
| 18*. | One minute power frequency withstnad test voltage, (kv (rms) | | | | | |
| 19* | 250/2500 microsecond impulse withstand test voltage, kV (peak) | | | | | |
| 20.* | 1.2/50 micro second impulse with stand test voltage KV (peak) | | | | | |
| 21* | One minute power frequency withstand | | | | | |

| | |
|---|---|
| | test voltage on secondaries, kV (rms) |
| 22. | Weight of oil per CT, Kgs. |
| 23. | Governing Standard for oil |
| 24. | Whether pressure relief device provided. |
| 25. | Total weight per Ct Kgs. |
| 26. | Drawing Nos. for magnetisation curves of CT cores supplied with tender. |
| 27. | Overall dimensions, mm |
| 28. | Other characteristics:<br>a) Ratio and phase angle curves:<br>b) Ratio correction factor curves |
| 29. | Temperature rise after passing short time thermal current for one second, |
| 30. | Current density in primary winding at:-<br>a) Normal rating Amps/Sq. cm.<br>b) Thermal rating of 1 second, Amps/Sq cm.<br>c) Dynamic rating amps/sqcm |
| 31* | Guaranteed partial discharge level at 266 kV(rms) / 156kV(rms) (Phase to ground) applied for not less than 1 minute. Picocoulomb. |
| 32. | a) Guaranteed Radio Interference level at 266 kV(rms) / 156kV(rms) Phase to Ground with terminal connector mounted, Microvolts.<br>b) Ditto, under test conditions. |
| 33.* | Visual corona extinction voltage kV (rms) |
| Note: | Technical Particulars Marked with (*)mark shall be subjected to guarantee. |

Signature
Name:
Status:
Whether authorised attorney
of tendering company.
Date:Name of the tendering
Place:company.

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

# SURGE ARRESTERS
**Part-8**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

## PART-8 (Vol. II)

## Technical Specification for Surge Arrestors

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# PART-8 (Vol. II)

## TECHNICAL SPECIFICATION FOR SURGE ARRESTORS

1.0 **SCOPE**

1.1 This specification provides for the design, engineering, manufacture, assembly, stage testing, inspection and testing before despatch, packing, forwarding and delivery, erection & commissioning at site of Metal Oxide (gapless) surge arrestors complete with discharge counter, insulating base and other accessories for 400kV and , 220 kV system as specified hereunder.

1.2 It is not the intent to specify completely herein all the details of design and construction of Surge Arrestors. However, Surge Arrestors shall conform in all respects to the high standard of design and workmanship and be capable of performing in continuous commercial operation upto Bidder's guarantee in a manner acceptable to Purchaser, who will interpret the meanings of drawings and specifications and shall have the power to reject any work or material which in his judgments are not in accordance therewith. The Arrestors offered shall be complete with all parts, necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of supply, irrespective of whether they are specifically brought out in the commercial order or not.

2.0 **STANDARDS**

2.1 The Surge Arrestors shall conform to the latest editions and amendments available at the time of supply, of the standards listed hereunder and in accordance with requirement specified in the specification.

| S. No. | Standard Ref. No. | Title |
|---|---|---|
| 1. | IEC 99-4 | Specification Part-4 for Surge arrestors without gap for AC system. |
| 2. | IS:3070 Part-I. | Specification for Lightning Arrestors for alternating current system (Part-I) |
| 3. | IS: 2629 | Recommended practice for hot dip galvanising of iron and steel. |
| 4. | IS: 2633 | Method for testing uniformity of coating on zinc coated articles. |
| 5. | IS:5621 | Specification for large hollow porcelain for use in electrical installation. |
| 6. | IS:2147 | Degree of protection provided by enclosures for low voltage switchgear and control. |
| 7. | | Indian Electricity Rules, 1956. |

**Note:**

i) For the purpose of this specification all technical terms used hereinafter shall have the meaning as per IEC specification.

ii) For the parameters of the Arrestor which are not specified in IEC specification for Surge Arrestors, the provisions of IS 3070 (Part-I) shall be applicable.

2.2 Surge Arrestors meeting with the requirements of other authoritative standards, which ensure equal or better quality than the standards mentioned above shall also be acceptable. Where the equipment offered by the Bidder conforms to other standards, salient points of difference between the standards adopted and the specified standards shall be clearly brought out in the offer. Four (4) copies of the reference standards in English language shall be furnished alongwith the offer.

## 3.0 CLIMATIC CONDITIONS

3.1 The Surge Arrestors and accessories shall be suitable for continuous satisfactory operation under climatic conditions listed below.

| | | |
|---|---|---|
| 1) | Maximum ambient Air Temperature in shade (deg.C) | 50 DEG.C |
| 2) | Minimum Ambient Air Temperature in shade (deg.C) | (-) 5 DEG.C |
| 3) | Maximum relative humidity (%) | 95 % |
| 4) | Min. relative humidity | 10% |
| 5) | Height above main sea level | less than 1000M |
| 6) | Dust storms are liable to occur during the period from | March to July |
| 7) | Average No. of thunder storm days/annum | 40 days |
| 8) | Average annual rainfall(mm) (Depending on area) | 10 TO 100cms |
| 9) | Average No. of months of tropical monsoon condition p.a. | 4 |

All the electrical devices shall be given tropical and fungicidal treatment to enable their satisfactory operation in the above climatic conditions.

4.0 **PRINCIPAL PARAMETERS**

The Surge Arrestors offered under this specification shall conform to the parameters given below:

| Sl. No. | Particulars | System Parameters | | |
|---|---|---|---|---|
| 1. | Nominal system voltage (kv rms) | 400 | 220 | 132 |
| 2. | Highest system voltage (kV rms) | 420 | 245 | 145 |
| 3. | 1.2/50 microsecond impulse voltage withstand level (kVp) | ±1425 | ±1050 | ±650 |
| 4. | Minimum prospective symmetrical fault current for 1 second at Arrestor location (kA rms) | 40 | 40 | |
| 5. | Anticipated levels of temporary overvoltage and its duration | | | |
| a) | Voltage (p.u.) | 1.5 | 1.5 | |
| b) | Duration (Seconds) | 1/10 | 1/10 | |
| 6. | System frequency(Hz) | 50 | 50 | 50 |
| 7. | Neutral Grounding | ----------Effectively earthed---------- | | |
| 8. | Number of Phases | ----------Three ---------- | | |

**Note: i. 1 p.u. = $\frac{420 \times \sqrt{2}\ kvp}{\sqrt{3}}$ $\frac{245 \times \sqrt{2}\ kvp}{\sqrt{3}}$**

ii. E.E. = Effectively earthed

5.0 **GENERAL TECHNICAL REQUIREMENTS**

5.1 The Surge Arrestors shall conform to the technical requirements as per Annexure-I and II.

5.2 Duty Requirement

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-voltage occurring during switching of unloaded transformers, reactors and long lines.
c) 420 kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for a 420 kV system on two successive operation followed immediately by 50 Hz energisation with a sequential voltage profile as specified below:

750 kVP for 3 peaks
580 kVP for 0.1 sec.
565 kVP for 1 sec.
550 kVP for 10 sec.

d) 245 kV class arrester shall be capable of discharging energy equivalent to class 3 of IEC for 245 kV system on two successive operations.
e) The reference current of arrester shall be high enough to eliminate the influence of grading and stray capacitance on measured reference voltages.
f) The duty cycle of CB installed in 420 / 245 kV system shall be 0-0.3 sec-CO-3-min. Co. The surge arrester shall be suitable for such circuit breaker duties in the system.
g) The energy handling capability of each rating of Arrester offered, supported by calculations, shall be furnished in the offer.

5.3 The Surge Arrestors shall be fitted with pressure relief devices and arc diverting ports and shall be tested as per the requirements of IEC specification for minimum prospective symmetrical fault current as specified in Clause 4.0 (4).

5.4 The grading ring on each complete Arrestor for proper stress distribution corona ring shall be provided if required for attaining all the relevant technical parameters.

5.5 Protective Levels:

The basic insulation levels and switching impulse withstand levels of the lines and equipment to be protected, have been specified in clause 4.0, "Principal Parameters" . The protective characteristics of the Arrestors offered shall be clearly specified in the schedule of guaranteed technical particulars.

5.6 General Requirements:

5.6.1 The materials and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment are deemed to be included in the scope of supply unless specifically excluded.

5.6.2 Unless otherwise brought out separately by the Bidder in the schedule of deviations the Surge Arrestors offered shall conform to the specification scrupulously. All deviations from the specification shall be brought out in the schedule of deviations. The discrepancies between the specification and the catalogues or literature submitted as part of the offer shall not be considered as valid deviations unless specifically brought out in the schedule of deviations.

5.63 Each individual unit of Surge Arrestor shall be hermetically sealed and fully protected against ingress of moisture. The hermetic seal shall be effective for the entire life time of the Arrestor and under the service conditions as specified. The Bidder shall furnish sectional view of the Arrestor, showing details of sealing employed.

5.6.4 The Bidder shall furnish in the offer, a sectional view of pressure relief device employed in the Surge Arrestors offered.

5.6.5 The Surge Arrestors shall be suitable for hot line washing.

5.7 CONSTRUCTION::

5.7.1 All the units of Arrestors of same rating shall be interchangeable without adversely affecting the performance.

5.7.2 The Surge Arrestors shall be suitable for pedestal type mounting.

5.7.3 All the necessary flanges, bolts, nuts, clamps etc., required for assembly of complete Arrestor with accessories and mounting on support structure to be supplied by the Purchaser, shall be included in Bidder's scope of supply.

5.7.4 The drilling details for mounting the Arrestor on Purchaser's support shall be supplied by the Supplier.

5.7.5 The minimum permissible separation between the Surge Arrestor and any earthed object shall be indicated by the Bidder in his offer.

5.7.6 The arrester shall not fail due to arrester porcelain contamination. Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lighting current.

5.7.7 The heat treatment cycle details alongwith necessary quality checks used for individual blocks alongwith insulation layer formed across each block are to be furnished. Metalissing 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.

5.7.8 The manufacturer will submit data for rejection rate of ZnO blocks during manufacturing / operation.

5.8 PORCELAIN HOUSING:

5.8.1 All porcelain housings shall be free from lamination cavities or other flaws affecting the maximum level of mechanical and electrical strengths.

5.8.2 The porcelain shall be well vitrified and nonporous.

5.8.3 The creepage distance of the Arrestor housing shall be as per *Annexure-I.*

5.8.4 The porcelain petticoat shall be preferably of self-cleaning type (Aerofoil design). The details of the porcelain housing such as height, angle of inclination, shape of petticoats, gap between the petticoats, diameter (ID and OD) etc., shall be indicated by the Bidder in his offer in the form of a detailed drawing.

5.8.5 The Arrestor housing shall conform to the requirements of IEC specification.

5.9 GALVANISATION, NICKEL PLATING ETC:

5.9.1 All ferrous parts exposed to atmosphere shall be hot dip galvanised as per

IS:2629 as amended from time to time., Tinned copper/brass lugs shall be used for internal wiring of discharge counter. Screws used for electrical connections shall be either made of brass or nickel plated.

5.9.2 Ground terminal pads and name plate brackets shall be hot dip galvanised.

5.9.3 The material shall be galvanised only after completing all shop operations.

5.10 ACCESSORIES AND FITTINGS:

5.10.1 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 alongwith necessary connection. Suitable leakage current meters should also be supplied within the same enclosure. The reading of milli ammeter and counters shall be visible through the 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 bands. The design of the surge monitor shall be such that it is possible to tilt the surge monitor downwards by an angle of upto 45 degrees from horizontal plane.

5.10.2 The discharge counter shall register operation whenever lightning or any other type of surge strikes the Surge Arrestor.

5.10.3 All necessary accessories and earthing connection leads between the bottom of the Arrestor and the discharge counter shall be in the Bidder's scope of supply. The connecting lead between discharge counter and Surge Arrestor shall be of copper flexible tape of size 25x4 mm and minimum of 1.5 metre length. The discharge counter shall be so designed that the readings of discharges recorded by the counter and the readings of milli-ammeter shall be clearly visible through an inspection window to a person standing on ground. The minimum height of Purchaser's support shall be 2.5 M.

5.10.4 Terminal connector conforming to IS:5561 shall be supplied alongwith the arrester.

5.10.5 Micro-processor based instruments for monitoring resistive current or wattless current of the arrester shall have to be supplied, if required.

5.10.6 Surge monitor consisting of discharge counters and mili ammeters should be suitable to be mounted on support structure of the arrester and should be tested for IP 55 degree of protection. The standard supporting structure for surge arrester should be provided with a mounting pad. Also all nuts, bolts, washers etc. required for fixing the surge monitor shall have to be supplied by the contractor.

5.10.7 Each Surge Counter shall have terminals of robust construction for connection to earthing lead and these shall be suitably arranged so as to enable the incoming and outgoing connections to be made with minimum bends.

5.10.8 The grounding terminals shall be suitable for accommodating Purchaser's grounding connection to steel earth mat. Proper functioning of the Surge counter with Surge Arrestor shall be ensured by the Supplier.

5.11 NAME PLATE:

The arrestor shall be provided with non-corrosive legible name plate indelibly marked with the following information:

1. Rajasthan Rajya Vidyut Prasaran Nigam Ltd.

2. Order No.

3. Manufacturer's name or trade mark and identification no. of the Arrestor being supplied.

4. Rated voltage.

5. Maximum continuous operating voltage.

6. Type.

7. Rated Frequency.

8. Nominal discharge current.

9. Long duration discharge class.

10. Pressure relief current in kA rms.

11. B.I.L. of the equipment to be protected.

12. Year of manufacture.

6.0 **TESTS**

6.1 In accordance with the requirements stipulated in Volume 1, "General Conditions of Contract", Surge Arrestors shall conform to the type tests and shall be subject to routine tests in accordance with IEC-99.

6.2 Test Charges and Test Schedule:

6.2.1 Type Tests:

The Surge Arrestors offered, shall be fully type tested as per the relevant standards. In case the equipment of the type and design offered, has already been type tested in an independent test laboratory, the Bidder shall furnish four sets of type test reports alongwith the offer. These tests must not have been conducted earlier than Seven years. The Purchaser reserves the right to demand repetition of some or all the type tests in the presence of Purchaser's representative. For this purpose the Bidder may quote unit rates for carrying out each type test. These prices shall be taken into consideration for bid evaluation. For any change in the design/type already type tested and the design/type offered against this specification the Purchaser reserves the right to demand repetition of tests without any extra cost.

6.2.2 ACCEPTANCE AND ROUTINE TESTS:

All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the Supplier in the presence of the Purchaser's representative.

6.3 Acceptance tests, whenever possible shall be conducted on the complete arrestor

unit. The number of samples to be subjected to acceptance tests shall be decided by the Purchaser at the time of actual testing.

6.4 The artificial pollution test shall be carried out as per applicable standards. This test shall be considered as a type test.

6.5 The special thermal stability test shall be carried out as acceptance test.

6.6 The acceptance tests shall include the galvanisation test on metal parts.

6.7 The functional (operational) acceptance tests shall be carried out on the Surge counter by way of checking its operation at the following nominal discharge currents:

a) 100 Amps with 8/20 microsecond wave shape.

b) 10 kA with 8/20 microsecond wave shape.

## 7.0 INSPECTION

i) The Purchaser shall have access at all times to the works and all other places of manufacture, where the Surge Arrestors are being manufactured and the Supplier shall provide all facilities for unrestricted inspection of the Supplier's works, raw materials, manufacture of the equipment, all the accessories and for conducting necessary tests as detailed herein.

ii) The Supplier shall keep the Purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.

iii) No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iv) The acceptance of any quantity of equipment shall in no way relieve the Supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection if such equipment are later found to be defective.

## 8.0 DOCUMENTATION

8.1 All drawings shall conform to International Standards Organization (ISO) "A" series of drawing sheets/Indian Standards specifications. All drawings shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. Units.

8.2 The Bidder shall furnish four sets of following drawings alongwith his offer:

i) General outline drawings of the complete Arrestors with technical parameters.
ii) Drawing showing clearance from ground and other live objects and between adjacent poles of Surge Arrestors, required at various heights of Surge Arrestors.
iii) Drawings showing details of pressure relief devices.

iv) Detailed drawing of discharge counters alongwith the wiring and schematic drawing of discharge counter and meter.
v) Outline drawing of insulating base.
vi) Details of grading rings, if used.
vii) Mounting details of Surge Arrestors.
viii) Details of line terminal and ground terminals.
ix) Volt-time characteristics of Surge Arrestors.
x) Details of galvanising being provided on different ferrous parts.
xi) Drawing of sectional view of hermatic seals.
xii) The detailed dimensional drawing of porcelain housing such as ID, OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.,

8.3. TEST REPORTS

i) Four copies of type test reports shall be furnished to the Purchaser within one month of conducting the tests. One copy will be returned duly certified by the Purchaser to the Supplier within three thereafter and on receipt of the same Supplier shall commence with the commercial production of the concerned material.

ii) Four copies of acceptance test reports shall be furnished to the Purchaser. One copy will be returned, duly certified by the Purchaser and only thereafter shall the materials be despatched.

iii) All records of routine test reports shall be maintained by the Supplier at his works for periodic inspection by the Purchaser.

iv) All test reports of tests conducted during manufacture shall be maintained by the Supplier. These shall be produced for verification as and when requested for by the Purchaser.

9.0 **PACKING & FORWARDING**

9.1 The equipment shall be packed in suitable crates so as to withstand handling during transport and outdoor storage during transit. The Supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied by the Supplier without any extra cost.

9.2 Each consignment shall be accompanied by a detailed packing list containing the following information:

a) Name of the consignee.

b) Details of consignment.

c) Destination.

d) Total weight of consignment.

e) Sign showing upper/lower side of the crate.

f) Handling and unpacking instructions.

g) Bill of materials indicating contents of each package.

9.3 The Supplier shall ensure that the packing list and bill of materials are approved by the Purchaser before despatch.

9.4 The material shall be transported within India to the respective destination by Road Transport/Rail Transport as the case may be at the option of the Purchaser.

## 10.0 QUANTITY AND DELIVERY REQUIREMENT

i) The scope of supply shall include a supply of 2.5% extra quantity of bolts, nuts, washers, split pins cotter pins and such other small loose items free of cost.

## 11.0 TESTING & 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 QP / Instructions of the equipment supplier or owner without any extra cost to the owner. The contractor shall arrange all instruments require for conducting these tests alongwith calibration certificates and shall furnish the list of instruments of the owner for approval.

a) Leakage current measurement.
b) Resistance of ground connection.

ANNEXURE - I

**TECHNICAL REQUIREMENTS FOR METAL OXIDE (GAPLESS) SURGE ARRESTORS**

| S. No. | Particulars | Requirement | |
|---|---|---|---|
| | | 400 kV | 220 kV |
| 1. | Rated Arrestor Voltage | 390 | 198 |
| 2. | M.C.O.V. (kV rms) | 303 | 168 |
| 3. | Installation | Outdoor | ---- Outdoor------ |
| 4. | Class | Station Class | ------ Station Class---- |
| 5. | Type of construction. Arrestor | Single Column, Single Phase | Single Column, Single Phase |
| 6. | i)Nominal discharge current corresponding to 8/20 microsec. wave shape . | 10 KA | 10KA |
| | ii) Discharge current for insulation co-ordination. corresponding to 8/20 microsecond wave. | 20 KA | 20 KA |
| 7. | Type of mounting | Pedestal | Pedestal |
| 8. | Connection (Between phase to earth P/E) (Between phase to phase P/P) | P/E | P/E |
| 9. | Long duration discharge class | 3 | 3 |
| 10. | i) Minimum switching surge residual voltage | 730 kvp | -- |
| | ii) Max. switching surge residual voltage. | 780 kvp | 580 kvp |
| 11. | Minimum discharge capability | 8 KJ/kV or corresponding to | 8 KJ/kV or corresponding to |

| | | |
|---|---|---|
| | clause 5.2 (c)which ever is higher. | clause 5.2 (c)which ever is higher. |
| 12. Max. residual voltage | | |
| i) Nominal discharge current kvp | 900 (10 KA) | 560 (5 kA) |
| ii) Nominal discharge current kvp | 975 (20 kvp) | 600 (10 kA) |
| iii) Steep fronted wave residual voltage at 10 KA (kvp) | 1050 | 650 |
| 13. Long duration discharge class | As per 5.2 (c) | 3 |
| 14. Min. prospective symmetrical fault current for pressure relief test (kA rms) | 40 | 40 |
| 15. High current short duration test value (4/10 micro second wave) kAP | 100 kAp | 100 kA p |
| 16. Low current long duration test value 2000 (micro sec). | As per IEC | As per IEC |
| 17. Prospective symmetrical fault current. | 40 kA rms For 0.2 sec. | 40 kA rms For 0.2 sec. |
| 18. Pressure relief class | A | A |
| 19. a) Terminal Connector | Twin / Quad Moose ACSR conductor at 450mm spacing. | Twin Tarantulla ACSR conductor at 300mm spacing. |
| b) Take off | Vertical / Horizontal | Vertical / Horizontal |
| 20. Voltage (corona extinction) (kv rms) | Rated voltage of the arrestor. | Rated voltage of the arrestor. |
| 21. Max. radio interference voltage at 1 MHz | Less than 500 micro volt at 266 kV rms | Less than 500 micro volt at 156 kV rms |
| 22. Whether insulating base an discharge counter with mili-ammeter are required. | Yes | Yes |
| 23. Min. creepage distance of arrester housing (mm) | 10500 | 6125 |

ANNEXURE - II

**TECHNICAL REQUIREMENTS FOR METAL OXIDE (GAPLESS) SURGE ARRESTORS**

**Gapless Surge Arrester (120 kV)**

| | | |
|---|---|---|
| 1. | Rated arrester voltage | 120 kV |
| 2. | Rated system voltage | 145 kV |
| 3. | Rated system frequency | 50Hz |
| 4. | System neutral earthing | Effectively earthed |
| 5. | Installation | Outdoor |
| 6. | Nominal discharge current | 10kA of 8/20 microsec wave. |
| 7. | Class of arrester | 10kA heavy duty type |
| 8. | Minimum discharge capacity | 3.5 kJ/kV (referred to rated voltage) |
| 9. | Continuous operating voltage at 50$^{ø}$C | 102kV |
| 10. | Maximum switching surge residual voltage (1kA) | 280kV |
| 11. | Maximum residual voltage at | |
| | (i) 5kA | 320kVp |
| | (ii) 10kA nominal discharge | 340kVp |
| 12. | Long duration discharge Class | 2 |
| 13. | High current short duration test value (4/10microsec. wave) | 100kAp |
| 14. | Current for pressure relief Test | 40kArms |
| 15. | Low current long duration test value (2000microsec.) | As per ISS/IEC |
| 16. | Min. total creepage distanc. | 3625 mm. |
| 17. | One minute dry power frequency withstand voltage of arrester housing. | 275kVrms |
| 18. | Impulse withstand voltage of arrester housing with 1.2/50 microsec. wave | ±650KVp |
| 19. | Pressure relief class | A |
| 20. | RIV at 92 kVrms. | Less than 500 microvolts at 92 kVrms |
| 21. | Partial discharge at 1.05 continuous over voltage | Not more than 50pC |

**ANNEXURE-III**

## GUARANTEED TECHNICAL PARTICULARS (SURGE ARRESTORS)

1. Name of Manufacturer

2. Arrestor Class & Type

3. Applicable Standard

4. Rated Arrestor Voltage (kV)

5. Maximum continuous operating voltage (MCOV) - (kV)

6. Nominal Discharge Current (kA) with 8/20 Micro-second wave

7. Long Duration Discharge Class

8. Minimum Energy Discharge Capability (KJ/KV)

9. Maximum switching current impulse residual voltage at

   i) 1000 Amps

   ii) 250 Amps

10. Maximum residual voltage with 1 micro-second current Wave at 10 kA (kVp)

11. Maximum residual voltage with 8/20 Micro-second wave:(kvp)

    i) 5 kA

    ii) 10 kA

    iii) 20 kA

12. Safe Fault Current (kA)

13. Lightning impulse withstand voltage of Arrestor housing with 1.2/50 micro-second wave (kVp)

14. One minute power frequency withstand voltage of housing (dry/wet) - kV (rms)

15. High Current short duration impulse withstand level with 4/10 micro-second wave (kA) Peak

16. Pressure Relief Class

17. Over-voltage withstand capability - kV

    a) 10 seconds

    b) 1 second

    c) 0.1 second

18. a) Reference Voltage (kV)

    b) Reference Current (kA)

19. a) Number of Units per phase and rating of each unit
    b) Unit rating of non linear resistors (KV rms)
    c) No.of non linear resistors per unit
    d) Demension of non linear resistor disk (height and diameter)

20. Minimum total creepage distance (mm)

21. Leakage current (mA)

22. Total weight of Arrestor (kg.)

23. Maximum cantilever strength

of SA (Including Wind Load)

24. Overall Height of SA (mm)

25. Maximum distance recommended from equipment to be protected by SA (mm)

26. Minimum distance between grounded object (mm)

27. Minimum distance between Arrestor phase legs (mm)

28. Any other particulars

Name of firm.....
Signature of Bidder.....
Designation & Seal.....
Date.....

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

# WAVE TRAP
**Part-9**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART- 9 (Vol. II)**

**TECHNICAL SPECIFICATION FOR WAVE TRAPS**


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**PART-9 (Vol.II)**

**TECHNICAL SPECIFICATION FOR 420 kV WAVE TRAPS (LINE TRAPS)**

## 1.0 SCOPE :-

1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply, packing, forwarding and delivery erection, testing and commissioning at site of wave traps and other accessories for 400 kV & 220 kV system as specified hereunder.

1.2 It is not the intent to specify completely here all the details of design and construction of the wave trap. However, the same shall conform in all respects to the high standard of engineering design and workmanship and shall be capable of performing in continuous commercial operation upto the Bidderôs guarantee in a manner acceptable to the Purchaser who will interpret the meanings of drawings and specifications and shall have power to reject any material which in his judgement is not in accordance therewith. The Wave Trap offered shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of the Bidder irrespective of whether they are superficially brought out in this specification and / or in the commercial order or not.

## 2.0 STANDARDS :-

2.1 The wave traps shall conform to the latest editions and amendments available at the time of supply of the standards listed hereunder :-

| Sl.No. | Standard Ref. No. | Title |
|---|---|---|
| i. | IS : 8792 ï 1978 | Line Traps. |
| ii. | IS: 9793 ï 1978 | Methods of tests for line traps. |
| iii. | IEC : 353 ï 1971 | Line traps. |
| iv. | IS : 3070 (Part ï I) 1974 | Specification for lightning arrestors for alternating current system. |

Note :-

I) For the purpose for this specification all technical terms used hereinafter shall have the meaning as per IEC specification.

II) For the parameters of the wave traps which are not specified in IEC specification for wave traps the provisions of IS : 8792 (1978) shall be applicable.

2.2 Wave traps meeting with the requirements of other authoritative standards, which ensure equal or better quality than the standards mentioned above shall also be acceptable. Where the equipment offered by the Bidder conforms to other standards, salient points of difference between the standards adopted and the specified standards shall be clearly brought out in the offer. Four (4) copies of the reference standards in English language shall be furnished alongwith the offer.

**3.0 Climatic conditions :-**

The wave traps and accessories shall be suitable for continuous satisfactory operation under the following Climatic conditions :-

| | | |
|---|---|---|
| i. | Maximum ambient temperature, °C. | 50 |
| ii. | Minimum ambient air temperature in shade ºC. | (-) 5ºC. |
| iii. | Maximum daily average ambient temperature, °C. | 45 |
| iv. | Maximum yearly weighted ambient temperature, °C. | 35 |
| v. | Average No. of thunder storm days per annum | 40 days. |
| vi. | Average No. of months of tropical monsoon condition per annum | 4 |
| vii. | Maximum relative humidity | 100%. |
| viii. | Minimum relative humidity | 10% |
| ix. | Height above mean sea level | Less than 1000 M |
| x. | Dust storms are liable to occur in the period from | March to July. |
| xi. | Maximum wind load | 195 Kg./$M^2$. |
| xii. | Seismic level<br>Horizontal acceleration | 0.3 g. |
| xiii. | Average annual rainfall (mm) | 10 to 100cm. |

All the electrical devices shall be given tropical and fungicidal treatment to enable their satisfactory operation in the above climatic conditions.

**4.0 PRINCIPLE PARAMETERS :-**The wave traps offered under this specification shall conform to the parameters given below :-

| Sl.No. | Particulars | System Voltage (kV rms) | |
|---|---|---|---|
| | | 400 | 220 |
| 1. | Nominal system voltage (kV rms) | 400 | 220 |
| 2. | Highest system voltage (kV rms) | 420 | 245 |

| | | | |
|---|---|---|---|
| 3. | Rated inductance at power frequency (mH) | 1.0 | 0.5 |
| 4. | Rated continuous current (Amps) | 2000 | 2000 |
| 5. | Rated short time current, duration 1 sec. (kA) | 40 kA | 40kV |
| 6. | System frequency (Hz) | 50 Hz. | 50 Hz |
| 7. | Neutral Grounding | -----Effectively earthed---- | |
| 8. | Number of phase | Three | Three |
| Note : I | 1 p.u. = $\frac{420 \times \sqrt{2}\ \text{kvp}}{\sqrt{3}}$ | $\frac{245 \times \sqrt{2}\ \text{kvp}}{\sqrt{3}}$ | |

**5.0 GENERAL TECHNICAL REQUIREMENTS :-**

5.1 The Wave Traps shall conform to the technical requirements as per Annexure ï I.

5.2 Wave Traps shall be inserted in series with the high voltage transmission lines to prevent undue loss of high frequency carrier signal for all power system conditions. Its impedance shall be negligible at power frequency (50 C/s) so as to not disturb the power transmission, but must be relatively high over any frequency band appropriate to carrier transmission i.e. 50 Kc/s to 500 Kc/s.

5.3 Line trap shall consist of a single phase, aircored inductor of dry type with natural air cooled main coil designed to carry continuously the rated current at the max. ambient temperature. It shall be supplemented with a protective device and tuning device. It should meet the requirements of IS ï 8792-1978 with latest amendments. Line trap shall be equipped with the bird carrier.

5.4 Line traps are to be tuned for a carrier frequency band which will depend upon the operational carrier frequency pair chosen for transmission line section in question. The relative component to impedance of the line trap within its band width shall not be less than 450 ohms for 400 kV system. The tuning device for 400kV system shall be arranged to permit inter change without removing the line trap.

5.5 The bidder shall offer 1.0 mH line traps for 400 kV system and 0.5 mH for 220 kV system shall specify various band width for which minimum resistive components of impedance will not be less than 450 Ohms. The tenderers shall be at liberty to quote the traps having higher inductance so that a larger band width is covered by the line traps.

Bidders shall also furnish the curve showing the blocking capability of the wave traps offered.

5.6 The bidder shall also specify the band width of the untuned line trap with which the tapping loss shall not exceed, 2.6 dB. For this tapping loss, the characteristic impedance of the H.T. line (the phase to earth impedance of a single conductor line) may be assumed to be.

**5.7 PROTECTION LEVELS ;**

5.7.1 Line trap shall be provided with protective device which shall be designed and arranged such that neither significant alternation in its protective function nor physical damage shall result from either the temperature rise or from the magnetic field of the main coil at continuous rated current or rated short time current. The protective device shall neither enter into operation nor remain in operation following transient actuation, at the power frequency voltage developed, across the line trap by the rated short time current.

5.7.2 The protective device shall be a non linear resistor type arrestor complying with the requirements of latest issue of IS:3070 (Part-I) - 1974 and shall be shunt connected to the main coil and the tuning device fro proper co-ordination with lightning arrestors installed in the sub-stations, the line traps shall be provided with protective device with nominal discharge current of 10 K.A.

5.7.3 In order not to exceed the maximum radio interference voltage it shall be necessary to provide corona rings on the line traps.

**5.8 GENERAL REQUIREMENTS :**

5.8.1 The materials and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment are deemed to be included in the scope of supply unless specifically excluded.

5.8.2 Unless otherwise brought out separately by the Bidder in the Schedule of Deviations the wave traps offered shall conform to the specification scrupulously. The deviations from the specification shall be brought out in the Schedule of Deviations. The discrepancies between the specification and the catalogues or literature submitted as part of the offer shall not be considered as valid deviations unless specifically brought out in the schedule of deviations.

5.8.3 Any deviations which has not been specifically brought out in the schedule of deviations of the Bid proposal sheets, shall not be given effect to. The deviations brought out in the schedule shall be supported by authentic documents, standards and other references.

5.9 The line traps should be suitable for outdoor structure mounted type and mechanically strong to withstand the stresses due to max. wind pressure of 260 Kg. / m2. Any suspension system of a line tap shall be designed for a tensile strength alteast twice the weight of the line trap plus 200 Kg.

5.10 I. The line trap shall be suitable for connecting to 4ò IPS Aluminium tube or 3ò IPS Al. tube or ACSR Moose / AAC Tarantulla Twin /Quad bundle conductor as the case may be. Necessary connectors shall be supplied by contractor.

II. Bidder should offer set of alteast 6 bolt type terminal clamps suitable for Twin /Quad ôMooseô ACSR conductor / AAC Tarantulla as the case may be, for connecting terminals of line traps to high tension line or station equipment.

III. Terminal connector shall conform to IS: 5561.

IV. No part of clamp or connector shall be of magnetic material.

**5.11 GALVANISATION, NICKEL PLATING ETC.**

5.11.1 All ferrous parts exposed to atmosphere shall be hot dip galvanised as per IS: 2629 as amended from time to time.

5.11.2 Ground terminal pads and name plate brackets shall be hot dip galvanised.

**5.12 NAME PLATE :**

The Wave Traps shall be provided with non-corrosive legible name plate indelibly marked with the following information :-

i. Rajasthan Rajya Vidyut Prasaran Nigam Ltd.,
ii. Order No.
iii. Manufacturerôs name or trade mark and identification No. of the Wave Trap being supplied.
iv. Rated voltage.
v. Rated continuous current.
vi. Type.
vii. Rated Power Frequency.
viii. Rated inductance at power frequency.
ix. Year of manufacture.

**6.0 TESTS :-**

6.1 In accordance with the requirements stipulated in volume 1, ñGeneral Conditions of Contractò, wave traps shall conform to the type tests and shall be subject to routine tests in accordance with IS: 8793 (1978) and IEC : 353 (1971).

**6.2 TEST CHARGES AND TEST SCHEDULE :**

**6.2.1 Type Tests :-**

The Wave Traps offered, shall be fully type tested as per the relevant standards. In case the equipment of the type and design offered, has already been type tested in an independent test laboratory, the Bidder shall furnish four sets of type test reports alongwith the offer. These tests must not have been conducted earlier than seven years. The purchaser reserves the right to demand repetition of some or all the type tests in the presence of purchaserôs representative. For this purpose the Bidder may quote unit rate for carrying out each type test. For any change in the design / type already type tested and the design / type offered against this specification the purchaser reserves the right to demand repetition of tests without any extra cost.

1. Measurement of Inductance of main coil.
2. Measurement of temperature rise.
3. Insulation test.
4. Short time current test.
5. Corona extinction voltage test.
6. RIV measurement.

**6.2.2 ACCEPTANCE AND ROUTINE TESTS :-**

All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier in the presence of the purchaserôs representative.

6.3 Acceptance tests, whenever possible shall be conducted on the complete wave trap unit. The number of samples to be subjected to acceptance tests shall be decided by the purchaser at the time of actual testing.

7.0 **INSPECTION :**

i) The purchaser shall have access at all times to the works and all other places of manufacture, where the wave traps are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplierôs works, raw materials,

manufacture of the equipment, all the accessories and for conducting necessary tests as detailed herein.

III) The supplier shall keep the purchaser informed in advance, about the manufacturing programme so that arrangement can be made for inspection. Atleast fifteen (15) days advance intimations shall be given for the readiness of the equipment for inspection.

IV) No material shall be despatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

V) The acceptance of any quantity of equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection if such equipment are later found to be defective.

8. **DRAWINGS :-**

8.1 The drawings shall conform to International Standards Organisation (ISO) ñAò series of drawing sheets / Indian Standards Specifications. All drawings shall be in ink and suitable for microfilming. All dimensions and data shall be in S.I. Units.

8.2 The bidder shall furnish four sets of following drawings alongwith his offer :-

i) General outline drawings of the complete wave traps with technical parameters.

ii) Drawing showing clearance from grounded and other live objects and between adjacent poles of wave traps.

iii) Mounting details of Wave Traps.

iv) Curve showing blocking capability of the wave traps.

v) Details of galvanishing being provided on difference ferrous parts.

9. **PACKING AND FORWARDING :-**

The loose equipment shall be packed in the suitable crates so as to withstand handling during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing and handling. The easily damageable materials shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost. Each

consignments shall be accompanied by a detailed packing list containing the following information :-

a) Name of the consignee.

b) Details of the consignee.

c) Destination.

d) Total weight of consignment.

e) Sign showing upper / lower side of the crate.

f) Handling and unpacking instructions.

g) Bill of material indicating contents of each package and spare material.

The supplier shall ensure that the packing list and bill of material are approved by the purchaser before despatch.

10. **QUANTITY AND DELIVERY REQUIREMENT :-**

i) This is set out in else-where of this specification.

ii) The scope of supply shall include a supply of 2.5% extra-quantity of bolts, nuts, washers, split pins, cotter pins and such other small loose items free of cost.

**********

**ANNEXURE – I**

**TECHNICAL REQUIREMENTS FOR 420 kV & 245kV WAVE TRAPS (LINE TRAPS)**

| Sl.No. | Particulars | Unit | System requirement para meters |
|---|---|---|---|
| 1. | Rated system voltage | KV (rms) | 420 245 |
| 2. | Rated inductance at power frequency | MH | 1.0 0.5 |
| 3. | Rated continuous current | A | 2000 2000 |
| 4. | Rated power frequency | Hz | 50 50 |
| 5. | Rated short ï time current (duration 1 sec.) | kA (rms) | 40 40 |
| 6. | Asymmetrical peak value of the first half wave of the rated short time current. | kA (Peak) | 100 100 |
| 7. | Nominal discharge current of protective device connected across main coil | | 10 10 |
| 8. | Resistive component of the blocking impedance (minimum value) | Ohm | 430 570 |
| 9. | Rated bandwidth | KHz (i)<br>(ii)<br>(iii) | 50 ï 185 50 ï 185<br>45 ï 130 45 ï 130<br>61 ï 500 61 ï 500 |
| 10. | Rated tapping loss within the rated bandwidth (maximum value corresponding to line trap impedance of 1.4 times line characteristic impedance) | dB | 2.6 2.6 |
| 11. | Tensile strength of the mounting system | Kg. | Twice the weight of the line trap plus 200 Kg. |
| 12. | Radio interference voltage (maximum value) | Micro volts. | 500 500 |
| 13. | Limits of temperature rise | | As per Table-2 of IS: 8792 ï 1978. |

**ANNEXURE - II**

**GUARANTEED TECHNICAL PARTICULARS OF WAVE TRAPS FOR 420 KV & 245 kV (LINE TRAPS)**

| Sl.No. | Particulars | |
|---|---|---|
| 1. | Type | |
| 2. | Type rated Voltage (kV) | |
| 3. | Max. service voltage (kV) | |
| 4. | Continuous current carrying capacity. | |
| 5. | Rated Inductance | |
| 6. | Minimum resistive component of blocking impedance. | |
| 7. | Rated short time current duration 1 sec. (kA) | |
| 8. | Asymmetric peak value of the first half wave of rated short time current (kA) peak. | |
| 9. | Maximum tapping loss. | |
| 10. | Attenuation at tuned frequency. | |
| 11. | Blocking band details. | |
| 12. | Change in impedance due to ambient temperature variation. | |
| 13. | Change in resonant frequency due to ambient temperature variation | |
| 14. | Whether lightning arrestor has been provided or not. | |
| 15. | Detials of lightning arrestor :<br>i) Make<br>ii) Type<br>iii) Rated Voltage.<br>iv) Nominal discharge current. | |
| 16. | Whether bird guards have been provided or not. | |
| 17. | Whether corona rings have been provided or not. | |
| 18. | Type of mouting (pipe structure or lattice structure). | |
| 19. | Details of terminal clamps. | |
| 20. | Ultimate tensile strength. | |
| 21. | Dimensions of equipment :-<br>i) Height. | |

| | | |
|---|---|---|
| | ii) Dimeter.<br>iii) Weight. | |
| 22. | Standards to which equipment should conform. | |
| 23. | Any other particulars. | |

Name of the firm _____

Signature of Bidder _____

Designation and Seal _____

Date _____

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

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FOR
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BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**PLCC System**
**Part-10 (Section-I)**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-10 (Vol. II)**

**Technical Specification for PLCC SYSTEM**

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# PLCC SYSTEM

## 1. GENERAL

1.1 All the PLCC equipment covered under the package shall conform to the requirements of latest edition of the relevant IEC/IS Specifications or equivalent National Standards.

## 2. STANDARD AND DRAWING

2.1 The IEC/IS Specifications and international publication relevant to the equipment covered under this specification shall include but not be limited to list given at Annexure'C' of Section GTR.

## 3. LOCATION OF EQUIPMENT

3.1 The PLCC Equipment and Line traps as specified shall be installed in substation at the respective ends of the transmission lines. The Contractor shall be responsible for coordinating the equipment supplied by him with the already existing carrier equipment at the respective substation.

## 4. FREQUENCY PLANNING

4.1 For planning frequency and output power of carrier terminals Bidders may plan for a minimum receive signal to noise ratio of 25dB for the speech channels without companders. The noise power in 2.1kHz band (300-2400 Hz) may be taken as 13 dBm referred to the coupling point of the H.T line. An additional minus two and a half dB may be assumed for psophometric factor. As far as coupling loss (phase to phase) is concerned the Bidders may assume the same as 6dB at one coupling end for evaluating SNR. For protection channels the minimum SNR shall not be less than 15 DB under adverse weather. A safety margin of 9 dB shall be taken over and above these SNR values in order to cater for variations in line attenuation from the computed value as in hand reserve. Frequency and output power of PLC terminals for protection shall be planned such that the protection signal is received with full reliability even when one of the phase is earthed or is on open circuit on the line side causing an additional minimum loss of 6 dB.

The Bidder shall indicate the noise power in the bandwidth used for protection signaling and shall submit the SNR calculations for speech as well as protection channels on all the line section given in at the proposed frequencies. Sample calculations for SNR requirement and power allocation over different channels must be furnished alongwith the bid. Maximum permissible line attenuation shall be clearly brought out in these calculations. Further, Bidder shall submit details of frequency planning done (including computer studies carried out and facilities available) for PLCC links on EHV lines in the past in the relevant schedule of DRS. Bidder must enclose one copy of computer study result done in the past along with the Bid.

4.2 Successful Bidder shall be fully responsible for the coordination required with owner finalising the frequency plan.

4.3 The frequency plan will be referred to wireless Adviser/DOP Department for clearance and in case any change in the Contractor's recommended carrier frequency and power outputs proposed by these authorities, the Contractor shall have to modify his proposal accordingly. Change of power output shall, however, not involve repeater stations.

## 5. PROPOSED ARRANGEMENT

5.1 The power line carrier communication equipment required by the OWNER is to provide primarily efficient, secure and reliable information link for carrier aided distance protection and direct tripping of remote-end breaker and also for speech communication between 400 kV and 220 kV substations. It shall include separate carrier terminals of multipurpose type for speech and protection purposes. All carrier terminals including those for protection shall be suitable for point to point speech communication also.

5.2 Each 400 KV transmission line shall be protected by Main-I and Main-II protections as given below:

| | |
|---|---|
| i) Main-1 Numerical Distance protection with Permissive inter-tripping | Code-I |
| ii) Main-II Distance protection of different measuring technique than that of relay under Main-I | Code-II |
| iii) Direct Command | Code-III |

5.3 The requirement of carrier information on each link covered under this specification is as below:

a) One protection channel for Main-I and another for Main-II distance protection schemes.
b) One speech channel (express basis) with a facility to superimpose telex and data signals.
c) One main and one back-up protection channel for direct circuit breaker inter-tripping for 400 kV lines.
d) One channel dialing basis with a facility to superimposed data signal.

5.4 The protection signals shall have high degree of reliability and speed. It shall be guaranteed to function reliably in the presence of noise impulse caused by isolator or breaker operation. It shall also be possible to effect direct tripping of breaker at one end when the other end breaker opens out either manually or by relays such as Bus fault relay etc.

5.5 The time intervals between receipt of a trip command on the transmit side, its transmission over the carrier link, receiption at the far end and giving command to the trip relays at the distant end shall not exceed 20 mS. for permissive intertripping and 30m.sec. for direct inter-tripping even for the longest line section. The above timings are inclusive of operating time for auxiliary relays and interposing relays, if any, included in the PLCC equipment.

5.6 The requirement of protection signaling channel is such that security against incorrect signals being received shall be at least two to three orders higher than reliability against a signal not being received.

5.7 Phase to phase coupling for 400 kV S/C and for 220 kV S/C and Inter-circuit coupling for 220 kV D/C shall be employed. Double differential coupling shall also be considered for double circuit lines. Bidders must furnish details i.e. write up on methods of coupling and recommended suitable coupling mode or double-circuit lines alongwith the bids. Coupling mode shall, however, be fully confirmed by Contractor after conducting detailed computer study taking into account the transpositions of 400 kV lines for optimum coupling mode over these line sections. The coupling arrangement shall be fully optimized by the Contractor after conducting detailed study of every line section individually, taking into account the temperature variations, transpositions earth

resistive, conductor configuration carrier channels requirements, security and reliability criteria and other relevant details. The lie attenuation shall be calculated for complete range of frequencies. The earth will be furnished to the Contractor for carrying out the computer studies and frequency planning. The Contractor shall complete the computer studies wherever required and submit the frequency plan and optimum coupling details within a period of one month from the date of receipt of above data.

5.8 The 400 kV transmission lines will be transposed.

The transmission tower configuration and conductor details shall be forwarded after the award to enable the contractor to make his own computer study assessment of the carrier path based on wave propagation over transposed lines with each transposition point acting as "Model Converter".

5.9 The parameters of the equipment quoted shall be such that the mode of wave propagation on 400 kV power line (with transpositions indicated) shall not impose any limitation on the efficient and reliable performance of information link from protection or communication point of view.

5.10 The Contractor shall have to check and prove through the results of his computer studies that attenuation due to transpositions in the EHV lines is within limits and the offered equipment will perform satisfactorily.

5.11 The Contractor shall have to check and prove through the results of his computer studies that attenuation due to transpositions in the EHV lines is within limits and the offered equipment will perform satisfactorily

5.12 The Bidder shall submit curves illustrating incorrect tripping' and Failure to trip probability plotted against corona noise level, in the presence of impulse noise due to switching of isolator and circuit breaker etc. Details of field tests and laboratory tests for successful operation of his equipment, under such adverse conditions shall be furnished by the Bidder. These are to be related to end-to-end signaling and shall take into account the type of communication link i.e. account shall be taken of transpositions in the phase to phase coupled H.T. line. Details of field tests and laboratory tests for successful operation of the equipment under the above circumstance shall be submitted by the Bidder illustrating the above parameters.

## 6. LINE TRAP

6.1 The Technical Specification of Line Trap is available at Part 10 of Volume II of Bid documents.

## 7. COUPLING DEVICE

7.1 The coupling devices shall be interposed between the capacitor voltage transformer and coaxial line to the PLC transmitter/receiver, and in conjunction with the capacitor voltage transformer shall ensure.

a) Efficient transmission of carrier frequency signals between the carrier frequency connection and the power line.

b) Safety of personnel and protection of the low voltage parts and installation, against the effects of power frequency voltage and transient over voltages.

7.2 The coupling device, in conjunction with the CVT shall from an electric filter of bank pass type:

a) It shall match characteristic impedance of H.T. line to impedance of the carrier frequency connection.

b) Galvanic isolation between primary and secondary terminals of the coupling device shall be performed by the above mentioned transformer.

c) Power frequency currents derived by the CVT may be drained to the earth by a separate inductance termed drain coil of suitable rating.

d) Voltage surges coming from the power line at the terminals of the coupling device shall be limited by a non-linear surge arrestor of suitable rating in the primary side. Requirement of a gas type voltage arrestor in secondary side of the coupling device shall have to be fully justified, but in any case the input circuit of PLC equipment shall have protective devices in the form of zener diodes and surge suppressers.

The surge arrester shall have power frequency spark over voltage coordinated with the equipment ahead of it.

e) For direct and efficient earthing of its primary terminals, the coupling device shall be equipped with an earthing switch. The Earth Switch shall be available for earthing of CVT-HT terminals, when the coupling filter units are removed from circuit for maintenance/replacement. The design shall take due regard of requirements for safety in accordance with the Indian Electricity Rules

7.3 Two numbers ‘phase to earth’ type coupling filters shall be used to achieve phase to phase/inter-circuit coupling connection between secondary of the two phase to earth type coupling device shall be through a balancing transformer/hybrid such that reliable communication shall be ensured even when one of the coupled phase is earthed or open circulated on the line side.

7.4 Coupling device shall conform to IEC-481 and shall have the following carrier frequency characteristics as applicable to a phase to earth type coupling device:

| | | |
|---|---|---|
| a) | Normal line side | 320 ohms for 400 kV line impedance |
| b) | Nominal equip ment side impedance | 75 ohms (unbalanced) |
| c) | Composite loss | Not more than 2 dB |
| d) | Return loss | Not less than 12 dB |
| e) | Bandwidth | Shall suit the frequency plan between 36 and 500 kHZ. |
| f) | Nominal peak Envelope power (for Inter-modulation product 80 dB down) | Not less than 650 Watt. |

7.5 The coupling device shall be suitable for outdoor mounting. Temperature of metallic equipment mounted outdoor is expected to rise upto 65 deg. C during the maximum ambient temperature of 50 deg. C specified. The equipment offered by the Bidder shall operate satisfactorily under these conditions.

7.6 The H.T Terminal of coupling device shall be connected to H.F Terminal of the CVt by means of 6 mm sq. copper wire with suitable lugs & taped with 11 kV insulation by the contractor.

7.7 Coupling device shall have at least two terminals for carrier equipment connection. Bidder shall confirm that such a parallel connection to coupling device directly will not result in any additional attenuation.

7.8 The coupling device including the drainage coil, surge arrester and earthing switch shall conform to type tests and shall be subject to routine tests as per IEC 481/IS:8998.

Routine tests shall include but not be limited to the following:-

i) Composite loss and return loss tests on coupling device.
ii) Turns ratio test and insulation tests on the balancing transformer.
iii) Milli volt drop test, power frequency voltage test and mechanical operation test on earthing switch.
iv) Power frequency spark over test for lightning arrester as per relevant IS/IEC.

7.9 Bidder shall furnish, alongwith his bid copies of all type and routine test conducted either on similar coupling device in accordance with relevant standards.

## 8. HIGH FREQUENCY CABLE

8.1 High frequency cable shall connect the coupling device installed in the switchyard to the PLC terminal installed indoor.

8.2 The cable shall be steel armored and its outer covering shall be protected against attack by termites. Bidder shall offer his comments on method employed by him for earthing of screen and submit full justification for the same with due regard to safety requirements.

Bidder must enclose n his bid a detailed construction drawing of the cable being offered, with mechanical and electrical parameters.

8.3 Impedance of the cable shall be such as to match the impedance of the PLC terminal on one side and to that of the coupling device on the other side over the entire carrier frequency range of 40-500 kHz.

8.4 Loop resistance of cable shall not exceed 30 ohm per Km at 20 deg. C.

8.5 The cable shall be designed to withstand test voltage of 4 kV between conductor and outer sheath for one minute.

8.6 Bidder shall specify attenuation per Km of the cable at various carrier frequencies in the range of 40 to 50 kHZ. The typical attenuation figures for H.F. cable shall be in the range of 1 to 5 dB/km in the frequency of 40 to 500 kHZ.

8.7 The H.F cable shall conform to type tests and be subjected to routine tests as per IEC:96-2/BS:2316/IS:5802.

8.8 All HF cables within the scope of this specification shall be laid and termination shall be carried out by the Contractor.

8.9 The cables shall be supplied wound on drums containing normal length of 500 meters each. However, exact requirement of drum lengths shall be finalized during details engineering to avoid joint in lHF cable and its wastage.

## 9. POWER LINE CARRIER TERMINAL

9.1 As already indicated the information link shall be provided for speech, protection, telex and data services.

9.2 PLC terminal shall use Amplitude Modulation and shall have single side bank transmission mode. These shall be equipped for fixed frequency duplex working.

Characteristic input and out put parameters of the SSB PLC terminals shall be as per IEC-495, unless otherwise specified.

9.3 The salient features are detailed out below:

| | | |
|---|---|---|
| a) | Mode of transmission | Amplitude Modulation single side band with supressed carrier or reduced carrier. |
| b) | Carrier frequency | 40 to 500 kHZ range. |
| c) | Nominal carrier frequency band in either direction of transmission. | 4.0 kHZ |
| d) | Power output (PEP) at HF terminal | 40 Watt |
| e) | Frequency difference between a pair of PLC terminals | Frequency difference between VF signal at the transmitting and receiving ends will not Exceed 2 Hz with suppressed Carrier. With reduce carrier Frequency difference shall Be zero. This shall include Permissible ambient tem-Perature variation and Supply frequency and Voltage variation of (+) 15% and (-) 10%. |
| f) | Automatic gain control | For 40 dB change in carrier frequency signal level within the regulation range, change in VF receive levels of both speech and other signals shall be less than 1 dB. |

| | | |
|---|---|---|
| g) | Supply voltage | 48 V DC + 15%-10% (Positive pole earthed) |

9.4 All the PLC terminals shall be of the multipurpose type. The Bidder shall confirm that the total transmission time for the teleprotection shall not exceed 20ms for permissive and 30ms for direct tripping signals. Speech and teleprotection channel shall independently fulfill the SNR requirement out of the power allocated to its channel from the total power of the PLC terminals.

Detailed calculations for SNR requirement and power allocation over different channels should be furnished alongwith the bid.

9.5 In the input of the PLC terminal protective devices shall be the provided in the form of zener didos or surge suppressers in the order to eliminate any surge transfer through the coupling device or the surge induced in the connecting path of H.F. cable.

9.6 To improve voice transmission characteristics for the system, companders and expanders shall be provided. The commanders shall have at least 2:1 compression ratio with the corresponding expansions ratio1:2. The operating range of the compander shall be compatible with the audio power levels specified for 4 wire operation. The improvement gained by companders shall however not be taken into account for power allocation and shall be in-hand reserve.

9.7 Sudden changes in the input level to the receiver shall not cause false tripping. The Bidder shall clearly indicate in his offer the method adopted to ensure above phenomenon. The receiver design shall also provide protection against false tripping from the random noise.

9.8 Fail-safe devices shall be provided, so that a malfunction in one unit or subassembly cannot cause damage elsewhere in the system. All plug in equipment shall be fitted with the features to prevent improper insertion. The electrical cables shall not be routed across sharp edges or near sources of high temperature. The adjustment which are susceptible to mis-adjustment from accidental contract/vibration shall be equipped with the suitable locking devices.

9.9 The PLC set shall be designed to give guaranteed performance from 0deg. Cto 50deg. C ambient temperature. The thermal capability of the equipment shall be so designed that the equipment remains operational successfully upto 60deg.C ambient temperature. Any ventilation fams provided for the circulation of air inside the cabinets shall conform to relevant Indian Standards.

9.10 The terminal shall be provided with the built-in indicating instrument to facilitate checking of important voltage and current values and single levels in different parts of the PLC Terminals. Protection fuses shall be provided in all important circuit and fuses shall be so mounted as allow their easy inspection and replacement. All the test points shall be easily accessible.

The carrier set shall be provided with the suitable supervision and alarm facilities. Individual parts of the carrier set should be accessible from front making it possible to

place the carrier cabinets side by side. All components and parts of the carrier set shall be suitably tropicalised.

9.11 PLC terminals shall be housed in floor mounting sheet metal cabinets, suitable for mounting on concrete plinth as well as channel frame by means of nuts and bolts or welding. The cabinets shall be properly cleaned and spray painted with two coats of synthetic enamel paint. Exterior of the cabinets shall be painted with smoke glossy finish. Interior of the cabinets shall be painted with white enamel paint with glossy by the Contractor. Contractor shall submit detailed drawing for earthing connections.

9.12 All the panels shall be protected against moisture ingress and corrosion during storage. Panels shall be properly dried before they are installed and energized. Bidder shall indicate measures adopted to prevent ingress of moisture during operation.

9.13 All cabinets having PLC terminals shall be provided with the lamps of sufficient wattage for interior illumination with the switch. Each panels shall be provided with 240 V AC single phase socket with switch to accept 5 &15A standards Indian plugs.

9.14 A name plate shall be provided on the front door of each cabinet indicating channels function transmitter frequency and direction etc.

9.15 Bidder shall submit type test & routine test certificates for the quoted PLC terminals in respect of characteristic input and output parameters of the PLC Terminals in accordance with IEC-495 alongwith the bid.

9.16 Heat Soaking of panels

All the solid state equipment panels shall be subjected to the Heat Soaking as per the following procedure:

All solid state equipment be burning for minimum of 120 hours continuously under operation condition. During the last 48 hours of testing the ambient temperature of the test chamber shall be 50C. Each PLC panels shall be complete with all associated sub system and the same shall in operation during the above test. During the last 48 hours of the above test the temperature inside the panels shall be monitored with all the doors closed. The temperature of the panel interior shall not exceed 65C.

## 10.0 SPEECH COMMUNICATION

10.1 PLCC equipment offered shall provide telephone communication between the station where the transmission lines are terminating. The equipment shall be suitable for providing the following facilities:

a) It shall be possible for subscriber at any of the station to contacts the subscriber at all other station connected in the system as shown in the specification drawing by dialing his call number. To achieve this a 24 lines EPAX with 4 wire interface & remote subscriber units shall be provided/available at different station.

b) The equipment shall contain all normal facilities like ring back tone, dial tone engage tone & priority tone, and suitable pulses to establish and disconnect communications between subscribers.

c) The equipment shall be provided with the necessary alarm circuits and fuses etc.

d) The equipment shall be of 4 kHz bandwidth on either direction and be suitable for providing superimposed data and tele-printer facilities at a later date without major modification and high cost. The Bidder shall clearly indicate in his bid the provision made in his proposals for future development and the extent to which additional facilities can be added at a later date.

e) The systems shall be completely automatic with definite number allocated for each telephone. The numbering scheme for telephones exchanges and tie lines shall be developed by the Bidder and indicated in the bid.Final numbering scheme shall be fully coordinated with the existing/proposed future system by the Contractor.

f) Arrangement for over riding facilities shall be provided by means of priority keys wherever specified. The over riding facility shall enable cutting in ongoing calls with the priority key and ask the concerned parties to finish their conversation. The wanted number should then get automatically connected without having to redial the number.

g) All the carrier telephone conversations shall be secret and it should not be possible for anybody to over hear the conversation going on between any two parties excepting those provided with the over riding facilities.

h) The necessary cables for connecting all the telephones instruments ordered for at each sub station (including wiring the termination ) shall be provided by the Contractor. These telephone instrument shall be located with in control room building at respective sub station.

i) The cabinets housing the equipment for EPAX, four wire E/M interface & remote subscriber units (four wire) shall have mounting arrangement similar to that for PLCC terminals.

j) All the terminals for speech shall be supplied fully wired for addition of the VFTs and transit filters. **Transit band filter shall be provided in all panels**.

k) Equipment for speech communication must be fully compatible with OWNER's existing equipment. Any interfaces required for proper matching and connection with the OWNER's existing equipment shall be provided by the Contractor.

l) Terminals for the protection shall be suitable for speech between two ends of each transmission line or on tandem operation basis with the back to back connection at the intermediate station.

m) Each PLCC terminals for speech as well as protections purpose shall be provided with the plug in type service telephone and buzzer. **Further, 4 wire remote telephone instruments (parallel to service telephone) shall also be provided in all panels**. These instruments shall be located in the respective Switchyard control room to enable the operator to make emergency calls on the point to point basis. Each such instruments shall be equipped with buzzer and press to call key and shall not require any additional power supply units.

n) **Remote subscriber interface facility shall be provided in all panels.**

10.2.1 The 24 line Electronic Private Automatic Exchange (EPAX) wherever specified shall be connected to minimum six trunk routes through PLCC channels (speech panels)with the Four wire E/M interface unit. This 4 fire interface unit either shall form an integral part of the EPAX system or be suitable for mounting/housing in the carrier panel . The

exchange will have its own ringing current and tone generator etc. The exchange shall be suitable for working on 48 V DC power Supply (positive pole earthed)

The exchange shall be fully automatic solid state and of modular construction and shall multiple switching routes(minimum 4 routes).

10.2.2 EPAX shall also be provided with the two additional interface units and operate exclusively with the OWNER's leased subscriber lines or Department of Telecommunication and compatible with 2 wire full duplex voice grade mode of operation.

The details of communication protocol, for interfacing of the DOT leased lines, shall be coordinated by the Contractor, with the licensing authority (DOT)

10.3 Remote End Four Wire œE/Mô Interface & Subscriber Unit or Equivalent EPAX (4x4)

10.3.1 The remote end four wire œE/Mô interface & subscriber units, wherever specified, shall be of electronic type and be suitable for working on fixed frequency power line carrier systems with E & M signaling. This shall be housed in the carrier set and be fully wired to the power line carrier terminal equipment.

10.3.2 This unit shall receive and register various signals, on PLCC Channels, from remote end exchanges or other remote end subscriber units and associated four write interface unit.

10.3.3 The four wire interface unit shall be equipped for routine transit calls and shall be supplied pre-wired to handle calls for minimum eight directions, in a form suitable for transmission over PLCC.

10.3.4 The bidder shall also indicate the total number of trunk-line capacity, available with each four-wire interface unit.

The unit shall be suitable for connecting two-wire telephone sets. Further, the associated telephone cables for locating two subscriber lines, within the control room is in the scope of this specification.

10.4 Network Protection Equipment (Protection Coupler)

10.4.1 The Bidder shall offer voice frequency transmission equipment which shall work on frequency shift or coded signal principle for transmission/reception of protection signals as single purpose channel. The equipment shall be suitable for connection to the power line carrier terminal.

10.4.2 The voice frequency transmission equipment shall not only be insensitive to corona noise but shall also remain unaffected by impulse type noise which are generated by electrical discharge and by the opening and closing of circuit breakers, isolator, earthing switches etc. The equipment shall also be made immune to a field strength of 10V/m expected to be caused by portable radio transmitters in the range of 20-1000 MHz. In his offer, bidder shall clearly explain as to what measures have been taken to make the equipment insensitive to corona noise, white noise and to impulse noise of an amplitude larger than the wanted signal and submit full field test and laboratory test reports. The guarantee on design data shall not be acceptable.

10.4.3 The equipment shall be unaffected by spurious tripping signals. The Bidder shall submit proof as to how this is achieved satisfactorily.

10.4.4 The equipment shall be suitable for transmission of direct and permissive trip signal as well as blocking signals for protective gear of power system. The equipment shall be operated in the audio frequency range in speech band or above speech band as superimposed channel in 4 kHZ band of SSB carrier. The equipment shall operate with full duplex frequency shift mode of operation. The protection signaling equipment shall be of solid state design, modular in construction and have a proven operating record in similar application over EHV systems. Details regarding application of the equipment over 400 kV/220 kV systems shall be submitted along with the bid. Each protection signaling equipment shall provide:

i) Transmission facilities for minimum two protection signals.
ii) Reception facilities for minimum two protection signals.

10.4.5 The equipment shall be designed for remote tripping/blocking on permissive basis and direct tripping for reactor fault and others. The overall time of PLC, VFT and transmission path for permissive trip/blocking shall be 20 m. Sec. Or less and for direct tripping 30 m. Sec. Or less even for the longest line section.

Operating time lower than specified above may be preferred provided they fulfill the requirements of security and reliability as mentioned below:

False-trip probability $10^5$

Fail to trip probability 10-2

For S/N 6 4B in 3.1 kHZ Band
(white Noise Measurement)

10.4.6 It may be emphasized that specified time, as mentioned above is composed of the following:

a) Back-to-back signal delay in frequency shift or coded signals protection equipment.
b) Back-to-back delay in PLC terminal.
c) Delay in transmission line.
d) Operation time of interposing relay, if any, in frequency shift or coding equipment.

Reference is invited in this regard to the guide lines expressed in CIGRE Publication ñTeleprotectionò report by Committee 34 and 35.

10.4.7 The following transfer criteria shall be provided by the equipment.

a) Transmit side

One number potential free NO (normally open) contact of protective relays (To be supplied by the OWNER) of under noted rating for each of the following functions:

i) Permissive trip command.
ii) Direct trip command
Contact Rating.

| | |
|---|---|
| Maximum Voltage | : 660 Volts |
| Maximum current rating | : 5 amps |
| Maximum power rating | : 1250 W/VA |

b) Receive Side

Voice frequency transmission equipment for network protection shall be provided with one potential free NO (normally open) contact of the under noted rating for each of the following functions:

i) Premissive trip command
ii) Direct trip command

Contact Rating:

| | |
|---|---|
| Rated Voltage | : 250 Volts DC |
| Rated current | : 0.1 A DC |
| Other Parameters | : As per IEC-255-0-20 |

c) Alarm

In addition, the voice frequency protection terminal shall provide at least one number potential free change over contact of the following rating for alarm purposes.

| | |
|---|---|
| Rated Voltage | : 250 Volts DC |
| Rated current | : 0.1 A DC |
| Other Parameters | : As per IEC-255-0-20 |

10.4.8 Frequency shift or coded signal protection equipment shall have at least two channels. In order to ensure full availability of PLC protection channel arrangement of parallel circuiting of these two channels as main and standby channels shall be made. This arrangement is generally shown in relevant specification drawing. Each arrangement shall be developed by the successful Bidder in coordination with protective relay Contractor. The parallel wiring should however retain the concept of two protection channels of each type of protection with each backing up the other 100% during normal operation and also permit testing without affecting the other. The Contractor shall submit drawings showing inter-connection between PLCC and protection panels for approval by the OWNER.

10.4.9 It has to be ensure that under no circumstances protection channel should share the power. Each protection channel shall be able to transmit power for which system is designed. For example, a 40 W PLC terminal shall transmit 40 Watt (max.) for protection channel alone in the event of fault. Speech and superimposed data channels, in the same protection terminal must get disconnected momentarily during the operation of protection channels.

10.4.10. The equipment shall be constructed such that in premissive line protection system, operational reliability of the protection channel may be checked over the carrier link by means of a loop test. It shall be possible to carry out the above test from either end of the carrier link. During healthy condition of the transmission line, the loop test shall not initiate a tripping command. In the event of a system faults, while loop test is in progress, protection signal shall over-ride the test signal.

10.4.11 The equipment shall be complete with built in counters for counting the number of trip commands sent and number of trip commands received.

10.4.12. The following type/routine tests as per IS:8686 shall be conducted on the relays associated with PLCC equipment for network protection, voice frequency protection signaling equipment and inter face unit with protective relay units if any :

I. Type Tests.

a) Impulse voltage withstand test as per Clause 6.1 of IS:8686 (for a test voltage appropriate to Clause III as per Clause 3.2 of IS:8686)

b) High Frequency Distrubance test as per Clause 5.2 of IS:8686 (for a test voltage appropriate to Clause III as per Clause 3.2 of IS:8686)

## 11. MANDATORY TESTING & MAINTENANCE EQUIPMENT

Print testing kit for PLCC terminal, E/M interface & subscriber unit, Protection coupler & EPAX.

Comprising of the following items of the reputed make in additional to any other special items required for testing and maintenance of this equipment packed in a carrying brief case:

1. Screw driver set with multi up fixing feature.
2. Nose pliers.
3. Cutting pliers.
4. Ordinary Pliers
5. Adjustable wrenches
6. Soldering iron with trip earthed

a) 150 watts. - 1 No.
b) 35 watts. - 1 No.
c) 10 watts - 1 No.

Operated with isolated (step down) transformer having provision for interchangeable taps.

7. Disoldering pump
8. Print extender
9. Print puller
10. Large selection of test leads.
11. Solder wire
12. Large selection of plugs, jacks & pistol probes compatible with equipment supplied.
13. Dummy load
14. Interface card/print for Tx to Rs loop-back
15. Test oscillator/tone generator with indicating meters-either built in or separate.
16. ESD wrist bank
17. ESD conducting mat

## 12. LIST OF COMMISSIONING TESTS

The following tests shall be carried out on complete system/subsystem during commissioning:

1. Composite loss and return loss on coupling device using dummy load.
2. Composite loss (altenuation) for HF Cable coupling device.
3. End to end attenuation measurement for verification of optimum coupling mode. Test shall be done for all combinations.
4. End to end return loss of optimum coupling mode.
   a) Open behind line trap.

b) grounded behind line trap.

5. If end to end return loss for optimum coupling mode is not satisfactory, same shall be measured for other coupling modes also.
6. Adjustment of Tx/Rx levels on PLCC equipment as per test schedule.
7. AF frequency response (end to end) for the entire 4 kHZ bandwidth with and without line energised.
8. Measurement of noise in 2 kHZ bandwidth with and without line energised.
9. SNR (test-one) with line energised nothing down weather conditions.
10. Transmission time for teleprotection and other data channels.
11. Observation of Tx/Rx levels (test-one) for each channel at both ends by sequential switching on/off parallel channels using dummy load and also with the transmission line.
12. Observation of end to end and trunk dialing performance.
13. Observation of end-to-end protection signaling (command sent & received) in conjunction with protective relays, nothing down transmission/receipt of unwanted commands under switching operation in the switchyard during protective relay testing.

Notes:

1. All measurement for link attenuation, composite loss and return loss shall be carried out for the entire range of carrier frequencies with specific attention to the frequencies.

   i) within coupling device bandwidth.
   ii) within line trap bandwidth, and
   iii) operating frequencies.

2. Following tests shall be carried out independently at each and

   i) Composite loss & return loss for coupling device.
   ii) Attenuation test for HF cable+coupling device.
   iii) Levels and other local adjustments (on dummy load).
   Final adjustment shall be on end to end basis.
   iv) Test for loading by parallel channels with dummy load.
   This test can be done alongwith tests for coupling device.

   v) Protection signaling under local loop test (dummy load).

3. Necessary test instruments required for all the above tests shall be brought by commissioning engineers of the contractor.

**ANNEXURE-I**

## GUARANTEED TECHNICAL PARTICULARS OF PLCC EQUIPMENTS

**Coupling Device (Phase to Phase Type)**

| | | | |
|---|---|---|---|
| 1. | Name of Manufacturer and Country | 1. | é é é é é é é é é |
| 2. | Type, Model and Catalogue Number | 2. | é é é é é é é é é |
| 3. | Whether suitable for mounting Outdoor in Switchyard? Type of mounting | 3. | é é é é é é é é é |
| 4. | Maximum temperature limit for satisfactory operation of coupling device mounted outdoor | 4. | é é é é é é é é é |
| 5. | Net Weight | 5. | é é é é é é é é é |
| 6. | Nominal Primary Side Impedance | 6. | é é é é é é é é é |
| 7. | Nominal secondary side Impedance | 7. | é é é é é é é é é |
| 8. | Composite loss with in pass-band | 8. | é é é é é é é é é |
| 9. | Return loss with in pass-band | 9. | é é é é é é é é é |
| 10. | Available Bandwidth (with 4400 pF CVTs) | 10. | é é é é é é é é é |
| 11. | Nominal Peak Envelope Power (with Distortion and Inter-modulation Products of 80 dB Down) | 11. | é é é é é é é é é |
| 12. | Maximum number of PLC terminals that can be connected in parallel: | 12. | é é é é é é é é é |
| a. | 20 W (PEP) PLC terminal | a. | é é é é é é é é é |
| b. | 40 W (PEP) PLC terminal | b. | é é é é é é é é é |
| 13. | Power Frequency Impedance between primary terminal and Earth Terminals of Coupling Device | 13. | é é é é é é é é é |
| 14. | 1 Minute Power Frequency Insulation level between Primary and Secondary Terminals of Coupling Device | 14. | é é é é é é é é é |
| 15. | Impulse (1.2/50 micro-sec.) Withstand Level between Primary and Secondary Terminals of Coupling Device | 15. | é é é é é é é é é |
| 16. | Power Frequency Current Carrying Capacity of Drain Coil (or Primary Winding of Matching Transformer) | 16. | é é é é é é é é é |
| a. | Continuous current | a. | é é é é é é é é é |
| b. | Short time current for 0.2 Sec. | b. | é é é é é é é é é |

| | | | |
|---|---|---|---|
| c. | Inductance of drain coil with tolerances (at 50 Hz) | c. | é é é é é é é é é |
| 17. | Surge Arrester in Primary Side of Coupling Device: | 17. | é é é é é é é é é |
| a. | Type, Model and Catalogue number | a. | é é é é é é é é é |
| b. | Power frequency sparkover voltage | b. | é é é é é é é é é |
| c. | Type of construction | c. | é é é é é é é é é |
| d. | Maximum permissible arrestor discharge current with 8/20 micro sec. impulse discharge | d. | é é é é é é é é é |
| e. | Maximum permissible short time current (2.2 micro sec.) | e. | é é é é é é é é é |
| f. | Power frequency discharge current for 0.2 sec. | f. | é é é é é é é é é |
| g. | Impulse spark over voltage 1.2/50 micro sec. | g. | é é é é é é é é é |
| h. | Rated cottage | h. | é é é é é é é é é |
| 18. | Surge arrestor in Secondary Side of Coupling Device | 18. | é é é é é é é é é |
| a. | Type, model and catalogue number | a. | é é é é é é é é é |
| b. | Power frequency sparkover voltage | b. | é é é é é é é é é |
| c. | Impulse spark over voltage (1.2/50 micro sec.) | c. | é é é é é é é é é |
| d. | Power frequency spark over voltage. | d. | é é é é é é é é é |
| 19. | Details of interlock provided with cover enclosed. | 19. | é é é é é é é é é |
| 20. | Overall dimensions | 20. | é é é é é é é é é |
| 21. | No. of H.F. Terminals provided for carrier equipment connection. | 21. | é é é é é é é é é |

**High Frequency Cable**

| | | | |
|---|---|---|---|
| 1. | Name of Manufacturer and Country | 1. | é é é é é é é é é |
| 2. | Type, Model and Catalogue No. | 2. | é é é é é é é é é |
| 3. | Applicable standards | 3. | é é é é é é é é é |
| 4. | Characteristic Impedance | 4. | é é é é é é é é é |
| 5. | Rated Capacitance | 5. | é é é é é é é é é |
| 6. | Service Voltage | 6. | é é é é é é é é é |

| | | | |
|---|---|---|---|
| 7. | Attenuation per km. of cable at various Carrier Frequencies in the Range of 50 to 500 KHz. (Typically at 50, 100, 200, 300, 400, 500 KHz) | 7. | é é é é é é é é é |
| 8. | Withstand Test Voltage (rms) between conductor and Sheath | 8. | é é é é é é é é é |
| 9. | Details and particulars of Insulation | 9. | é é é é é é é é é |
| 10. | Loop Resistance per km. (typical at 20ºC) | 10. | é é é é é é é é é |
| 11. | Details of Armouring | 11. | é é é é é é é é é |
| 12. | Number and Diameter of Stranded Conductor | 12. | é é é é é é é é é |
| 13. | Overall Diameter of Cable | 13. | é é é é é é é é é |
| 14. | Net weight per km. | 14. | é é é é é é é é é |
| 15. | Minimum bending radius | 15. | é é é é é é é é é |
| 16. | Earthing detail of H.F. Cable | 16. | é é é é é é é é é |
| 17. | Packing Length per drum | 17. | é é é é é é é é é |
| 18. | Construction drawing, type test and performance reports enclosed or not. | 18. | é é é é é é é é é |

**Power Line Carrier Terminal For**
**Speech And Data Transmission**

| | | | |
|---|---|---|---|
| 1. | Name of Manufacturer and Country | 1. | é é é é é é é é é |
| 2. | Type, Model and Catalogue No. | 2. | é é é é é é é é é |
| 3. | Type of Modulation | 3. | é é é é é é é é é |
| 4. | Mode of Transmission | 4. | é é é é é é é é é |
| 5. | Carrier Frequency Range | 5. | é é é é é é é é é |
| 6. | Nominal Carrier Frequency Band in either direction of transmission | 6. | é é é é é é é é é |
| 7. | Return loss within the Nominal Carrier Frequency Band | 7. | é é é é é é é é é |
| 8. | Effectively Transmitted V.F. Band | 8. | é é é é é é é é é |
| a. | For Speech | a. | é é é é é é é é é |
| b. | For Telephone signaling | b. | é é é é é é é é é |
| 9. | Return Loss within the Effectively Transmitted Voice Frequency Band. | 9. | é é é é é é é é é |
| 10. | H.F. Oscillator Details | 10. | é é é é é é é é é |
| 11. | I.F. Oscillator Details | 11. | é é é é é é é é é |
| 12. | Frequency Difference between the V.F. Input and V.F. Output of a pair of terminals connected back to back for permissible Ambient Temperature and Supply voltage variations. | 12. | é é é é é é é é é |
| 13. | Maximum H.F. Amplifier output with Single / Multiple tone keying (Peak Envelope Power) | 13. | é é é é é é é é é |
| 14. | Nominal carrier frequency Power (Peak Envelop Power) at output terminals. | 14. | é é é é é é é é é |
| 15. | H.F. Impedance at output of carrier terminals. | 15. | é é é é é é é é é |
| 16. | Stability of the carrier frequency. | 16. | é é é é é é é é é |
| 17. | Improvement in S/N due to compander | 17. | é é é é é é é é é |
| 18. | Whether carrier is suppressed or reduced during transmission of signal | 18. | é é é é é é é é é |
| 19. | Whether frequency locking between Tx/Rx provided. | 19. | é é é é é é é é é |
| 20. | Automatic gain control range and regulation | 20. | é é é é é é é é é |

| | | | |
|---|---|---|---|
| 21. | Level of spurious emissions at | 21. | é é é é é é é é é |
| a. | Edge of nominal Carrier Frequency Band | a. | é é é é é é é é é |
| b. | 4.0 KHz away from nominal carrier frequency band | b. | é é é é é é é é é |
| c. | 8.0 KHz away from nominal carrier frequency band. | c. | é é é é é é é é é |
| 22. | Relative level at V.F. 4 wire terminating points: | 22. | é é é é é é é é é |
| a. | Send leg | a. | é é é é é é é é é |
| b. | Receive leg | b. | é é é é é é é é é |
| 23. | Permissible limits for level variation with frequency relative to 800 Hz in a speech channel (without companders) transmitted over a pair of terminals connected back to back. | 23. | é é é é é é é é é |
| 24. | Level of telephone signaling channel: | 24. | é é é é é é é é é |
| a. | Input level | a. | é é é é é é é é é |
| b. | Output level | b. | é é é é é é é é é |
| 25. | Near and far end cross talk due to telephone signaling channel in a pair of PLC terminals (without companders) connected back to back | 25. | é é é é é é é é é |
| 26. | Pulse distortin of telephone signaling channel when operated at a signaling speed of 10 pps and with a mark to space ratio of 40/60 in PLC terminals connected back to back. | 26. | é é é é é é é é é |
| 27. | Psophometric Noise contribution of a pair of PLC terminals connected back to back. | 27. | é é é é é é é é é |
| 28. | Group delay distortion in the frequency band relevant to the transmission of protection signals. | 28. | é é é é é é é é é |
| 29. | Performance Under Noise condition: | 29. | é é é é é é é é é |
| a. | Noise generated within terminal | a. | é é é é é é é é é |
| b. | Additional noise introduced when terminals are connected back to back at repeater station. | b. | é é é é é é é é é |
| c. | Noise Band width | c. | é é é é é é é é é |
| 30. | Power Supply requirements | 30. | é é é é é é é é é |
| a. | Voltage | a. | é é é é é é é é é |
| b. | Permissible voltage variation | b. | é é é é é é é é é |

| | | | |
|---|---|---|---|
| c. | Maximum current | c. | é é é é é é é é é |
| d. | Quiescent current | d. | é é é é é é é é é |
| 31. | Installation details | 31. | é é é é é é é é é |
| 32. | Insulation level | 32. | é é é é é é é é é |
| 33. | Meters provided on test panel, their ranges and purposes. | 33. | é é é é é é é é é |
| 34. | Is the equipment suitable to work in dust laden atmosphere | 34. | é é é é é é é é é |
| 35. | Whether interior lamps with door switch provided in cabinets. | 35. | é é é é é é é é é |
| 36. | Overall dimensions | 36. | é é é é é é é é é |
| a. | Length | a. | é é é é é é é é é |
| b. | Width | b. | é é é é é é é é é |
| c. | Height | c. | é é é é é é é é é |
| 37. | Weight | 37. | é é é é é é é é é |
| 38. | Earthing detail of PLC Cabinets | 38. | é é é é é é é é é |
| 39. | Whether Tx/Rx loop-back facility is available for testing locally. | 39. | é é é é é é é é é |

**Power Line Carrier Terminal For**
**Network Protection**

| | | | |
|---|---|---|---|
| 1. | Name of Manufacturer and Country | 1. | é é é é é é é é é |
| 2. | Type, Model and Catalogue No. | 2. | é é é é é é é é é |
| 3. | Type of Modulation | 3. | é é é é é é é é é |
| 4. | Mode of Transmission | 4. | é é é é é é é é é |
| 5. | Carrier Frequency Range | 5. | é é é é é é é é é |
| 6. | Nominal Carrier Frequency Band in either direction of transmission | 6. | é é é é é é é é é |
| 7. | Return loss within the Nominal Carrier Frequency Band | 7. | é é é é é é é é é |
| 8. | Effectively Transmitted V.F. Band | 8. | é é é é é é é é é |
| 9. | Return Loss within the Effectively Transmitted Voice Frequency Band. | 9. | é é é é é é é é é |
| 10. | H.F. Oscillator Details | 10. | é é é é é é é é é |
| 11. | I.F. Oscillator Details | 11. | é é é é é é é é é |
| 12. | Frequency Difference between the V.F. Input and V.F. Output of a pair of terminals connected back to back for permissible Ambient Temperature and Supply voltage variations. | 12. | é é é é é é é é é |
| 13. | Maximum H.F. Amplifier output with Single / Multiple tone keying (Peak Envelope Power) | 13. | é é é é é é é é é |
| 14. | Nominal carrier frequency Power (Peak Envelop Power) at output terminals. | 14. | é é é é é é é é é |
| 15. | H.F. Impedance at output of carrier terminals. | 15. | é é é é é é é é é |
| 16. | Stability of the carrier frequency. | 16. | é é é é é é é é é |
| 17. | Improvement in S/N due to compander | 17. | é é é é é é é é é |
| 18. | Whether carrier is suppressed or reduced during transmission of signal | 18. | é é é é é é é é é |
| 19. | Whether frequency locking between Tx/Rx provided. | 19. | é é é é é é é é é |
| 20. | Level of spurious emissions at : | 20. | é é é é é é é é é |
| a. | Edge of nominal Carrier Frequency Band | a. | é é é é é é é é é |
| b. | 4.0 KHz away from nominal carrier frequency band | b. | é é é é é é é é é |

| | | | |
|---|---|---|---|
| c. | 8.0 KHz away from nominal carrier frequency band | c. | é é é é é é é é é |
| 21. | Whether frequency locking between Tx/Rx provided | 21. | é é é é é é é é é |
| 22. | Relative level of V.F. 4 wire terminating Points: | 22. | é é é é é é é é é |
| a. | Send leg | a. | é é é é é é é é é |
| b. | Receive leg | b. | é é é é é é é é é |
| 23. | Permissible limits for level variation with frequency relative to 800 Hz in a speech channel (without companders) transmitted over a pair of terminals connected back to back. | 23. | é é é é é é é é é |
| 24. | Variation in overall loss of speech circuit with a pair of PLC terminals connected back to back (without companders and limiters) when voice frequency input level changes from 10 to 0 dBm. | 24. | é é é é é é é é é |
| 25. | Psophometric Noise contribution of a pair of PLC terminals connected back to back. | 25. | é é é é é é é é é |
| 26. | Noise frequency Band width | 26. | é é é é é é é é é |
| 27. | Group delay distortion in the frequency band relevant to the transmission of protection signals. | 27. | é é é é é é é é é |
| 28. | Signal Delay with Two PLC Terminals connected back to back. | 28. | é é é é é é é é é |
| 29. | Power supply requirements | 29. | é é é é é é é é é |
| a. | Voltage | a. | é é é é é é é é é |
| b. | Permissible voltage variation | b. | é é é é é é é é é |
| c. | Maximum current | c. | é é é é é é é é é |
| 30. | Installation details | 30. | é é é é é é é é é |
| 31. | Metrs provided on Test Panel, their range and purpose. | 31. | é é é é é é é é é |
| 32. | Is the equipment suitable to work in Dust laden atmosphere without air conditioning? | 32. | é é é é é é é é é |
| 33. | Whether interior lamps with door switch is provided in cabinets. | 33. | é é é é é é é é é |
| 34. | Overall dimensions | 34. | é é é é é é é é é |
| a. | Length | a. | é é é é é é é é é |
| b. | Width | b. | é é é é é é é é é |

| | | | |
|---|---|---|---|
| c | Height | c | é é é é é é é é é |
| 35. | Weight | 35. | é é é é é é é é é |
| 36. | Insulation level | 36. | é é é é é é é é é |
| 37. | Cabinet earthing details | 37. | é é é é é é é é é |
| 38. | Whether indication is available in sending end panel for receipt / execution of trip signal / command at remote end. | 38. | é é é é é é é é é |
| 39. | Whether Tx/Rx loop-back facilty is available for testing locally. | 39. | é é é é é é é é é |

**VF Transmission Terminal For**
**Network Protection Signals**
**(Protection Coupler)**

| | | | |
|---|---|---|---|
| 1. | Name of Manufacturer and Country | 1. | é é é é é é é é é |
| 2. | Type, Model and Catalogue Number | 2. | é é é é é é é é é |
| 3. | Whether equipment works on frequency shift principle of coded signal principle | 3. | é é é é é é é é é |
| 4. | Whether Equipment is suitable for Independently Protecting Two Circuits | 4. | é é é é é é é é é |
| 5. | Frequencies used in the equipment for transmission of signal for un-coded Signal transmission: | 5. | é é é é é é é é é |
| a. | Guard frequency | a. | é é é é é é é é é |
| b. | Working frequency (Trip System ï I) | b. | é é é é é é é é é |
| c. | Working frequency (Trip System ï II) | c. | é é é é é é é é é |
| d. | Working frequency (Trip System ï I & II) | d. | é é é é é é é é é |
| 6. | Criteria used for command Transmission | 6. | é é é é é é é é é |
| 7. | Whether equipment is protected against Tripping by Spurious Signals. | 7. | é é é é é é é é é |
| 8. | Transmission time corresponding to telegraph speed for transmission on PLCC channel of coded signal | 8. | é é é é é é é é é |
| a. | 600 Bds. | a. | é é é é é é é é é |
| b. | 400 Bds. | b. | é é é é é é é é é |
| c. | 200 Bds. | c. | é é é é é é é é é |
| 9. | Whether in the presence of spurious signals as well as Protection Signals simultaneously, the equipment will initiate a Trip Command | 9. | é é é é é é é é é |
| 10. | Mode of Transmission of guard signal | 10. | é é é é é é é é é |
| 11. | Whether equipment is suitable for Direct Circuit Breaker tripping. | 11. | é é é é é é é é é |
| 12. | Maximum number of Noises Impulses pps in presence of which the equipment will satisfactorily perform its duty. | 12. | é é é é é é é é é |
| 13. | Signal Delay with Two Terminals connected back to back. | 13. | é é é é é é é é é |

| | | | |
|---|---|---|---|
| 14. | Whether the Command Signal is acknowledged at receiving end and in the event of non-receipt of the correct signal, the command is repeated or not by the transmitter? | 14. | é é é é é é é é é |
| 15. | Whether it is possible to alter the priority of commands of various codes at site. | 15. | é é é é é é é é é |
| 16. | What are the performance based results under severe line noise conditions for : | 16. | é é é é é é é é é |
| a. | False trip probability | a. | é é é é é é é é é |
| b. | Fail to trip probability | b. | é é é é é é é é é |
| 17. | Transmitter Input Requirements (Contact Ratings) | 17. | é é é é é é é é é |
| a. | Voltage | a. | é é é é é é é é é |
| b. | Current | b. | é é é é é é é é é |
| c. | Power | c. | é é é é é é é é é |
| d. | No. of Contacts | d. | é é é é é é é é é |
| 18. | Receiver Output (Contact Rating) | 18. | é é é é é é é é é |
| a. | Voltage | a. | é é é é é é é é é |
| b. | Current | b. | é é é é é é é é é |
| c. | Power | c. | é é é é é é é é é |
| d. | No. of Contacts | d. | é é é é é é é é é |
| 19. | Additional facilities provided in Receiver output | 19. | é é é é é é é é é |
| 20. | Supervisory and Alarm Contact Facilities | 20. | é é é é é é é é é |
| a. | Current | a. | é é é é é é é é é |
| b. | Voltage | b. | é é é é é é é é é |
| c. | No. of contacts | c. | é é é é é é é é é |
| 21. | Installation | 21. | é é é é é é é é é |
| 22. | Power Supply | 22. | é é é é é é é é é |
| a. | Voltage | a. | é é é é é é é é é |
| b. | Current | b. | é é é é é é é é é |
| c. | Power | c. | é é é é é é é é é |

| | | | |
|---|---|---|---|
| 23. | Type and number of countries for recording the number of Trip Commands sent and number of Trip Commands received | 23. | é é é é é é é é é |
| 24. | Whether loop test is possible | 24. | é é é é é é é é é |
| 25. | Insulation Level | 25. | é é é é é é é é é |
| 26. | Whether the equipment is suitable for transmitting and receiving more than two independent commands (please give full details) | 26. | é é é é é é é é é |

**EPAX**

| | | | |
|---|---|---|---|
| 1. | Name of Manufacturer | 1. | é é é é é é é é é |
| 2. | Type of Model | 2. | é é é é é é é é é |
| 3. | Number of subscriber lines | 3. | é é é é é é é é é |
| a. | Wired for | a. | é é é é é é é é é |
| b. | Equipped for | b. | é é é é é é é é é |
| 4. | Number of trunk line provided | 4. | é é é é é é é é é |
| a. | Wired for | a. | é é é é é é é é é |
| b. | Equipped for | b. | é é é é é é é é é |
| 5. | Whether the facility to bar Subscribersô access to the carrier lines is provided during maintenance? | 5. | é é é é é é é é é |
| 6. | Whether P.G. lockout facility provided along with alarm? | 6. | é é é é é é é é é |
| 7. | Whether alarm type fuse provided for audio and visual indications? | 7. | é é é é é é é é é |
| 8. | Whether suitable for satisfactory operation in conjunction with PLCC system | 8. | é é é é é é é é é |
| 9. | Signalling Pulse width: | 9. | é é é é é é é é é |
| a. | Engage Pulse | a. | é é é é é é é é é |
| b. | Priority pulse | b. | é é é é é é é é é |
| c. | Digit pulse | c. | é é é é é é é é é |
| d. | Inter Digit Pause | d. | é é é é é é é é é |
| e. | Release Pulse | e. | é é é é é é é é é |
| 10. | Operating Voltage | 10. | é é é é é é é é é |
| 11. | Power Requirement | 11. | é é é é é é é é é |
| 12. | Overall dimensions | 12. | é é é é é é é é é |
| 13. | Mounting arrangement | 13. | é é é é é é é é é |
| 14. | Weight | 14. | é é é é é é é é é |
| 15. | Type of Switching | 15. | é é é é é é é é é |
| 16. | Whether four-wire interfaces are built-in | 16. | é é é é é é é é é |

| | | |
|---|---|---|
| 17. | In case four-wire interfaces are built-in maximum number of PLC terminals which can be connected to single EOAX. | 17. é é é é é é é é é |
| 18. | Whether self-diagnostic and monitoring features are built-in | 18. é é é é é é é é é |
| 19. | Whether the following facilities are built-in: | 19. é é é é é é é é é |
| a. | Priority cutting | a. é é é é é é é é é |
| b. | Conference | b. é é é é é é é é é |
| c. | Alternate routing | c. é é é é é é é é é |
| d. | Call transfer | d. é é é é é é é é é |
| 20. | Maximum loop resistance permissible | 20. é é é é é é é é é |
| a. | For trunk line | a. é é é é é é é é é |
| b. | Subscriber lines | b. é é é é é é é é é |
| 21. | Whether suitable to work in conjunction with electro-mechanical PAX | 21. é é é é é é é é é |
| 22. | Whether suitable tow ork with DOT leased lines. | 22. é é é é é é é é é |

**Electronic 4 Wire E/M Interface & Remote Subscriber Unit**

| | | | |
|---|---|---|---|
| 1. | Manufacturerôs Name | 1. | é é é é é é é é é |
| 2. | Type and Model | 2. | é é é é é é é é é |
| 3. | No. of directions upto which it can handle the calls | 3. | é é é é é é é é é |
| 4. | Whether the selector is provided with a busy key if required for maintenance | 4. | é é é é é é é é é |
| 5. | No. of simultaneous conversations which the equipment can handle. | 5. | é é é é é é é é é |
| 6. | Signalling Pulses | 6. | é é é é é é é é é |
| a. | Engage Pulse | a. | é é é é é é é é é |
| b. | Priority Pulse | b. | é é é é é é é é é |
| c. | Digit Pulse | c. | é é é é é é é é é |
| d. | Inter Digit Pause | d. | é é é é é é é é é |
| e. | Release Pulse | e. | é é é é é é é é é |
| 7. | Whether optional free line selector facility possible? | 7. | é é é é é é é é é |
| 8. | Whether supervision self diagnostic and alarm facilities provided? | 8. | é é é é é é é é é |
| 9. | Insulation level | 9. | é é é é é é é é é |
| 10. | Operating Voltage | 10. | é é é é é é é é é |
| 11. | Power requirements | 11. | é é é é é é é é é |
| 12. | Overall dimensions | 12. | é é é é é é é é é |
| 13. | Weight | 13. | é é é é é é é é é |
| 14. | Mounting arrangement | 14. | é é é é é é é é é |
| 15. | Whether internal A.C. ringing facility available | 15. | é é é é é é é é é |
| 16. | Telephone instrument to be used is ordinary two wire auto dial type or other wire type. | 16. | é é é é é é é é é |

**Frequency Planning Details**

| Lines for which Frequency Planning done | Voltage Rating | Year of Commissioning of PLCC Link | Whether Computer study done | No. of Channels |
|---|---|---|---|---|
| 1.<br>2.<br>3.<br>4.<br>5.<br>6.<br>7. | | | | |

| Facilities for Computer Study | Name of Organisation where computer studies are done | Date Required for each Line |
|---|---|---|
| | | |

Bidder may attach additional sheets of similar format, if required.

**RAJASTNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT MAMAGEMENT UNIT)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

# FIBER OPTIC TERMINAL EQUIPMENT

**Part-10 (Section-II)**

**Superintending Engineers (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-10 (Section-II)**

# TECHNICAL SPECIFICATION FOR

# FIBER OPTIC TERMINAL EQUIPMENT

## SDH (STM-1) Equipment with integrated Access Multiplexer

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## TECHNICAL SPECIFICATION FOR FIBER OPTIC TERMINAL EQUIPMENT

### 1.0 Scope of Specification

RRVPNL is installing OPGW in various 400kV lines to meet the growing need for high speed data network and digital teleprotection. The details of the Sub-stations and 400kV lines covered under this project are described elsewhere in this specification. Bidders are required to provide **Fiber Optic Terminal Equipment; SDH (STM-1) with integrated Access Multiplexer** at various locations as per the specification BOQ and meeting the following technical parameters. The OPGW, associated approach cable and it's termination on FODP are included in scope of this specification.

The contractor shall be responsible for complete integration of the Fiber Optic Terminal Equipment with the SCADA, CRP and other associated equipment. All interface data and communication cables are covered under scope of this specification.

Lengths of various line sections are indicated in the specification and are limited to max 225km. The bidder should offer a suitable solution without involving repeater station. The proposed solution may be with booster amplifiers.

The basic channel requirements are generally as follows:

1. Teleprotection commands; three per 400kV or two per 220kV line.
2. One Line differential relay interface per 400kV or 220kV line.
3. LAN ports; four numbers 10/100 baseT, one 100Base-FX and one 1000Base-LX/SX at each node.
4. Eight numbers of E&M interfaces at each node.
5. Eight ports programmable data interface (2 modules of 4 ports each) at each node (other than SLDC/Sub-LDC) and corresponding 8 ports at remote end (nearest SLDC/Sub-LDC).

The desired final channel plan shall be furnished to the contractor within one month of issue of order, for successful implementation. The unit rate of all modules shall be furnished in the bid to take care of price adjustment due to any addition/deletion based on the final channel plan. Also, unit rate of following optional modules shall be furnished in the bid:

1. E1 interface module
2. G.703, 64kbit/s data Interface module
3. Analogue Subscriber Interface modules
4. Any other items

## 2.0 General requirements

The offered equipment should have been working satisfactorily for more than 5 years in telecommunication networks operated by power utilities, as on the bid opening date. Bidder should confirm continuation of regular supply of same model of Fiber Optic Terminal Equipment (for any additional requirement) upto 7 years from the date issue of order and availability of its spare parts for at least 7 years from date of discontinuation of regular manufacture. Discontinuation of regular manufacture must be immediately intimated by the supplier to RVPNL in writing. Bidder must furnish documentary evidence to above effect with the bid. Further, the published MTBF values should also be furnished with the bid.

The digital multiplex equipment shall be designed to operate in electrical high-voltage networks and shall be suitable for installations in substations with harsh environment and high electromagnetic interference. It shall be highly reliable and provide secure communications for real time signals such as voice, SCADA, teleprotection, data including IP/Ethernet and status/control signals. It shall comply with the latest ITU-T recommendations and ETSI standards and be able to be interconnected with legacy multiplex and other telecommunication equipment.

On TRANSPORT LEVEL interfaces for optical transmission on PDH (8Mbit/s), STM-1 (155Mbit/s) shall be available. For connection to higher order transport equipment STM-1 electrical interfaces shall be available.

The equipment shall be software controlled, of modular design and all modules shall form an integrated part of a 19" shelf.

The platform shall have means to cross-connect, drop and insert individual channels (64kbit/s time slots), 2Mbit/s framed (G.704) and unframed (G.703) signals. It shall also support termination and cross connection of VC 12, VC-3 and VC-4.

Equipment protection and various protection schemes shall be supported.

For stations with teleprotection and telecommunication requirements, integrated teleprotection functions (distance and differential protection) have to be provided. External teleprotection equipments are only accepted in stations, where existing equipments have to be extended.

Each network element shall be manageable locally and also from an operation centre. There shall be means available to supervise external/existing equipment via binary signals. It must be possible to access the platform over a TCP-IP network. Access over SDH OHC channel using the OSI protocol shall be possible.

Modules for direct connection to following USER SIGNALS shall be available as plug-in modules for the equipment:

- Analogue subscriber interface: subscriber and exchange side
- 4-wire E&M voice interface
- G.703, 64kbit/s data Interface
- Programmable data interface X.24/V.11, V.24/V.28, V.35, RS485 and Ethernet
- Alarm collection interface
- Teleprotection command interface for distance relays & direct trip
- Optical interface according to IEEE C37.94 for line differential relays
- Binary signal (status and control) interface
- 2Mbit/s electrical interface for unframed signals acc. to ITU-T G.703 and framed signals acc. to G.703 and G.704.
- LAN interface 10/100BaseT electrical interface RJ45, IP/Ethernet
- LAN Interface for 100BaseFX and 1000BaseLX/SX, IP/Ethernet

The modules required presently are indicated in the tender BOQ.

On TRANSPORT LEVEL the equipment shall support the following connection ports:

- Upto Four STM-1 SDH optical ports per module for medium and long distances, with automatic laser shut down programmable on each interface. Out of these, at least 2 ports shall be upgradable to STM-4 in future.
- Up to four STM-1 SDH electrical ports
- Up to eight 8Mbit/s optical ports

All optical ports shall support SFPs (small-factor pluggable unit) for short, medium, long and extra-long optical communication. ALS (Automatic Laser Shut-down) shall be fully supported.

The modules required presently are indicated in the tender BOQ.

### 3.0 Teleprotection Requirements

The Teleprotection and communication system has to ensure the easy and secure function of the teleprotection. Therefore following features have to be provided:

- At least an 8 bit command addressing for teleprotection signal shall be provided to prevent tripping if the signal is inadvertently re-routed through the telecommunication network.
- An automatic and periodic loop test (<100s) has to be provided for a signal delay measurement.
- A switch-over of the teleprotection command in less than 10 ms has to be guaranteed
- The configuration of the teleprotection has to be integrated into the communication configuration tool in order to ensure an easy maintenance.

More details on the requirement of the teleprotection features are defined under the Teleprotection Interface.

### 4.0 General Conditions

The equipment shall be capable of functioning as a terminal, in 'through connection' (transit, repeater) mode and as add-drop multiplex. First order multiplexing (2Mbps), second order multiplexing (8Mbps) and STM-1 multiplexing shall be integrated. Conference for voice channels and point to multipoint function for data signals shall be possible. The equipment shall be of fully modular design.

#### 4.1 Channel capacity: Digital Cross Connection

The equipment shall be equipped with redundant, decentralised cross-connection functions. The cross-connect capacity shall be at least 40x 2Mbit/s (i.e. 1200x 64kbit/s) and non-blocking. For high-density applications the cross-connect capacity shall be upgradeable up to 128x 2Mbit/s. It shall cross-connect 64kBit/s as well as 2Mbit/s (G.703 unframed and G.704 framed) and VC12. The cross-connect shall be capable of cross-connecting the SDH overhead with any 64kBit/s timeslot on the system.
On addition the equipment shall offer an SDH cross-connect capacity of at least 4xVC-4 in the same equipment.

#### 4.2 Redundant centralised functions

The equipment shall be equipped with redundant circuits for all centralised functions.

#### 4.3 Power Supply

The multiplex equipment shall operate from a nominal 48Volt-DC battery with positive ground. The equipment shall work satisfactorily over battery voltage variations of + / – 15% (40.8 volts through 55.2 volts). Redundant power-supply (N+1 protection) shall be supported. The equipment shall support dual power feed i.e. that two power sources can be connected directly to the equipment (two connection points).

#### 4.4 Safety

The equipment shall be safe to use and shall comply with EN 60950 class V1.

#### 4.5 Electromagnetic compatibility and safety regulations

The equipment shall comply with the EN50022 class A, EN50082, IEC 801-2, IEC 801-6 and shall be conformant with CE.

#### 4.6 Ambient Conditions

Storage and transport:

. Temperature range: - 25°C ... +70°C
Humidity: max. 98% (no condensation)

Operation;

| | |
|---|---|
| Temperature range: | - 5°C ... +55°C |
| for Ethernet: | - 5°C ... +45°C |
| Humidity: | max. 95% (no condensation) |

#### 4.7 Mechanical construction

The equipment shall be available as a 19" shelve to be mounted in a 19" rack or 19" cabinet. It shall be of robust design. All modules shall be integrated in the same shelf. All connectors shall be accessible from the front and comply with international specifications. The minimum cabinet depth required shall be stated.

#### 4.8 Network configuration/management system

The network management system (NMS) shall have facilities to supervise, monitor, control and configure each equipment and the whole network. It shall have capabilities of fault, configuration, performance and security management. It shall provide various graphical views to the network such as geographical overview, logical network structure, and hierarchical view. The network management system shall allow to define different user profiles.

A comprehensive alarm management shall show current alarms such, that icons of the network elements change their colours according to the alarm level. The alarms shall be categorised as critical, major, minor alarms and of the warnings and a summary shall indicate the total number of them in the entire network. An alarm list shall list all alarms of the entire network according to the time of their occurrence. It shall be possible to filter alarms with various filter criteria. Operators shall be able to add comments to the alarms.

The DCN (Data Communication Network) to access all Network Elements shall be based on TCP-IP. - The management system shall offer an SNMP interface for alarm integration into higher order networks.

#### 4.9 Local User Terminal

It shall be possible to connect the craft terminal to any Network Element in the network using the TCP-IP protocol. The craft terminal shall support configuration, maintenance, and status information. It shall provide a 'windows' oriented user interface.

#### 4.10 1+1 Path protection

The equipment shall provide means to protect 64kBit/s channels. The protection shall be end to end from one interface (telephone or data) to the other. It shall switch automatically from the main channel to the standby channel. It shall be configurable whether the system switches back to the main channel (reversible switching) or not (non-reversible).
If a path has switched to its standby route because the main route is disturbed this shall be indicated with an alarm. The switching shall be

done within the multiplexer without using the Network Management System.

### 4.11 1+1 Section protection

The equipment shall provide means to protect STM-1 (MSP). It shall be possible to use two independent links: one as the main and the other as the standby. The system shall automatically switch to the standby connection and generate an alarm if the main connection is disturbed.
The switching shall be done within the multiplexer without using the Network Management System.

### 4.12 Network Topology

It shall be possible to build point to point, linear, ring, T, and meshed networks.

### 4.13 Synchronisation

It shall be possible to synchronise the equipment using an external clock source, derived from a network or with an internal oscillator. The synchronisation shall be configurable and it shall be possible to distribute the synchronisation to other equipment as well. The system shall have the means of switching to select the synchronisation source as well as a means of preventing the system from creating synchronisation loops. The equipment shall be capable of selecting the source of synchronisation by means of SSM (Synchronisation Status Messaging) on 2Mbit/s PDH or SDH port or by means of a priority-based sequence.
For teleprotection event recording it shall be possible to synchronise the clock of all teleprotection interfaces with one GPS in one station. The GPS time shall be distributed over the teleprotection channel.

### 4.14 Alarms

Each module shall supervise its functions and shall have an alarm-indication LED on its front. All alarms shall be collected by the NMS. Each node shall be capable of collecting up to 50 external alarms.

### 4.15 Test Loops

The equipment shall provide means to loop signals on 64kBit/s level as well as on 2Mbit/s level. It shall indicate an alarm if a loop is activated.

### 4.16 Maintenance facilities

Every Network Element shall have a built-in Signal Generator and Analyser to analyse communication paths. It must be possible to connect the Generator and Analyser to the communication channels and terminate the signal on other Network Elements. It shall be possible to configure circuits locally with the craft terminal and remotely from the NMS or the craft terminal. It shall be possible to loop-back signals locally and remotely using the craft terminal or the NMS.

## 5.0 Requirements for Transport Level

### 5.1 SDH Modules

The interface shall be designed for use on single mode fibre (conforming to ITU-T G.652 or G.655). The interface card shall be based on SFP technology and use LC/PC connectors.
The following main functions shall be supported:

- Prepared for SFPs (small-factor pluggable units) for short, medium, long and extra-long optical communications (1310nm and 1550nm)
- Termination of the OS-, RS-, MS- and VC-4 layer
- Extraction and insertion of the SOH communications information
- Through connections of VC-12, VC-3 and VC-4
- Support MSP (Multiplex Section Protection)

The following maintenance functions shall be supported:

- Status indications
- Loops
- Restart after ALS
- TTI monitoring
- BIP Error Insertion

The following SDH interfaces shall be available:

- STM-1 (155Mbit/s) optical 1-port or 4-port interface
- STM-1 (155Mbit/s) electrical 1-port interface

### 5.2 PDH Modules

An 8Mbit/s module for optical communication on 1310nm or on 1550nm shall be available. Each module shall provide at least 4x 2Mbit/s (G.703) electrical ports and have an integrated switch matrix to convert the incoming optical signal directly into electrical G.703 signals.

## 6.0 User signal interfaces

### 6.1 4-Wire Interface (VF interface)

This module shall provide 8 connections for voice channels with a bandwidth of 300 Hz - 3.4 kHz and 2 signalling channels (M => E, M' => E') per voice channel. Each voice channel shall be configurable to operate with or without CAS. With CAS it shall use the "a" and "b" bits for the two signalling channels.
The level shall be software adjustable within the following range:

- Input: +7.5 to -16dBr
- Output: +7.0 to -16dBr

Modules where each voice channel can be individually configured with 1+1 path protection shall be available.

### 6.2 Analogue Subscriber Interface (FXS)

A module with at least 10 subscribers as well as high-density module for up to 30 subscribers shall be available. The ringing generator shall be integrated on the subscriber module. The ringing frequency shall be adjustable for 20Hz, 25Hz, and 50Hz.
The following main functions shall are supported:
Downstream signaling

- Ringing, Metering, Polarity reversal, Reduced battery, No battery

Upstream signaling

- On/off-hook, Pulse and DTMF dialing, Flash impulse, Earth key

General:

- Constant current line feeding, Line test, Permanent line checks, CLIP (On-hook VF transmission), Metering after on-hook

### 6.3 Exchange Interface (FXO)

This module shall provide at least 10 ports for connection to the ports for remote analogue subscribers of a telephone exchange (PAX, PABX). It shall provide the following functions:

- pulse dialing, tone dialing (DTMF), earth key function, metering function(12 kHz or 16 kHz), flash impulse, polarity reversal, indication of busy lines

The following parameters shall be configurable by software:

- Input voice level -5 .. +4dBr, output voice level -7.5 .. -1dBr
- metering pulse enable/disable, signaling bit definition,
- loop back of voice to the telephone

### 6.4 Party line Telephone System (Engineering Order Wire)

An engineering order wire (EOW) facility shall be provided at each multiplexer. Following options shall be available:

- The EOW shall be configured as a party line and use in band DTMF signaling to call another EOW-Terminal. The Terminal shall have an integrated DTMF decoder allowing to program a subscriber call number (1..4 digits), and two group call numbers (1..4 digits each).
- EOW based on Voice over IP (VoIP). The EOW traffic shall be routed over the management channel.

### 6.5 Data Interfaces

Following interfaces shall be available:

- V.24/V.28, V.11/X.24, V.35, RS485

Following bit rates shall be supported:

- Synchronous and asynchronous: 0.6 é 38.4kbit/s
- Synchronous: 48, 56, Nx 64kbit/s (n = 1 é 31)

Following options shall be available:

- 1+1 path protection, Sub rate multiplexing, Point-Multipoint, Performance Monitoring

### 6.6 64kbit/s Co-directional Interface

This module shall comply with the ITU-T G.703 part 1.2.1 for co-directional data transfer. A module shall have at least 8 interfaces. Modules where each interface can be individually configured with 1+1 path protection shall be available.

### 6.7 IP/Ethernet Interface

Ethernet module shall comply with the following specification:

- Ethernet electrical connection: 10/100BaseT
- Ethernet optical connection: 100Base-FX and 1000Base-LX/SX
- Switching: bypass mode for IEEE Std 802.3 frame or based on port or VLAN tag ID
- WAN capacity: 63x VC-12 or 3x VC-3
- Logical WAN ports (LWP): minimum 8
- Framing: According General Framing Procedure (GFP) ITU-T G.7041
- Capacity: Virtual Concatenation (VCAT) acc. ITU-T G.707
- Protection: Link Capacity Adjustment Scheme (LCAS) acc. ITU-T G.7042

Additionally a module with an integrated Ethernet Router shall be available with following function:

- Ethernet connection: Minimum 10BaseT
- Routing Protocols: Static IP route, OSPF2 V2
- WAN protocols: PPP
- WAN capacity: Nx 64kbit/s (n=1 to31)
- WAN-ports: > 30

Additionally a module with Power over Ethernet shall be available to power e.g. camera, telephone set (Voice over IP).

### 6.8 Alarm Interface

This module shall provide means to collect minimum 8 external alarms, which shall be displayed on the Network Management System. It shall be used to supervise external equipment by the Network Management System.
Minimum 4 outputs shall be available, which can be switched by the Network Management System. It shall be possible to connect an input to an output so that if an alarm occurs, the output contact will be switched.
It shall be possible to label an alarm. The label-text shall be read from the interface module so that it can be indicated on the Network Management System as well as on the local craft terminal.

### 6.9 Module to transmit Protection Commands

This module shall support the following features related to the protection commands:

- Transmit 4 protection commands bi-directionally. Each command shall be programmable for permissive, blocking or direct trip functions.

- Accept protection command signals in the range of 24VDC é 250VDC (site programmable) directly from station battery without involving any intermediate converter.
- All inputs and outputs shall independent and be isolated and with EMC immunity for harsh environment.
- Security and Dependability shall be selectable and programmable.

It shall also be able to drop and insert commands, transfer commands as a transit station and to realize AND- and OR-combinations between commands. The module shall support T-node configurations.

The teleprotection module shall provide

- an integrated non-volatile event-recorder, which shall synchronized either internally or by external Global Positioning System (GPS) clock.
- A command counter, which counts trip commands.

The teleprotection module shall further support:

- Signal delay measurement
- 1+1 protection, switching shall be done within less than 4ms (typical value)
- Periodically automatically initiated loop-tests (e.g. every 60s).
- Command addressing: This function shall be used to prevent tripping if the signal is inadvertently re-routed through the telecommunication network

Under no circumstances will the module cause trip-commands in case of power supply failure or when equipment is put into or taken out of service.

### 6.10 Module to interface directly with Line Differential Relays (Optical interface)

This module shall have 4 optical ports each of them allowing direct connection to protection relays with interfaces complying with ANSI/IEEE C37.94. Each interface shall support all 12 time slots (12x 64kbit/s) in accordance with ANSI/IEEE C37.94.

The ports shall be configurable to be used also for connection with protection relays using the former interface operate according to IEC 870-5-1, format class FT 1.2 on 1300nm using MCMI line coding.

### 6.11 Module for transmission of Binary Signals

This interface shall provide means to transmit binary signals and support the following features:

- Isolated inputs and outputs (I/O)
- Accepting I/O for 24 é 60VDC.
- Outputs shall be solid-state relays.
- The interface shall provide a 24VDC auxiliary power supply, short circuit proof.

### 6.12 2 Mbit/s Interface according to ITU-T G.703 and G.704

This module shall comply with the ITU-T G.703 / G.704 recommendations and also allow transparent 2Mbit/s signals complying with G.703.
The module shall have at least 4x 2Mbit/s interfaces, each of which may be individually activated. It shall be possible to have up to 126 x 2Mbit/s interface modules in a multiplexer.
Features:

- Impedance of 120 ohms and 75 ohms
- Supporting CRC-4 multi-frame according to ITU-T G.704 (enabled and disabled by software).
- The CAS signaling according to ITU-T G.704 table 9 shall be activated optionally.
- 2Mbit/s loop-back of the incoming signal as well as the loop-back of the internal signals.

The interface shall be able to extract the 2.048MHz clock for synchronization of the multiplex equipment.

### 7.0 Optical Amplifier System:

In order to achieve the distances upto 250 Kms, Optical amplifier systems shall be proposed along with the FOTE system. The optical Amplifier system shall consist of the following components:

Wavelength Translator Unit:
The WT shall interface 1310 nm –short-haul data transmission equipment to optically amplified systems. The line transmitters and receivers of the WT series shall be designed to to reach maximum distance with minimum equipment.
Wavelength Converter Unit:
The WC shall interface 1310 nm –short-haul data transmission equipment to optically amplified systems. The line transmitter and receivers of the WC series shall be designed effective receiver for long haul transmission systems
Power Amplifier:
The power-amplifier system shall be installed right after the transmission equipment; it shall provide post amplification of the signal into the link. The unit shall provide a saturated output signal power of 10 to 24 dBm.
Pre Amplifier:
PreAmplifier system shall operate as a pre-amplifier. It shall be installed right before the receive equipment; it shall provide pre-amplification of the signal from the link.
Raman Amplifier
The Raman amplifier system shall consist of multiplexed laser diode Raman pump source to provide up to 12 dB of optical gain, and 3-4 dB of system improvement for links where extra margin is required. The unit shall be inserted at the receive end of the fiber link.

***Features should include:***

- Data rates including STM-1/OC3, STM-4/OC12, and STM-16/OC48 and multi-rate
- Dual input power supply
- CRAFT terminal interface
- Remote alarm indication through dry contact relays
- External inputs, reset, disable

***Physical Specifications:***

- Package 19" or 23" rack or ETSI compatible rack

***Equipment Management:***

- Craft Terminal Interface Proprietary through RS-232 serial link
- Alarms Outputs Relay contact for alarms
- External Inputs Emergency shutdown, forced reset

**APR (Automatic Laser Shut-Down) mechanism**

The **APR** mechanism shall be implemented on systems that use Boosters and Pre-Amplifier. On the presence of a fiber cut or fiber degradation, a LOS shall be detected on the Pre-amplifier and, through an Ethernet switch used to connect the equipment to the management system, it shall send a tele command to reduce by 30% the Booster output power. In this situation the Pre-amplifier, on the other station, will also detect a LOS and reduce the Booster output power. After the fiber restoration is done, the Pre-amplifiers should be put at their nominal output power through the management network and the system would return to normal operation.
This mechanism can be enabled or disabled through the management system.

These Optical Amplifier systems shall be 19" rack mountable or Din rail mountable and of 1U height.

Bidder shall design the Optical Amplifier system as per the Distances and Optical Power Budget Link Calculations shall be furnished with the bid.

Please refer the tender BOQ for further details.

Bidder must submit Optical Power Budget calculation sheet keeping in view sufficient Optical Power Budget Reserve Margins of Min 6 dBm.

### 8.0 Summary of Standards

The Equipment shall comply with the latest ITU-T recommendations for the plesiochronous and synchronous hierarchies. The equipment shall be KEMA type tested. In particular the mentioned recommendations shall be covered:

**ETSI**

- ETSI EN 300 386 V1.3.2 (2003-05):
  - Electromagnetic compatibility and Radio spectrum Matters (ERM)
  - Telecommunication network equipment; Electromagnetic Compatibility (EMC) requirements

- 7.2.1 Equipment operating in telecommunication centers.
- 7.2.2 Equipment operating in locations other than telecommunication centers.

**IEC**

- IEC 61000-6-2 (1999-01):
  - Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments.
- IEC 61000-6-5 (2001-07):
  - Electromagnetic compatibility (EMC) - Part 6-5: Generic standards - Immunity for power station and substation environments. Test: 1.2, 1.3, 2.3 and 2.5

**IEEE**

- IEEE C37.1 (1994): Definition, Specification and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control - 6.6 Electromagnetic interference (EMI) and electromagnetic compatibility (EMC).
- IEEE C37.90.2 (1995): Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
- IEEE C37.94 : IEEE Standard for Nx 64kbit/s Optical Fiber Interfaces Between Line Differential relay and Multiplexer Equipment

The PDH interfaces shall conform to the following recommendations:

**ITU**

- ITU-T G.702: General aspects of digital transmission systems ï Terminal equipment - Digital hierarchy bit rates
- ITU-T G.703: Digital transmission systems ï Terminal equipment ï General Physical/electrical characteristics of hierarchical digital interfaces
- ITU-T G.704: Digital transmission systems ï Terminal equipment ï General Synchronous frame structures used at 1544, 6312, 2048, 8448 and 44 736kbit/s hierarchical levels
- ITU-T G.706: General aspects of digital transmission systems ï Terminal equipment - Frame alignment and cyclic redundancy check (CRC) procedures relating to basic frame structures defined in recommendation G.704
- ITU-T G.711: Pulse code modulation (PCM) of voice frequencies
- ITU-T G.712: Transmission performance characteristics of pulse code modulation channels
- ITU-T G.732: General aspects of digital transmission systems ï Terminal equipment - Characteristics of primary PCM multiplex equipment operating at 2048kbit/s
- ITU-T G.735: Characteristics of primary multiplex equipment operating at 2048kbit/s and offering synchronous digital access at 384kbit/s and/or 64kbit/s
- ITU-T G.736: General aspects of digital transmission - Characteristics of a synchronous digital multiplex equipment operating at 2048kbit/s
- ITU-T G.737: Characteristics of external access equipment operating at 2048kbit/s and offering synchronous digital access at 384kbit/s and/or 64kbit/s
- ITU-T G.823: The control of jitter and wander within digital networks, which are based on the 2048kbit/s hierarchy
- ITU-T G.826: Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate

The architecture of optical SDH interfaces shall conform to the following recommendations:

**ETS/EN**

- ETS 300 147: Synchronous digital hierarchy multiplexing structure
- ETS 300 417: Transmission and Multiplexing (TM); Generic requirements of transport functionality of equipment
- ETS 300 417-1-1 / EN 300 417-1-1 V1.1.2: Generic Processes and Performance
- ETS 300 417-2-1 / EN 300 417-2-1 V1.1.2: SDH and PDH Physical Section Layer Functions
- ETS 300 417-3-1 / EN 300 417-3-1 V1.1.2: STM-N Regenerator & Multiplex Section Layer Functions
- ETS 300 417-4-1 / EN 300 417-4-1 V1.1.2: SDH Path Layer Functions

**ITU**

- ITU-T G.707: Network node interface for the synchronous digital hierarchy
- ITU-T G.783: Characteristics of synchronous digital hierarchy (SDH): equipment functional blocks
- ITU-T G.803: Architecture of transport networks based on the synchronous digital hierarchy (SDH)
- ITU-T G.805: Generic functional architecture of transport networks
- ITU-T G.826: Error performance parameters and objectives for international, constant bit rate digital paths at or above the primary rate
- ITU-T G.841: Types and characteristics of synchronous digital hierarchy (SDH) network protection architectures
- ITU-T G.957: Optical interfaces for equipment and systems relating to the synchronous digital hierarchy
- ITU-T G.958: Digital line systems based on the synchronous digital hierarchy for use on optical fiber cables
- ITU-T M.2101.1: Performance limits for bringing into service and maintenance of international SDH paths and multiplex section
- ITU-T T.50: International Reference Alphabet (IRA) - Information technology 7 bit coded character set for information interchange

The synchronisation and timing of optical SDH interfaces shall conform to the following recommendations:

**ETS/EN**

- ETS 300 417-6-1 / EN 300 417-6-1 V1.1.2: Synchronisation Layer Functions
- ETS 300 462-1 / EN 300 462-1-1 V1.1.1: Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 1: Definitions and terminology for synchronization networks
- EN 300 462-4-1 V1.1.1: Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 4-1: Timing characteristics of slave clocks suitable for synchronization supply to Synchronous Digital Hierarchy (SDH) and Plesiochronous Digital Hierarchy (PDH) equipment
- ETS 300 462-5 / EN 300 462-5-1 V1.1.2: Transmission and Multiplexing (TM); Generic requirements for synchronization networks; Part 5: Timing characteristics of slave clocks suitable for operation in Synchronous Digital Hierarchy (SDH) equipment

**ITU**

- ITU-T G.813: Timing characteristics of synchronous digital hierarchy (SDH) equipment slave clocks (SEC)

## 9.0 Abbreviations

AAL ATM Adaptation Layer
ADM Add-drop multiplexed
ATM Asynchronous Transfer Mode
ALS Automatic Laser Shutdown
BIP Bit Interleaved Parity
CAS Channel Associated Signalling
CAP Carrier-less Amplitude and Phase
CRC Cyclic Redundancy Check
DTMF Dual Tone Multi-Frequency
EN European Norm
EOW Engineering Order Wire
ETS European Telecommunications Standards
GPS Global
HDSL High Density Subscriber Line
IEC International Electrical Commission
ITU International Telecommunication Union
IP Internet Protocol
ISDN Integrated Services Digital Network
MCMI Multi Coded Mark Inversion
MS Multiplex Section
NE Network Element
NMS Network Management System
LAN Local Area Network
OS Optical Section
OSPF Open Shortest Path First
PDH Plesiochronous Digital Hierarchy
PPP Point-to-Point Protocol
RS Regenerator Section
SDH Synchronous Digital Hierarchy
SNMP Simple Network Management Protocol
SOH Section Overhead
STM Synchronous Transport Module
TCP Transmission Control Protocol
TTI Trail Trace Identifier
VC Virtual Container
VF Voice Frequency

**Annexure-I**

## Table of compliance

Data about offered equipment is to be filled in by the bidder.

Name of Manufacturer: _____

Model: _____

Type: _____

| | | REQUIRED | OFFERED |
|---|---|---|---|
| **GENERAL:** | | | |
| Type of multiplexer | | SDH: ADM | |
| Complying to ITU-T rec. | | Yes | |
| Transmission Capacity | Mbit/s<br>Mbit/s | STM-4: 622<br>STM-1: 155 | |
| Access capacity on 64kbit/s | channels | Minimum 200 | |
| Access capacity on 2Mbit/s | channels | Minimum 40 | |
| Redundant central processor | | Shall be available | |
| Digital cross connect function | | Fully non-blocking | |
| PDH cross connect capacity | | Minimum 40x2Mbit/s | |
| SDH cross connect capacity, high order | | Minimum 4x VC4 | |
| Equipment used in substation environment | | List of 10 reference substation projects | |
| The equipment is KEMA type tested | | YES | |
| **Teleprotection interface:** | | | |
| Integrated distance teleprotection interface | | YES | |
| Integrated optical teleprotection interface | | YES | |
| Addressing of protection commands | | YES | |
| Loop test for measuring delay time | | YES | |
| 1+1 switch-over less than 10ms | | YES | |
| **TRANSPORT LEVEL: Interfaces:** | | | |
| SDH based on SFP technology | | YES | |
| Electrical SDH interface | | YES | |
| Optical 8Mbit/s interface | | Yes | |
| HDB3, 2Mbit/s interfaces per module | No. | Minimum 8 | |
| Complying to ITU-T rec. | | G.703, transparent G.704, selectable | |
| | | | |
| **USER interfaces** | | | |
| **Voice interfaces for trunk lines:** | | | |
| 1+1 com path protection, individually programmable | | YES | |

| | | | |
|---|---|---|---|
| Analogue, 4wire with E&M: Input level<br>Output level | dBr | +7.5 to ï 16<br>+7.0 to ï 16.5 | |
| Analogue, 2wire with E&M: Input level<br>Output level | dBr | +6.5 to ï 12.5<br>ï 1.0 to -20 | |
| Digital, 2Mbit/s CAS or PRI | | YES | |
| **Voice interfaces for remote subscriber:** | | | |
| 2wire, subscriber side | dBr | -5 é +4 / -7.5 ... -1 | |
| Minimal number of subscriber | No. | 10 | |
| 2wire, PABX side | dBr | -5 é +4 / -7.5 ... -3 | |
| Minimal number of PABX | No. | 10 | |
| **Integrated teleprotection** | | | |
| Interface for Commands: | | | |
| Number of independent commands | No. | 4 | |
| Transmission time max. | ms | 6 | |
| Signal voltage | Vpeak | 250 | |
| 1 + 1 com path protection | | YES | |
| Interface(s) for Differential Protection: | | | |
| Electrical interface: G.703 | kbit/s | 64 | |
| Optical interface IEC 870-5-1 | kbit/s | Minimum 64 | |
| Optical interface IEEE C37.94 | Channels<br>Time slots | 12 | |
| **Data: interfaces per module** | | | |
| V.24/V.28 (RS-232), V.11/X.24 (RS-422), V.35 and RS485 | number | 4 | |
| Integrated LAN port available on DATA Interface | | YES | |
| Software programmable board available | | YES | |
| Functions available for individual configuration:<br>- 1+1 path protection<br>- point-multipoint<br>- performance monitoring<br>- sub rate multiplexing<br>available for all data interface | | <br>YES<br>YES<br>YES<br>YES<br>YES | |
| **Ethernet interface** | | | |
| Ethernet A: 10/100BaseT<br>1000Base LX/SX<br>L2 switching function<br>WAN capacity<br>Logical WAN ports<br>GFP (acc. ITU-T G.7041)<br>VCAT (acc. ITU-T G.707)<br>LCAS (acc. ITU-T G.7042) | ports<br><br><br>Mbit/s<br>ports<br><br><br> | 4x RJ45 electrical<br>2x optical<br>YES<br>63x VC12 or 3x VC3<br>Minimum 8<br>Yes<br>On VC-12 and VC-3<br>Yes | |
| Ethernet B: 10BaseT<br>L3 Routing function<br>Routing protocols | ports<br><br> | 1x RJ45<br>YES<br>static IP routing | |

| | | | |
|---|---|---|---|
| WAN capacity<br>WAN ports<br>WAN protocol | <br>ports | OSPF2 V2<br>2x 2Mbit/s (64kbit/s granularity)<br>> 30<br>PPP | |
| Ethernet C: Power over Ethernet | ports | Min. 6x RJ45 | |
| **Integrated alarm gathering module:** | | | |
| Number of external alarms per module | No. | Min. 8 | |
| Auxiliary power supply for ext. contacts | | | |
| **Configuration Management:** | | | |
| Type/Name of configuration tool | | | |
| For local / remote operation | | YES / YES | |
| Data communication network (DCN) | | Ethernet / IP | |
| Integrated Management of Teleprotection Command module | | YES | |
| **Network Management System** | | | |
| Type/Name of configuration tool | | | |
| For fault / configuration management | | YES / YES | |
| Data communication network (DCN) | | Ethernet / IP or Ethernet / OSI | |
| Integrated Management of Teleprotection Command Module | | YES | |
| Remote Access package | | YES, please provide details | |
| **Ambient Conditions:** | | | |
| Storage: ETS 300 019-1-1, class 1.2 | °C / % hum | - 25 é + 70°C / 98% | |
| Transport: ETS 300 019-1-2, class 2.2 | °C / % hum | - 25 ... + 70°C / 98% | |
| Operation: ETS 300 019-1-3, class 3.1E<br>For xDSL, ISDN and IP/Ethernet modules | °C / % hum<br>°C / % hum | - 5 é +55°C / 95%<br>- 5 ... +45°C / 95% | |
| **Power Supply** | | | |
| Operation | VDC | 48 (-15/+20%) | |
| Fully redundant power supply | | YES | |
| Dual power feeding | | YES | |

**Emission of the equipment (substation environment)**

| No | Test Name | Description | Basic standard | Class | Comply |
|---|---|---|---|---|---|
| 1.1 | Radiated radio frequency interference | 30 MHz to 1 GHz | EN 55022 | A | |
| 1.2 | Conducted radio frequency interference AC/DC Power supply | 150 kHz to 30 MHz | EN 55022 | A | |

**Immunity of the equipment (substation environment)**

| No | Test Name | Description | Basic standard | Level | Comply |
|---|---|---|---|---|---|
| 2.1 | ESD test | Contact/air discharge | IEC 61000-4-2 | 6 / 8kV | |
| 2.2 | Radiated electromagnetic field | 80 to 1000 MHz, 80% AM, 1 kHz modulated | IEC 61000-4-3 | 10V/m | |
| 2.3 | Radiated electromagnetic field | 1.0 to 2.5 GHz, 80% AM, 1 kHz modulated | IEC 61000-4-3 | 10V/m | |
| 2.4 | Fast transient test | AC/DC Power supply:<br>all other ports: | IEC 61000-4-4 | 4kV<br>2kV | |
| 2.5 | Surge test (1.2/50 μs) | <u>AC/DC Power supply:</u><br>Common mode<br>Differential mode<br><u>DC Power supply 48 V:</u><br>Common mode<br>Differential mode<br><u>Signal terminals:</u><br>Common mode<br>Differential mode<br><u>Telecommunication ports:</u><br>Common mode | IEC 61000-4-5 | <br>2.0kV<br>1.0kV<br><br>0.5kV<br>0.5kV<br><br>2.0kV<br>1.0kV<br><br>1.5kV | |
| 2.6 | Conducted radio frequency interference | 0.15 to 80 MHz, 80% AM, 1kHz modulated | IEC 61000-4-6 | 10V/m (e.m.f.) | |

| No | Test Name | Description | Basic standard | Level | Comply |
|---|---|---|---|---|---|
| 2.7 | Power frequency magnetic field | Continuous<br>Short (1 to 3 s) | IEC 61000-4-8 | 30 A/m<br>300 A/m | |
| 2.8 | Damped oscillatory waves | <u>AC/DC Power supply:</u><br>Common mode<br>Differential mode<br><u>Signal terminals:</u><br>Common mode<br>Differential mode<br><u>Telecommunication ports:</u><br>Common mode<br>1 MHz, 400 Hz repetition rate, 2 s burst duration | IEC 61000-4-12 | <br>2.5kV<br>1.25kV<br><br>2.5kV<br>1.25kV<br><br>2.5kV | |
| 2.9 | Conducted common mode disturbance | Frequency 50 Hz, continuous mode | IEC 61000-4-16 | 10 / 30 Vrms | |

Bidder shall provide all necessary information that deems to be necessary to complete the project in all respects.

## Synchronisation and Test Equipment

Master clock for the synchronisation of SDH equipment: Type XL-DC or similar
Supplier: TrueTime or similar

Optical Power Meter for 1300nm and 1550nm, handheld: OLP-6 or similar
Suppliers: JDSU/Acterna or similar

Digital Communication Analyzer: PFA-35 or similar
for signal analysis on 64kbit/s and 2Mbit/s level
Suppliers: JDSU/Acterna or similar

Optical Time Domain Reflectometer OTDR
Suppliers: Anritsu, Fujicura or similar

Test equipment for Teleprotection Module: Test set or similar
Suppliers: Teleprotection module supplier or similar

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**Battery & Battery Charger**
**Part-11**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**Vol-II Part-11**

**Technical Specification of VRLA Battery & Battery Charger**

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## VOL.II – PART-11

## Technical Specification for Battery & Battery Charger

### 1.0 VRLA BATTERY

### 1.1 SCOPE

The specification covers design, manufacture / fabrication shop test and offer for inspection, testing and checking before delivery of valve regulated lead acid maintenance free battery sets alongwith accessories duly packed suitable for indoor installation in Grid Sub Station. These equipments shall be complete in every respect, details to the functions designated to the entire satisfaction of the purchaser. It is required that the supplier accepting the contract agrees to furnish all apparatus, appliances and material whether specifically mentioned or not but which may be found necessary to complete to perform and testing any of the herein specified equipment(s).

### 1.2 GENERAL

1.2.1 The Battery sets to be supplied by the supplier shall meet the requirement of updated IEC-896-2 :1995 & BS 6290 (Part IV) 1997) and shall be suitable for continuous operation for the climatic conditions specified in the specification. The batteries shall be suitable for float quick charging. The floating voltage shall be regulated to within +/- 1% of the normal voltage when the required load is discharged by the battery.

1.2.2 Battery sets shall be maintenance free, sealed type in thermoplastic containers with minimum expected life of 15 years at 27 deg. Temp. The batteries shall include battery mounting racks and other equipment required to provide a complete operational battery sub system . Battery sets shall be capable of operating at a peak ambient temperature of 50 deg. C. The average ambient temperature shall be 35 deg. C. The offered battery shall be compact and shall require no regular maintenance. All safety equipment required for installation shall be provided by the manufacturer.

### 1.3 CLIMATIC CONDITIONS

The equipment to be supplied against the specification shall be suitable for satisfactory continuous operation under the following tropical conditions :

| | |
|---|---|
| Max. ambient air temperature | 50 deg. C. |
| Max. daily average ambient temp. | 45 deg. C. |
| Max. yearly weighted ambient temp. | 35 deg. C. |
| Min. ambient air temperature | (-) 5 deg. C. |
| Max. humidity | 100% |
| Average number of thunder strom day per annum | 40 |
| Average annual rain fall | 15 cm to 100 cm |
| Number of months during which tropical Monsoon conditions prevail | 4 months (June to Sept.) |
| Altitude above MSL | Varies from 61 meters to 815 Mtrs |
| Sesmic level (Horizontal acceleration) | 0.3 g. |

| | |
|---|---|
| Degree of pollution | Heavy |
| Intensity of solar radiation | 1.0 KW/ Sq.M. |
| Maximum wind load | 195 kg / sq.m. |

## 1.4 GENERAL REQUIREMENT OF BATTERIES

1.4.1 The manufacturer supplying the cells / batteries as per this document shall be responsible to replace / repair free of charge, the battery / cell becoming faulty, owing to defective workmanship or material as per the provisions of the bid document

1.4.2 All electrical and mechanical equipments shall be designed and manufactured so that no damage will result in transportation, installation and operation of the equipment under the climatic conditions to which it will be subjected.

## 1.5 STANDARD

All material and equipments used for battery set shall comply in all respect with the requirements of the latest edition of the relevant Standards. The tenderer shall quote for sealed maintenance free batteries complying to relevant BS:6290 (Part IV-1997) and IEC-896-2/BSEN6089.2, IEEE-1188/1189.

The tenderer shall however furnish all the necessary type test reports / literature and past performance reports of the type of batteries offered with the tender.

## 1.6 MATERIAL AND CONSTRUCTION

### 1.6.1 General

The storage batteries should be fabricated with Flat pasted type positive plates and Flat pasted type negative plates as per relevant standards and shall be assembled in hard containers of durable and robust construction.

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. The cells shall be so designed as to be suitable of horizontal / vertical Stacking.

### 1.6.2 Containers

The containers 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 conditions. 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.

1.6.3 **Cell covers**

The cell covers shall be made of suitable material compatible with the container material and permanently sealed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant and shall comply with the provisions set forth in clause of 1.6.2 above. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

1.6.4 **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 can not be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

1.6.5 **Terminal Posts**

Both the positive and negative 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 resistance 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 positive and negative posts shall be clearly and unambiguously / identifiable. All exposed metal parts (connectors, terminal etc) shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

1.6.6 **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 connections 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. The area of cross-section of the connectors shall be rated at 2 Amps/ sq.mm minimum at 6 hour rate of 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 exposed metal parts (Connectors, terminals etc.) shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

1.6.7 **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.

1.6.8 **Separators**

The separators used shall be 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.

1.6.9 **Stand / Supporting Rack**

Necessary stands / supporting racks for fixing and installing the batteries shall be supplied with cell insulators and stand insulators. These racks/ stands shall be so designed that cells are placed within easy reach at convenient height to facilitate easy maintenance. Minimum number of screw should be used primarily for anchoring. The joining of the frames should not leave crevices and ensure proper and tight fit. Necessary screws etc. should be supplied such that the racks can be filtted without any extra material. Racks shall be constructed so as to permit free access to the floor directly beneath, thus cleaning of both cells and floor is quick and simple task. Racks shall be duly painted with two (2) coats of acid reistance paint and supplied in assembled state with marking.

## 1.7 CAPACITY REQUIREMENT

1.7.1 The battery voltage shall not vary beyond 1% of the nominal voltage under float charge conditions and while discharging at 10 hours rating.

1.7.2 When the battery is discharged at 10 hour rate, it shall be capable to deliver upto 80% of C (rated capacity, corrected at 27 deg. Celsius)

1.7.3 The battery shall be capable of being recharged from the fully exhausted condition (1.75V /cell) at the specified float voltage. The battery design shall permit the charging of the battery at 2.35V(For a short duration) /cell. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

1.7.4 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 minute of discharge | : | 1.98V |
| b) | After six hours of discharge | : | 1.92 V |
| c) | After 8 hours of discharge | : | 1.85 V |
| d) | After 10 hours of discharge | : | 1.75 V |

1.7.5 The bidder shall provide the Tables & Graphs showing relation of the closed circuit voltage, impedance and the residual capacity of each cell in the battery, when it is discharged to the end voltage of 1.75V/cell at C/10 and C/8 rate of discharge. A table and graph showing the relation between the impedance and residual capacity of each cell shall also be provided by the bidder.

1.7.6 Loss in capacity during storage at an average ambient temperature of 35 deg. C. 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 that 80%.

## 1.8 CHEMICAL REQUIREMENT

1.8.1 Oxygen recombination efficiency of cell / battery shall be higher than 95% for charge current C/10 under normal working conditions. The cell pressure shall be sufficient for 99% gas recombination when working at C/10 rate of charge and ambient temperature of 27 deg. Under normal operating conditions grid corrosion shall not be more than 0.05mm/year.

1.8.2 Throughout its life, in the operating condition of C/10 rate of charge and C/8 rate of discharge in average ambient temperature of 35 deg. Celcius, shedding of battery active material shall not lead to short circuit. The growth of positive plate shall be less than 8% of the total plate area throughout the specified life.

1.8.3 While operating in the normal operating conditions, the cell or battery shall not lead to dry out, throughout the life of the battery. Manufacturer shall supply the necessary data to support the requirement. The battery shall not exhibit thermal runaway while working in the average ambient temperature of 35 Deg. C and at a charge rate of C/10 and discharge rate of C/8.

## 1.9 MARKING AND PACKING

### 1.9.1 Marking

The following information shall be indeligibly and durably marked on the outside of the cell.

a) Nominal voltage
b) Manufacturerôs name, type and trade name.
c) AH capacity at 10 hour rate.
d) Voltage for float operation at 20 deg. C with tolerance of (+/-) 1%.
e) Month & year of manufacture.
f) Country of origin
g) S.No. of cell / cell no.

The cells and batteries may also be marked with the ISI certification mark, if any.

### 1.9.2 Packing

The cells shall be suitably packed so as to avoid any loss or damage during transit.

## 1.10 INSTRUCTIONS MANUAL

The manufacturer shall supply three copies of instructions manual for initial charging (if required) / treatment, and routine maintenance during service, with each and every battery set. The manufacturer shall supply 5 copies of instructions manual to the purchaser.

The following information shall be provided on, the instruction cards.

a) Designation of cell or battery.
b) Ampere hour capacity.
c) Nominal voltage.
d) Manufacturerôs instructions for charging.
e) Voltage for float operation at 20 deg. C. with tolerance (+/-)1%.
f) Maintenance instructions.

g) Environmental & safety provisions required.

1.11 **TESTS**

All the acceptance tests as per relevant Standards mentioned shall be carried out for batteries in presence of our inspecting officer free of cost. Type test certificates (not older than 7 years from the date of opening of tender) are to be submitted for approval of purchaser.

1.12 **DRAWINGS**

The tenderer will submit the detailed dimensional drawings for battery sets including stands.

1.13 **ACCESSORIES**

Each battery set shall be supplied complete with all necessary accessories viz. stand, inter connections, cell No. plates with sticker, multi meter complete with leads and spanners.

1.14 **BILL OF MATERIAL**

The firm shall also have to furnish the bill of material used in battery set.

1.15 **SAMPLING**

The sampling scheme and criteria for acceptance test for cells upto and including 600AH capacity shall be in accordance with 11.1.4 of IS 8320-1982.

1.16 **GUARANTEED TECHNICAL PARTICULARS**

Guaranteed technical particulars for battery sets as per Annexure-I attached shall be furnished alongwith the tender.

2.0 **220 V BATTERY CHARGER**

2.1 **The battery chargers with separate float & boost sections** to be supplied shall meet the requirements of latest ISS. The battery charger shall be constant potential type with current and voltage limiting facility and shall meet the requirements of clause 6 of IS:15549:2005

(specification for stationary VRLA battery). Battery chargers shall be of sufficient capacity to suit battery sets of respective ratings.

2.2 The equipment shall be suitable for float charging, as well as quick charging of associated battery sets of 220 V- 600 AH ratings. The bus bar voltage shall be maintained at all times even during quick charging. The float voltage to the load shall be maintained within + / - 1% of the set voltage at all times even during boost charging. The float section as well as the boost section of the charger shall be silicon Control Rectifier (SCR) based to control the voltage as per requirement of the load / VRLA battery set.

2.3 The battery charger shall be capable of recharging the battery within 12 to 16 hours from a completely discharged conditions, i.e the float charger should be capable of charging the batteries from 1.75 volts per cell to 2.35 volts per cell.

2.4 During normal working conditions, the float charger shall supply the load current and also keep the batteries on ôFloatô. The boost charger will remain off under these conditions. During failure of mains supply, the load be automatically fed by the batteries (time delay not permitted).

2.5 On resumption of supply, the batteries may need to be boost charged. For this the Boost charger should be switched on to boost the batteries. The Boost charger should be SCR controlled type and its output voltage be available from 1.75 V per cell to 2.35 per cell.

However under Boost charge condition, the voltage across the load should not exceed the rated value. The Boost charger construction shall be such that every time when it is switched ON, it shall charge the battery set at the selected voltage at a boost rate not exceeding 120A for 220V battery set . The voltage shall also not exceed 2.30 Volt per cell.

2.6 The float section of the charger suitable for 600 AH batteries shall be capable of delivering a continuous load of 90A . The boost section shall be capable of delivering a continuous load of 120 Amps.

2.7 Battery charging equipment causing unbalance in charging current of various cells of the battery shall not be acceptable. All cells will receive adequate and permissible value of charging current. There should not be any discontinuity of DC supply to the bus bar during any transition period and battery power should be available for tripping circuit, if necessary, even during quick charging.

2.8 The float & boost section of the battery charger should be able to stabilize the DC output voltage within plus minus 1% and with the variation of plus minus 10% in the AC supply with simultaneous load variation from 0 to 100% of rated current. The efficiency of Float & Boost charger shall not be less than 85% at rated voltage & rated load conditions.

Both float charger and boost charger shall be provided with temperature compensation features so as to protect VRLA batteries ( to enhance battery life) against temperature variation. It should increase or decrease the output voltage depending upon the situation whether temp. is below or above 27 Deg. C respectively. The circuit should have a temp. sensor and be supplied with min. 10 meter long cable. Its function should be :

(a) To decrease the output voltage if the temperature increases beyond 27 Deg. C. such that for every 1 Deg. C. increase in ambient, the output voltage should decrease at the rate of 3 mv ± 15% per cell.

(b) Similarly to increase the output voltage if the temperature decreases beyond 27 deg. C such that for every 1 Deg. C. decrease in ambient, the output voltage should increase the at rate of 3 mv ± 15% per cell. However in both the cases the output voltage should not fall below 2.15V or go beyond 2.35V per cell.

Normally the charging voltage to be set in chargers at 27 Deg. C are :-

i) Float voltage = 2.23/2.25 ± .02 x Nos. of Cells
ii) Boost Voltage = 2.30 ± 0.2 x Nos. of Cells.
iii) The battery charger shall also have the following features :

a) Higher voltage cut off at 2.35 volts per cell.
b) Lower voltage cut off at 1.70 volts per cell.

2.9 Automatic run down circuit shall be provided so that at the incidence of power failure, the DC output voltage of the float charger reaches the minimum position automatically and, therefore, when the power is resumed the voltage reaches a normal floating level from the minimum voltage slowly, by which the excessive in-rush current into the discharged battery is minimized.

2.10 Current limiting circuit shall be provided to protect the float charger & boost charger.

2.11 Keyed push button arrangement shall be provided by which the boost charger can be used as a float charger, whenever the float charger is down due to any defect or failure.

2.12 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. MCCBs should have auxiliary contacts for annunciation.

2.13 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.

2.14 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.

2.15 INSTRUMENTS

One AC voltmeter and one AC ammeter alongwith 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.

2.16 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. óONô and óOFFô position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCBôs of suitable ratings shall also acceptable in place of Air Break Switch.

2.17 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.

2.18 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.

2.19 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 ñCHARGER TROUBLEò in Ownerôs 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.

2.20 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.

2.21 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 2.0 mm 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 chargerôs 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 IS:2147.

2.21.1 All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the charger.

2.21.2 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 of identification. At least 20% spare terminals shall be provided for control circuits.

2.21.3 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 atleast 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.

2.20 PAIINTING

All sheet steel work shall be pretreated, in tanks, in accordance with IS:6005. 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 óClass-Cô as specified in IS:6005. 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 gray) of IS:5 shall be applied, unless required otherwise by the Owner. The inside of the charger 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.

2.21 TESTS

2.21.1 Battery chargers shall conform to all type tests as per relevant Indian 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 IS: 4540 and short circuit test as per IS; 2026. Following type tests shall be carried out for compliance of specification requirements :

i) Voltage regulation test.
ii) Load limiter characteristics test.
iii) Efficiency test.
iv) High voltage test.
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 ocilloscope.

2.21.2 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.

2.21.3 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.

2.21.4 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 for contactors.
xiii) Makes of above equipment shall be subject to Ownerôs approval.

3.0 **50 V SMPS BATTERY CHARGER**

3.1 **General Technical Requirement**

The battery chargers of 50 V, 100 Amps. in N+1 configuration with ultimate capacity of atleast 125Amp shall be of SMPS type with +ve earth. The system should have a monitoring & control sub system comprising a monitoring and control module (CSU), a user interface board (MUIB), main monitoring board (MMIB), switch mode rectify (SMR) etc. The chargers shall be capable of continuous operation with float voltage 2.23 to 2.25 Volt per cell (at 27 deg. C) and 2.30 volt per cell (at 27 deg. C) for battery charging voltage while supplying the constant DC load.

3.1.1 The SMPS battery chargers shall have 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.

3.1.2 **Principal Parameters**

| **Inputs** | |
|---|---|
| Nominal Voltage | 400V Three phase (Module shall have a facility to distribute in 3 phases) |
| Input Voltage range | 165 V to 260 V rms |
| Frequency | 48 Hz to 52 Hz |
| Power factor | >0.95 at 50% and above load. |
| Efficeiency | >0.85 at 50% and above load. |
| Start up Inrush Current | < 8A peak at nom. Mains voltage. |
| Soft Start time | 10 Secs. Min. output current ramp-up. |
| **Output** | |
| Output Voltage | |
| Float Adjustable | 48V to 56V |
| Current limit Adjustable | 5A to 100A |
| Regulation:<br>(i) Output voltage over shoot / under shoot when charger is switched on.<br>(ii) DC output voltage over shoot for a step change in AC voltage 165V to 260V single phase.<br>(iii) DC out put voltage for a step load change of 25% to 100%. | <br>±5% of DC output voltage for any load of 25% to 100%.<br><br>±5% of DC output voltage for any load of 25% to 100%.<br><br>±5% of DC output voltage for any load of 25% to 100%. |
| Ripple | <2mV RMS psophometric |
| Load Sharing | Better then ± 5% active current sharing at full load. |
| Noise level | <50dBA (A weighted) |
| Cooling | Forced cooling, switching of fans is based on Heat sink temperature. |

3.2 **Main Features Of SMPS Charger**

**3.2.1 Control & Supervisory Unit (CSU)**

The monitoring and control signals, such as battery current, temperature, battery status, system voltage etc., are connected to the control & supervisory unit via a users interface card (MUIB). A cable which carries the digital communications signals that allow control &

monitoring of the rectifiers shall connects the CSU to all the rectifiers in a ñDesign chainò arrangement so that all the rectifiers receive the same signal.

The principal features of the unit shall be as follows:-

a) Monitoring of any alarm condition of the each of the rectifiers.
b) Monitoring of the output current of each rectifiers.
c) Enables setting of parameter all the rectifiers using the CSU front panel.
d) Enables monitoring of DC load current and voltage.
e) Temperature compensation of the battery floor and equalization voltage.
f) Programmable battery charging current limit.
g) Automatic equalization of the battery with selectable start (choose voltage/current level or discharge Amp. Hour) and end (chose time duration or equalization current) parameter.
h) Active current sharing.

### 3.2.2 **Switch Mode Rectifier Assembly**

The rectifier assembly shall be fully / half controlled bridge type and shall be designed to meet the duty as required by the charger. The technology used shall be pulse rate modulation using micro controllers, IGBT and MOSFETS. 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.

### 3.2.3 **Battery Temperature Compensation**

The charger shall be provided with the appropriate circuitry to interface with the temperature probe assembly. With the probe, the charger shall automatically compensate gasing and constant voltage setting inversely propotional to the probeôs temperature/ battery ambient temperature, so that over charging at high temperature and under charging at low temperature can be prevented.

### 3.2.4 **Air Break Switches**

One DC output switch shall be provided in the charger. 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. óONô and óOFFô position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCBôs of suitable ratings shall also acceptable in place of Air Break Switch.

### 3.2.5 **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.

3.2.6 **Blocking Arrangements**

Blocking arrangement shall be provided in the positive pole of the output circuit of the charger to prevent current flow from the DC battery into the charger.

3.2.7 **Monitoring / Protection / Annunciation System**

The SMPS charges shall provide the following monitoring / protections / annunciations:-

a) The charger shall monitor / display the system voltage with an accuracy of ± 0.5% at full load.
b) The charger shall monitor the current with an accuracy of ± 1% at full load and shall display the bar graph also.
c) The indication of SMR normal , SMR alarm and SMR shut down shall be provided on front panel of each module.
d) The annunciation shall be provided if the cells discharge beyond 80% of its rated capacity and if the discharge rate is also greater than C/10 rate (C-capacity).
e) The charging of cell shall not be faster than c/10 rate (c-capacity)
f) The path current for each batteries in the bank shall be restricted to 10% of the battery capacity.
g) AC power failure.
h) Rectifier / chargers fuse blown.
i) Over current / Over temperature
j) Abnormal voltage (High / Low)
k) Any other monitoring / protection / annunciation, if required.

Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication ñCHARGER TROUBLEò in Ownerôs Control panel & the indication for charger in float mode and charge mode through indicating lamps shall also be provided in owners control panel.

3.2.8 **Radio Interference**

The equipment shall be efficiently screened against interference to radio and also other communication equipment, which may be installed in the same building. All sources of noise shall be filtered if necessary with suppressors generally in accordance with relevant BS.

3.2.9 **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.

3.3 **CHARGER PANEL CONSTRUCTION**

3.3.1 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 2.0 mm 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 chargerôs 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 IS:2147.

3.3.2 All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the charger.

3.3.3 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 of identification. At least 20% spare terminals shall be provided for control circuits.

3.3.4 The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 1.5 KV AC for one minute. An air clearance of atleast 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.

3.3.5 **Painting**

All sheet steel work shall be pretreated, in tanks, in accordance with IS:6005. 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 óClass-Cô as specified in IS:6005. 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-631 of IS:5 shall be applied, unless required otherwise by the Owner. The inside of the charger 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.

3.4 **TESTS**

3.4.1 Battery chargers shall conform to all type tests as per relevant IS/IES/BS. Performance test on the Chargers as per Specification shall also be carried out on each Charger as per specification. Following type tests shall be carried out for compliance of specification requirements :

i) Voltage regulation test.
ix) Load limiter characteristics test.
x) Efficiency test.
xi) High voltage test.
xii) Temperature rise test
xiii) Short circuit test at no load and full load at rated voltage for sustained short circuit.

xiv) Degree of protection test.
xv) Measurement of ripple by ocilloscope.

3.4.2 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.

3.4.3 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.

3.4.4 The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by the OWNER.

i) CSU
ii) Switches.
iii) Relays / MCCBs/MCB
iv) Instruments.
v) DC fuses.
vi) SMR.
vii) Temp. Compensation
viii) Condensers.
ix) Semi-conductor.
x) Annunciator.
xi) Control wiring.
xii) Push buttons for contactors.
xiii) Makes of above equipment shall be subject to Ownerôs approval.

**ANNEXURE-I**

## GURANTEED TECHNICAL PARTICULARS OF VRLA BATTERY

| | | 50 V Battery | 220 V Battery |
|---|---|---|---|
| 1. | Manufacturerôs Name and address | | |
| 2. | Standard specifications to which material shall conform. | | |
| 3. | a) Type and make of battery set.<br>b) Capacity of Battery set at 10 Hrs rate. | | |
| 4. | No. of cells. | | |
| 5. | Battery design life expectancy | | |
| i) | Float application | | |
| ii) | Cylic operation (DOD Cycle) | | |
| 6. | Ampere hour efficiency without negative tolerance. | | |
| 7. | Watt hour efficiency without negative tolerance | | |
| 8. | Oxygen recombination efficiency | | |
| 9. | Type of negative plate. | | |
| 10. | Type of positive plate. | | |
| 11. | Type of material of separators | | |
| 12. | Method of connections between cells i.e. Bolted or Burnt. | | |
| 13. | Voltage per cell at the end of charge. | | |
| 14. | Recommended trickle / float charging rates for (min./ max.) different type of working. | | |
| 15. | Material of container. | | |
| 16. | Max. allowable Ambient temperature at which cell can safely operate. | | |

| | | | |
|---|---|---|---|
| 17. | Overall dimension of each cell in mm. | | |
| 18. | Distance between the centres of each cell when erected in mm. | | |
| 19. | Total weight of cell with acid in Kg. | | |
| 20. | Recommended maximum period of storage. | | |
| 21. | Internal Ohmic resistance of each cell. | | |
| 22. | Recommended float charge. | | |
| 23. | Recommended Boost charge. | | |
| 24. | Voltage ripple allowable. | | |
| 25. | Time required for Boost charge from fully discharged condition at 27 Deg. C. | | |
| 26. | Max. No. of charge / discharge cycles required to reach the rated capacity. | | |
| 27. | Whether cells and battery sets bear ISI certification mark. | | |

**ANNEXURE-II**

## GURANTEED TECHNICAL PARTICULARS OF BATTERY CHARGER

| | | Charger for 50 V | Charger for 220 V |
|---|---|---|---|
| 1. | Manufacturerôs Name & Country of manufacture | | |
| 2. | Whether requirements of charger manufacturerôs furnished | | |
| 3. | Charger dimensions | | |
| | i) Height (mm) | | |
| | ii) Depth (mm) | | |
| | iii) Width (mm) | | |
| | iv) Sheet thickness (mm) | | |
| 4. | Charger weight (kg) | | |
| 5. | Charger rated output current | | |
| | i) Float charging mode | | |
| | ii) Boost charging mode | | |
| 6. | Load limiter current setting range (Trickle mode) | | |
| 7. | Automatic voltage regulator (Float mode) | | |
| | i) Type | | |
| | ii) Percentage stabilization of the output DC voltage | | |
| | iii) Voltage setting range | | |
| 8. | Manual voltage regulator (Float mode) | | |
| | i) Type | | |
| | ii) Voltage setting range | | |
| 9. | Boost charging current setting range | | |
| 10. | Boost charging limit setting range | | |
| 11. | Rectifier assembly | | |
| | i) Type of semi conductor material | | |
| | ii) Rate direct current percell | | |
| | iii) Rated direct voltage | | |
| | iv) Rated input voltage | | |
| | v) Type of connections of rectifier elements | | |
| | vi) Standard applicable | | |
| 12. | Rectifier transformer | | |
| | i) Type | | |
| | ii) Rated KVA & % impedance | | |
| | iii) Input line winding connection in vector representation. | | |
| | iv) Cell winding connection vector representation. | | |
| | v) One minute power frequency withstand voltage (kV) | | |
| | vi) Standard applicable. | | |
| 13. | Instruments | | |
| | i) Type | | |
| | ii) DC Voltmeter range | | |
| | iii) DC Ammeter range | | |
| | iv) Dial size | | |

| | | | |
|---|---|---|---|
| | v) Accuracy class as per IS | | |
| 14. | Contactor | | |
| | i) Type | | |
| | ii) Rated voltage | | |
| | iii) Rated current | | |
| | iv) No. of power contacts | | |
| | v) No. of type rating of aux. contacts. | | |
| | vi) Operating coil | | |
| | vii) Drop out voltage | | |
| 15. | Thermal Overload relay | | |
| | i) Tripping current range | | |
| | ii) Whether single phasing protection provided | | |
| | iii) Standard applicable | | |
| 16. | Air Break Switches | | |
| | i) Type | | |
| | ii) Rated voltage | | |
| | iii) Rated current | | |
| | iv) Type and material of contacts | | |
| | v) Standards applicable | | |
| 17. | Fuses | | |
| | i) Type | | |
| | ii) Rupturing capacity | | |
| | iii) Standard applicable | | |

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**FRLS Power & Control Cables**
**Part-12**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-12 (Vol. II)**

**Technical Specification for FRLS Power & Control Cables**

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**Part-12 (Vol. II)**

**Technical Specification for FRLS Power & Control Cables**

## 1. 1.1 KV GRADE FRLS POWER & CONTROL CABLES

1.1 CRITERIA FOR SELECTION OF POWER & CONTROL CABLES

1.1.1 Aluminum conductor XLPE insulated armoured FRLS type 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 Aluminum conductor PVC insulated armoured FRLS type power cables shall be used for various other applications in switchyard area / control room except for control / protection / DC Supply purposes.

1.1.3 For all control / protection / instrumentation purposes / DC Supply FRLS type PVC insulated armoured control cables of minimum 2.5 Sq.mm. size with standard Copper conductors shall be used.

1.1.4 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.

| S.No. | From | To | Cable Size | Cable Type |
|---|---|---|---|---|
| 1. | Main Switch Board | LT Transformer | 2-1C X 630 mm ² per phase 1-1C X 630 mm ² | XLPE |
| 2. | Main Switch Board | AC Distribution Board | 2-3½C X 300 mm² | XLPE |
| 3. | Main Switch Board | Air Conditioning Board | 1-3½ X 300 mm² | XLPE |
| 4. | Main Switch Board | Oil Filtration Unit | 1-3½ X 300 mm² | XLPE |
| 5. | Main Switch Board | Colony Lighting | 1-3½ X 300 mm² | XLPE |
| 6. | Main Switch Board | HVW Pump LCP | 1-3½ X 300 mm² | XLPE |
| 7. | Main Switch Board | Lighting transformer | 1-3½ X 300 mm² | XLPE |
| 8. | Lighting transformer | Main Lighting Distribution Board | 1-3½ X 300 mm² | XLPE |
| 9. | AC Distribution Board | DG Set AMF Panel | 2-3½ X 300 mm² | XLPE |
| 10. | AC Distribution Board | Emergency Lighting Transformer | 1-3½ X 70 mm² | PVC |

| | | | | |
|---|---|---|---|---|
| 11. | Emergency Lighting Transformer | Emergency Lighting DC | 1-3½ X 70 mm² | PVC |
| 12. | AC Distribution Board | ICT MB | 1-3½ X 70 mm² | PVC |
| 13. | AC Distribution Board | Bay MB | 1-3½ X 35 mm² | PVC |
| 14. | AC Distribution Board | Battery Charger | 1-3½ X 70 mm² | PVC |
| 15. | DCDB | Protection / PLCC Panel | 1-2C X 6 mm² | PVC |
| 16. | Main Lighting DB | Lighting panels (Indoor) | 1-3½ X 35 mm² | PVC |
| 17. | Main Lighting DB | Lighting panels ( Outdoor) | 1-3½ X 35 mm² | PVC |
| 18. | Main Lighting DB | Receptacles (Indoor | 1-3½ X 70 mm² | PVC |
| 19. | Main Lighting DB | Sub - Lighting panels | 1-3½ X 70 mm² | PVC |
| 20. | Lighting Panel | Street Lighting Panels | 1-4C X 16 mm² | PVC |
| 21. | Lighting Panel | Street Lighting Poles | 1-4C X 16 mm² | PVC |
| 22. | Lighting Panel / Sub lighting panels | Lighting Fixtures (Outdoor) | 1-2C x 6 mm² | PVC |
| 23. | Bay MB | Equipments | 1-4C X 16 mm² / 1-4C X 16 mm² / 1-2C x 6 mm² | PVC |
| 24. | Air-Conditioning Board | A/C Unit Panel | 1-3½ X 35 mm² | PVC |
| 25. | Air-Conditioning Board | AHU | 1-3½ X 35 mm² | PVC |
| 26. | Air Conditioning Board | Heater | 1-3½ X 35 mm² | PVC |
| 27. | Air-Conditioning Board | Chiller Pump | 1-3½ X 35 mm² | PVC |

1.1.5 Cables shall be laid conforming to IS: 1255.

1.1.6 While preparing cable schedules for control / protection purpose following shall be ensured :

1.1.6.1 Separate cables shall be used for AC & DC.

1.1.6.2 Separate cables shall be used for DC1 & DC2.

1.1.7 For different cores of CT & CVT separate cable shall be used.

1.1.8. Atleast one (1) core 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.

1.1.9 For control cabling, including CT/VT circuits, 2 cores of 2.5 Sq.mm. size copper cables shall be used per connection. However, if required form 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.

1.2 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. 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 aluminum / 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 aluminum used in the cables shall be of H2 grade.

1.2.1.5 The fillers and inner sheath shall be of non-hygroscopic, fire retardent 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 following method (a) mentioned in the relevant ISS 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 retardant test as per IS: 1554 (Part - I0).

1.2.1.10 The normal current rating of all PVC insulated cables shall be as per IS: 3961.

1.2.1.11 Repaired cables shall not be accepted.

1.2.1.12 Allowable tolerance on the overall diameter of the cable shall be plus or minus 2mm.

1.2.2 XLPE POWER CABLES

The XLPE insulated cable shall be of FRLS type, C2 category conforming to IS 7098(Part-I) and its amendments read alongwith this specification. The conductor shall be stranded aluminum / Copper 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 IS:5831. When armouring is specified for single core cables, the same shall consist of aluminum wires / strips. The outer sheath shall be extruded PVC to Type ST-2 of IS:5831 for all XLPE cables.

1.2.3 PVC POWER CABLES

1.2.3.1 The PVC (70°C) insulated 1100V grade power cables shall be of FRLS type, C2 category, conforming to IS: 1554 (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 aluminum / copper. the insulation shall be extruded PVC to type-A of IS:5831. 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 IS:5831 for all cables.

1.2.4 PVC CONTROL CABLES

1.2.4.1 The 1100 V grade control cables shall be of FRLS type C2 category conforming to IS:1554 (Part-I) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables whether armoured or not. The oversheath shall be extruded PVC to type ST-1 of IS:5831 and shall be gray in colour except where specifically advised by the Owner to be black.

1.2.4.2 Cores shall be identified as per IS:1554 (Part-1) for the cables upto 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 Clause 10.3 of IS 1554 (Part-1).

1.3 CABLE DRUMS

1.3.1 Cables shall be supplied non-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.

1.3.2 Standard lengths for each size of power 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. However, the total quantity of cables after taking into consideration of all cables drums for each size shall be within the tolerance of ± 2%.

1.3.3 A lay of water proof paper shall be applied to the surface of the drums and over the outer most cable layer.

1.3.4 A clear space of at least 40 mm shall be left between the cables and the lagging.

1.3.5 Each drums shall carry the manufacturer's name, the owner's name, address and contract number and type, size and length of the cable, net and gross weight stenciled 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.

1.3.6 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.

1.4 TESTS

1.4.1 All cables shall conform to all type, routine and acceptance tests including FRLS tests listed in the relevant IS.

1.4.2 All power cables of sizes 240 Sq.mm and above shall meet the requirements of the following additional tests and type tests may be conducted to prove their capabilities.

1.4.3 Short time current test on conductor (s).

1.4.4 Short time current test on armour (s).

## 2.0 HT CABLE FOR AUXILIARY POWER SUPPLY

2.1 Only overhead connection has been foreseen for interconnecting 630 KVA, LT transformer to the territory of ICT.. However, HT cable connections in place of overhead connection, if necessary shall also be in the scope of contractor. In this case contractor shall provide, HT cable of suitable size and rating alongwith necessary terminating accessories. The HT cable shall be single core XLPE insulated armoured cable conforming to IS 7098 Pt.II and IEC 60502-2 1998. Terminating accessories shall conform to IEC 61442 1997/IEC 60502-4 1998.

2.2 Size and rating of HT cables shall be decided by bidder based on system parameters and relevant codes and practices and shall be subject to owner's approval during detailed engineering.

2.3 Contractor shall submit type test reports of cable as well as for terminating accessories offered conforming to IEC/IS requirements.

**ANNEXURE-I**

## GUARANTEED TECHNICAL PARTICULARS FRLS POWER CABLES (PVC AND XLPE)

1. Manufacturer's name and address
2. Standard specification to which the material shall conform.
3. Type of cable
4. Conductor details
5. Type of sheathing
   i) Inner sheath
   ii) Outer Sheath
6. Type of armouring
7. Weight of the finished cable in Kgs. Per KM
8. Standard length in metres.
9. total length of the cables on each drum in meters.
10. Gross weight of each drum (Kgs.).
11, Weight of each drum in Kg.
12. Maximum continuous current carrying capacity.
   i) When laid directly in ground (Amps.)
   ii) When laid in covered trenches (Amps.)
   iii) When laid vertically in air (Amps.)
13. Recommended depth of laying
14. Maximum short circuit current of cable (0.5 sec., between occurrence of short circuit and rupture).
15. Short circuit MVA capacity.
16. Voltage drop 1000 meters length at rated current :
   i) When laid in ground
   ii) When laid in covered trenches

iii) When laid vertically in air

17. Impulse strength

18. Max. conductor temp. in °C

i) When laid in ground

ii) When laid in covered trenches

iii) When laid vertically in air

19. Whether testing facility available for
    a) Flammability test
    b) Smoke generation by sheath under fire
    c) Acid gas generation by sheath under fire
    d) Oxygen index test
    e) Temperature index test
    f) Thermal stability test

20. Whether PVC compounding plant available to manufacture fire resistance quality control cables, if so the capacity.

21. whether bidder have ISI cerficatation mark

22. Whether sample enclosed with bid, Yes/No.

**ANNEXURE-II**

## GUARANTEED TECHNICAL PARTICULAR FOR FRLS CONTROL CABLES

1. Name of the Manufacturer and trade name of cable, if any.

2. No. and cross section of cores.

3. No. and diameter of wires per core.

4. Shape of each core.

5. Current carrying capacity :

   a) In air
   b) In conduct.
   c) In trench.

6. Material of conductor.

7. Insulation thickness of individual core, mm

8. a. Thickness of inner sheath, mm
   b. Thickness of outer sheath, mm

9. Nominal over all diameter

10. Minimum bending radius

11. Type and material of armouring

12. temperature rise of conductor of cables.

13. Maximum allowable temperature rise of the cable in conduits.

14. Insulation resistance per K.M. at 20°C.

15. conductor resistance per K.M. at 20°C.

16. Colour scheme of cores.

17. Test voltage both AC & DC between conductors and earth, between any two adjacent conductor and the direction of the test.

18. a) Standard length of cable per drum, mtrs.
    b) Tolerance on standard drum length, mtrs.
    c) Tolerance on ordered quantity for each type of cable.

19. Net weight of drum length Kg.

20. Gross weight per Kg.

21. current rating factor based on variation in ambient air temperature

22. Area of conductor mm2

23. Whether testing facility available for :

    a) Flammability Test
    b) Smoke generation by sheath under fire.
    c) Acid gas generation by sheath during fire.
    d) Oxygen Index Test.
    e) Temperature Index Test.
    f) Thermal stability test.

24. Whether PVC compounding plant available to manufacture fire resistance quality control cables. If so, the capacity.

25. Whether Bidder have ISI certification Mark.

26. Whether sample enclosed with the Bid, Yes/No.

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**Lighting System**
**Part-13**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

## PART-13 (Vol. II)

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**PART-13 (Vol. II)**
**Section-I**

## Technical Specification for Lighting System (Illumination) - Switchyard

1.0 **SOCPE**

1.1 This specification covers design of computer based energy efficient / cost effective flood lighting scheme for 400 kV Substation switchyard. Design, manufacture, testing at works supply, erection, testing and commissioning at site of various lighting fixtures complete with lamps, supports and accessories, lighting wires, G.I. earth wire, high pressure sodium vapor lamps, ballasts, electronic Ignitors, P.F. capacitors, distribution pillars boxes, PVC cables, conduits steel trays, etc. Drawing, design and installation of luminaries at appropriate location must conform to foregoing specifications of illumination levels as per clause 3.2. Lighting towers are included in specification of structures.

1.2 It is not the intent to specify completely here all the details of design and construction of the switchyard flood lighting. However, the complete lighting arrangement of the bay / station area shall conform in all respects to the high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation up to the Bidderôs guarantee in a manner acceptable to the purchaser who will interpret the meanings of drawings and specifications and shall have power to reject any material which in his judgement is not in accordance therewith. The switchyard area lighting offered shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of the Bidder irrespective of whether they are specifically brought out in this specification and/or in the commercial order or not.

2.0 **STANDARDS**

Lighting installation, lighting fixtures complete with lamps, supports and accessories, high pressure sodium vapor lamps, Ballasts, Electronic Ignitors, P.F. Capacitors, distribution pillar-boxes, PVC cables, conduits steel trays, etc. shall conform to the provisions of relevant latest Indian Standard specification (including those listed below and referred therein) amended up to date. The equipments, for which no I.S. is specified, shall conform to relevant international standard ( to be indicated in the bid)

| | | |
|---|---|---|
| 1. | IS: 694 | PVC insulated cables for working voltage upto and including 1100 volts. |
| 2. | IS:1569 | Capacitors for use in tubular fluorescent high pressure mercury and low pressure sodium vapor discharge lamp circuits. |
| 3. | IS:1947 | Flood lights. |
| 4. | IS:1913 (Part-I to Part V) | General & safety requirements for luminaries (tubular florescent lamp. |
| 5. | IS:6616 | Ballast for high pressure mercury vapor lamps. |
| 6. | IS:9974 | High pressure sodium vapor lamps. |

| | | |
|---|---|---|
| | (Part-I to Part-II) | |
| 7. | IS:10027 | Composite units of Air break switches and re-wireable type fuses (for voltage not exceeding 650 volts) |
| 8. | IS:5039 | Distribution pillars for voltages not exceeding 1000 volts. |
| 9. | IS:4218 | ISO metric screw threads. |
| 10. | IS:4827 | Electroplated coating of nickel and chromium on copper and copper alloys. |
| 11. | IS:1573 | Electro-plated coating of Zinc on Iron and steel |
| 12. | IS:1868 | Anodic coating on aluminium and its alloy. |
| 13. | IS:1068 | Electroplated coating of nickel and chromium on iron and steel. |
| 14. | IS:2147 | Degree of protection provided by enclosures, low voltage switchgear and control gear. |

Apart from above, bidder may quote lighting equipments covered by this specification conforming to other National / International Standards having same as IS or better specification. The bidder with their bids shall furnish copy of such standards.

## 3.0 LIGHTING SYSTEM DESIGN

3.1 The bidder must prepare and submit detailed computer based energy efficient / cost saving design and drawings showing the lighting layout of the areas as specified in the scope of work of this section. The above layout drawings will include disposition and location of lighting towers / fixture, wiring diagram, cable schedule, distribution pillar-box, control gear and cable trays etc. for substation yard.

3.2 The average lux level in switchyard area shall be maintained at 50 lux on main equipments (i.e. transformer, reactor, ISO, CB, CT, CVT, LA ) at first level (equipment connection level) and 20 lux on balance area of switchyard and street / road at ground level.

3.3 The minimum lux level to average lux level ratio should not be less than 0.3 (i.e Emin/Eac>0.3) throughout the switchyard. The maintenance factor for illumination design shall be less than 0.7.

3.4 For achieving the specified lux levels in the switchyard, the contractor can provide luminaries of 1x400 W/1 x 250 W and 2x400/2x250W flood light from high-pressure sodium vapour lamps as per requirement. The lighting system shall be designed so as to avoid direct emission towards sky.

3.5 Lighting level shall take into account appropriate light output ratio of luminiaries, co-efficient of utilization, duration with time and dust deposition etc.

3.6 The contractor shall submit detailed calculation for reaching the above lux level and shall conform the lux levels at different locations of the switchyard and street lighting by measurement.

3.7 One set of Aluminium ladders comprising each size shall be supplied by the contractor for maintenance purpose.

3.8 Each cable run shall be tagged with number that appear in the cable schedules. Cables shall be tagged at their entrance and / or exit form any piece of equipment, floor opening etc.

3.9 The tag shall be made up of aluminium 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.

3.10 Locations of cables laid directly under ground shall be indicated clearly by cable marker made of galvanized iron plate embedded in concrete block.

3.11 The location of under ground cable joints if any, shall be clearly indicated with cable marker with an additional inscription ñcable jointò.

3.12 The marker, which is concrete block, shall project 150mm 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.

3.13 **Lighting Towers**

The lighting towers having overall height of 24 m ( 22m with additional 2m high platform )shall be provided as per the structural drawing Part of the specification.

4.0 **GENERAL TECHNICAL REQUIREMENT**

4.1 **Luminaries (i.e. Lighting Fittings)**

4.1.1 Flood light luminaries shall be of outdoor type conforming to IS:1947-1980 & IS:1913 (Pt.I-1978). Its body shall be of corrosion resistant low copper content, die-cast aluminum alloy. It shall be mounted on hot dip galvanized mild steel bracket with provision to rotate in horizontal plane on a central bolt fixed on a base plate and end blots used for locking it in protected locking slot. Luminaries shall be provided with aiming protector for aiming luminaries at any vertical angle. It shall also be provided with anodized aluminium parabolic reflector, which shall be electro-chemically brightened. Reflector shall be provided with focusing device for its focusing. Front of luminaries shall be provided with glazed thoughened and heat resistant glass held in position by stainless steel clamps and sealed in by heat and O-zone resistant synthetic rubber (e.g. neoprene, ethylene-propylene etc.) gasket in the front and a silicon rubber in the rear cover (for replacement of lamp ) to render it fully weather proof. It shall be provided with vent screw for breathing. The size of flood light body shall be such that it provides large cooling area with excellent heat dissipation. Fins will be provided, if necessary. Lamp holder should conform to IEC finger test and shall have screws of such material to prevent galvanic corrosion.

4.1.2 Bidder shall furnish nominal lumens output from each lamp and the flood light distribution cure of luminaries offered.

4.1.3 The provision for lamp fixing and replacement shall be from rear by means of a low copper aluminium alloy cover (with gasket) to facilitate ease of replacement of lamps without changing the aiming position. Rear cover shall be fixed to main body by

phosphor bronze chromium plate clip assembly. Laminary shall be provided with 19 mm cable gland and terminal block.

4.1.4 Each luminary shall be provided with a separate weather proof cast aluminium control gear box which shall house the control gear components, i.e. copper improvement capacitor, electronic ignitor etc. The control gear box should have adequate number of cooling fins for proper heat dissipation to keep temperature rise within limit as prescribed by relevant standard. Control gear box will comply with requirement of IS-1913.

4.1.5 Luminaries shall be finished as per IS:1947 by stoving paint. Power factor correcting capacitors shall improve the power factor of the lamp to 0.85 or higher.

4.1.6 The front glass cover, lamp holder, terminal (s), focusing devices mechanics, cables, fingers, screws, washters nuts etc. shall comply with the requirement of IS-1947-1980.

4.1.7 Luminaries and control gear shall have earthing facilities, creeping distance, clearances as per IS-1947 and shall be designed for wind load specified therein.

4.2 **Sodium Vapour Lamps**

4.2.1 High-pressure sodium vapour lamp shall have broad spectrum golden white light. The material of discharge tube and of the inner coating on glass and composition of filling gases shall be indicated in the bid with their merit. The lamp with spectrum of light close to sensitive curve of human eye shall be preferred. The bidder shall furnish the absolute spectral energy distribution curve and the sensitive curve of human eye on the same graph.

4.2.2 Sodium vapour lamps shall be ósON-Tô or better type and shall comply with the requirement of IS:9974. In addition, it shall comply with clause 4.1.2.2, 7.3, 7.5, 7.6 and 9.0 of IS:9900 (Pt.-I) in respect of lamp data either given in IS:9974 Pt.II or as Guaranteed by the bidder.

4.3 **Ballasts & Capacitors**

Ballasts for high pressure sodium vapour lamps shall conform to the requirements of IS:9974 (Pt.I) and IS:6616 to the extent applicable. Any deviation with reference to IS:6616 shall be clearly brought out in the bid. Capacitors shall conform to the requirements of IS:1569. Ignitors shall conform to relevant IS.

4.4 **Wiring**

4.4.1 Wiring between distribution pillars and luminaries (including their control gear) shall be by 660/1100 V. copper conductor PVC insulated cable conforming to IS:694.

4.4.2 Wiring from distribution pillar to luminaries shall be run on steel trays properly fixed on lighting towers.

4.5 **A.C. Outdoor Distribution Pillars (Boxes)**

4.5.1 Distribution pillar boxes shall be installed on these towers at an average level of 1.15 meters from gravel level.

4.5.2 A.C. outdoor distribution pillar shall be made of 2mm thick sheet either hot dip galvanized or spray pained with zinc rich paint. It shall be rain dust and vermin proof and shall be provided with front cover which shall be provided with front cover

which shall be securely hinged, lined with strong rubber seal around and fitted with lockable handle.

4.5.3 Wiring from each luminary shall be brought up to the distribution pillar and shall be provided with MCB of adequate capacity in phase and neutral.

4.5.4 Each distribution pillar shall have 2 nos. triple pole switch with MCB and connections for neutral. A.C. supply from switch fuse unit shall be connected to 3 phase and neutral bus from which single phase to neutral supply will be given to each luminaries. Each phase will cater approximately to one third number of the luminaries. Each luminary shall also be provided with MCB of adequate capacity. Luminaries for 50 lux level should be grouped in 2 parts also. One group should provide 30 lux zone while other group should provide additional 20 lux.

4.5.5 Distribution pillar shall be provided with one 5 amps., three pin plug socket of standard size with on/off switch and MCB. Distribution pillar and all metallic parts other than live and neutral parts, shall be earthed.

4.5.6 Short circuit level for switch fuse unit shall be 20 kA rms.

4.5.7 All material used viz. Distribution pillars, Contractors, Switches, MCBs Cables and Wires etc. should be of reputed makes.

## 5.0 INSPECTION / TEST

5.1 The manufacturing programme shall be intimated by the contractor in advance to enable the purchaser to arrange for inspection during manufacture, if so desired. The contractor shall also notify the readiness of equipment for final inspection by the purchaser. Unless otherwise agreed all equipment shall be inspected and tested as per clause 6.2.3 to 6.2.8 shall be witnessed by the purchaserôs representative before dispatch of consignment from manufacturerôs works. The test reports shall be submitted in quadruplicate. All test reports whether for the type tests or for the routine tests/additional tests shall be got approved from the purchaser before the dispatch of equipment.

5.2 All charges for tests shall be covered in prices quoted for the equipment and nothing extra shall be payable. The type test certificates (as per clauses 6.2.3 to 6.2.8 ) in quadruplicate along with bid shall be submitted to judge the merits of the equipment offered, by the purchaser.

5.3 Luminaries shall comply with the requirements of tests as per IS:1947-1980 and tests for protection against electric shock as per IS:1913 Part-I. Unless otherwise agreed, photometric tests shall be conducted as per Annexure óBô of IS:1947.

5.4 Ballast shall comply with the tests requirements respectively of IS:6616 (and IS:9974 as far as applicable).

5.5 Capacitor shall comply with tests requirements of IS-1569.

5.6 Lamps shall comply with the test requirement of tests specified in IS:9974 and clause 4.1.2.3, 7.3 to 7.6 and 9.0 of the IS:9900.

5.7 Electronic ignitor shall conform to test as specified in relevant standard specification. Bidder shall indicate characteristics of ignitors and tests to be carried out on them.

5.8 Control gear box and Distribution pillar (box) shall be dust proof and drip proof (IP 5 & IP 2).

## 6.0 SITE TESTS

6.1 Immediately after installation & commissioning of the switchyard lighting system, the contractor shall measure the lighting level throughout the switchyard in the presence of the purchaserôs representative to establish that the same are as per the

provision of clause 3.2 of this specification. Lux level shall be that specified at clause 3.2 divided by maintenance factor (which shall take into account ageing of lamp, reduction in efficiency of reflector and front glass due to weather and dust deposition). The results of these measurements shall be supplied in triplicate to the purchaser.

## 7.0 DRAWING FOR LUMINARIES ETC. FOR SWITCHYARD

7.1 In addition to any other drawing which the bidder may like to furnish to explain the merits of his proposal following drawings shall be submitted with the bid :-

a) Detailed drawing showing location wise number of luminaries on each tower.
b) Drawing of low level portable towers with weight and their details.
c) Computer calculations of switchyard including oil storage tank, fire fighting room lighting levels.
d) Drawing of luminaries, lamps, control gear and distribution pillars (boxes)
e) Schematic wiring diagram of pillar box showing rating wise accessories provided.
f) Absolute spectral energy distribution curve of each type of lamp with sensitive curve of human eye on same graph.
g) Type and routine testing reports for lamp, luminaries, ballasts, capacitors, electronic ignitors and distribution pillar boxes etc.
h) Photometric data of the luminaries.

7.2 After the award of contract, the contractor shall submit 10 copies of detailed dimentioned and scaled drawing and manuals as listed above.

## 8.0 SAMPLES

8.1 The bidder shall, if required, submit / display samples of luminaries its control gear offered.

## 9.0 ERECTION & COMMISSIONING

9.1 Erection and commissioning of the new addition / upgradation of existing lighting system is in the scope of the supplier. Switchyard lighting installation includes installation of lighting equipment complete in all respect with wiring up to distribution pillars (to be supplied and installed by the contractor) mounted on the flood light towers.

9.2 A.C. single / three phase supply will be made available by the purchaser up to the location of the distribution pillars of all the towers for connecting with main A.C. supply by RVPN.

9.3 The bidder shall quote installation, commissioning charges for each complete system or luminaries basis.

**Vol.II, Part-13**

**(Section-II)**

## CONTROL ROOM BUILDING, SUB CONTROL ROOM BUILDING, BAY LEVEL KIOSKS AND STREET LIGHTING SPECIFICATIONS

1.0 SCOPE

The scope of work comprises of computer based energy efficient / cost effective lighting scheme. Design, engineering, manufacture, testing at works, supply, erection, and commissioning of (i) various lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with regulators and accessories, lighting panels, ganvanised rigid steel conduits, lighting wires, G.I. Earth wire, receptacles, switchboards, switches, junction boxes, pull out boxes complete with accessories at control room building (including pump house etc.) and (ii) high pressure sodium vapor lamps, ballasts, electronic igniters, PF capacitors, lighting poles complete with distribution boxes, PVC cables, conduits steel trays for street lighting etc. on turn key basis. Drawing, design and installation of luminaries at appropriate location must conform to illumination levels as per Clause 3.5. The following specific areas are included in the scope of lighting.

i) Control room cum administrative office building including Rest Rooms etc.
ii) Bay level Kiosks.
iii) Fire fighting pump house.
iv) Street lighting (Peripheral) inside switchyard fencing (Street lighting shall be done using street lighting poles.)
v) Landscape lighting around control room.

1.2 It is not the intent to specify completely here all the details of design and construction of the buildings, street lighting. However, the complete lighting arrangement of the station shall conform in all respects to the high standard of engineering, design and workmanship and shall be capable of performing in continuous commercial operation upto the bidder's guarantee is a manner acceptable to the purchaser who will interpret the meanings of drawings and specifications and shall have power to reject any material which in his judgement is not in accordance therewith. The building, street lighting offered their effective and trouble free operation. Such components shall be deemed to be within the scope of the bidder irrespective of whether they are specifically brought out in this specification and / or in the commercial order or not.

2.0 STANDARDS

Lighting installation, lighting fixtures complete with lamps, supports and accessories, ceiling fans complete with regulators and accessories, lighting panels, ;lighting poles complete with distribution boxes, galvanized rigid steel conduits, lighting wires GI earth wire, receptacles, switchboards, switches, junction boxes, pull out boxes complete with accessories, high pressure sodium vapor lamps ballasts, electronic igniters, PF capacitors, distribution pillar boxes, PVC cables, conduits steel trays, etc. shall conform to the provisions of relevant latest Indian Standard Specification (including those listed below and referred therein amended upto date. The equipments, for which no I.S. is specified, shall conform to relevant International Standard (to be indicated in the bid).

| | | |
|---|---|---|
| 1. | IS: 694 | PVC insulated cables for working voltage upto and including 1100 volts. |
| 2. | IS:1569 | Capacitors for use in tubular fluorescent high pressure mercury and low pressure sodium vapour discharage lamp circuits. |
| 3. | IS: 1947 | Flood lights |
| 4. | IS: 1913 (Part-I to | General & safety requirements for luminaries (tubular |

| | | |
|---|---|---|
| | Part-V) | florescent lamp) |
| 5. | IS:6616 | Ballasts for high pressure mercury vapour lamps. |
| 6. | IS:9974 (Part-I to Part-II) | High pressure sodium vapour lamps |
| 7. | IS:9900 (Part-I to Part-IV) | High pressure mercury vapour lamps. |
| 8. | IS:10027 | Composite units of air break switches and rewireable type fuses (for voltage not exceeding 650 volts). |
| 9. | IS:5039 | Distribution pillars for voltages not exceeding 1000 volts. |
| 10. | IS:4218 | ISO metric screw threads |
| 11. | IS:4827 | Electroplated coating of nickel and chromium on copper and copper alloys. |
| 12. | IS:1573 | Electroplated coating of zinc on iron and steel. |
| 13. | IS:1868 | Anodic coating on aluminium and its alloy |
| 14. | IS:1068 | Electroplated coating of nickel and chromium on iron and steel. |
| 15. | IS:2147 | Degree of protection provided by enclosures, low voltage switchgear and control gear. |

Apart from above, bidder may quote lighting equipment covered by this specification conforming to other National / International Standards having same as IS or better specifications. The bidder with their bids shall furnish copy of such standards.

3.0 LIGHTING SYSTEM DESIGN

3.1 The bidder must prepare and submit detailed computer based energy efficient / cost saving design and drawings showing the lighting layout of the areas as specified in the scope of work with bid. The above layout drawings will include disposition and location of lighting fixtures, receptacles, switchboards, ceiling fan points etc. The conduit layout for sub-station buildings, cable schedule for sub-station yard etc. for wiring of these equipment shall also be prepared by the bidder.

3.2 The illumination should be uniform and free from shadows of dark patches as far as possible. A ratio of minimum intensity to maximum intensity of illumination equal to 70% is acceptable limit.

3.3 Lighting levels shall take into account appropriate light output ratio of luminaries, coefficient of utilization, maintenance factor (of 0.7) to take into account duration with the time and dust deposition.

3.4 The layout plan of various buildings, streets for 400 kV GSS Sub-station is enclosed elsewhere. The air-conditioned buildings have fall ceiling. The building plans, height of ceiling and falls ceiling etc. is given in drawings enclosed elsewhere.

3.5 The limit in glare index shall be as per IS:3646 Part-II. The average lighting levels in various areas is as below :

| Sl. No. | Area | Lux |
|---|---|---|
| 1. | Control Room | 250 |
| 2. | Shift engineer / SE / XEN / AEN | 150 |
| 3. | Staff Room / Library | 150 |
| 4. | Pantry | 150 |
| 5. | Toilet | 150 |
| 6. | Battery Room | 100 |
| 7. | LT Room | 150 |
| 8. | Entrance lobby | 150 |
| 9. | Corridor & landing | 150 |
| 10. | Conference Hall | 250 |
| 11. | Ante Room / Rest Room / Dinning Room etc. | 150 |
| 12. | A C Bay level Kiosk | 300 |

| | | |
|---|---|---|
| 13. | Pump House | 150 |
| 14. | Store | 150 |

3.6 Provision for 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 to be supplied.

3.7. Provision for DC 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, rest room, conference room, control room building, AC Kiosk and fire fighting pump house so that the operating personnel can safely find their way even during emergency of a total AC failure. These light will be normally óOFFôand will be switched óONô automatically when under voltage occurs in the AC main lighting distribution board.

3.8 Provision for Portable Fixtures :

A few battery operated, portable fixtures will be provided in the control room building and fire fighting pump house. These fixtures will be provided at important locations in the above mentioned areas.

Battery operated portable fluorescent lamps assembly shall be provided as per following:-

Control Room Building : 4 Nos.

Fire Fighting Pump House : 2 Nos.

3.9 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. Wall mounted fans shall be provided in the conference room, shift engineer / electrical engineer room in control room building.

3.10 One no. of aluminum ladder of each size shall be supplied by the contractor for maintenance purpose.

3.11 Each cable and conduit run shall be tagged with number that appear in the cable and conduit schedules. Cables and conduits shall be tagged at their entrance and / or exit form any piece of equipment, junction or pull box, floor opening etc.

3.12 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 GI wire. Cable tags shall be rectangular in shape for power cables and circular shape for control cables.

3.13 Locations of cables laid directly under ground shall be indicated clearly by cable marker made of galvanised iron plate embedded in concrete block.

3.14 The location of under ground cable joints, if any, shall be clearly indicated with cable marker with an additional inscription ócable jointô

3.15 The marker, which is 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.

4.0 Description of items

The bidder shall supply and install the following equipment and accessories in accordance with the specification.

4.1 LIGHTING PANELS

4.1.1 415 AC lighting panel with 4 15 V, 63 A, 3 phase 4 wire bus and one no. 63 A, TP, MCB with neutral unit as incomer and 20 A, MCB as outgoing feeders, the details are as follows. These panels are without lighting transformers.

| Sl.No. | Description | Details of outgoing feeders |
|---|---|---|
| 1. | Indoor | 8 nos. ï 20 A single pole MCB. |
| 2. | Outdoor | 9 nos. ï 20 A single pole MCB and 1 No. 20 A triple pole MCB with neutral and suitable timer and contactor for automatic switching. |
| 3. | Outdoor street lighting panel | 3 nos. ï 220 A triple pole MCB with neutral with suitable timer and contractor for automatic switching. |

Note :- The numbers of outgoing feeders indicated above are the minimum.

4.1.2 220 V DC indoor type change over board and 220 V DC 32 A two wire bus and one 32 A contractor backed up by 32 A double pole MCB as incomer. The panel shall have local push button controls. Following are the various types of panels required with control timer.

| Sl.No. | Description | Details of outgoing feeders |
|---|---|---|
| 1. | Indoor | 6 nos. ï 16 A DP MCB unit |

4.1.3 Sub-lighting panels

| Sl. No. | Description |
|---|---|
| 1. | 4 pole 32 A isolator suitable for 415 V, 50 cycles AC supply, standard kopp make enclosure shall be suitable for outdoor use with IP-55 degree of protection as per IS:13947 (Part-1) |

4.1.4 Lighting fixtures and Receptacles

Lighting fixtures / fittings / luminaries

| Sl.No. | Description |
|---|---|
| 1. | 2x 36 W fluorescent lamp in corrosion proof fixture consisting of a canopy made of fiber glass reinforced polyester (FRP) with gasket a gear tray made of sheet steel and reeded acrylic cover fixed by toggle clips, similar to philips Cat. No.TDC-10/236/Bajaj Cat. No.BJI-236 FG/Compton Greaves Cat No. I FC-1124 HSB. |
| 2. | 150 W SON-T tubular sodium vapour lamp in street lighting luminaries. A special optical reflector clear acrylic over, a single piece die cast aluminum housing made out of LM6 and corrosion resistance proof. Similar to Philips Cat No.SRP-51 and Bajaj Cat No. BJMSC/10/Crompton Greaves. Cat No.SSG 1515H. |
| 3. | 2x36 fluorescent lamp in industrial reflector type fixture complete with accessories and suitable for pendent mounting, similar to philips Cat No.TKC 24/236/Bajaj Cat No.BJIV/236/Crompton Greaves Cat No.1VE 1224 HSB. |
| 4. | 100 W Incandescent GLS lamp in recesed black / anodised bowl, reflector with provisions for lamp replacement from bottom, similar to Philips Cat No.DBD-10/Crompton Greaves. |
| 5. | Whether proof integral floor lighting with housing made of corrosion resistant die cast aluminum painted black. Grey powder coated outside suitable for 150 W SON-T lamp complete with all accessories and suitable for termination with conduits / flexible Cat. No.F.69045 (c). Similar to Philips Cat No.SNT 100 / Bajaj Cat No.BGEMF-150 W SV Crompton Greaves Cat No.FAD 11151H. |
| 6. | 1x11 W CFL Lamp emergency light with battery operated portable fixture with built in chargeable batteries and battery charger suitable for a lighting period of six hours similar to ALPHA DELUX of M/s.DELTA FLASH LITE / MICRO LIT OF M/s. MICRO. |
| 7. | 9 W CFL lamp in Bulkhead fixtures with cast aluminum alloy body, suitable for column, wall and ceiling mounting finished stove enameled silver gray outside white inside to be supplied complete (prisat front glass, wire guard, tropicalised, gasket and ES porcelain, lamp holder taped ¾ò ET for conduit entry) similar to Philips Cat No.FXC 101/Bajaj Cat No. JBJE 19 / Crompton Greaves. |
| 8. | 2x36 W fluorescent lamp with mirror optics in recessed mounting type decorative fluorescent fitting consisting of white stove enamelled sheet steel housing with accessories and reflector of aluminium sheet steel duty electrochemically brightened and anodised fitted with aluminum lamella painted white. Similar to Philips Cat. No.TBS-285/236 and Bajaj Cat No.BJLM 236 / Crompton Greaves Cat No.CRFA 24 HSB. |
| 9. | 2x36 W Fluorescent lamps in decorative lighting fixture with wide spread mirror optics suitable for pendent mounting with twin tube complete with all accessories : similar to philips cat No.TCS/31/236 and Bajaj Cat No.BJSM-236 / Crompton Greaves Cat No.CSB W 1124 HSB. |

Note :- Bidder can also offer scheme with latest energy efficient / cost effective lighting fixtures / luminaries of any other made, instead of Philips / Bajaj / Crompton Greaves, but it should be better than these makes both in look and efficiency.

4.1.5 RECEIPTACLES

| Sl.No. | Description |
|---|---|
| 1. | 15 A, 240 V, outdoor receptacle 2 pole, 3 pin type. |
| 2. | 5/15 A, 240 V Indoor Receptacle 3 ï pin type. |
| 3. | 63 A, 415 V Interlocked switch socket, outdoor receptacle. |

4.1.6 SWITCH BOARDS

| Sl.No. | Description |
|---|---|
| 1. | Decorative type switch-board with adequate number of switches & receptacle. |

4.1.7 CONDUITS AND ACCESSORIES
Galvanised rigid steel conduits of 19 mm / 25 mm / 32 mm / 40 mm dia.

4.1.8 JUNCTION BOXES with 5 nos. of terminal blocks
4.1.9 LIGHTING POLS ï To be designed and supplied by the bidder as per relevant IS: safety and design provisions.
4.1.10 CEILING FANS ï 1400 mm sweep with electronic regulator.
4.1.11 MAINTENANCE EQUIPMENT
i) A type aluminum ladder of 3 mtr. Vertical height.
ii) Cartwheel mounted aluminum ladder vertical height 7.5 mtrs.
4.1.12 LIGHTING TRANSFORMERS
Supply, erection, testing and commissioning of 100 kVA or above (in case the capacity of transformer required is higher than 100 kVA as per approved calculations), 415 / 415 V, 3 phase, 50 Hz dry type natural air cooled lighting transformers. 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 | 415 / 415 V |
| No. of Phases | Three |
| Frequency | 50 Hz |
| Winding connection | Dyn-1 |
| Class of insulation | B class |
| Impedance | 4% $\pm$ 10%. |
| No. of taps & steps | 5 $\pm$ 5% in steps of 2.5% |
| Ref. Standard | IS: 2026 |

The enclosure for the above transformer shall have degree of protection not less than IP-42. The rating of lighting transformer should be suitable for lighting load. The contractor shall submit the supporting calculation for the rating of lighting transformer.

5.0 Specifications of Items used :-
5.1 LIGHTING FIXTURES AND ACCESSORES
5.1.1 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.
5.1.2 Temperature Rise

All lighting fixtures and accessories shall be designed to have a low temperature rise according to the relevant Indian Standards. The design ambient temperature shall be taken as 50 deg. C.

5.1.3 Supply Voltage

5.1.3.1 Lighting fixtures and accessories meant for 240 V AC operation shall be suitable for operation on 240 V AC 50 Hz, supply voltage variation of ± 10%, frequency variation of ± 5% and combined voltage and frequency variation of ± 10%.

5.1.3.2 Lighting fixture and accessories meant for 220 V DC operation shall be suitable for operation on 220 V DC with variation between 190 to 240 volts.

5.1.4 Lighting Fixtures

The lighting fixtures shall be phillips or Bajaj or Crompton Greaves make only. The different types of lighting fixtures are as indicated elsewhere in this section.

5.1.4.1 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 by reflection.

5.1.4.2 All lighting fixtures shall be complete with fluorescent tubes / incandescent lamps, halogen / sodium vapour lamps as specified and shall be suitably wired up.

5.1.4.3 All fluorescent lamp fixture shall be complete with all accessories like ballasts, power factor improvement capacitors, lamps, starters, holders etc.

5.1.4.4 Each lighting fixture shall be provided with an earthing terminal suitable for connection to 16 SWG GI earthing conductors.

5.1.4.5 All light reflecting surfaces shall have optimum light reflecting co-efficient such as to ensure the overall light output as specified by the manufacturer.

5.1.4.6 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.

5.1.5 ACCESSORIES

5.1.5.1 Reflectors

The reflectors shall be manufactured from sheet steel or aluminum as applicable of not less than 22 SWG thickness. They shall be securely fixed to the captive type.

5.1.5.2 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 HPSV lamps and HPSV lamps shall be of screwed type, manufactured in accordance with relevant standard and designed to given long and satisfactory service.

5.1.5.3 Ballasts

a. The ballasts shall be design, 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 ï locking anti-vibration fixing and shall be easy to remove without dismantling the fixtures. They shall be totally enclosed units.

c. The 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 ï pressure mercury vapour / HPSV lamps shall be provided with suitable tapings 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.

5.1.5.3 Starters

Starters shall have bimetal electrodes and high mechanical strength. Starters shall be replaceable without disturbing the reflector or lamps and without the use of any tool. Starters shall have brass contacts and radio interference suppressing capacitor.

a. The capacitors shall have constant value of capacitance and shall be connected across the supply of individual lamp circuits.
b. 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 metal enclosure.

5.1.6 Lamps

5.1.6.1 General lighting services (GLS) lamps shall be provided with screwed caps and shall be of "clear" type unless otherwise specified.

5.1.6.2 The fluorescent lamps shall be "Day-light-colour" type unless otherwise specified and shall also be provided with features to avoid blackening of lamps ends. The bidder should clearly state these features in the bid.

5.1.6.3 Sodium vapour lamps shall be colour corrected type, with screwed caps.

5.1.7 The bidder shall furnish typical wiring diagram for fluorescent, HPSV fitting including all accessories. The diagram shall include technical details of accessories i.e. starters, chokes, capacitors etc.

5.1.8 Flexible conduits if required, for any fixture shall be deemed to be inlcuded in contractor's scope.

5.2 RECEPTACLES

a. All receptacles shall be of cast steel / aluminum, 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) 15 A, 240 V, 2 Pole, 3 pin type with third pin grounded, metal clad with gasket having cable gland entry suitable for 2 cx 6 Sq.mm PVC / Aluminum 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) Combination of 5 A and 15 A, 240 V, 3 pin type with third pin grounded, suitable for flush mounting. The switch shall be of piano key type and shall be flush mounted.
   iii) 63 A, 415 V, 3 phase 4 pin interlocked plug and switch with earthing contacts. Other requirements shall be same as (i). The receptacle shall be suitable for 3.5 c x 35 / 3.5 c x 70 Sq. mm. Aluminum 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 2 mm thick GI sheet, with hinged door with padlocking arrangement. Door shall be lined with good quality gasketing. This shall conform to IP – 55.

5.3 SWITCH AND SWITCHBOARD

a.) All switchboards / boxes shall be of bent steel construction, fabricated of 16 SWG sheet with 6 mm thick Bakelite or 3 mm thick perspex sheet cover.
b.) Switch board / boxes located in office / building areas shall be flush mounted type of brick wall with only the switch knob projecting outside.
c.) Switch boards / boxes shall have conduit knock outs on all the sides. Adequate provision shall be made for ventilation of these boxes.
d.) Flush type receptacles provided shall be so located that only the plug project outside.
e.) Switches shall be of piano key type having quick make and quick-break mechanism complete with position indicator and shall conform to relevant Indian Standard.
f.) All the components housed in the switchboard shall be wired to an outgoing terminal block by 2.5 Sq.mm stranded copper wire. The terminal block shall be of adequately rated.

g.) 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.

5.4 CONDUITS & CONDUIT ACCESSORIES

5.4.1 The conduits shall conform to IS:9537. All conduits shall be seemed by welding, shall be of heavy gauge and shall be hot dip galvanised.

5.4.2 Flexible conduits wherever required shall be made with bright, cold rolled annealed and electro-galvanised mild steel strips.

5.4.3 All conduits accessories shall conform to relevant IS and shall be hot dip galvanised.

5.5 JUNCTION BOXES

5.5.1 The junction boxes shall be suitable for mounting on walls, columns, lighting poles, structures etc.

5.5.2 Junction boxes shall be of square / rectangular type of 1.6 mm sheet steel with minimum 6 mm thick pressure diecast aluminum material LM-6 and shall have bolted cover with good quality gasket lining.

5.5.3 The junction box and cover shall be hot dip galvanised.

5.5.4 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 conduit / 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 and for steel lighting / switchyard lighting suitable for 2 numbers 4Cx16 Sq.mm aluminum cable.

5.5.5 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 415 volt junction box.

5.5.6 The junction boxes shall be weather proof type with gaskets conforming to IP-55 as per IS:13947 (Part-I). The conduit connection shall also be properly sealed to prevent entry of water.

5.6 TERMFINAL BLOCKS

5.6.1 Each terminal shall be suitable for terminating upto 2 nos. 10 Sq.mm stranded aluminum 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. 4 C x 16 Sq.mm aluminum cables.

5.7 PULL OUT BOXES

5.7.1 The pull out boxes shall be suitable for mounting on walls, column, structures etc. The supply of bolts, nuts and screws required for the erection shall be included in the installation rates.

5.7.2 The pull out boxes shall be circular of case iron or 16 SWG sheet steel and shall have cover with good quality gasket lining.

5.7.3 The pull out boxes and cover shall be hot dip galvanised.

5.7.4 The pull out boxes shall be completed with conduit knock outs / threaded hubs and provided at approximately 3 meters intervals in a conduit run.

5.7.5 The pull out boxes used outdoor shall be weather proof type with gaskets conforming to IP-55 as per IS:13947 (Part-I).

5.8 LIGHTING PANELS (L.P.)

5.8.1 Each panel shall be provided with one incoming triple pole switch fuse unit with neutral l ink and outgoing miniature circuit breakers as per Clause 2.0. The panels shall conform to IS:8623.

The outdoor and street lighting panels shall be provided with a timer device having twenty four hour hand set dial with a facility for setting ON & OFF times. The main contacts shall be rated equal to the rating of main contacts in the incomer. There will be a provision of selecting either the manual control or the automatic control.

5.8.2 Constructional Features

5.8.2.1 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) or 2.5 mm (hot rolled) smoothly finished, levelled and free from flaws. Stiffeners shall be provided wherever necessary.

5.8.2.2 All outdoor panels and panels located in damp atmosphere shall have degree of protection not less than IP-55 as per IS:13947 (Part-I). All indoor panels shall have degree of protection not less than IP-52 as per IS:13947 (Part-I).

5.8.2.3 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 MS brackets.

5.8.2.4 Panels, shall have a dead front assembly provided with hinged door (s) with padlocking arrangement with single key supplied in duplicate.

5.8.2.5 All doors removable covers and plates shall be gaketed all around with neoprene gaskets.

5.8.2.6 All doors shall be suitable for cable / conduit entry from the top and bottom. Suitable removable cable gland ï 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.

5.8.2.7 The panels shall be so constructed as to permit free access to connection of terminals and easy replacement of parts.

5.8.2.8 The panels shall be so constructed as to permit free access to connection of terminals and easy replacement of parts.

5.8.2.9 Each panel shall have caution notice fixed on it.

5.8.2.10 Each panel shall be provided with a circuit directory plate (of anodised aluminum with the inscriptions indelibly etched on the plate) which is fitted on the inside of the door.

5.8.2.11 Each lighting panel shall be provided with one no. ñONò indicating lamp for each phase alongwith fuses.

5.8.3 Main Bus Bars

5.8.3.1 Bus bars shall be of aluminum alloy conforming to IS:5082 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 1sec. for AC panels and 4 kA for 1 sec. for DC panels.

5.8.4 Switch-Fuse Units

5.8.4.1 Switches shall be hand operated, air break, heavy duty, quick make, quick break type conforming to IS:13947.

5.8.4.2 The rating of switch shall be so chosen as to get complete protection under all normal / abnormal conditions such as full load, overload, short circuit etc.

5.8.4.3 FAll fuses shall be plug in HRC cartridge link type. The fuses shall be of Class 3 type (20 kA prospective breaking current) for AC circuit and class 1 (16 kA prospective current) for DC circuit. Fuses shall be provided with visible operation indicator to show that they have operated. All accessible live connections shall be adequately shrouded and it shall be possible to change fuses with the circuit alive, without danger of contact with live metal.

5.8.5 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.

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 incomer fuse 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 fuse in incomer switch fuse unit in such a way that if fault currents higher than breaker rating, the fuse should blow earlier than the breaker. If the fault current is less than MCB breaking capacity, MCB shall operate first and not the incomer fuse.

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 terminal of the MCBs and the ópenôóclose ôand ótripôconditions shall be clearly and indelibly marked.

f) The contractor 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 employerôs approval.

g) The MCB shall generally conform to IS:8828.

h) MCBôs shall be Moorarjee Dorman Smith or STANDARD make.

5.8.6 Contactors

Contactors shall be of the full voltage, direct-on line air break, single throw, electromagnetic type. They shall be provided with atleast 2-NC and 2 ï NO auxiliary contnacts. Contactor shall be provided with the three element, positive, acting, ambient temperature compensated time aged, 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 witching on Tungsten filament lamp also. The bidder shall check the adequacy of the contactors rating wire with respect to lighting load.

5.8.7 Push Buttons

All push buttons shall be of push to actuate type having 2 ônoôand 2 ôNCôself reset contacts. They shall be provided with integral escutcheon plates engraved with their functions. Push buttons shall be of reputed make.

5.8.8 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 background.

b. All incoming and outgoing circuit 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 bldu background.

5.8.9 Earthing Terminals.

5.8.9.1 Panels shall be provided with two separate and distinct earthing terminals suitable to receive the earthing conductors of size 50x6 GS Flat.

5.8.10 All lighting panels shall have to be tested for the following items and test certificates shall be furnished for the same.

i) Wiring continuity test.

ii) High voltage (2.5 kV for 1 minute) and insulation test.

iii) Operational test.

iv) Degree of protection.

v) Heat run test.

5.8.11 Lighting Transformer

Lighting transformer shall be in separate enclosure. Enclosure shall have degree of protection not less than IP-42 as per ISO-13947 (Part-I).

5.9 Emergency Portable Lighting Fixtures

5.9.1 The portable fixtures shall have a built in battery rated for six hours, battery chargers and solid state inverters. These shall be of approved make.

5.9.2 The portable fixtures shall be of a single unit, completely tropicalised and suitable for prolonged use with no maintenance.

5.9.3 The portable fixtures shall be supplied and necessary supporting brackets of galvanized steel suitable for wall / column mounting shall also be supplied.

5.9.4 The portable fixture shall come up automatically in the event of failure of normal supply.

5.10 LIGHTING POLES

5.10.1 The contractor shall design and supply, store and install the steel tubular lighting poles required for street lighting.

5.10.2 Street / flood light poles shall conform to the relevant IS safety and design specifications. The complete civil works for erection of the lighting poles shall be included in the scope of work.

5.10.3 Lighting poles shall be complete with fixing brackets and junction boxes. Junction boxes should be mounted one meter above ground level.

5.10.4 The lighting poles shall be coated with bituminous preservating plaint 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).

5.10.5 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 and junction box shall be as specified in the specification. However, terminals shall be stud type and suitable for 2 nos. 16 Sq.mm cable.

5.10.6 Wiring (2.5 mm wire) from junction box at the bottom of the pole to the fixture at the top of the pole shall be included in the price of the pole.

5.10.7 Distance of centre of pole from street edge should be approximately 1000 to 1200 mm.

5.10.8 Earthing of the poles should be connected to the switchyard main earth mat wherever it is available and the same should be earthed through 3 m long, 20 mm dia, earth electrode.

5.11 CEILING FANS AND REGULATORS

5.11.1 The contractor shall supply and install 1400 mm sweep ceiling fans complete with electronic regulator and switch, suspension rod, canopy and accessories.

5.11.2 The contractor shall supply and install the switch electronic regulator and board for mounting switch and electronic regulator.

5.11.3 Winding of the fans and regulators shall be insulated with Class-E insulating material. Winding shall be of copper wire.

5.11.4 Electronic regulator with smooth control shall be provided.

5.11.5 Fans and electronic regulators shall be of Crompton Greaves / Bajaj Electricals / Usha Electrical make.

5.12 LIGHTING WIRES

5.12.1 The wiring used for lighting shall be standard products of reputed manufacturers.

5.12.2 The wires shall be of 1100 V grade, PVC insulated product of reputed manufacturers.

5.12.3 The conductor sizes for wires used for point wiring beyond lighting panels shall be single core 4 Sq.mm, 6 Sq.mm and 10 Sq.mm stranded aluminum wires and 2.5 Sq.mm, 4 Sq.mm, 6 Sq.mm and 1.5 Sq.mm stranded copper wire.

5.12.4 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, 1100 V grade flexible PVC insulated cords, unsheathed, conforming to IS:694 with nominal conductor cross sectional areas of 2.5 Sq.mm.

5.12.5 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).
Gray for DC (Negative).

5.13. PAINTING OF SHOP MADE ITEMS

5.13.1 All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with IS:6005 "Code of Practics for Phosphating Iron and Steel"

5.13.2 Oil grease and dirt shall be thoroughly removed by emulsion cleaning.

5.13.3 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.

5.13.4 After phosphating through rinsing shall be carried out with clean water, followed by final rinsing with diluted dichromate solution and oven drying.

5.13.5 The phosphate coating shall be sealed by the application of two coats of ready mixed stoving type metal primer (comprising of red oxide and zinc chromate in a synthetic medium). The first coat may be "flash dried" while the second coat shall be stoved.

5.13.6 After application of the primer, two coats of finishing synthetic enamel paint shall be applied with each coat followed by stoving. The second finishing coat for the external of panels shall be applied after completion of tests.

5.13.7 Both outside and inside of lighting panel, sheet metal fabricated junction boxes etc. and outside of lighting fixtures shall be finished in light gray (IS-5 shade 631). Inside of lighting fixtures shall be finished in white.

5.13.8 Each coat of primer and finishing paint shall be of slightly different shade so as to enable inspection of the painting.

5.13.9 The final finished thickness of paint film on steel shall not be less than 100 microns and shall not be more than 150 microns.

5.13.10 Finished painted appearance on equipment shall present on aesthetically pleasing appearance, free from dents and uneven surfaces.

6. LIGHTING SYSTEM INSTALLATION WORKS

6.1 General

6.1.1 In accordance with the specified installation instructions as shown on manufacturers drawings or as directed by owner, 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.

6.1.2 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.

6.2 Conduit System

6.2.1 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, check nuts, 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.

6.2.2 All unarmored cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.

6.2.3 Size of conduit shall be suitably selected by the contractor.

6.2.4 Conduit support shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

6.2.5 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 masonary or concrete for conduit support is not acceptable.

6.2.6 Where conduits are alongwith cable trays they shall be clamped to supporting steel at an interval of 600 mm.

6.2.7 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.

6.2.8 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

6.2.9 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

6.2.10 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 applicable on embedded conduit and red lead for exposed conduit.

6.2.11 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.

6.2.12 Conduit 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.

6.2.13 The conduit system in all buildings (Control room, AC Kiosk etc.) shall be embedded / concealed.

6.3 Wiring

6.3.1 Wiring shall be generally carried out by PVC wires in conduits. All wires in a conduit shall be drawn simultaneously. No subsequent drawings of wires is permissible.

6.3.2 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.

6.3.3 Wiring shall be spliced only at junction boxes with approved type terminal strip.

6.3.4 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.

6.3.5 For vertical run of wires in conduit, wires shall be suitably supported by means of wooden / hard rubber plugs at each pull / junction box.

6.3.6 Maximum two wires can be terminated to each way of terminal connections.

6.3.7 Separate neutral wires are to be provided for each circuit.

6.3.8 AC and DC wiring should not run through the same conduit.

6.4 Lighting Panels

6.4.1 The lighting panels shall be erected at the locations to be finalised during detailed engineering.

6.4.2 Suitable foundations / supporting structures for all outdoor type lighting panels and necessary supporting structures for indoor lighting panels shall be provided by the contractor.

6.5 Foundation and Civil works.

6.5.1 Foundation for street lighting poles and panel foundation and transformer foundation shall be done by the contractor. The rates for these civil works shall be included in the erection rates of respective items.

6.5.2 All final adjustment of foundation levels, chipping and dressing of foundation surfaces, setting and grounting of anchor bolts, sills, inserts and flastening devices shall be carried out by the contractor including minor modification of civil works as may be required for erection.

6.5.3 Any cutting of masonary / concrete work, which is necessary shall be done by the contractor at his won cost and shall be made good to match the original work.

All the items covered under this section should be type tested, design, conforming to the relevant standard.

7.0 Inspection / test

7.1 The manufacturing programme shall be intimated by the contractor in advance to enable the purchaser to arrange for inspection during manufacture, if so desired. The contractor shall also notify the readiness of equipment for final inspection by the purchaser. Unless otherwise agreed all equipment shall be inspected and tests as per Clause 8.2.3 to 8.2.8 shall be witness by the purchaserÕs representative before dispatch of consignment from manufacturerÕs works. The test reports shall be submitted in quadruplicate. All test reports whether for the type tests or for the routine tests / additional tests shall be got approved from the purchaser before the dispatch of equipment.

7.2 All charges for tests shall be covered in prices quoted for the equipment and nothing extra shall be payable. The type test certificates (as per Clauses 8.2.3 to 8.2.8) in quadruplicate alongwith bid shall be submitted to judge the merits of the equipment offered, by the purchaser.

7.3 Luminaries shall comply with the requirements of tests as per IS:1947-1980 and tests for protection against electric shock as per IS:1913 Part-I. Unless otherwise agreed, photometric tests shall be conducted as per Annexure ÕBÕ of IS:1947.

7.4 Ballast shall comply with the tests requirements respectively of IS:6616 (and IS:9974 as far as applicable).

7.5 Capacitor shall comply with tests requirements of IS:1569.

7.6 Lamps shall comply with the test requirement of tests specified in IS:9974 and Clause 4.1.2.3, 7.3 to 7.6 and 9.0 of the IS:9900.

7.7 Electronic ignitor shall conform to test as specified in relevant standard specification. Bidder shall indicate characteristics of ignitors and tests to be carried out on them.

7.8 All the items if not covered under this section should also be type tested, design, conforming to the relevant standard.

8.0 SITE TESTS

8.1 immediately after installation & commissioning of the lighting system, the contractor shall measure the lighting level at various buildings and street in the presence of the ownerÕs representative to establish that the same are as per the provision of Clause 3.5 of this specification. Lux level shall be that specified at Clause 3.5 divided by maintenance factor (which shall take into account ageing of lamp, reduction inefficiency of reflector & front glass due to weather and dust deposition). The results of these measurements shall be supplied in triplicate to the purchaser.

8.2 In case some additions / alternations are required in building and street lighting scheme due to these measurements, these alternations / additions shall be done without extra cost and measurements shall again be carried out to establish confirmation to Clause 3.2.

9.0 DRAWINGS

9.1 In addition to any other drawing which the bidder may like to furnish to explain the merits of his proposal following drawings shall be submitted with the bid:-

a) Detailed drawing of their proposals showing type of lighting fittings used, its location & height, number of tubes used etc. Different alternative schemes shall be clearly indicated in drawings.

b) Computer calculations / sheets showing different illumination level at mentioned buildings and streets of switchyard including oil storage tank lighting levels.

c) Drawing of luminaries, lamps, control gear and its detailed literature.

d) Absolute spectral energy distribution curve of each type of lamp with sensitive curve of human eye on same graph.

e) Type and routine testing reports for lamp, luminaries, ballast, capacitors, electronic ignitors etc.

f) Photometric data of the luminaries.

9.2 After the award of contract, the bidder shall submit 6 copies of detialed dimensioned and scaled drawings and manuals as listed above.

10.0 SAMPLES

10.1 The bidder shall, if required, submit / display samples of light fittings, luminaries and its control gear offered.

11.0 ERECTION AND COMMISSIONING

11.1 Erection and commissioning of the control room building and street lighting system is in the scope of the supplier. This lighting installation includes installation of lighting equipment complete in all respect with wiring upto main distribution panels (to be supplied and installed by the contractor).

11.2 AC single / three phase supply will be made available by the purchaser upto the location of the distributing main for connecting with main AC supply by RVPN.

11.3 The bidder shall quote installation, commissioning charges for each complete system or luminaries basis.

**ANNEXURE-I**

**GUARANTEED AND OTHER TECHNICAL PARTICULARS**
**(FOR SWITCHYARD LIGHTING SYSTEM AT 400 kV GSS)**

| Sl.No. | Particulars | Required as per Specification | Bidders Name |
|---|---|---|---|
| 1. | Number, type and manufacturer of luminaries | | |
| 2. | Number, type, voltage and wattage of lamps | | |
| 3. | Lighting Design | | |
| a. | Lumens per lamp | | |
| b. | Total lumens output of lamps | | |
| c. | Area to be lit, Sq. meters. | | |
| d. | Design, illumination level, Lux. | | |
| | i. Maximum minimum & average illumination level in operation area.<br>ii. Maximum, minimum & average illumination level in general area<br>iii. Minimum illumination level in dark area<br>iv. Whether calculation attached. | | |
| 4. | Number of lighting tower required | | |
| 5. | Flood light luminaries | | |
| a. | Classification as per beam spread vide Clause 5 | | |
| b. | Beam factor, percentage | | |
| c. | /class of luminaries (vide Clause 2 IS:1913 Pt.I | | |
| d. | Light out put ratio | | |
| e. | Co-efficient of utilization | | |
| f. | Material of main body | | |
| g. | Material of rear cover | | |
| h. | Material of cradle | | |
| i. | Material of screws of lamp holder | | |
| j. | Type of front glass cover | | |
| k. | Material of gasket on front glass cover | | |
| l. | Material of rear cover | | |
| m. | Cable gland size | | |
| n. | Number and material of fixing hinges etc. for front glass and rear cover | | |
| o. | Whether cradle have : | | |
| | i. Base with protector for positioning of any horizontal angle, if so indicate range & whether variation is in step or is continuos. | | |
| | ii. Fixing device with protector aiming any vertical angle, if so indicate range and whether variation in steps or continuous | | |
| p. | Number of lamps per luminaries | | |
| q. | Type of reflector (i.e. round, parabolic one piece, multi pieces etc.) | | |
| r. | Grade of aluminum used for reflector | | |

| | | | |
|---|---|---|---|
| s. | Grade of Anodic film on reflector as per IS: 1868 | | |
| t. | Finishing of reflector | | |
| u. | Rated light output of luminary when | | |
| | i. New | | |
| | ii. Aged | | |
| | iii. Whether dimensional drawing of luminaries, attach size (LxBxH) in mm | | |
| 6. | High Pressure Sodium Vapour Lamp | | |
| a. | Wattage | | |
| b. | Lamp starting voltage, volts | | |
| c. | Maximum starting time in minutes | | |
| d. | Warm up voltage of lamp, volts | | |
| e. | Warm up current, Amps. | | |
| f. | Warm up time (i.e. time required to reach 50 V minimum at lamp terminals), minutes | | |
| g. | Lamp current Amps | | |
| h. | Minimum supply voltage for table operation, volts | | |
| i. | Operation voltage at lamp terminals, volts | | |
| j. | Average luminous flux, lumen after 100 hrs. of aging (horizontal) | | |
| k. | Maximum luminance, cd / Sq.cm. | | |
| l. | Maximum permissible bulb temperature | | |
| m. | Maximum permissible base temperature | | |
| n. | Material of discharge tube | | |
| o. | Composition of filling gases. | | |
| p. | Bulb, finish (i.e. material) of inner coating | | |
| q. | Whether dimensional drawing of bulb attached | | |
| r. | Average life of the bulb | | |
| s. | Red ratio of the lamp (vide IS:9900 Pt.I) | | |
| t. | Classification & dimensions of lamp caps | | |
| u. | Pulse characteristic | | |
| | i. Height, volts peak | | |
| | ii. Wave shape | | |
| | iii. Direction | | |
| | iv. Position, electrical degrees of pen circuit voltage | | |
| | v. Rise time, microseconds | | |
| | vi. Duration time, microseconds | | |
| | vii. Repetion rate | | |
| v. | Lamp size | | |
| | i. Cap. Designation | | |
| | ii. Maximum bulbs diameter, mm | | |
| | iii. Maximum overall length, mm | | |
| | iv. Maximum voltage increase at lamp terminal, volts | | |
| 7. | P.F. Correction Capacitors | | |
| a. | Type and make | | |

| | | | |
|---|---|---|---|
| b. | Rated voltage, volts | | |
| c. | Rate frequency, Hz | | |
| d. | Rated minimum & maximum temperature | | |
| e. | Rated capacitance, micro farads | | |
| f. | Tolerance on rated capacitance, percent | | |
| g. | Ohmic value of discharge resistor, mega ohms | | |
| 8. | Ballasts | | |
| a. | Rated voltage | | |
| b. | Rated frequency | | |
| c. | Rated current | | |
| d. | Power factor of the current | | |
| e. | Voltage current ratio | | |
| 9. | Ignitors | | |
| | Name of manufacturer & IS to which ignitors conform | | |
| 10. | Details of Distribution Pillar boxes | | |
| a. | Thickness & dimensions of pillar box | | |
| b. | Details of accessories provided in pillar box | | |
| | i. | | |
| | ii. | | |
| | iii. | | |
| | iv. | | |
| | v. | | |
| c. | Whether type test report of pillar box attached. | | |
| d. | Whether detailed wiring diagram attached | | |
| 11. | Details of PVC cables to be used (size, make No. of cores, materials of conductor, dimensions etc. | | |
| 12. | Details of lighting towers in general area | | |
| | Number of luminaries, No. of wattage of lamp in each luminaries etc. to be provided at | | |
| i. | Tower location No.-1 | | |
| ii. | Tower location No.-2 | | |
| iii. | Tower location No.-3 | | |
| iv. | Tower location No.-4 | | |
| v. | Tower location No.-5 | | |
| vi. | Tower location No.-6 | | |
| vii. | Tower location No.-7 | | |
| viii. | Tower location No.-8 | | |
| ix. | Tower location No.-9 | | |
| x. | Tower location No.-10 | | |
| xi. | Tower location No.-11 and so on | | |
| | | | |
| 13. | Any other information (with details) | | |

**(Signature)**
**Bidder's Name**

**ANNEXURE-II**

**SCHEUDLE OF GUARANTEED AND OTHER TECHNICAL PARTICULARS FOR CONTROL ROOM BUILDING, BAY LEVE KIOSKS AND STREET LIGHTING**

Lighting Fixtures & Accessories
(Data to be submitted separately for
each type and size)

| | | |
|---|---|---|
| 1. | Manufacturerôs name and country | |
| a. | Fixtures | |
| b. | Accessories | |
| 2. | Country of manufacturer for | |
| a. | Fixtures | |
| b. | Accessories | |
| 3. | Applicable standards for | |
| a. | Fixtures | |
| b. | Accessories | |
| 4. | Manufacturerôs type and catalogue No. for | |
| a. | Fixtures | |
| b. | Accessories | |
| 5. | Nominal working voltage (volts) | |
| 6. | Maximum permissible supply voltage variation for satisfactory operation of | |
| a. | Fixtures (+/- O/L) | |
| b. | Accessories (+/- O/L) | |
| 7. | Power factor at nominal working voltage and frequency | |
| 8. | Full load input current at nominal working voltage (Amps.) | |
| 9. | Power loss per ballast at nominal working voltage and frequency (Watts) | |
| 10. | Maximum hot spot temperature of ballast case (°C) | |
| 11. | Maximum average ballast wining temperature (°C) | |
| 12. | Ambient temperature within the fitting in continuous operation at the design ambient air temperature (°C) | |
| 13. | Insulation class of ballast winding (°C). | |
| 14. | Average life expectancy of | |
| a. | Ballasts | |
| b. | Capacitors. | |
| c. | Lamps | |
| 15. | Lamp output at the design temperature | |
| a. | After 100 burning hours (lumens) | |
| b. | After 1000 burning hours (lumens) | |
| 16. | Lamp output at the end of the expected life period (lumens) | |
| 17. | Average light output of the fitting as | |

| | | |
|---|---|---|
| | a percentage of lamp output | |
| a. | Downwards (%) | |
| b. | Upwards (%) | |
| 18. | Earthing terminal | |
| a. | Material | |
| b. | Suitable for earthing conductor of size. | |
| 19. | Weights of Fixtures (Kg.) | |
| 20. a. | Starting current & PF for lamp (Amps.) | |
| b. | Operating current (Amps.) | |
| c. | Time Vs. mains current & PF characteristics during starting enclosing (yes / no) | |

Conduits & Accessories
(for each type & size)

| | | |
|---|---|---|
| 1. | Manufacturerôs name and country of manufacture | |
| 2. | Manufacturerôs type, designation | |
| 3. | Applicable standard | |
| 4. | Whether descriptive pamphlet is enclosed? (Yes/No) | |

Junction Boxes
(for each type & size)

| | | |
|---|---|---|
| 1. i. | Manufacturerôs name and country of manufacture | |
| ii. | Manufacturerôs type, designation | |
| iii. | Material specification | |
| iv. | Type of enclosure | |
| v. | Terminals | |
| a. | Make | |
| b. | Current rating (Amps.) | |
| c. | Voltage rating (volts) | |
| d. | Stud type (Yes / No) | |
| e. | Complete with insulated barriers (Yes / No) | |
| vi. | Whether descriptive pamphlet is enclosed? (Yes / No) | |

Lighting Panels
(for each type and size)

| | | |
|---|---|---|
| 1. | General | |
| a. | Manufacturerôs name and country of manufacture | |
| b. | Indoor / outdoor application | |
| c. | Design ambient air temp. (°C) | |
| d. | Thickness of sheet steel (mm) | |
| e. | Degree of protection provided (as per IS:2147 or equivalent) | |

| | | |
|---|---|---|
| f. | Bill of material for various equipment giving make, type rating, etc. enclosed (Yes / No) | |
| g. | Colour of finish paint | |
| i. | Outside | |
| ii. | Inside | |
| h. | Bus bars | |
| i. | Material | |
| ii. | Temp rise at rated current over specified | |
| iii. | Continuous current rating at 50 (°C) ambient temp. | |
| iv. | Whether suitable for one second current rating of 5 KA, AC or 4 kA, DC as applicable (Yes /No) | |
| v | Cross section | |
| vi | Applicable standard | |
| (i) | Control Wiring | |
| i. | Material of conductor | |
| ii. | Size of conductor / dia of wire (2) | |
| (j) | Conductor ï solilid / stranded | |
| k. | Terminal blocks | |
| i. | Make | |
| ii. | Current rating | |
| | a. Power terminals (Amps) | |
| | b. Other terminals (Amps) | |
| (l) | All tests as specified in specifications will be carried out (Yes / No) | |
| 2. | Air Break Switches<br>(for each type of size) | |
| a. | Manufacturerôs name and country of manufacture | |
| b. | Manufacturerôs type description | |
| c. | Applicable standard | |
| d. | Rated voltage (volts & frquency (Hz) | |
| e. | Rated current (Amps) | |
| f. | Rated breaking current (Amps). | |
| g. | Maximum through fault current withstand de-rating factor for use under site ambient conditions | |
| h. | Temperature rise of contacts when carrying continuous rated current under site conditions (°C). | |
| 3. | Fuses (for each type & size) | |
| a. | Manufacturerôs name and country of manufacture | |
| b. | Manufacturerôs type , description | |
| c. | Applicable standard | |
| d. | Rated voltage (volts) | |
| e. | Rated current (amps) | |
| f. | Whether fuse is mounted in an insulated carrier (Yes/No) | |

| | | |
|---|---|---|
| g. | Whether fuse carrier has an aperture for fuse failure indication (Yes / No) | |
| h. | Category of duty (IS:2208) | |
| i. | Rupturing capacities (prospective current (KA) | |
| j. | Maximum let rhough current for 1 sec. (KA) | |
| k. | Whether time / current characteristics are enclosed (Yes / No) | |
| 4. | Miniature circuit breaker (for each type and rating) | |
| a. | Manufacturerôs name and country of manufacture | |
| b. | Type | |
| c. | Rated voltage | |
| d. | No. of poles | |
| e. | Frequency | |
| f. | Current rating | |
| | i. Continuous at 50°C | |
| | ii. 1 Sec. (KA rms) | |
| g. | Breaking capacity (single pole / double pole / triple pole) | |
| | i. Symmetrical (KA rms at volt) | |
| | ii. Asymmetrical (KA rms at volt) | |
| h. | Total interrupting cycle time | |
| i. | Type of blow out device | |
| j. | Type of overload (thermal / magnetic) | |
| k. | Terminal suitable for cable size | |
| l. | Up to what fault current discrimination between in-comer fuse & MCB will be obtained | |
| m | Miniature breaker conform to | |
| 5. | Contractors<br>(for each type (DC/AC size) | |
| a. | Manufacturerôs name and country of manufacture | |
| b. | Rated voltage & permissible variation (volts) | |
| c. | Rated burden (VA) | |
| d. | Rated current (thermal) of main contacts | |
| e. | No. & type of aux. Contacts (if any) | |
| f. | Rated voltage of coil (volts) | |
| g. | Pick up voltage | |
| h. | Rated duty class | |
| i. | Drop off voltage | |
| j. | Applicable standard | |

Lighting Wires
(for each type & size)

| | | |
|---|---|---|
| 1. | Manufacturerôs name and country of manufacture | |
| 2. | Standards applicable | |
| 3. | Rated voltage (volts) | |
| 4. | Continuous current rating when laid in conduit in an ambient temperature of 50° (Amps). | |
| 5. | Conductor | |
| a. | Material | |
| b. | Nominal cross sectional area (mm°) | |
| c. | Number & diameter of wires (no / mm) | |
| 6. | Insulation | |
| a. | Composition of insulation | |
| b. | Thickness of insulation | |
| c. | Tolerance on thickness of insulation | |
| | Specific insulation resistance at 60 Deg. C. | |
| 7. | Colour scheme for identification of wires | |
| 8. | Whether descriptive pamphlets is enclosed (Yes / No) | |

Paining, Primer, Finish Coat

| | | |
|---|---|---|
| 1. | Paints<br>(for each type) | |
| a. | Manufacturerôs name and country of manufacture | |
| b. | Manufacturerôs type, designation / brand name | |
| c. | Shade | |
| 2. | Number of coats provide for | |
| a. | Junction Boxes | |
| 3. | Applicable standards | |
| 4. | Name and address of the contractor / sub-contractor who shall supply , install and commission the lighting system in accordance with the technical specifications | |

(SIGNATURE)
BIDDER

**RAJASTNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT MAMAGEMENT UNIT)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**Fire Fighting system**
**Part-14**

**Superintending Engineers (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-14 (Vol. II)**

**Technical Specification Fire Fighting System**

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## SPECIFICATION FOR FIRE PROTECTION SYSTEM

### 1.00.00 INTENT OF SPECIFICATION

This section covers the design and performance requirements of the following types of fire protection system.

a. Hydrant System

b. High Velocity Water (H.V.W) Spray system

c. Addressable Fire Detection System

d. Portable Fire Extinguishers

1.00.01 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 TAC/NEPA norms.

1.00.02 The scope of work include complete earthwork (i.e. excavation, backfilling etc.) for the entire buried piping for HVW spray system & Hydrant system, valve pits and pipe supports for buried, entrenched and over ground piping.

1.00.03 The equipment offered shall comply with the relevant Indian Standards. The equipment conforming to any other approved international standards shall meet the requirement called for in the latest revision of relevant Indian Standard or shall be superior.

1.00.04 Ambient temperature for design of all equipment shall be considered as 50°C.

1.00.05 The piping and instruments diagram for Hydrant and HVW spray system is annexed at Drawing No.1. The successful bidder shall prepare detailed layout and piping drawing based on this drawing and also other drawing such as road, drainage, cable trench, switch yard layout etc. as furnished by the Owner during detailed engineering.

1.00.06 Various equipment under the fire protection system should be supplied from the suppliers as per make of equipment / material given at Appendix - II.

### 2.00.00 DESIGN AND CONSTRUCTION

#### 2.01.00 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 as well as outdoor. These hydrant valves are located throughout the sub-station and also at strategic locations within control room building. 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 the sub-station.

a) Control room building
b) L.T. Transformer area
c) CT and CVT area
d) Fire Fighting pump House
e) Stores
f) Kiosks in switchyard
g) Future Transformer Area.

### 2.02.00 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 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 the substation. 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 to be installed in future. However, for the purpose of design it shall be assumed that only one Transformer will be on fire. The system shall be designed to have a pressure of 5.5Kg/$CM^2$ at 350 $m^3$/hr. at the farthest transformer/ reactor location as identified in the tender drawing

2.02.01 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 | 420 kV bushing | 3500 mm |
| 2 | 245 kV bushing | 2150 mm |
| 3 | 145 kV bushing | 1300 mm |
| 4 | 52 kV bushing | 630 mm |
| 5 | 36 kV bushing | 320 mm |

2.02.02 Minimum water pressure available at the farthest and/ or highest projector (H.V.W spray system) on the equipment protected shall be 3.5 kg/sq.cm(g). However, water pressure available at any projector shall not exceed 5.00 kg/sq.cm(g). Water shall be applied at a rate of 10.2 LPM/$M^2$ of the surface area of the entire transformer/ Reactor including bottom surface, radiator, conservator, etc.

2.02.03 **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 from which will enable manual electrical operation of the valve. In addition to this, each valve shall be provided with local operation latch.

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.

2.02.04 **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 traveling 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 of oxygen supply and provide sufficient cooling.

2.02.05 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.

2.03.00 **Fire Detection System**

2.03.01 Suitable fire detection system using smoke detectors and/ or heat detectors shall be provided for the entire control room building, including corridor and toilets. Fire detectors shall be located at strategic locations in various rooms of the building. 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.
5. A signal shall be given to air conditioning system for its shut down.

2.03.02 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.

2.03.03 Fire detectors shall be provided below and above false ceiling wherever applicable. Coverage area of each smoke detector shall not be more than 80 m2 and that of heat detectors shall not be more than 40 m2. Ionisation type smoke detectors shall be provided in all areas except AHU Room where heat detectors shall be provided. However, in addition to Ionisation type, photo electric type smoke detectors shall also be provided in the ratio 1:1 for cable vault area. Ionisation type and photo electric type detectors shall be provided in a mixed manner and alarm shall be initiated if either type of detector is activated. 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.

2.04.00 **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 DG set & FF building. These extinguishers will be used during the early phases of fire to prevent its spread and costly damage.

The design, construction & testing of pressurised water type, dry chemical powder type and Carbon dioxide type portable fire extinguishers shall meet the requirements as per clause 10.00.00.

2.05.00 **Water Supply System**

Water for hydrant & HVW system shall be supplied separately by one no electrical motor driven pump for each system with another pump, driven by diesel engine which shall be used as standby for both the systems. Two nos. water storage tanks of requisite as per bidders design capacity shall be provided. Pumps shall work under positive suction head. Annunciation of the hydrant & HVW spray systems shall be provided in fire water pump house and repeated in 400 kV control room.

The outdoor piping for the system in general shall be laid above ground on concrete pedestals with proper clamping. 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 as per Cl. No. 7.04.05. Such locations shall be finalised during detailed engineering.

The whole system will be kept pressurised by providing combination of air vessel and jockey pumps. Minor leakage will be met by Jockey pump. One additional jockey pump has been provided as standby. The pumps and air vessel with all auxiliary equipment will be located in firewater pump house.

2.05.01 Operation of all the pumps shall be automatic and pumps shall be brought into operation at present pressure. Pumps shall only be stopped manually. Manual start/ stop provision shall be provided in local control panel.

2.05.03 The design and construction of horizontal centrifugal pumps alongwith drives and accessories shall be in line with the requirements of Tariff Advisory Committee of India.

2.05.04 The technical specification of the diesel engine driven fire pump and electric motor driven fire pumps shall meet requirements as set in Data Sheet. The general design of the fire fighting pump sets shall meet the requirements under clauses no. 5.00.00 for Horizontal centrifugal pumps and 12.00.00 for Electrical motors.

2.05.05 Each pump shall be provided with a nameplate indicating suction lift/ delivery head, capacity and number of revolutions per minute.

2.05.06 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.

2.06.00 **Instrumentation and Control System**

2.06.01 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.

2.06.02 **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 switch gears and DCDBs located in control building.

a) Panel for motor driven fire water pump

The panel shall be provided with:

| | | |
|---|---|---|
| 1 | TPN switch | 1 No. |
| 2 | Auto/ manual switch | 1 No. |
| 3 | Start/ Stop Push buttons 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. |

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 switch for Jockey Pumps | 1 No. each |
| 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 jockey pump |
| 6. | Indication lamp for trip indication | 1 No. each for all the drives. |

c) **Panel for 2 Nos. batter charger & diesel engine driven fire water pump** 1 No.

The Panel shall be provided with the following:-

| | | |
|---|---|---|
| 1. | Auto/ manual switch for Diesel Engine driven Pump | 1 No. |
| 2 | Start/Stop push buttons with indication lamp | 1set |
| 3 | Indicating lamp showing drive ON/OFF | 1 set |
| 4 | D.C. Voltmeter/Ammeter in the battery charger circuit | |
| 5 | Battery charger will be as per specification described | |
| 6. | Selector switch for selecting either set of batteries for Diesel engine starting | |
| 7. | Selector switch for selecting either set of batteries for Diesel engine starting | |
| 8. | Selector switch for boost charging/ trickle charging of battery set. | |

d) Individual local control panel is to be considered for each transformer 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 annunciation 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 Ownerôs event logger.

2.06.03 **Annunciation Panels**

a)**Location: Fire Water Pump House**

i) Indicating lamps showing power supply ñONò and status indication lamps for each motor.

ii) Annunciation windows complete with buttons. Details are as follows:-

| S.No. | Description | Number |
|---|---|---|
| 1. | Electric motor driven fire water pump running | 1 |
| 2. | Electric motor driven firewater pump fails to start | 1 |
| 3. | Diesel engine driven fire water pump running | 1 |
| 4. | Diesel engine driven water pump fails to start | 1 |
| 5. | Jockey pump-1 running | 1 |
| 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 | 1 for each equipment |
| 10. | Deluge system operating for transformer | 1 for each equipment |
| 11. | Fire fighting system in operation/ Header pressure low | 1 |
| 12. | Fire in smoke detection system zone | 1 |
| 13. | Water storage tank water level low | 2 |
| 14. | High speed diesel tank level low | 1 |
| 15. | Spare | 10 |

b) **Location 400 kV Control Room**

i) Indication lamp showing supply 'ON'

ii) Following annunciation shall be provided

iii) Provision shall be made in the panel for a signal for spray ON for each Transformer for Owner's use for event logger.

| S.No. | Description | Number |
|---|---|---|
| 1. | Electric motor driven fire water pump running | 1 |
| 2. | Electric motor driven firewater pump fails to start | 1 |
| 3. | Diesel engine driven fire water pump running | 1 |
| 4. | Diesel engine driven water pump fails to start | 1 |
| 5. | Jockey pump-1 running | 1 |
| 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 | 1 for each equipment |
| 10. | Deluge system operating for transformer | 1 for each equipment |
| 11. | Fire fighting system in operation/ Header pressure low | 1 |
| 12. | Fire in smoke detection system zone | 1 |
| 13. | Water storage tank water level low | 2 |
| 14. | High speed diesel tank level low | 1 |
| 15. | Motor driven fire water pump in operation | 1 |
| 16. | Fire/ Fault | 1+1 (duplicate) For each zone as applicable |
| 17. | Spares | 10 |

c) Each annunciation panel shall be provided with a hooter.

d) Indication for fault in respective areas shall also be provided. Each annunciation window shall exhibit 'FIRE' and 'FAULT' conditions separately.

2.06.04 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 under any of the following conditions:

a) HVW spray or Hydrant system header pressure low.

b) Operation of any deluge valve.

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) 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**

Jockey pump shall start automatically when water pressure in header falls below the set value. 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.

3.00.00 **SHOP AND SITE TESTS**

3.01.00 **Shop Tests**

3.01.01 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.

3.01.02 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:

a) Materials analysis and testing
b) Hydrostatic pressure test of all pressure parts, piping etc.
c) Dimensional and visual check.
d) Balancing test of rotating components.
e) Determination of performance characteristics of pumps, compressors, diesel engines, electrical drive motors etc.
f) Response characteristics of heat/ smoke detectors.
g) Performance characteristics of HVW spray nozzles (projectors)
h) Temperature rating test on Heat detectors.
i) Flow rate and operational test on Flow control valves.
j) Operational test of alarm valve (water-motor gang)
k) Calibration tests on instruments and tests on control panel.
l) Destruction/ burst tests on 2% or minimum one(1) no. of hoses and portable type fire extinguishers for each type as applicable. Any fraction number shall be counted as next higher integer.
m) Performance test on fire extinguishers as required in the code.

3.01.03 In the absence of any Code/ Standard, equipment shall be tested as per mutually agreed procedure between the supplier and the Owner.

3.01.04 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 leveling.

3.01.05 All test certificates and reports shall be submitted to the Owner for approval.

3.01.06 The Owner's representative shall be given full access to all tests. The manufacturer shall inform the Owner allowing adequate time so that, if the Owner so desires, his representatives can witness the test.

3.02.00 **Site Tests**

3.02.01 **General**

a) All piping and valves, after installation will be tested hydraulically at pressure of 1.5 times that of the maximum attainable pressure in the system 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 Owner.

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, paining 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 Owner.

h) Automatic starting of all the fire pumps by operating the test valves.

i) Automatic operation of the Jockey pump

j) Operation of the automatic flow control valve by operating the test valve and remote operating of the solenoid valve.

k) Operation of entire annunciation system.

3.02.02 After erection at sire, 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 Owner's approval. It shall be in line with standard Performance Guarantee Test procedure enclosed at Appendix-I.

3.02.03 All the detectors installed shall be tested for actuation by bringing a suitable source of heat/smoke near the detector and creating a steam of hot air/ smoke over the detector. The exact procedure of this test shall be detailed out by the Owner to the successful Bidder.

4.00.00 **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'.

5.00.00 **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.

5.01.00 The material of the various components shall conform to the applicable IS/BS/ASTM/DIN Standards.

5.01.01 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. In case of contradiction between this specification and "horizontal centrifugal pump data specification sheets" enclosed, stipulations of the data specification sheets will prevail.

5.02.00 **General Performance Requirements**

5.02.01 The pump set shall be suitable for continuous operation at any point within the "Range of Operation".

5.02.02 Pumps shall have a continuously rising head capacity characteristics from the specified duty point towards shut off point, the maximum being at shut off.

5.02.03 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.

5.02.04 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.

5.02.05 **Drive Rating**

The drive rating shall not be less than the maximum power requirement at any point within the "Range of Operation" specified where the supply frequency is 51.5 Hz (and the motor is running at 103% of its rated speed).

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.

5.02.07 Pump set along with its drive shall run smooth without undue noise and vibration. Acceptable peak to peak vibration limits shall generally be guided by Hydraulic Institute Standards.

5.02.08 The Contractor under this specification shall assume full responsibility in the operation of the pump and drive as one unit.

5.03.00 **Design & Construction**

5.03.01 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.

5.03.02 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.

5.03.03 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 reaction not less than those specified in API-610

5.03.04 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.

5.03.05 **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.

5.03.06 **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.

5.03.07 **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.

5.03.08 **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.

5.03.09 Shaft sleeves shall be securely fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

5.03.10 **Bearings**

Bearings and hydraulic devices (if provided for balancing axial thrust) of adequate design shall be furnished for taking the entire pump load arising from all probable conditions of continuous operation throughout its õRange of Operationò 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.

Bearing shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.

5.03.11 **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, e.t.c. shall form an integral part of the pump assembly.

5.03.12 **Shaft Couplings**

All shafts shall be connected with adequately sized flexible couplings of suitable design. Necessary guards shall be provided for the couplings.

5.03.13 **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 minimize misalignment caused by mechanical forces such as normal piping strain, hydraulic piping thrust etc. Suitable drain taps and drip lip shall be provided.

5.03.14 **Balancing**

All rotating components shall be statically and dynamically balanced at shop.

5.03.15 All the components of pumps of identical parameters supplied under this specification shall be interchangeable.

5.03.16 **Prime Mover**

The design and construction of the electric drive motor shall be as specified in clause 12.00.00.

5.04.00 **Tests and Inspection**

5.04.01 The manufacturer shall conduct all tests required to ensure that the equipment furnished conform to the requirement 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 Owner/ Engineer for approval before conducting the tests.

5.04.02 Where stage inspection is to be witnessed by Owner, in addition to above, the Bidder shall submit to the Owner/ Engineer at the beginning of the contract, the detailed PERT-Chart showing the manufacturing programme and indicating the period where Owner or his authorised inspecting agency are required at the shop.

5.04.03 **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 Owner/Engineer.

5.04.04 Where stage inspection is to be witnessed by Owner, all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication, by Ownerõs 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 Owner, as per the

requirements of specified material standard. The samples for physical and chemical tests shall be drawn up in presence of Owner's inspector who shall also witness the tests.

5.04.05 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.

5.04.06 **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.

5.04.07 **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 Owner/ Engineer's representative as per the requirements of the Hydraulic Institute Standards/ ASME Power Test Code PTC 8.2/BS-599/I.S.S., latest edition. Routine tests shall be done on all the pumps.

5.04.08 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.

5.04.09 Tests shall preferably be conducted along with the actual drives being supplied.

5.04.10 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.

5.04.11 In case of model testing, the stipulations of latest edition of Hydraulic Institute Standards shall be binding. Phototype or model tests, however shall be conducted with the suction condition identical to the field conditions i.e. sigma values of phototype and model is to be kept same.

5.04.12 Prior to conducting model testing, calculations establishing model parameters, sizes and test procedure will be submitted to Owner/ Engineer for approval.

5.04.13 All rotating components of the pumps shall be subjected to static and dynamic balancing tests.

5.04.14 After installation, pumps offered may be subjected to testing at field also by Owner. 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 Owner and Contractor. The Contractor shall furnish all necessary instruments, accessories and personnel for site testing. Prior to testing, the calibration curves of all instruments and permissible tolerance limit of instruments shall be mutually agreed upon.

5.04.15 If desired by the Owner, the Contractor shall conduct necessary model test for establishing optimum sump dimensions/ flow correcting devices in existing sump, to suit the pump offered.

5.04.16 The Owner or his authorised representative shall have full access to all tests. Prior to performance tests, the Contractor shall intimate the Owner allowing adequate time so that if the Owner so desires, his representative can witness the test.

5.04.17 Report and test certificates of the above tests shall be submitted to the Owner/ Engineer for approval.

6.00.00 **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.

6.01.00 **Design and Construction**
**General**

6.01.01 The diesel engine shall be of multicylinder type four-stroke cycle with mechanical (airless) injection, cold starting type.

6.01.02 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.

6.01.03 Reference conditions for rated output of engine shall be as per IS: 10000, part II or ISO: 3046, part I.

6.01.04 The engine shall be designed with regard to ease of maintenance, repair, cleaning and inspection.

6.01.05 All parts subjected to substantial temperature changes shall be designed and support to permit free expansion and contraction without resulting in leakage, harmful distortion or misalignment.

6.01.06 **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.

6.01.07 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.

6.01.08 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 batters. The automatic starting arrangement shall include a "Repeat Start" feature. The battery capacity shall be adequate for 10 (ten) consecutive starts without recharging with a cold engine under full compression.

6.01.09 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 utilized for charging either of the two (2) batteries.

6.01.10 For detail design of battery and battery charger, sub-section Electrical may be referred to.

6.01.11 **Governing System**:

The engine shall be fitted with a speed control device, which will control the speed under all conditions of load.

6.01.12 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 devices is manually reset to normal operating position (Vol. II, NFPA, 1978).

6.01.13 The governor shall be suitable for operation without external power supply.

6.01.14 **Fuel System**

The diesel engine will run on High Speed Diesel

6.01.15 The engine shall be provided with fuel oil tank having adequate capacity to hold sufficient fuel oil for a minimum of six (6) hours of full load run. The fuel oil tank shall preferably be mounted near the engine. No fuel oil tank will be provided by the Owner.

6.01.16 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.

6.01.17 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.

6.01.18 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.

6.01.19 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.

6.01.20 A manual fuel pump shall be provided for priming and releasing of air from the fuel pipelines.

6.01.21 **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 casting. 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.

6.01.22 **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.

6.02.00 **Testing & Inspection**

6.01.01 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 Owner for approval before conducting the tests.

6.02.02 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.

6.02.03 Material analysis and testing.

6.02.04 Hydrostatic pressure testing of all pressure parts.

6.02.05 Static and dynamic balance tests of rotating parts at applicable over-speed and determination of vibration level.

6.02.06 MPI/DPT on machined parts of piston and cylinder.

6.02.07 Ultrasonic testing of crankshaft and connecting rod after heat treatment.

6.02.08 Dimensional check of close tolerance components like piston, cylinder bore etc.

6.02.09 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 óAô 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.

6.2.14 Adjustment of speed governor as per BS:5514.

6.2.15 Diesel engine shall be subjected to routine tests as per IS:10000/BS:5514.

7.0 **PIPING, VALVES AND SPECIALITIES**

7.1 This clause covers the design, manufacture, shop testing, erection, testing and commissioning of piping, valves and specialities.

7.2 **SCOPE**

The piping system which shall include but not be limited to the folowing :

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 dampers, 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 Ownerôs RCC works, bidder will furnish all inserts.

7.2.7 Painting, anti-corrosive coatings etc. inside and outside 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 Heavy grade pipes as per IS:1239 or IS:3589 suitably wrapped / coated as per IS:10221.

b) Over-ground pipes normally full of water

Mild steel heavy grade pipes as per IS:1239 or IS:3589 duly painted as per IS:536 fire red.

c) Over ground pipes normally empty, but periodic charge of water and for detector line for HVW System.

Mild steel heavy grade galvanised pipes as per IS:1239 or IS:3589.

7.3.2 All fittings to be used in connection with steel pipe lines upto a size of 80 mm shall be as per IS:1239. Part-II Mild steel tubulars and other wrought steel pipe fittings, heavy grade. Fittings, with sizes above 80 mm upto 150 mm shall be fabricated from IS:1239 heavy grade pipes or steel plates having thickness not less than those of IS:1239 Part-I heavy grade pipes. Fittings with sizes above 150 mm shall be fabricated from IS:3589 Class-2 pipes. All fittings used in GI piping shall be threaded type. Welding shall not be permitted on GI piping.

7.3.3 Pipelines carrying water, air etc. should be sized on the basis of following values of allowable velocities based on the rated capacity of the pumps :

| SL. NO. | SERVICE DESCRIPTION | | VELOCITY IN M/SEC. | |
|---|---|---|---|---|
| | | | PIPE SIZE | |
| | | BELOW 50 MM | 50-150 MM | 200 MM AND UPWARDS |
| a. | Pump Suction | - | 1.2-1.5 | 1.2-2.0 |
| b. | Pump Discharge | 1.2-1.8 | 1.8-2.4 | 2.1-2.5 |
| c. | Header | - | 1.5-2.4 | 2.1-2.4 |
| d. | Compressed air below 2 kg/cm2 (g) | 15-20 | 20-30 | 25-35 |
| e. | Compressed air 2 kg/ cm2g and above | 20-30 | 25-40 | 35-45 |

7.3.4 For steel pipeline, welded construction should be adopted unless specified otherwise.

7.3.5 All piping system shall be capable of withstanding the maximum pressure arising from any condition of operation and testing including water hammer effects.

7.3.6 Gate/sluice valve will be used for isolation of flow in pipe lines and shall be as per IS:778/BS-5150 (for size upto 40 mm), IS:780 (for sizes above 40 mm and upto 300 mm) and IS:2906 (for sizes above 300 mm). Valves shall be of rising spindle type. PN 1.6 class valves shall be provided.

7.3.7 Gate valves shall be provided with the following :-
a) Hand wheel.
b) Position indicator.
c) Draining arrangement of valve seat.
d) Locking facility (where necessary)

7.3.8 Gate valves shall be provided with back seating bush to facilitate gland removal during full open condition.

7.3.9 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.

7.3.10 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. These valves shall generally conform to IS:5312.

7.3.11 Whenever any valve is found to be so located that it can not be approached manually from the nearest floor / gallery / platform hand wheel with floor stand or chain operator shall be provided for the same.

7.3.12 Valves below 50 mm size shall have screwed ends while those of 50 mm and higher sizes shall have flanged connections.

7.3.13 **STRAINERS**

**BASKET STRAINER**

a) Basket strainers shall be of 30 mesh and have the following materials of construction : Body fabricated mild steel as per IS:2062 (tested quality). Strainer wires of stainless steel (AISI:316), 30 SWG, suitably reinforced.
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 atleast 4 times pipe cross sectional area at inlet.
e) Pressure drop across strainer in clean condition shall not exceed 1.5 MWC at 410 M3/hr flow.

7.3.14 **Y TYPE ON-LINE STRAINERS**

Body shall be constructed of mild steel as per IS:2062 (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 atleast 4 times pipe cross-sectional area at linlet.

7.3.15 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 :

a) Column pipe M.s. IS:1239 med. grade.
b) Hydrant Valve

| | | |
|---|---|---|
| i) | Body | Gun metal. |
| ii) | Trim | Leaded tin bronze as per IS:318. |
| iii) | Hand wheel | Cast Iron as per IS:210, Grade-20. |
| iv) | Washer, gasket etc. | Rubber as per IS:638 |
| v) | Quick coupling connection | Leaded tin bronze as per IS:318 Grade-2. |
| vi) | Spring | Phosphor Bronze as per IS:7608. |
| vii) | Cap and chain | Leaded tin bronze as per IS:318 Grade-2. |

The general design of hydrant valve shall conform to IS:5290.

7.3.16 **HOSES, NOZZLES, BRANCH PIPES AND HOSE BOXES**

a) Hose pipes shall be unlined flax canvas / reinforced rubber-lined canvas construction as per IS:4927/type A of IS:636 with nominal size of 63 MM (2 1/2") and lengths of 15 metre or 7.5 metre, as indicated elsewhere. All hoses shall be ISI marked.
b) Hose pipes shall be capable of withstanding an internal water pressure of not less than 35 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 joints 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 (as per IS:318 Grade-2) at both ends. One end of the branch pipe

will receive the quick coupling while the nozzles will be fixed t o the other end.

e) Nozzles shall be constructed of leaded tin bronze as per IS:318 Grade-2.

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. The furnished design must meet the approval of Tariff Advisory Committee.

h) All instantaneous couplings, as mentioned under clauses 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**

The contractor shall fabricate all the pipework strictly in accordance with the related approved drawomgs/

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 Owner / Engineer.

b) Surface of overground pipes shall be thoroughly cleaned of mill scale, rust etc. by wire brushing. Thereafter one (1) coat of red lead 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) Coating and wrapping shall be in line with IS:10221.

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 signaling 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 erection 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 Owner.

7.5.3 **Welding**

a) Welding shall be done by qualified welders only.

b) Before welding, the ends sh all be cleaned by wire brushing, filing or machine grinding. Each weld-rn shall be cleaned of slag before the next run is deposited.

c) 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.

d) 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 owner / consultant.

e) 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.

f) No backing ring shall be used for circumferential butt welds.

g) Welding carried out in ambient temperature of 5°C or below shall be heat-treated.

h) Tack welding for the alignment of pipe joints shall be done only by qualified welders. Since tack welds from 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.

i) 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. |

j) 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.

k) 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.

l) 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.

m) On completion of each run craters, weld irregularities, slag etc. shall be removed by grinding or chipping.

n) 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). Atleast two runs shall be made on socket weld joints.

7.6 **Tests at Works**

7.6.1 **Pipes**

a) Mechanical and chemical tests shall be performed as required in the codes / standards.

b) All pipes shall be subjected to hydrostatic tests as required in the codes / standards.

c) 10% spot Radiography test on welds f 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 hydro statically 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 form 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.

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

Unlined flax / reinforced rubber-lined canvas hoses shall be tested hydro statically. Following tests shall be included as per IS:4927/IS:636.

a) Percolation test.
b) Pressure test at 221 kg/cm2g
c) Burst test at 32 kg/cm2g (minimum)

The branch pipe, coupling and nozzles shall be subjected to a hydrostatic test pressure of 21 kkg/cm2g to detect any leakage through defects of casting.

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 IS:2825.

8.2 Inside surface of the tank shall be protected by anti-corrosive paints / coating / linings as required.

8.3 Outside surfaces of the vessels shall be provided with one (1) of red lead primer with two (2) coats of synthetic enamel paint of approved colour and characteristics.

8.4 TESTS AND INSPECTION

8.4.1 Air vessels shall be hydraulically tested at 1.5 times design pressure or 2 times the working pressure, whichever is higher, for a period not less than one (1) hour.

8.4.2 All materials used for fabrication shall be 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 IS 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

i) 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.

ii) Codes and Standards

All equipment supplied shall conform to internationally accepted codes and standards. All equipment offered by Bidders should be TAC approved or have been in use in installations which have been approved by TAC.

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 must be approved by the Tariff Advisory Committee, India or FOC, London or a reputed international Authority.

e) 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 form the network. This drop in water pressure will actuate the Deluge Valve.

f) The bidder may offer alternative method of heat detection and type of heat detectors, provided these are acceptable to the Tariff Advisory Committee and the Owner.

9.2 **HVW 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. Material of construction of projector shall be in line with TAC / NFPA requirement.

9.3 **FIRE DETECTORS**

9.3.1 Fire detectors shall be approved by FOC-London or similar international authorities and also by Tariff Advisory Committee of India.

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. The set point shall be adjustable.

9.3.4 Fire detectors shall be equipped with an integral LED 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 Department of Atomic Energy (DAE), Government of India shall be made available for ionisation type smoke detectors. All accessories required to satisfy DAE 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 twenty five (25) years.

10.0 **PORTABLE FIRE EXTINGUISHERS**

i) Intent of Specification
This specification lays down the requirement regarding fire extinguishers of following types :
Portable fire extinguishers
a) Pressurized water type
b) Dry chemical powder type
c) Carbon Dioxide

ii) All the extinguishers offered by the Bidder shall be of reputed make and should have been approved by Tariff Advisory Committee of India or any other international authorities like FOC-London / NFPA-USA. Certificates to this effect shall be furnished by the Bidder. All extinguishers shall be ISI marked.

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 nitial 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 Indian Standard.

10.1.6 Pressurisation of water type fire extinguishers shall either be done by compressed air or by using gas cartridge. The constant air pressure type shall conform to IS:6234 and the gas pressure type shall conform to IS:940. Both these extinguishers shall be ISI marked.

10.1.7 Dry chemical powder type extinguisher shall conform to IS:2171.

10.1.8 Carbon Dioxide type extinguisher shall conform to IS:2878.

10.2 **TESTS AND INSPECTION**

10.2.1 All tests required to ensure that the equipment conforms to the specification requirements and relevant standards and codes shall be conducted. Tests shall be conducted by the manufacturer. Owner shall be informed of these tests in advance, so that Owner's representative may witness the test, if desired by Owner.

10.2.2 Particulars of shop tests and procedure shall be submitted to the Owner before had for his approval.

10.2.3 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 Owner.

10.2.4 Performance testing of extinguisher shall be in line of applicable Indian Standards. In case where no Indian 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 **Performance Guarantee**

The contractor shall guarantee all equipment supplied by him against any defect due to faulty design, material and workmanship. The equipment shall be guaranteed to operate satisfactorily at the rated conditions at site.

10.4 **Painting**

Each fire extinguisher shall be painted with durable enamel paint of fire red colour conforming to relevant Indian Standards.

11.0 **INSTRUMENTS**

(a) **Intent of Specification**

The requirements given in the sub-section shall be applicable to all the instruments being furnished under this specification.

(b) 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 / Combination / Differential Gauges & Switches.

11.1.1 The Pressure sensing elements shall be continuous ñCòbourdon 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, stowed 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 burden 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 micro-meter 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.

11.1.12 All gauges shall have ½ inch NPT bottom connection.

11.1.13 All instruments shall conform to IS:3624 - 1966.

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 DC actuation set point shall be adjustable throughout the range. ON-OFF differential (difference between switch 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.

11.1.17 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 AC. 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 Owner / Consultant as per the agreed quality plan.

11.7 Makes of control panel and local instruments, accessories shall be as per Owner'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 and Standards**

12.2.1 The design, manufacture, installation and performance of motors shall conform to the provisions of latest Indian Electricity Act and Indian 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 IS or 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 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 10% 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 415 V (3 phase, solidly earthed)
Below 0.2 kW 240 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-54 as per IS:4691. For hazardous locations, the enclosures of the motor shall be of flameproof construction.

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.

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 IS:325.

d) The locked rotor withstand time under hot condition at 100% of rated voltage shall be more than the starting time with the driven equipment at minimum permissible voltage.

12.3.5 **Running requirements**

i) The double amplitude of motor vibration shall be within the limits specified in IS:4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

ii) 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.

iii) Induction motors shall be so designed as to be capable of withstanding the voltage and torque stresses.

iv) Motors shall be capable of developing the rated full load torque even when the supply voltage drops to 70% of rated voltage.

v) 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.

vi) 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.

ii) **Stator core**
The stator laminations shall be made from suitable grade magnetic sheet steel varnished on both sides.
iii) Insulation and winding
a) All insulated winding conductor shall be of copper.

12.4.2 **Rotor**

iv) Rotors shall be so designed as to keep the combined critical speed with the driven equipment away from the running speed by atleast 20%.
v) 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 415 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.
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.
vi) Suitable tinned brass compression type cable glands and cable lugs shall be supplied by the contractor to match ownerôs cable.
vii) Terminal box for single core cable shall be of non-magnetic material.
viii) Marking of all terminals shall be in accordance with IS:4728.

12.4.4 **Rating Plates**

i) Rating plates shall be provided for all motors giving the details as called for in the following standards.
a) IS:325 (for three phase squirrel cage induction motors).
b) IS:996 (for single phase AC and universal electric 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.
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.

12.5.2 Motors 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 type and routine tests in accordance with the following standards :

a) for 3 phase induction motors IS:325 & IS:4029.
b) For single phase induction motors IS:996.

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 Results of type and routine tests carried out on all motors in accordance with the standards indicated above shall be furnished to the engineer in six (6) copies for his scrutiny and approval. Only on acceptance from his side, motors can be considered suitable for despatch.

12.6.4 The Owner reserves the right to send his representative (s) to witness the tests. At least 15 days notice shall be given intimating the date of tests.

12.6.5 **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.

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.

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.

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 DC voltage shall be obtained normally after necessary rectification by battery charger.
13.1.4 The battery shall be large enough to crank the engine 10 times without charging in between and without getting drained to an extent which will affect its life.

13.1.5 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 DC loads.

13.2 **General Design**
The Battery and Battery Charger shall be located indoor.
The Battery Charger shall have suitable provision for mounting on column / wall.

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) Positive and Negative terminal posts shall be clearly and indelibly marked for easy identification.
iv) The electrolyte shall be of battery grade sulphuric acid conforming to IS:226-2692. Water for storage batteries conforming to IS:1069 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 Indian 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.

iv) The charging equipment shall be housed in a panel of sheet steel construction with hinged door on the front side. The minimum thickness of sheet steel shall be 2.5 mm.

v) 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.

vi) The panel shall be complete with internal wiring an input-output terminal block.
vii) Space heaters of adequate capacity shall be provided to prevent moisture condensation in the panel.
viii) The panel shall be chemically cleaned, rinsed, bonderised, rinsed and air dried.

13.3 Testing
13.3.1 The Battery Charger shall also be subjected to the following tests at manufacturer's works as per IS:4540.
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 IS:1651.
a) Marking and packing.
b) Verification of dimensions.
c) Test for capacity
d) Test for voltage during discharge.

## 14.0 CONTROL AND ANNUNCIATION PANELS

### 14.1 Intent of Specification
The following requirement shall be applicable to the control 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 Owner.
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 and annunciation panels shall be furnished complete with all accessories and wiring for safe and trouble free operation of the plant.

### 14.4 AC/DC Power Supply
14.4.1 The Owner will provide one feeder each for AC and DC to the panel. The contractor shall make for his own arrangements for providing these power supplied to different panels.

14.4.2 The contractor shall provide suitable isolating switch fuse unit in the control panel for receiving the above incoming AC and DC supplied.

### 14.5 Wiring
14.5.1 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.
14.5.2 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.
14.5.3 Extra-flexible wire shall be used for wiring to devices mounted on moving parts such as doors.

14.5.4 Spare contacts of auxiliary relays, timers and switches shall be wired out to the terminal blocks as required by the Owner / Engineer at the time of detailed engineering.

14.6 **Terminal Blocks**

14.6.1 Terminal blocks shall be 650 V grade, rated for 10 Amps and in one piece moulding.

14.6.2 Terminal blocks shall be arranged with at least 100 mm clearance between two sets of terminal block.

14.6.3 The terminal blocks shall have at least 20% spare terminals.

14.7 **Grounding**

A continuous copper bus 25x3 mm size shall be provided along with 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 (25x6 mm MS Flat).

14.8 **Space Heater and Lighting**

14.8.1 space heaters shall be provided in the panels for preventing harmful moisture condensation.

14.8.2 The space heaters shall be suitable for continuous operation on 240V AC, 50 Hz, single phase supply.

14.8.3 Free standing panel shall have a 240 V AC, plug point and a fluorescent light operated by door switch.

14.9 **Control and Selector Switches**

14.9.1 Control and selector switches shall be of rotary type, with escutcheon plates clearly marked to show the function and positions.

14.9.2 Control / selector switches shall be spring return or stay put type as per the requirements.

14.9.3 The contact ratings shall be at least the following :-

| | | |
|---|---|---|
| i) | Make and carry continuously | 10 Amp. |
| ii) | Breaking current at 240V DC | 1 Amp. (Inductive) |
| iii) | Breaking current at 240 V DC | 5 Amp. At 0.3 p.f. lagging. |

14.10 **Push Buttons**

Push buttons shall be spring return, push to actuate type and rated to continuously carry and break 10A at 240V 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.

14.11 **Indicating Lamps**

14.11.1 Indicating lamps shall be of the panel mounting, filament type and of low-watt consumption.

14.11.2 Lamps shall have translucent lamp covers with different colours for ON, OFF, auto trip, alarm, heating conditions.

14.11.3 Bulbs and lamps covers shall be easily replaceable from the front of the panel.

14.11.4 Indicating lamps should be located directly above the associated push button / control switches.

14.12 Fuses

14.12.1 All fuses shall be of HRC cartridge plug-in-type and shall be of suitable rating, depending upon circuit requirements.

14.12.2 All fuses shall be mounted on fuse carriers, which shall be mounted on fuse-bases.

14.13 **Contactors**

14.13.1 Contactors shall be of air break, electromagnetic type rated as per requirement.

14.13.2 Operating coils of AC contactors shall be of 240 V AC or 220 V DC as required.

14.13.3 DC contactors shall have a coil voltage of 220 V DC and shall be suitable for satisfactory continuous operation at 80% to 110% of the rated voltage.

14.14 **Relays and Timers**

14.14.1 All auxiliary and timers shall be of proven design and of reputed make.

14.14.2 All relays and timers shall have at least two NO and two NC contacts.

14.14.3 All relays and timers shall be suitable for 240 V AC and 220 V DC as required.

14.15 Indication Instruments

14.15.1 All indicating and integrating meters shall be flush mounted on panel front.

14.15.2 All instruments shall be compensated for temperature errors and factory calibrated to directly read the primary quantities.

14.15.3 All instruments shall have white dials with black numerals and lettering. Black knife edge pointer with parallax free dials will be preferred.

14.15.4 Ammeters provided on motor feeders shall have a compressed scale at the upper current region to cover the starting current.

14.16 **Annunciation System**

14.16.1 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.

14.16.2 Indications shall be engraved on Acrylic inscription plate window and shall be visible clearly when the indication lamp is lighted.

14.16.3 audible horn shall sound when a trouble contact operates and shall continue to sound until the acknowledge button is pressed.

14.16.4 Indication lamps shall flash when trouble contact operates and shall continue flashing until acknowledge button is pressed.

14.16.5 After acknowledge button is pressed, the horn and flashing shall stop but the indication lamps shall remain lighted.

14.16.6 When test button is pressed, all lamps shall flash and horn shall sound.

14.16.7 Annunciator systems shall operate on 220 V DC systems.

14.16.8 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.

14.16.9 20% spare windows shall be provided on the panel.

14.17 **Painting**

14.17.1 all sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005.

14.18 **Tests**

14.18.1 Following tests / inspection shall be carried out by the contractor in the presence of Owner's representative :

(A) Factory Tests

i) Compliance with approved drawings, data and specification.

ii) Visual check for workmanship.

iii) Wiring continuity and functional checks.

iv) Calibration of instruments, relays and metres wherever required by inspector.

v) HV test

vi) Insulation resistance measurement before and after HV test.

vii) Testing to observe compliance to degree of protection as per IS:2147 (latest)

(B) Inspection / Testing at site :

i) IR test before and after HV test

ii) HV test

iii0 Functional testing

(C)

i) The fire detection and annunciation panel shall be tested as per BS:3116 Part-IV.

ii) The Annunciation System shall be routine tested.

**APPENDIX-I**

**STANDARD PERFORMANCE GUARANTEE**
**TEST PROCEDURE**

1. **SCOPE, PURPOSE AND CODES**

1.1 **Scope**
This test procedure shall cover the performance guarantee tests for all the sub-systems covered in the subject package.

1.2 **Purpose**
The purpose of this test procedure is to describe the criteria of acceptance test for the sub-systems of fire protection system.

1.3 **Codes**

The following codes and standards shall be applicable for conducting test unless otherwise modified or supplemented by the enclosed procedure and mutually agreed to, between the Owner and the contractor

| | | |
|---|---|---|
| 1 | NFPA-13 | Standard for the Installation of sprinkler system. |
| 2. | NFPA-15 | Standard for water spray fixed system for the fire protection. |
| 3. | NFPA-12 A | Standard for Halon 1301 Fire Extinguishing System |
| 4. | NFPA-72E | Standard on Automatic Fire Detectors. |
| 5. | Fire Protection Manual by TAC (Latest Edition). | |
| 6. | NFPA-12 | Standard on Carbon dioxide extinguisher systems. |
| 7. | IS:3034 | Fire safety of industrial building : Electrical generating and distributing stations code of practice. |
| 8. | IS:2878 | CO2 (Carbon Dioxide) type extinguisher. |
| 9. | IS:2171 | DCP (Dry Chemical Powder) type |
| 10. | IS:940 | Pressuriesed Water Type |

2.0 **CONDITIONS OF TEST**

2.1 **Conduct of Test**
Test shall be conducted by accredited representatives of the contractor and the owner. The contractor shall be given permission to inspect the entire system in advance and make it ready for the test. Contractor's representatives shall witness all phases of the test and record and data jointly with Owner's representatives.

2.1.1a. The responsibility for conducting the test rests with the contractor.
b. Any instruments required for the PG test will be provided by the contractor. Calibration of test instruments shall be the responsibility of the contractor.
c. Calibration of instruments to be used in the test shall be carried out at an Govt. approved test lab.
d. Replacement of fused / damage parts i.e. quartzoid bulb, thermoelectric sprinkler and liner heat sensing cable etc. during the test shall be responsibility of contractor.

2.1.2 The design performance of the equipments / systems shall be demonstrated by the contractor after evaluating the acceptance test.

2.1.3 All hand appliances and their accessories as well as components of hydrant, sprinkler and other protective equipments shall be of a type and make, as per norms of Tariff Advisory Committee / IS.

2.1.4 All operating parts of the systems shall be fully tested to arrive that they are in operating conditions.

2.1.5 The operating tests shall include the tests of automatic detection equipment.

2.1.6 Provision shall be made for the disposal of water issuring from outlets to avoid property damage.

2.1.7 Contractor should furnish a written statement to the effect that the work covered in this contract has been completed and all specified flushing of underground, above ground piping has been successfully completed together with specified hydrostatic pressure tests.

2.1.8 All the erection / commissioning protocols in respect of hydrotest of hydrant mains, spray lines, vibration / noise level, date of pumps, holiday test results of pipe coatings, IR / conductor resistance values of LHs cables, alarm / annunciation / control systems, batteries, pipe line flushing laying of pipelines as per approved drawings, compliance of all hand appliances and their accessories as well as all components of hydrant / sprinkler / spray / other protective equipments to TAC, BIS; all other systems / equipments shall be made available before conducting the PG test. Sample checking of all the above mentioned items shall be carried out during PG test.

3.0 **HYDRANT SYSTEM**

3.1 I a) Sequential auto start of the electric and diesel engine pumps shall be checked by opening the test hydrants.

b) The minimum running pressure of 3.5 kg/sq.cm at th e highest / farthest shall be available with hydrant pump running at full capacity and 2 hydrants open simultaneously.

This test shall be repeated every month during guarantee period.

c) Vibration and noise level measurements for the pumps at 100% and 150% duty points should be below the specified value indicated in the approved data sheets.

d) Auto operation of jockey pump, for pressurising of system shall be checked for eight hours and reading of actuating / cut of pressures shall be recorded.

e) control panel / annunciation panel shall be checked for operation i.e. proper functioning and audiovisual indicators.

f) Battery and battery charger shall be checked for auto charging and providing sufficient power for three consequential starting kicks to diesel engine within five minutes with AC supply switched off.

g) The hydrant mains shall be hydraulically tested and shall be capable withstanding for 30 minutes a pressure equivalent to 150% of the design pressure or 200% of maximum operating pressure, whichever is higher. In case this test have been conducted before commissioning, such test is not mandatory and shall be verified.

h) All the hydrant valves, isolating valves and values of monitors shall be operated repeatedly for smooth operation and there shall be no leakage.

i) For diesel engine test shall be carried out for two (2) hours out of which half hour at full load and on 10% overload for half hour. Performance of diesel engine shall be observed at the end of the above test.

II. Following readings shall be taken after half an hour and shall be compared with the specified values indicated in the approved data sheet.

a) Exhaust temp. (with engine mounted calibrated temp. gauge).

b) Closed circuit water temp. (with engine mounted calibrated temp. gauge).

c) Lubricating oil pressure (with engine mounted calibrated temp. gauge).

d) Lubricating oil pressure (with engine mounted calibrated pressure gauge).

e) Speed (with digital non-contract RPM meter / tacho - meter).

Efficiency of combustion shall be verified from the colour of the exhaust. The colour of exhaust shall be haze clear and not black.

Vibration and noise level measurement shall also be taken at full load and at overload run test. It shall be below the specified value indicated in approved data sheet.

3.2 HVW Spray Systems

a) Spray system shall be hydraulically tested and shall be capable of withstanding thirty minutes, a pressure equivalent to 150% of the design pressure.

b) 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.

c) Rigidity of pipe supports shall also be checked during the water flow.

d) The maximum number of systems that may be expected to operate in ca se of fire shall be in full operation simultaneously in order to check the adequacy and condition of the water supply.

e) The discharge pressure at the highest and most remote nozzle shall be atleast 3.5 bar for which the system was designed.

f) Operation of deluge valve shall be checked by actuating detection system or opening the drain valve of deluge valves.

g) Resetting of deluge valve shall also be checked.

Performance test of sprinkler system shall be done basically to test :

a) The adequacy of coverage and discharge of sprinkler in the hydraulically remote areas. The tests shall be conducted as per IS:9972.

b) Automatic actuation of alarm valve due to opening of sprinklers.

c) Automatic operation of sprinkler pump.

d) Rigidity of pipe supports during the water flow.

e) Measurement of discharge pressure at most remote sprinkler by putting a pressure gauge.

f) Test certificate shall be submitted for quartzoid bulb to check the bursting temperature. In case of certificate is not produced, the appropriate method should be adopted to check the bursting temperature of quartzoid bulb.

g) I case of cable galleries, operation of alarm valve and thermoelectric sprinklers shall be checked by the actuation of the detection system. The actuation can be through a combination of ionisation and photoelectric type smoke detector or LHS cable or manually from control panel.

3.4 Fire Alarm System

The entire installation shall be tested to ensure that it operates satisfactorily and that :

a) All detector and manual call points function properly.
b) The control and indicating equipment correctly registers and indicates the state of the installation.
c) All ancillary equipment functions properly.
d) A restorable heat detector shall be tested with heat source, such as a hair dryer or shielded heat lamp, until it responds. After each heat test, the detector shall be reset.
e) The percent of all non-restorable detectors i.e. heat detector, QB and thermoelectric sprinkler shall be operated. These detectors shall be replaced by the contractor at his own cost.
f) Smoke detector shall be tested with rapid developing fire source emitting visible or invisisble smoke particles.

3.5 Linear Heat Sensing Cable Type Heat Detection System

a) Conductor resistance and insulation resistance values of all LHS cables shall be measured.

b) A portion of a cable shall be heated by burning coal / blow lamp till the time it gets short. Check all the indications, alarms and actuating signals are in operation.

c) Location of LHS cable may be checked physically w.r.t. specification requirements.

3.6.0 Portable Fire Extinguishers

a) All portable fire extinguishers of same type, shape, design and capacity produced by the same manufacturer from similar materials shall be grouped together to constitute a lot.

b) Each lot shall be considered individually for the purpose of evaluation of quality.

c) One number of sample, for testing, to be taken at random from a lot.

d) The samples tested shall pass the tests, indicated in the relevant IS code, for the lot to be declared to conform the performance test requirements.

**APPENDIX-II**

**MAKE OF EQUIPMENT/ MATERIALS**

| S.No. | Equipment / Material | Make |
|---|---|---|
| 1. | Fire Water pumps & jockey pumps (Horizontal Centrifugal) | KBL /M&P |
| 2. | Motors (LT) | KEC / SIEMENS / NGEF / CROMPTION / ABB |
| 3. | Diesel Engine (Horizontal Multi Cylinder) | RUSTON & HORNSBY KBL |
| 4. | Batteries | EXIDE / AMCO |
| 5. | Battery Charger | CHABBI / UNIVERSAL / LOGICSATAT / CALDYN / EXPOFYN |
| 6. | M.S. / G.I. Pipe | JINDAL / SAIL / SURYAROSHANI / AJANTA / TATA |
| 7. | C.I. Valves | H. SARKAR / VENUS / UPDHAY / KIRLOSKAR |
| 8. | Gun Metal Valve, Gate Valve | LEADER / LEVCON / SIGMA |
| 9. | Deluge Valve | ACE TURNKEY / HD FIRE / M&P / SBJ |
| 10. | Strainer | GRAND PRIX / JAYPEE / MULDTITEX / GUJRAT OTO FILT |
| 11. | Hume pipe | INDIAN HUME PIPE / PARGATE CONCRETE UDYOG |
| 12. | HV spray Nozzle, QB Detectors | HD FIRE / ACE TIRMLEY /GTECH / SBJ |
| 13. | Pressure Gauge | H. GURU / GENERAL INSTRUMENT |
| 14. | Pressure Switches | INDFOS / SWITZER / VERMATANG |
| 15. | Level Switches, Indicator Gauge | LEVCON / SIGMA |
| 16. | Hydrant Valve and Accessories | SUKAN / SHAH B / NEWAGE / MINIMAX / GTECH /SBJ / HD FIRE |
| 17. | Hose (Flax Canvas) | INDIAN RAYCON IND. / JAYSHREE / NEW AGE |
| 18. | Solenoid Valves | AVCON / ROTEX |
| 19. | Micro Processor based Fire Alarm Panel | ZITON / EDWARD / KIDDE / EST./ APPLO |
| 20. | Heat & smoke detectors | APPOLLO / ZITON / EDWARD / SYSTEM SENSOR / EST |
| 21. | AC, DC Distribution Board | SARVANA / ECS / C&S /UNILIEC |
| 22. | DE panel with charger | SARVANA / ECS / C&S |
| 23. | FRLS Cables | TORRENT / UNIVERSAL / NICCO / CCI /KEI. |
| 24. | Fire Extinguishers | NITIN / VIJAY FIRE / LIGHTEX / ZENITH / MINIMAX / CHANDRAKANTA / DYNAMIC |
| 25. | Spray Nozzles | M&P / HD FIRE |

NOTE :- Items not covered in the above list will be conforming to relevant TAC / ISS / International Standards & will have to be got approved at the time of Design Engineering.

**APPENDIX-III**

**HORIZONTAL CENTRIFUGAL PUMPS**

| SL.NO. | DESCRIPTION | H.V.W.SPRAY / HYDRANT PUMPS | JOCKEY PUMPS |
|---|---|---|---|
| 1.0 | Number of units | three (3) (One Diesel engine driven & two motor driven | two (2) |
| 2.0 | Type | Horizontal centrifugal | Horizontal centrifugal |
| 3.0 | Location | Indoor | Indoor |
| 4.0 | Service | As per TAC regulation | |
| 5.0 | Liquid to be pumped | Raw Water | |
| 6.0 | Capacity | 410 M3/hr | 10.8 M3/hr |
| 7.0 | Total dynamic head | 70 MWC | 80 MWC |
| 8.0 | Hydrostatic test pressure | As per specifications | |
| 9.0 | Suction condition / temp. | Flooded / 36°C | |
| 10.0 | Nature of BHP curve | Non-over loading type | |
| 11.0 | Type of bearing | As per manufacturing standard | |
| 12.0 | Sealing / cooling / lubrication | Graphited asbestos packing / self liquid cooling / lubrication | |
| 13.0 | Material of Construction | | |
| | a) Casing | C1, IS:210 FG : 260 | |
| | b) Impeller | Leaded Gun metal to IS:318 Grade-II | |
| | c) Wearing ring | Leaded Gun metal to IS:318 GradeV. | |
| | d) Base Plate | Fabricated Steel IS:226 | |
| | e) Shaft | Mild Steel to BS:970 EN.8 | |
| | f) Shaft Sleeve | SS-316 | |
| | g) Stuffing box | 2.5% Nickel CI to IS:210 Grade FG 260. | |
| | h) Gland | -do- | |
| | i) Gland Packing | Graphite Asbestors | |
| 14.0 | Drive Motor Particulars | | |
| | a) Type | AC Squirrel cage Induction Motor | |
| | b) Enclosure | TEFC ï IP ï 54 | |
| | c) Insulation Class | Class F with temp. rise limited to Class B | |
| | d) Starter | Direct on-line. | |
| 15.0 | Accessories to be provided with each pump by the supplier | Common base plate, companion flanges, drain plug, vent, priming connection, coupling guard, eye bolts, lifting lugs etc. | |

**GUARANTEED TECHNICAL PARTICULARS**

**OF**

**FIRE FIGHTING EQUIPMENTS**

**Annexure-I**

**SCHEDULE OF GUARANTEED AND OTHER TECHNICAL PARTICULARS FOR EMULSIFIER SYSTEM**

| | | |
|---|---|---|
| **1.** | **Fire Pump** | |
| a) | Type of Pumps | |
| b) | Name of manufacturer | |
| c) | No. of pumps offered | |
| d) | Whether pump is approved by the Fire Insurance Council | Yes / No |
| e) | Design flow | $M^3$/Hr. |
| f) | Guarantee Heat at Design Flow | M |
| g) | Guaranteed efficiency at Design flow. | % |
| h) | Guaranteed BHP at design flow at Guaranteed head | / $CM^2$ |
| i) | Power requirement of pump at designed flow and guaranteed head | KW |
| j) | Material of Impeller | |
| k) | Impeller diameter | mm |
| l) | Impeller diameter for rating | mm |
| m) | Speed | rpm |
| n) | Maximum suction lift meters | M |
| o) | Maximum allowable case working pressure | $Kg/cm^2$ |
| p) | Hydrostatic test pressure | $Kg/cm^2$ |
| q) | Type of shaft sealing arrangement | |
| r) | Type of bearing and lubrication. | |
| s) | Whether cooling water is required for bearing and seals, if so quantity required. | |
| t) | Couplings | |
| | i) Manufacturerøs name. | |
| | ii) Type | |
| u) | i) Suction connection details | |
| | ii) Discharge connection details | |
| v) | Total weight of complete assembly. | |
| **2.** | **Motors** | |
| a) | Manufacturerøs name and type | |
| b) | Rate output | KW |
| c) | Rated Speed | rmp |
| d) | Voltage, No. of phases and frequency in cycles / sec. | |
| e) | Insulation class | |
| f) | Full load current | Amps. |
| g) | Method of starting | |
| h) | Starting torque | |
| i) | F.L. Torque | |
| j) | Motor overload capacity with duration | |
| k) | Type of enclosure | |
| l) | Whether suitable for outdoor operation | |
| m) | Guaranteed motor efficiency and power factor at full load | |
| n) | Standard to which motors conform | |
| o) | Type of motor bearing and lubrications | |
| p) | Type of connections during continuous running | Star / Delta |
| q) | Total weight of motor | Kg. |
| **3.** | **DIESEL ENGINE (For emulsifier system only)** | |
| a) | Diesel engine details | |
| b) | Whether diesel engine as listed under clause A.3 shall be supplied. | |
| **c)** | Whether all spares listed in the specification included in the scope of supply | |
| **3.** | **Hydrant and Emulsifier system particulars** | |
| **A.** | **MS pipes (underground & over ground), Stand Pipes and fittings.** | |
| i) | Manufacturerøs name | |
| ii) | Class | |
| iii) | Specification | |
| iv) | Type of flanges/joints | |
| v) | Type of gaskets. | |
| **B.** | **GI Pipes (Under ground & over ground)** | |
| i) | Manufacturerøs name | |
| ii) | Class | |

| | | |
|---|---|---|
| iii) | Specification | |
| iv) | Type of joints | |
| **C.** | **Fire Hydrant Valves** | |
| **i)** | **Manufacturer's name** | |
| **ii)** | **Type** | |
| **iii)** | **Standards to which valves conform** | |
| **iv)** | **Body material** | |
| **v)** | **Trim material** | |
| **vi)** | **Painting** | |
| **vii)** | **Direction of handwheel rotation for closing the valve.** | |
| **viii)** | **Flange details** | |
| **ix)** | **Whether approved by TAC.** | |
| **D.** | **Fire Hose** | |
| **i)** | **Manufacturer** | |
| **ii)** | **Material** | |
| **iii)** | **Standard to which it conforms** | |
| **iv)** | **Type** | |
| **v)** | **Test pressure** | |
| **vi)** | **Operating pressure** | |
| **vii)** | **Size** | |
| **viii)** | **Length per piece and No. of pieces.** | |
| **ix)** | **Type of coupling** | |
| **x)** | **Method of attachment.** | |
| **xi)** | **Whether approved by Tariff advisory committee insurance Association of Indian (TAC)** | |
| **E.** | **HOSE CABINETS** | |
| **i)** | **Size** | |
| **ii)** | **Weight** | |
| **iii)** | **Nos. included in the scope of supply** | |
| **F.** | **FOG NOZZLES (FOR HYDRANT SYSTEM)** | |
| **i)** | **Manufacturer's name** | |
| **ii)** | **Standard to which conform** | |
| **iii)** | **Branch pipe material** | |
| **iv)** | **Nozzle material** | |
| **v)** | **Diameter of nozzle** | |
| **vi)** | **Pressure required at inlet** | |
| **vii)** | **Flow through nozzle** | |
| **viii)** | **Range of jet.** | |
| **ix)** | **Number of nozzles** | |
| **x)** | **Whether approved by Tariff advisory committee.** | |
| **G.** | **Isolating Valves, EMULSIFIER SYSTEM, HYDRANT SYSTEM** | |
| i) | Manufacturerôs name | |
| ii) | Type | |
| iii) | Body material | |
| iv) | Trim material | |
| v) | Flange particulars | |
| vi) | Direction of hand wheel operation | |
| **5.** | **Water Requirement** | |
| i) | Design requirement of water for emulsifying system | $M^3$ |
| ii) | Design requirement of water for hydrant system | $M^3$ |
| iii) | Total requirement of water | $M^3$ |
| iv) | Design dimension of the water reservoir for storage of water (length x breadth x depth) | |
| v) | Quantity of water required to be stored. | |
| vi) | Dimensions of two compartments of the reservoir (LXBXD) | |
| vii) | Design dimensions of water pump which will be common for both the compartments (LXBXD) | |
| viii) | Minimum pressure at which water should strike all surface for effective emulsification. | $Kg/cm^2$ |
| ix) | Minimum pressure distance of projectors from the equipment for emulsification. | Meters |
| x) | Max. load of pressure permitted due to air friction (max,) air pressure to be taken as | |
| xi) | Minimum value of discharge / unit surface | $M^3$/ hr. |
| **6.** | **Automatic Emulsifying System** | |

| | | |
|---|---|---|
| **i)** | **Water requirement at the deluge valve or terminal point** | |
| | a) Quantity | $M^3$ / hr. |
| | b) Pressure | $M^3$ / hr. |
| **ii)** | **Compressed air requirement at terminal point** | |
| | a) Quantity | $M^3$ / hr. |
| | b) Pressure | $M^3$ / hr. |
| **iii)** | **Compressor details** | |
| | a) Number | |
| | b) Capacity | |
| | c) Delivery pressure | |
| | d) Manufacturer | |
| | e) Type | |
| | f) Motor rating and speed | KW-rpm |
| | g) Weight of compressor with motor/ coupling & base plate | |
| | h) Compressor cooling arrangement | |
| **iv)** | **Detector net works** | |
| | a) Pressure to be maintained | $Kg/cm^2$ |
| | b) Low air pressure alarm setting | |
| **v)** | **Detectors** | |
| | a) Manufacturer | |
| | b) Type | |
| | c) Temperature setting | Deg. C. |
| | d) Material | $M^2$ |
| | e) Area covered by each detector | |
| | e) Min. no. of detectors per equipment | |
| | f) No. of spare detectors included in the scope of supply | |
| **vi)** | **Water Projectors (emulsifier system)** | |
| | a) Manufacturer | |
| | b) Size | mm |
| | c) Design flow | $M^3/cm^2$ |
| | d) Pressure required at inlet | Kg/cm2 |
| | e) Diameter of nozzle | |
| | f) Spacing | |
| | I) Minimum | |
| | II) Maximum | |
| | g)Material | |
| | h) No. of projector proposed (state no. for each equipment) | |
| | i) Type of control & sensing device | |
| | j) Standard to which conform | |
| **vii)** | **Deluge valves** | |
| | a) Manufacturer | |
| | b) Size | |
| | c) Contacts provided as per specification | Yes/No |
| | d) Material of construction | |
| **7.** | **Rate for effective Emulsification.** | |
| | a) Catalogue of detectors, projectors, deluge valve and other equipment offered enclosed with the bid | Yes/No |
| | b) G.A. drawing schematic drawing of each system whether enclosed with the tender | Yes / No. |

**SINGATURE OF TENDERER**

**NAME**

**STATUS**

**WHETHER AUTORISIED ATTRONEY OF THE TENDERING COMPANY SEAL**

**PLACE :**

**DATE:**

**Annexure – II**

SCHEDULE OF GUARANTEED AND OTHER TECHNICAL PARTICULRS

(Automatic Fire Alarm System based on Micro-processor controlled technology)

Note :- 1. To be furnished by the tenders along with tender.
2. Particulars which are guaranteed shall be marked with asterisk (*).

| | | |
|---|---|---|
| 1. | AUTOMATIC FIRE ALARM SYSTEM | |
| A. | MAIN FIRE CONTROL PANEL | |
| i. | Name of manufacturer | |
| ii. | Place of manufacture | |
| iii. | Type of Designation | |
| iv. | Over all dimensions | |
| v. | Gross weight | |
| vi. | Mounting ï State whether suitable for wall mounting or floor mounting or desk type | |
| vii. | No. of zones | |
| viii. | Maximum no. of detectors per zone | |
| Ix | Zone controls; state whether panel is provided with the following indication / facilities | |
| a. | Indication of zone fire | Yes / No |
| b. | Indication of zone fault open circuit and short circuit | Yes / No |
| c. | Switch for isolation of zones | Yes / No |
| d. | Common output for remote indication | Yes / No |
| e. | Fire test switch | Yes / No |
| x. | Alarm network : state whether wired for the following facilities | |
| a. | Combined main fire alarm | Yes / No |
| b. | Combined fire / fault hooter | Yes / No |
| c. | Individual fire hooter | Yes / No |
| d. | Alarm cancel for fire / fault | Yes / No |
| e. | Remote audio indication | Yes / No |
| xi. | Sate whether fully solid state & micro-processor based, capable to process & evaluate incoming signals. | |
| Xii | Type of construction ï whether modular | |
| xiii. | Particulars of PA system | |
| a. | Entire Installation | |
| | i. Type as per IS: 1881 | |
| | ii. Signal to noise ratio | |
| | iii. Sensitivity | |
| b. | Amplifying system | |
| | i. Amplifier gain (dB) | |
| | ii. Frequency response (excluding speakers) | |
| | iii. Provision of tone control | |
| c. | Microphones | |
| | Frequency response | |
| xiv | Input AC supply voltage requirement | |
| xv | Built in stand by battery particulars | |
| a. | Voltage | |
| b. | Capacity (AH) | |
| c. | No. of cells | |
| d. | Make of battery | |
| xvi | Particulars of battery charger for charging battery at Sr. No.(xv) above. | |
| a. | State whether two rate charger provided | |
| b. | Capacity of float charger (Amps) | |
| c. | Capacity of boost charger (Amps) | |
| xvii. | Whether panel have front glass door with locking arrangement | |
| xviii. | Colour shade as per IS:5. | |
| B. | FIRE DETECTORS (ADDRESSABLE) | |
| a. | PHOTO-ELECTRONIC LIGHT SCATTERED SMOKE | |

| | | |
|---|---|---|
| | DETECTORS | |
| i. | Name of manufacturer and address. | |
| ii. | Type designation | |
| iii. | Standard specification to which conform. | |
| iv. | Principle of operation. | |
| v. | Whether any radio-active material is employed. | |
| vi. | Smoke density alarm level of detector. | |
| vii. | Area coverage | |
| viii. | Overall dimensions | |
| ix. | a. Mounting type | |
| | b. Arrangement for visual supervision | |
| x. | Whether bears approval of TAC | |
| xi. | Detector voltage | |
| xii. | Alarm current | |
| xiii. | Standby current. | |
| Xiv | Locations where employed. | |
| xv. | Response time (in seconds) | |
| b. | IONIZATION CHAMBER SMOKE DETECTOR | |
| i. | Name of manufacturer and address. | |
| ii. | Type designation | |
| iii. | Standard specification to which conform. | |
| iv. | Principle of operation. | |
| v. | Ionization source. | |
| vi. | Strength of radioactive source. | |
| vii. | Detector voltage | |
| viii. | Standby current | |
| ix. | Alarm current | |
| x. | Operating temp. | |
| xi. | Coverage area | |
| xii. | Arrangement for visual supervision | |
| xiii. | Overall dimensions | |
| Xiv | Mounting type | |
| xv. | Locations where employed | |
| Xvi | Whether bears approval of TAC | |
| Xvii | Response time (in seconds | |
| C. | ELECTRO PNEUMATIC DETECTORS | |
| i. | Name of manufacturer and address. | |
| ii. | Type designation | |
| iii. | Standard specification to which conform. | |
| iv. | Principle of operation. | |
| v. | Mode Of operation ï whether fixed temp. and rate of rise mode equipped additionally. | |
| vi. | Operating fixed temperature. | |
| vii. | Operating rate of temperature rise. | |
| viii. | Coverage area | |
| ix. | Overall dimensions & weight | |
| x. | Type of mounting | |
| xi. | Contact rating for alarm / indication | |
| xii. | Arrangement for visual supervision | |
| xiii. | Whether bears approval of TAC | |
| Xiv | Locations where employed | |
| xv. | Response time (in seconds) | |
| D. | LINEAR HEAT SENSOR CABLE | |
| i. | Name of manufacturer and address. | |
| ii. | Type designation | |
| iii. | Standard specification to which conform. | |
| iv. | Principle of operation. | |
| v. | No. of cores & core material | |
| vi. | Type of core insulation | |
| vii. | Type of outer insulation covering. | |
| viii. | Operating temperature | |
| ix. | Monitoring current & voltage | |
| x. | Operating current | |
| xi. | Whether suitable for installation in topical conditions | |

| | | |
|---|---|---|
| xii. | Whether bears approval of TAC | |
| xiii. | Locations where employed | |
| E. | RESPONSE INDICATOR | |
| i. | Name of manufacturer and address. | |
| ii. | Type designation | |
| iii. | Standard specification to which conform. | |
| iv. | Overall dimensions | |
| v. | Weight | |
| vi. | Whether suitable for surface and recess mounting | |
| vii. | Rating of filament lamp and colour of lens | |
| viii. | Whether bears approval of TAC | |
| ix. | Locations where employed | |
| F. | MANUAL PUSH BOTTON STATION | |
| i. | Name of manufacturer and address. | |
| ii. | Type designation | |
| iii. | Standard specification to which conform. | |
| iv. | Push button type & make | |
| v. | a. NO. of NO / NC contacts.<br>b. Contact ratings | |
| vi. | Construction whether aluminum dia cost or MS sheet | |
| vii. | Dimensions | |
| viii. | Gross weight including weight of hammer & chain | |
| ix. | Finish ï State colour shade | |
| x. | Whether bears approval of TAC | |
| G. | ELECTRONIC HOOTER / SPEAKER / SOUNDER | |
| i. | Name of manufacturer and address. | |
| ii. | Type designation | |
| iii. | Standard specification to which conform. | |
| iv. | Principle of operation. | |
| v. | Whether finished in interior décor. | |
| vi. | Whether suitable for fire alarm signals and public address system | |
| vii. | Effective frequency range (10 dB below average response) | |
| H. | FRLS CONTROL AND POWER WIRING CABLE | |
| i. | Name of manufacturer | |
| ii. | Type of cable whether armoured | |
| iii. | Material an size of core | |
| Iv | Core insulation | |
| v. | Whether cable is tested for fire resistant | |
| vi. | Standard specification to which conform | |

SIGNATURE OF TENDERER
NAME
STATUS
WHETHER AUTHORISED ATTORNEY OF THE TENDERING COMPANY
COMPANY SEAL

DATE
PLACE

**Annexure-III**

**GUARANTEED TECHNICAL & OTHER PARTICULARS OF PORTABLE FIRE EXTINGUISHERS.**

| | | |
|---|---|---|
| i) | Name of Manufacturer & address | |
| ii) | Name of CCTC, FOAM type CO2, Gas expelled type, dry, powder type. | |
| iii) | Design & construction standard | |
| iv) | Capacity | |
| v) | Gas pressure (Bars) | |
| vi) | Test pressure of cylinder (Bars) | |
| vii) | Whether cylinders are rechargeable type. | |
| viii) | Type of mounting, whether universal. | |
| ix) | Type of actuation. | |
| x) | Type of complete discharge | |
| xi) | Whether manual lock off switch provided. | |
| xii) | Whether complete with all accessories including syphon tube, if required. | |
| xiii) | Empty weight (Kgs.) | |
| xiv) | Colour finish | |
| xv) | Whether bears approval of TAC. | |

**Note:- For each type of cylinder above details may be furnished separately.**

**SINGATURE OF TENDERER**

**NAME**

**STATUS**

**WHETHER AUTORISIED ATTRONEY OF THE TENDERING COMPANY SEAL**

**PLACE :**

**DATE:**

**RAJASTNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT MAMAGEMENT UNIT)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**Air Conditioning System**
**Part-15**

**Superintending Engineers (P&P )**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-15 (Vol. II)**

**Air Conditioning System**

**INDEX**


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| 1 | 1.0 | General | 2 |
| 2 | 2.0 | Specification for Split AC Units | 4 |

## Technical Specification of Air conditioning system

### 1.0 GENERAL

1.1 This specification covers supply, installation, testing and commissioning and handing over to RVPN of Air conditioning system viz 5 star rating industrial grade Air-Conditioning Units, Timer Circuits, Stabilizers etc. for the control room building and AC Kiosks.

Air-conditioning units shall be set to maintain the following inside conditions

DBT 23 DegreeC +/- 2 DegreeC

1.2 The following rooms in control room building shall be air ï conditioned.

i) Control Room and OLTE / SAS Panel Room
ii SE / XEN Room
iii) Battery Room
iv) Rest Rooms etc.

1.3 Air conditioning requirement of rooms indicated at clause No. 1.2 shall be met using split AC unit. High wall / Cassette (Only for Control Room) type split AC units of 2TR capacity each with high wall type indoor evaporator unit shall be used for all rooms.

1.4 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 Bidderôs proposal, but are required to make the equipment / system complete for its safe, efficient, reliable and trouble free operation.

1.4.1 High wall / Cassette (Only for Control Room) type split AC unit of 2 TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.

1.4.2 Copper refrigerant piping complete with insulation between the indoor and remote outdoor condenses as required.

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

1.4.4 Power and control cabling between the indoor unit and outdoor unit and earthing.

1.4.5 **Air Conditioning Unit of AC Kiosks :**

The Air conditioning system shall be provided in the kiosks to be used for housing panels having control and protection IEDs for performing station automation and protection functions generally confirm to relevant IS codes as detailed in section GTR.

These kiosks shall be located in the switchyard area generally unmanned therefore, the air-conditioning system (preferably TELE PACK or Equivalent type) shall be rugged, reliable, maintenance free and designed for long life.

i) Operation :

The air conditioning is required for critical application i.e. for maintaining the temperature for critical sub-station and protection equipment. To provide redundancy for such critical applications each kiosk shall be installed with environment control system comprising of two units of air conditioners working in conjunction through a micro processor based controller for desired operation. The system shall be designed for 24 hours, 365 days of the year to maintain the inside kiosk temperature for proper operation of the critical equipment. One of the air conditioner shall be running at a time and on failure of the same or as described hereunder, the other unit shall start automatically. To ensure longer life of the system, the redundant units shall also be running in cyclic operation through the controller. However, during running of one air conditioner unit, if inside temperature of the shelter reaches to a predefined (i.e. 35 deg. C) the other unit shall start running to maintain the temperature to specified value (i.e. 23 ± 2 deg. C) and gives alarm for such situation. After achieving this temperature the other unit shall again shut off.

ii) Sequence of Operation of the Unit :

Suitable arrangement shall be made to operate the unit in the following order. However, the actual operation arrangement shall be finalized during detailed engineering.

a. Evaporator Fan
b. Condenser Fan
c. Compressor

iii) Construction :

The air conditioning unit shall be completely self-contained. All components of the units shall be enclosed in a powder coated cabinet and colour of same shall be matched with kiosk colour. 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. The maintenance of unit shall be possible from outside the kiosk.

iv) Required Features of Various Components :

The compressor shall be very reliable, trouble free and long life i.e. hermitically sealed scroll type of reputed make suitable for operation. Compressor should be installed on vibration isolated mountings or manufacturerôs 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 evaporation coil condenser coil, evaporator blower filter, cabinet indoor supply and return grill etc.

2.0 Specification for Industrial grade Split AC Units (5 Star Rating)

2.1 The Industrial grade split AC units will be complete with indoor evaporation unit outdoor condensing units and cordless remote control units.

2.2 Outdoor unit shall comprise of hermetically sealed reciprocating / rotary compressor mounted on the vibration isolators, propeller type axial flow fans and copper tube aluminum finned coils all assembled in a steel 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 The indoor units shall be High wall / Cassette (Only for Control Room) / TELE PACK (Only for AC Kiosks) type. The indoor units shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by special motors and copper tube aluminum 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.

2.4 The Split AC units shall be carrier, Hitachi, Daikin, Mitsubishi or Oô General make.

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**STRUCTURES**
**Part-16**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

# PART-16 (Vol. II)

## Technical Specification for Structures

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# PART-16 (Vol. II)

## Technical Specification for Structures

1.0 SCOPE

1.1 This specification covers design (except design of those structures which have been standardized and enclosed with the specification),proto fabrication and assembly, mass fabrication, galvanisation, inspection/testing at manufacturerôs work before despatch and supply of Galvanised substation Steel structures i.e. Columns,Beams, Flood light towers and equipment support structure ( except Breaker etc. ) including Anchor bolts/stubs attachments for holding tension and suspension insulator strings, bolts/stub and nuts, step bolts, spring washers, Anchor bolt stub setting template etc.

1.2 The scope shall include supply and erection of all types of structures including bolts, nuts, washers, hangers, shackles, clamps anti-climbing devices, bird guards, 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.

1.3 The connection of all structures to their foundations shall be by base plates and embedded anchor / foundation bolts. All steel structures and anchor / foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 0.610 kg/m2 for anchor bolts/foundation bolts and for structural members. One additional but shall be provided below the base plate which may be used for the purposed of leveling.

1.4 Bidders are required to quote for all materials and works as detailed in the specification. They shall furnish full particulars of design calculations of columns (superstructure and foundation) as called for in addition to filling in completely the schedules annexed to this specification. Quoted price will also include all accessories, parts and works, which are not specifically mentioned but which are necessary for satisfactory operation and usual in similar equipment / works and they shall not be paid extra for these items.

2.0 STANDARDS :

2.1 Except as modified in this specification, the material and work covered under ñScopeò clause 1.1 to 1.5, shall conform to the latest revision with amendments thereof the following Bureau of Indian Standards and other International Standards.

| S.No. | Bureau of Indian Standards (BIS) | Title | International & Internationally recognized standard |
|---|---|---|---|
| 1. | IS 209 | Specification for Zinc | ISO/R/752 |
| 2. | IS 226 & IS 2062 | Structural steel (standard quality) | ISO/R/660 |
| 3. | IS 432 | Mild steel and medium Tensile bars and hard drawn steel wire for concrete reinforcement | BS-785 |

| | | | |
|---|---|---|---|
| 4. | A) 802 | Code of practiced for use of structural steel in overhead transmission line | |
| | | Part I :Load and permissible stresses | |
| | | Part II: Fabrication Galvanising Inspection and Packing | |
| | | Part III: Testing | |
| 5. | IS 1367 | Technical supply condition for threaded fasteners (first Revised) | |
| 6. | IS 1893 | Criteria of Earthquake resistant design structures | |
| 7. | IS 2016 | Plain Washers | ISO/R/987 |
| 8. | IS 2551 | Danger Notice Plates Recommended practice for hot dip galvanizing of Iron and Steel | |
| 9. | IS 2629 | Danger Notice Plates Recommended practice for hot dip galvanizing of Iron and Steel | |
| 10. | IS 2633 | Method of testing uniformity of casting of zinc coated articles | |
| 11. | IS 3063 | Single coil rectangular section spring washers for bolt nuts, screws | DIN-127 |
| 12. | IS 1367 (Part-III) | Hot dip galvanized coatings on fasteners | |
| 13. | IS 6610 | Specification for heavy washers for steel structures | |
| 14. | IS 1852 | Specification for Rolling and cutting tolerances for hot rolled steel products | |
| 15. | IS 6639 | Hexagonal bolts for steel structures | |
| 16. | IS 6745 | Method of determination of weight of zinc coating of zinc coated iron and steel articles. | |
| 17. | IS 10238 | Specification of step Bolts for steel structures | |
| 18. | IS 456 | Code of practice for plain & Reinforced concrete | |
| 19. | IS 875 | Part I & III (Code of practice for design loads for structure. | |
| 20. | IS 1893 | Criteria for earthquake resistant design of structures. | |
| 21. | | INDIAN ELECTRICITY RULES 1956 | |

2.1 The standards mentioned above are available at

| Reference / Abbreviation | Name and Address from which the standards are available |
|---|---|
| IS | BUREAU OF INDIAN STANDARDS, Manak Bhavan, 9-Bahadul Shah Zafar Marg, New Delhi (India) |

| | |
|---|---|
| ISO | INTERNATIONAL ORGANISATION FOR STANDARDISATION, Danish Board Standardisation, Danish standardisening Straat, Aureheeugej, 12 DK-2900, Helleprup DENMARK |
| CSA | CANADIAN STANDARD ASSOCIATION,178, Rexdale Boulevard, Rexdale, Ontario, CANADA M9W IR |
| BS | BRITISH STANDARDS, British Standard Institution, 101, Pentonvile Road, N-19, ND, UK |
| DIN | DEUTSHES INSTITUTE FIIR NOR Gurggrafenstrasse 4-10 Post Fach 1107 D-1000, Berlin-30 |
| INDIAN ELECTRICITY RULES 1956, REGULATION FOR ELECTRICAL CROSSING OF RAILWAY TRACKS | KITAB MAHAR Baba Khark, Singh Marg, New Delhi- 110 001 (INDIA) |

3.0 TYPE OF STRUCTURES, THEIR REQUIREMENTS

3.1 The various types of structures are required to be fabricated for 400 kV substations as under:-

| | |
|---|---|
| **(A)** | **LATTICE STRUCTURE** |
| **(a)** | Tower (400 kV) MKD TC |
| **(b)** | Tower (400 kV) MKD TD |
| **(c)** | Tower (400 kV) MKD TE |
| **(d)** | Tower (400 kV) MKD TF |
| **(e)** | Tower (400 kV) MKD TG |
| **(f)** | Tower (400 kV) MKD TH |
| **(g)** | Tower (400 kV) MKD TI |
| **(h)** | Tower (400 kV) MKD TJ |
| **(i)** | Tower (400 kV) MKD TK |
| **(j)** | Tower (400 kV) MKD TL |
| **(k)** | Tower (400 kV) MKD TM |
| **(l)** | Tower (400 kV) MKD TN |
| **(m)** | Girder (400 kV) MKD G1 |
| **(n)** | Girder (400 kV) MKD G2 |
| **(o)** | Lightning Mast 24 Mtr. Height |
| **(p)** | 220 kV tower type AT4 |
| **(q)** | 220 kV tower type AT6 (With Peak) |
| **(r)** | 220 kV tower type AT6 (Without Peak) |
| **(s)** | 220 kV tower type AT1 |
| **(t)** | 220 kV tower type AT3 |
| **(u)** | 220 kV Beam type AB1 / AB2 |
| **(v)** | 400 kV C.T. Support structure |
| **(w)** | 220 kV CT support structures |
| **(B)** | **PIPE STRUCTURES** |
| **(a)** | 400 kV CVT |
| **(b)** | 220 kV CVT |
| **(c)** | 400 kV Surge Arrestor |

| | |
|---|---|
| **(d)** | 220 kV Surge Arrestor |
| **(e)** | 120kV Surge Arrestor |
| **(f)** | 400 kV Isolator |
| **(g)** | 220 kV Isolator |
| **(h)** | 400 kV Wave Trap |
| **(j)** | 220 kV Wave Trap |
| **(k)** | 400 kV BPI |
| **(l)** | 220 kV BPI |
| **(m)** | 72.5 kV Isolator |
| **(n)** | 42kV, 52 class Lightning arresters |
| **(o)** | 36kV, 52 class EMVT |
| **(p)** | 72.5 kV Horn gap fuse |
| **(q)** | 72.5 kV Post insulators |

4.0 DESIGN OF STRUCTURE

4.1 The flood light towers shall accommodate flood light luminaries. Platforms shall be rectangular and in layers and shall be suitable for convenience of work man to rest with tools etc. Suitable ladder shall be provided up to the height of top platform. Suitable provision for laying power cable (25 mm. sq.-50 mm.sq. four core) from bottom of the tower to top plate form shall be make.

4.2 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 which are of lattice type.

4.3 Details of Tower Structures & Girders / Beams available in Part-24, Vol.II of specification are tentative and for tender purpose only. The Bidder shall have to design the Structures & Girders / Beams based on actual loadings on the basis of Short Circuit Fore Calculations, if required.

4.4 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.

4.5 The beams shall be connected with lattice columns by bolted joints.

4.6 Foundation bolts shall be designed for the loads for which the structures are designed.

5.0 MATERIAL

5.1 The structure shall be made of open herewith structural steel sections having its yield strength not less than 2600 kg /sq cm and ultimate strength not less than 4200 kg/cm and shall conform to IS 226-1976/IS-2062.

5.2 The Steel and zinc required for the fabrication of structures (i.e. Angles, Plates, round etc.) shall be arranged by the contractor. The price quoted for structures shall be including cost of steel and zinc. The size of angle sections shall be restricted to equal angles however the use of 45x450x6 and 45x45x5 mm angle sections will be permitted for bracings. The procurement of designed steel sections shall be responsibility of the contractor and the purchaser will not be responsible for any extra cost if substitution of designed section by the higher section is effected due to non availability of designed section after the approval of final bill of material prepared the sections which are used in their design are readily available and are in the rolling programmer of the steel producers. No relaxation in the delivery time shall be allowed on account of non-availability or short supply of raw material. Before submitting the tender bidder shall ensure availability of the proposed steel sections.

6.0 FOUNDATIONS.

6.1 The structure legs shall rest over base plates as per purchaserôs drawing or contractorôs approved drawings, as the case may be and shall be connected to these plates by base cleats. The substation columns shall be further secured in block type concrete foundation by appropriate number of anchor bolts. The anchor bolts passing through the base plate and embedded in the concrete block, shall firmly and adequately secure the structure to the foundation.

7.0 STEP BOLTS ON COLUMNS

7.1 Mild steel step bolts shall be provided on each substation column upto its top on its two diametrically opposite legs and shall be 175 mm long, 16mm (5/8ò)diameter capable of withstanding vertical load of 150 kgs. Step bolts shall be fixed on both the flanges of leg member at an integral of about 450mm to give step of 225mm. Each step bolt shall be provided with two nuts on one end to fasten bolt securely to the column/tower and a button head at the other end to prevent operatorôs feet from slipping. Requisite holes for step bolts shall be punched on relevant leg member. The location of step bolts should be such that proper safely clearance is available from live part. For the safety of man if at some places screen etc is required to achieve the safety clearance than same is included in scope.

8.0 CONDITION AND USE OF GUSSET PLATES

8.1 All field connections shall be bolted. The use of gusset plates and splices shall be as shown on the drawing. The corners of the members to the connected with gusset plates shall be chipped where necessary to eliminate or reduce eccentricity in joints. Any alternations, if required, shall be subject to the approval of the purchaser.

8.2 The inside angle of the lap splices and the splice angle of butt splices shall be ground at the heel to fit the fillet of the outside angle. At splices 1.6mm (1/16ò) clearance shall be provided between the faces of spliced angle members.

9.0 GALVANISATION

9.1 All structural members including legs, shielding wire peak, beam members, lattices, base plates, base cleat etc. shall be fully galvanized. The charges for galvanizing shall be included in the price quoted by the tenderers. No extra cost due to the increase in the weight of (galvanized) members due to galvanizing shall be paid.

9.2 All material shall be fully fabricated before galvanizing. No machine or shop work, die work etc. will be allowed after galvanizing. The galvanizing shall be of sufficient thickness and not less than 0.61 kg. of zinc/sq. meter of surface. The galvanizing shall consist of continuous coating of pure zinc of uniform thickness and so applied that it adheres firmly to all surfaces of steel and will give the proper protection to steel after erection. Galvanising shall be free from all defects as it may affect its service. The finished surface shall be clean and smooth. Before being galvanized the steel shall be thoroughly cleaned of all paint, grease, rust scale or such other materials, as may interfere with the proper bonding of zinc spelter with the steel, by employing accepted methods used in the process of hot dip galvanizing. The preparation for galvanizing and the galvanizing itself shall not adversely affect the mechanical properties of the coated steel.

9.3 The zinc coating shall not flake or be loosened from the steel when struct squrely with chisel faced hammer.

9.4 The test shall be made of the galvanizing from time to time, on as many samples as may be considered necessary. The supplier/fabricator shall supply all samples and equipment necessary to carry out the test without any extra cost. The galvanizing in all respects, shall conform to IS 2629 (or its latest amendment)

10.0 BOLTS, NUTS AND WASHERS

10.1 Standard bolts and nuts, pack washers, square washers and spring washers shall be used for jointing the column members. All bolts, nuts step bolts etc. and spring washers conforming to relevant IS shall be galvanized and shall be arranged by the contractor. Standard bolts and nuts shall be GKW make or equivalent to be approved by the purchaser. The member connected shall bear upon the shank of the bolt and not on the threaded portion of the bolt. The length of bolt shall extend at least 6mm beyond the nut when fully tightened. All nuts shall fit hand tight to the point where the shank of the bolt connects to the head. Flat and tapered washers shall be provided for insertions under one nut. The necessary details of all the joints shall be shown in the structural drawings and the required bolts, spring and flat washers should be indicated in the drawings as well as in the bill of material. No bolt shall connect aggregated thickness of more than three times its diameter. Assembled structure shall have bolts head on the outer surface of towers and nuts on the inside. Bolts at the joints may be staggered such that the nuts may be tightened with spanners without fouling. The Anchor bolts shall be partially galvanized upto 150mm below threaded portion.

11.0 WORKMANSHIP AND FINISH

11.1 Fabrication of the substation structures of bolted construction shall be carried out in conformity with the latest practices employed in the fabrication of such steel structures. Workmanship and finish shall be of the highest standard required by most modern practices with fabrication tolerances as indicated in the specification. All members shall be cut to jig and all holes shall be drilled or punched to jig. All parts shall be carefully cut and holes accurately located so that the members are in position, the holes will be diametrically opposite to each other before being bolted up. Drilling or reming to enlarge defective holes shall not be permitted. All holes in material over 12mm thick must be drilled through the plated and sections forming the joint in one operation. Joints shall be so designed and detailed as to avoid eccentricity as far as possible.

11.2 The drilling, punching, cutting and bending of all fabricated steel works shall be such as to prevent any possibility or irregularity occurring which might introduce difficulty in erection of the substation structures at site. No rough/sharp edge and burrs from shears shall be left in the entire structure. All sheared and cut ends shall be properly smoothened. No steel packing washers and/or steel or wrought iron tapered washers shall be provided wherever necessary. The flanges of the angle sections at the ends of the members shall be properly chamfered, if there are even slight test chances of its fouling with other members or if they cause difficulty in proper tightening of the bolts. All chipping, back cuts, grinding bonds, holes etc. shall be trued to the detailed drawings and free from burrs. No angle member shall have two legs brought together by closing the angle.

11.3 The following maximum tolerances in accuracy of punched holes is permissible:-

a) Holes must be perfectly circular and no tolerance in this respect is permissible.
b) The maximum allowable difference in diameter of the holes on the two sides of the plate or angle i.e. allowable tapper in punched hole should not exceed 0.8mm (1.32ò) on diameter or 0.4mm (1/64ò) on radius.
c) Holes must be square with the plates or angle and slant holes will not be permitted.
d) Bolts, holes whether punched or drilled must be larger than the sizes of the bolt and shall not be more than 1.5mm larger than diameter of the bolt. All burs left by drill or punch shall be removed completely before galvanizing.

11.4 The following minimum edge securities would be acceptable.

| | Edge security From rolled edge | Edge security to sheared edge |
|---|---|---|
| For 16 mm (5/8ò) dia bolts | 20mm | 23 mm |

11.5 In dimensioning gauge lines, allowances would be made for mill tolerances as per IS 1852-1979 in the width or legs or flanges so as to ensure that the specified minimum edge distances will be provided.

12.0 INTERCHANGEABILITY

12.1 All similar members of different structures shall be made accurate to gauge or jig and shall be interchangeable in every respect.

13.0 INSPECTION

13.1 During the course of manufacture, purchaserôs representative shall have all the rights to inspect the materials, workmanship and the progress of manufacture of the structures on order and may reject nay item which is defective or unsuitable for the purpose intended or which is not in accordance with the intent of this specification. The contractor upon demand by the purchaser or his representative shall rectify the defects or replace such defective or unsuitable material. Tenderer shall provide all reasonable inspection facilities to purchasrôs Inspector.

13.2 The successful Bidder shall keep the purchaser informed well in advance of the commencement of manufacture, progress of manufacture thereof and fabrication of various structure parts of various stages, so that arrangements is could be made for inspection by the purchaser. 15 days advance information shall be given for readiness of material for inspection.

13.3 The acceptance of any batch of items shall in no way relieve the Bidder or any of his responsibilities for meeting all the requirements and intent of his specification and shall not prevent subsequent rejections if any item of that batch is later found defective.

13.4 The purchaser or his authorized representative shall have free access at all reasonable times to those parts of the supplierôs work connected with the fabrication of the material covered under the contract for satisfying themselves that the fabrication is being done in accordance with the provisions of this specification.

13.5 Unless specified otherwise, inspection shall be made at the place of manufacture prior to dispatch and shall be conducted so as not to interfere unnecessarily with the operation of the work.

13.6 Should any member of the structure be found not to comply with the approved design, it shall be liable for rejection. No member once rejected shall be resubmitted for inspection, except in cases where the purchaser or his authorized representative considers that the defects can be rectified.

13.7 Defects which occurs during fabrication shall be made good with the consent of and according to the procedure to be laid down by the purchaser.

13.8 All gauges and templates necessary to satisfy the purchaser for conducting tests shall be made available at the test site by the supplier.

13.9 The correct grade and quality of steel shall be used by the supplier. To ascertain the quality of steel, the purchaser may at his discretion get the material tested at an approved laboratory.

13.10 No material being supplied against this specification shall be desptached until inspected and approved by the purchaser and/or his representative. Such inspection and approval shall not relieve the tenderer of full responsibility for furnishing structures conforming to the requirements of the specifications nor prejudice any claim right or privilege which the purchaser may have because of the use of defective or unsatisfactory material. Should the inspection be waived by the purchaser, such waival shall not relieve the tenderer in any way from his contractual obligations.

13.11 Structures shall be capable of performing satisfactorily upto contractors maximum guarantee. All tests required by specification, including repeat tests and inspections, that may be necessary owing to failure to meet any tests specified, shall be made at tendererôs expenses. If material fails to pass the specified tests, purchaser shall have option to reject the unit. Addition tests shall be made to locate the failure and after reconstruction, testing shall be repeated to prove that the rebuilt material meets the specification in all respects.

14.0 TESTING

14.1 The successful tenderer shall afford all facilities to the purchaserôs inspector to satisfy himself that the work in hand is in all respect according to the specification. The supplier shall make all necessary arrangements so that the material may be inspected as desired by the Inspector.

14.2 Samples of fabricated and galvanized structure material shall be subjected to tests as per relevant Indian Standards specifications or equivalent standard.

14.3 The contractor shall supply free of charge the samples of galvanized steel for testing and shall at his own cost, furnish and prepare the necessary test pieces and supply labour and appliances for such testing as is called for in this specification. In case of non-availability of facilities at his own works for carrying out the prescribed tests, the supplier shall make suitable arrangements, at his own cost, at some other place or Govt. Testing laboratoryôs required by the purchaser.

14.4 The purchaser shall be free to have any of the prescribed test, carried out under his supervision and at supplierôs cost at any time till the completion of the contract and may, if considered necessary, have the contract and may, if considered necessary, have the tests to determine the quality of the material used. In doing so he shall be at liberty to sue any reasonable procedure. In inspector shall have free access at all times to all parts of the plant which concern the manufacture of the material to be inspected while work on the contracted supply is being performed. The supplier shall offer the inspector, without change, all reasonable facilities to satisfy him that workmanship or fabrication and galvanizing is in accordance with the specification. When structures under the contractare to be inspected at the plant of any sub-contractor the inspector shall have the same privilege at the plant of as the sub-contractor at the plant of contractor and the contractor shall make necessary arrangements with the sub-contractor to ensure the same.

14.5 Waiving off inspection or acceptance of structure by an inspector shall not relieve the contractor from the responsibility of furnishing fabricated and galvanized structures in accordance with this specification. The structure members whose fabrication and galvanizing are found to be defective subsequent to delivery at site shall be replaced promptly by the supplier without charge and without loss of any kind to the purchaser.

15.0 STRAINGHTENING

15.1 All steel sections, before any other work of cutting etc. is started, shall be carefully straightened and trued by pressure and not by hammering. These shall again be trued after being punched and drilled.

16.0 IDENTIFICATION

16.1 Each separate member of the structure shall be given an identification number which should tally with the number shown in structural drawing. The number should be prefixed with the type, designation of the structure. Similar members should have the same identification number. The structure type letters and member identification number shall be embossed (engraved) in to the steel members with metal die in letters and figures not less than 12mm x 18mm size so that these are distinctly visible even after galvanizing and are distinctly visible even after galvanizing and remain permanent. These marks should be stamped near one end in such a manner that no hole comes in the marks nor they should be located in between two holes which are quite near to each other and visibility of the identification marks is obstructed after fixing of nuts.

17.0 PACKING AND DESPATCHING

17.1 Members belonging to the same structure and bearing same identification mark shall be packed and delivered in a manner as described hereafter. The weight of one bundle shall be not more than 100 kgs. Approximately. Heavy leg members may be dispatched as single pieces. One bundle shall contain members of one identification mark. The bundle shall be securely tied at both ends mark. The bundle shall be securely tied at both ends (Long members to be tied in the middle as well) with galvanished malleable iron wire made up of 3 strands of nos. 15 s.w.g. The wire being bound at least twice round and passed through holes wherever possible.

17.2 All levels to be used on bundles or tegs shall be of tin securely bound with the wire and shall have descriptive marking stamped thereon.

17.3 The packing shall avoid losses/damages during transit.

17.4 Each bundled package shall have the following markings on it.

a) The name and designation of the consignee to be intimated by the purchaser.
b) The relevant marks and number of structure members or reference number of small components.

18.0 REPLACEMENTS

18.1 If any structure member is damaged or lost during the transit, the purchaser shall give information to the contractor about the particulars of the material damaged/lost during transit. The replacement of such material shall be affected free of cost by the contractor within reasonable time to avoid delay in the commissioning of the substation.

19.0 SUBMISSION AND APPROVAL OF DRAWINGS, MODEL ASSEMBLIES AND TESTING

19.1 The contractor shall offer model assemblies of all structures with 45 days of the receipt of the purchase order. The model assemblies shall be based on drawings supplied with this specification.

19.2 The purchaser/his representative shall reach firmôs works for inspection of the model assemblies within 15 days of receipt of the inspection call. Final structural drawings and Bill of Materials based on approved model assemblies shall be furnished within 15 days for purchaserôs approval for the date of approval of the Model assembly.

19.3 The purchaser shall convey approval/comments on drawings and Bill of Material within three weeks from the date of receipt by the purchaser. One copy of duly approved/commented drawings and BOMs shall be returned to the supplier.

19.4 Six copies alognwith one reproducible print of final drawings and Bill of Materials of all structures will be furnished by the supplier with 15 days of approval of the Model assemblies. Final drawings and BOMs will be based on approved Model assemblies. The foundation design for each columns/towers based on given loading condition will also be simultaneously furnished.

19.5 Any shop work done prior to approval of the drawing/Model assembly shall be at the contractorôs risk.

19.6 Each structural drawing and BOM shall be identified by a drawing number and each subsequent submission, revision or addition to the drawing and BOM or procedure shall be identified by a revision number or issue number and shall mention contract number, place of installation and scale. All structural drawing and BOMs shall be thoroughly checked for accuracy and completeness and signed or initialed by a responsible officer of the contractor.

19.7 Checking and approval of the drawings and model assemblies by the purchaser is for the benefit of the purchaser and shall not relieve the contractor of full responsibility for completeness and accuracy of the above drawings, fabrication, galvanization and proper fitting of the structures members in the field and successful operation up to the maximum guarantee period.

19.8 The contractor shall report and incorporate only after the purchaserôs approval all deviations, correction, commission, changes etc. occurring through out the fabrication, assembly and testing phases and submit a complete set of ñas builtò structural drawings with reproducible forms within 15 days of the date the structure is considered to be placed in satisfactory operating conditions.

19.9 The purchaser shall arrange inspection of the fabricaited-galvanised material within 15 days of receipt of the inspection call.

19.10 Should the contractor wish to resubmit a revision or change for approval, such submission shall be in by three prints.

19.11 The delivery period indicated in the Schedule of requirements and desired delivery at Appendix-1 includes all above periods fro submission of drawings, BOMs approvals and inspection of model assemblies and in section/testing of finally fabricated and galvanized structure members and delivery at site.

19.12 Any shop work done prior to approval of the drawing/model assembly shall be at the contractorôs risk.

19.13 Each structural drawing and BOM shall be identified by a drawing number and each subsequent submission, revision or addition to the drawing or procedure shall be identified by a revision number or issue number and shall mention contract number, place

of installation and scale. All structural drawings shall be thoroughly checked for accuracy and completeness and signed or initialed by a responsible officer of the contractor.

19.14 Checking and approval of the drawings by the purchaser is for the benefit of the purchaser and shall not relieve the contractor of full responsibility for completeness and accuracy of the above drawings and relevant specification.

19.15 The contractor shall report and incorporate only after the purchaserôs approval all deviations, corrections, omissions, changes etc. occurring through out the fabrication assembly and testing phases and submit a complete set of ñas builtò structural drawings in reproducible forms within 30 days of the date of the structure is considered fit to be placed in satisfactory operating conditions.

20.0 MODEL/PROTOTYPE ASSEMBLIES

20.1 Before proceeding with the bulk fabrication of the structures the supplier shall fabricate and assemble his works one structure for inspection by an authorized representative of the purchaser according to the approved structural assembly arrangement drawings to be prepared by the supplier and approved by the purchaser, for the purpose of checking the accuracy and workmanship. The check assembly shall be with the structure in a horizontal position and not erected vertically. Bolts and nuts should not be more than finger tight. Any error due to bad workmanship or wrong fabrication shall be rectified at the expenses of the supplier. The purchaser may waive model assemblies if has been carried for the same structure earlier by the contractor.

20.2 No extra charges on account of erecting the assemblies or getting them inspected will be permissible. It is however, to be mentioned that responsibility for proper fitting of various members for the proper and easy erection of the structure in the field will rest with the supplier and any discrepancy found at the time of erection will have to be rectified by the supplier at his own cost.

21.0 WEIGHT

21.1 The weight of the structure or its accessories shall mean the weight of structure or accessories calculated by using standard sectional weight (as per IS:808) of all steel structural members of the sizes indicated in all steel structural members of the sizes indicated in the drawings without taking in to consideration the reduction in weight due to drilling of holes, skew, cuts, heel grinding, chamfering etc. Increase in weight due to galvanizing shall not be taken in to account.

21.2 In case the weights of the structure to be supplied is more than the guaranteed weight (as per tender), no extra charges shall be paid to the contractor.

21.3 If , however the weight of the finally approved and accepted structure is less than the guaranteed weight ( as per tender ) the payment shall be made on the basis of the finally accepted weights only.

22.0 PLACE OF FABRICATION , GALVANISATION AND TESTING

The tenderer shall state in Schedule-5 of the tender the complete address and location of places of his office, workshops for fabrication & galvanising workshops. The address of registered Head Office and the office with which necessary correspondence is to be done may be indicated.

23.0 RESOURCES OF THE TENDERERS

Before any tender is considered for award, the purchaser for his satisfaction, requires there tenderer to submit a statement of fabrication and galvanization facilities and financial resources available to the tenderer and to be used in performing the contract to purchaserôs satisfaction. The information shall be given in Schedule-C which must accompany the tender.

24.0 SETTING TEMPLATES

The contractor will be required to design and supply one suitable setting template for each type of column and flood light tower. The template should be designed to be as simple as possible and yet of rigid required to maintain the accuracy. The design shall be such then even unskilled labour may be able to handle it without any difficulty. The supplier shall also supply the necessary details for setting of the anchor bolts which will ensure that he anchor bolts will remain in position while being concerted. The templates will be provided with a coating of red lead while nuts and bolts will be kept black. The fabrication charges per MT of such template may be indicated separately.

25.0 COMPLETENESS OF STRUCTURE

The structures offered shall be considered complete provided all the accessories as per scope of supply are also supplied installed at site.

26.0 CLARIFICATION AND REVISIONS

26.1 In case any portion of this specification is not clear to the bidder, clarification must be obtained before submission of the bid.

26.2 The purchaser reserves the right to revise or amend this specification or other conditions of supply prior to the date notified for receipt of bids. Any such revision/amendment will be communicated to all the prospective bidders as an addendum to this tender invitation.

**ANNEXURE-1**

## GUARANTEED TECHNICAL PARTICULARS OF STRUCTURES

1. Name of the Manufacturer
2. Address of registered office
3. Works address
4. The Guaranteed weight of structure

| | Fabricated Members (KGs.) | Bolts & Nutes (Kgs.) |
|---|---|---|
| a)Column type | | |
| I) Super structure with base plates | | |
| II) Anchor bolts | | |
| b)Beam type | | |
| c)Flood light tower | | |
| I) Super structure with base plates | | |
| II) Anchor bolts | | |
| d) Anchor bolt setting templates | | |
| i) For _____ column. | | |
| ii) For _____ tower. | | |

5 Other Particulars

1. Ultimate tensile strength of the steel sections .
ii) Standards according to which properties of sections have been adopted in designs.
iii) Standard specification according to which the quality of steel for the sections assumed in designs.
iv) Standard specification according to which the quality of bolts & nuts assumed in the design.
v) Quality of zinc used for galvanizing.
vi) Standard to which galvanizing will conform.
vii) Minimum sheared edge distances.
viii) Minimum rolled edge distances.
ix) Weight of zinc quoting.
x) Thickness of Zinc quoting.
xi) Factors of safety
i) Normal Conditions.
ii) Abnormal conditions.
xii) Nuts & Bolts
I) Make
II) IS to which conform

(Signature of the bidder)
Name:
Status:
Whether authorized attorney of the tendering company
Name and Seal of tenderer

Date :

Place:

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**SWITCHYARD ERECTION**
**Part- 17**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-17 (Vol. II)**

**Technical Specification for Switchyard Erection**

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**PART-17 (Vol. II)**

# Technical Specification for Switchyard Erection

## 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, (alongwith its spares) as detailed herein.
This section covers the description of the following items of jobs.

- String insulators and hardware
- ACSR conductor
- Galvanised Steel Earthwire
- Aluminium Tubular Bus Bars
- Spacers
- Bus post insulators
- Earthing & Earthing materials
- Conductor tube earth wire clamps
- Lightning protection
- Cabling material, etc.

Wherever cross over stringing is required to be done for future bays, the same shall be in the scope of the bidder to avoid requirement of shutdown in future.

## 1.01 Principal Parameters

The disposition of various bay equipments is shown in single line diagrams and layout drawing.
The bus bar material used in the 400/220 kV substation shall be suitable for following bus bar parameters.

| S.No. | Description | Parameters |
|---|---|---|
| a. | 400 kV Main Bus I & II | -ACSR quadruple Moose 450mm sub conductor spacing (square formation) |
| b. | 400 kV equipment interconnections | 114.2mm Al. Tube |
| c. | 400 kV overhead bus & droppers with Y Jumpers | -ACSR Twin Moose 450mm sub conductor spacing. |
| d. | 220kV Main Bus I & II and Auxiliary Bus | Twin Tarantulla 300mm sub-conductor spacing. |
| e. | 220 kV equipment interconnection in bus coupler bay, transfer Bus Coupler bay, sectionlizer bay & transformer bay. | 114.2mm Al. Tube |
| g. | 220 kV feeder bay | Single Tarantulla |
| h. | 33 tertiary connection | 73.03mm Al. tube |

**Note:- All the dropped jumpers shall be of Y-type.**

## 1.02 Standards

1.02.1 The bus bar material and associated accessories shall conform to the latest issues of standards as given below, except to the extent explicitly modified in the specification.

| Indian Standard Numbere | Title |
|---|---|
| IS:2629 | Recommended practice for hotdip galvanising of Iron & Steel. |

| | |
|---|---|
| IS:2633 | Specification for method of testing uniformity of coatings on zinc coated articles. |
| IS:4759 | Hotdip zinc coating on struc IS:1367(Part XIII) tural steel and other allied products. |
| IS:6745 | Specification for methods for determination of weight of zinc coating on zinc coated iron and steel articles. |
| IS:1573 | Specification for electro plated coatings, for zinc on iron and steel. |
| IS:209 | specification of zinc |
| S:4826 | Specification for galvenised coating on ground and steel wires. |
| IS:12776 | Galvanized steel stranded wire. |
| IS:2121(pt. I & II) | Conductor and Earthwire accessories. |
| IS:617 | Aluminium & Aluminium ingots and casting for general engineering purpose. |
| IS:10162 | Specification for spacers & spacer dampers for twin horizontal bundle conductors. |
| IS: 731 | Insulators units and insulators string . |
| IS:2486 (Pt-I,II,III&IV) | Fittings and clamps for insulator strings. |
| IS:5082 | Alluminium alloy tubes. |
| IS:2673 IS:2678 | Dimensions of aluminium alloy tubes. |
| IS:1816 | Tensile test |
| IS:5561 | Power Connectors. |
| BS:970 | Specification for stainless heat resisting and valve steel. |
| IS:3635 | Electrical resitivity test |
| IS:398(Pt I,V) | Aluminium conductor for over head transmission purpose. |

In case material conforms to other international standards which ensure equivalent or better performance than that specified under clause 1.02.1 then the English version of such standards or the relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately in additional information schedule.

1.1 **String Insulators & Hardware**

The insulators for suspension and tension strings shall conform to IS: 731 and long rod insulators shall conform to IEC-433.Insulator hardware shall conform to IS: 2486

1.1.2 Insulator string hardware assemblies shall generally consist of following components.

| S.No. | Particulars | Double Tension String | Single suspension string |
|---|---|---|---|
| 1. | Anchor Shackles for fixing with gantry | 2 | 1 |
| 2. | Chain link | 1 | 1 |
| 3. | Arcing Horn (adjustable type) | 1 set | 1 set |
| 4. | Yoke Plate (gantry end) | 1 | - |
| 5. | Ball Clevis | 2 | 2 |
| 6. | Socket Clevis | 2 | 1 |
| 7. | U-clevis for clearance from yoke plate | 2 | - |

| | | | |
|---|---|---|---|
| 8. | Yoke plate (line side) | 1 | 1 |
| 9. | *Grading cum Corona control ring/loop | 1 set | 1 set |
| 10. | Clevis-clevis | 2 | - |
| 11. | SAG Adjustable Plate | 2 | - |
| 12. | Clevis Eye | 2 | 2 |
| 13. | Tension Clamps for: | | |
| | i) Quadruple / Twin moose (O.D.31.77mm) at sub-spacing of 450mm for 400 kV string | 2 | - |
| | ii) Twin Tarantulla (O.D.36.61mm) at sub-spacing of 300mm for 220 kV string | 2 | - |
| 14. | Suspension Clamps | | |
| | i) 25 nos. of disc insulator string for 400 kV and single suspension strings. | - | 2 |
| | ii) 15 Nos. of disc insulator / string for 220 kV and Single suspension strings | - | 2 |

1.2 **Construction Features**

1.2.1 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 strain strings. Each insulator shall have rated strength markings on porcelain printed and applied before firing.

1.2.2 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.

1.2.3 Glazing of the porcelain shall be uniform brown colour, free from blisters, burrs and other similar defects.

1.2.4 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.

1.2.5 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 in accordance with the latest edition of IS: 2629. The zinc used for galvanizing shall be of grade Zn-99.95 as per IS-209. 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.

1.2.6 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 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.

1.2.7 Design of Hardware

1.2.7.1 The general design of hardwares shall be such as to ensure uniformity, high strength, freedom from noise and high resistant against corrosion. All hooks, eyes, pins, bolts tension clamps and other fittings for attaching insulators to the structure of the line conductor shall be designed so as to reduce to minimum any damage to the conductor, insulator or the fittings arising from conductor vibration. Special attention must be paid to ensure smooth surface finish throughout. Adequate bearing area between fittings shall be provided and ñPoint or lineò contacts shall be avoided.

1.2.7.2 Each insulator string assembly shall be supplied complete in all respects and shall include all fittings necessary for composing the insulator strings. The bidder shall be responsible for satisfying himself that the insulator fittings offered are complete and entirely suitable for the proposed attachment to substation structure and for the quadruple & twin moose conductor (Outer dia 31.77mm) at sub-spacing of 450mm for 400 kV strings and twin Tarantulla conductor (36.61mm OD) at sub spacing of 300mm for 220kV strings. All fittings made of steel or malleable iron shall be hot dip galvanised. Cottor or split pins shall be of phosphor bronze or stainless steel. All galvanizing shall be done after machining, punching etc. and shall conform to the IS:2486(Pt.I) and its upto date amendments. Galvanising shall be uniform, free from bilsters and shall not peel off due to abrasion. Zinc coating shall be thick enough to withstand six, one minute dips in copper sulphate solution for all ferrous parts, except for threaded portion which shall withstand at least 4, one minute dips.

1.2.7.3 Spring washers wherever used shall be electro galvanized. All bolts, nuts, screw-heads shall be of the with-worth standard thread. Bolt heads and nuts shall be hexagonal. Wherever required, nuts shall be locked in an approved manner, the threads in nuts and tapped holes shall be rerun after any other make of experience, to be approved by the purchaser. The bolt threads shall be under-cut to take care of increase in diameter due to galvanizing. 2.5 percent extra bolts, uts washers, split, pins, security clips.etc. shall be supplied. All clevises and their bolt holes shall be so dimensioned that when fitting plat between bolt and clevis, clevis and member to which it if fitting is minimum. Washers etc. if required the play will be supplied without extra cost.

1.2.8 **MATERIAL OF HARDWARES:-**

1.2.8.1 All hardware fittings, except suspension and tension clamps shall be made of forged steel and/or malleable cast iron and shall be ho-dip galvanized after all machining except female threads which shall be cut after galvanizing and shall be protected from rust by means of greasing. Zinc Coating shall satisfy the requirements, of relevant standards. The Anchor shackles shall be made of high tension steel.

1.2.8.2 Suspension and Tension Clamps.

A) Suspension Clamps_ The suspension clamps keeper pieces offered shall be made of high strength aluminium alloy and shall be suitable for use with the quadruple and twin moose conductor (outer dia 31.77mm) at sub-spacing of 450mm for 400 kV strings and twin tarantulla conductor (36.61mm OD) at subspacing of 300mm for 220 kV strings. The design of suspension claps shall be such as to avoid all hot spots, kinks, cuts, groves or projections which are likely to injure the conductor or lead to localized pressure. There shall be no sharp radious of curvature, ridges and exersences. The cottor pins, cottor bolts, U bolts, nuts washers etc. shall preferably be made of galvanized steel. If dissilar material are used for suspension clamps, suitable

precaustions shall be taken to minimize electrolytic corrosion. The clamps shall be of free centre type and have ease of oscillation around a horizontal axis. Clamps should be high corrosion resistant, light in weight, have low effective power loss and small moment of inertia enabling it to follow freely, the movements of the conductor. The compression on the conductor must be uniform so as to prevent occurance of grooves or dangerous abrasions. The clamps shall be designed, manufactured and finished to have a suitable shpe so that it avoids the possibility of hammering and chattering between the clamp and the conductor due to vibrations. It should, however, have sufficient contact surface to minimize damage due to fault currents and shall have a sufficient slipping strength to resist conductor tension. The clamps shall also be provided with suitable clevis eye (made of drop forged steel) for connecting these to the yoke plates. The clamps shall be as light as possible. All clamp shall be designed to avoid any separation of individual strands. The clamps also cover the suspension tee clamps for conductor dropping.

B) Tension Clamps:- The tension clamps shall be made out of high strength aluminium alloy and shall be of bolted type suitable for quadruple & twin moose conductor (outer dia 31.77mm) at sub-spacing of 450mm for 400 kv strings and twin tarantulla conductor (36.61mm OD) at subspaing of 300mm for 220 kV strings. The bolts, nuts, washers clamps shall not permit slipping of or damage to or failure of the complete conductor or any part thereof at a load less than 95 percent of the ultimate strength of conductor limited to E&M strength of the tension strings. The mechanical efficiency of tension clamps shall not be effected by method of erection involving come-along or similar clamps or tension stringing operation, during or after assembly and erection of tension clamps. The tension clamps shall have the same conductivity on the conductor. The clamp shall be as light as possible. The head and threaded part of the bolt and nut, under fully tightened position shall be screened by clamp body itself.

1.2.8.3 Arcing Horns and Corona cum Grading Rings:-
Each hardware assembly shall be provided with a set of combined corona control and grading rings at the line end and arcing horn shall be of adjustable type and shall only be attached to the hardware fittings and not to the insulator ball or caps. The design of the combined corona control and grading rings shall satisfy the requirements of this specification regarding switching surge withstand voltage and shall be such that it will avoid decrease of negative polarity wet switching surge withstand voltage and shall ensure that the insulator strings withstand power frequency arcs. The setting range of the arcing horns and the dry, wet and impulse flashover values should be given in the bid.

1.2.9 Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projection. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

1.2.10. The tension string assemblies shall be supplied along with suitable turn buckle. Sag compensation spring if required may also be provided.

1.2.11 All hardware shall be bolted type.

1.2.12 **Long Rod Insulators**

1.2.12.1 As an alternative to disc insulator string, Bidder can offer a combination of long rod insulators, with suitable hardware. This combination should be suitable for application specified and should offer the same equivalent parameters as would be available from insulator string composed of specified disc insulators and hardware combination. Further the complete long rod insulator string shall be subjected to the tests as specified and the insulator shall also be subjected to all tests as per relevant standards.

1.2.12.2 All other constructional features specified at clause 1.2 of this section shall also apply to the long rod insulator string.

1.2.14 **Parameters**

1.2.14.1 **Disc insulators**

| | | |
|---|---|---|
| a | Type of insulators | Anti Fog type |
| b | Size of insulator units (mm) | 255 x 145 |
| c | Electro mechanical strength | 120 kN |
| d | Creppage distance of individual insulator units (minimum and as required to meet total crepage distance) | 430 mm |
| e | Markings | Markings on porcelain shall be printed and applied before firing. |
| f | Power frequency puncture withstand voltage | 1.3 times the actual wet flashover voltage |

1.2.14.2 **Insulator String (Electrical Characteristics)**

| | | 400 kV | 220 kV |
|---|---|---|---|
| a) | Power frequency withstand voltage of the complete string with Corona Control ring (wet) - kV rms | 680 | 460 |
| b) | Lightning impulse withstand Voltage of string with corona control ring (dry) ï kVp | ± 1550 | ± 1050 |
| c) | Switching surge withstand voltage of string with corona control rings (wet) ï kVp | ± 1050 | NA |
| d) | Minimum corona extinction voltage level of string with corona control rings (dry) - kV rms | 320 | 156 |

| | | | |
|---|---|---|---|
| e) | RIV level in micro volts of string with corona control rings at 305 kV (rms) for 400 kV string and 156 kV for 220 kV string across 300 Ohms resistor at 1 MHz | 1000 (Max.) | 1000 (Max.) |
| f) | Total creepage distance of the insulator string (mm) | 10500 | 6125 |
| g) | Total number of discs per strings | 25 | 15 |

1.2.13.3Insulator String (Mechanical Characteristics)

Tension and suspension hardware assemblies for 400 kV (Suitable for quadruple and twin moose conductor OD 31.77 mm at sub-spacing of 450mm) and 220 kV (suitable for twin tarantulla conductor OD 36.61mm at sub spacing of 300mm)

i) Double tension string for 400 kV system suitable for 2x11500 kg. UTS disc.

ii) Double tension string for 220 kV system suitable for 2x7000 Kg UTS disc.

iii) Single suspension string for 400 kV system suitable for 11500 kg UTS disc.

iv) Single suspension string for 220 kV system suitable for 7000 Kg UTS disc.

| S.No. | Item | Specification insulator string assembly | | | |
|---|---|---|---|---|---|
| | | Single suspension String for | | Double Tension string for | |
| | | 400 kV | 220 kV | 400 kV | 220 kV |
| 1. | Tolerance on hardware length | ±2% | ±2% | ±2% | ±2% |
| 2. | Tolerance on Insulator | ±45mm | ±30mm | ±45mm | ±30mm |
| 3. | No. of disc per set | 25 nos. | 15 nos. | 2x25 nos. | 15nos. |
| 4. | Arcing horns | Loop type and on tower side only. | | | |
| 5. | Corona control & grading ring | 2 nos. | | 2 nos. | |
| 6. | Type of clamps | Free centre conventional or armour grip type | | Bolted type | |
| 7. | Material of clamps | Gravity dia cast high strength, corrosion resistant aluminium alloy, supporting components of galvanised steel | | Outer sleeves of extruded E.C. Grade4 aluminium & inner sleeves of galvanised mild steel. | |
| 8. | Slip strength of clamps | 8 to 15% of UTS of the conductor | | 11500 kg. | 7000kg. |
| 9. | Minimum failing load of each clamps. | 11500kg | 7000kg | 2x11500kg | 2x7000kg |
| 10. | Magnetic power loss corresponding to 600 amp. per sub-conductor | Not more than 7 watts | Not more than 7 watts | Not more than 7 watts | Not more than 7 watts |
| 11. | Material for string fittings / metal parts & accessories | | | | |

| | | |
|---|---|---|
| | i) Socket ended items | Malleable cast iron |
| | ii) Ball ended items, U-clevis. and chain. | Drop forged steel |
| | iii) Yoke plate | Mild steel |
| | iv) Locking devices. | Phospher Bronze or stainless steel |

1.2.14 **Tests**

The suspension and tension strings, insulator discs and hardware shall be subjected to the following type tests, acceptance tests and routine tests:

1.2.14.1 Type tests on insulator strings

a) Dry and wet power frequency voltage withstand test with corona control rings as per IS-731.
b) Switching surge voltage withstand test (wet) {400 kV only} as per IEC-383 and BS-137 (Part-II).
c) Lightning impulse voltage withstand test (dry) with corona control rings as per IS-731

d) Voltage distribution test (Dry)

The string shall be energized with 100 kV power frequency voltage. The voltage across each insulator unit shall be measured by using a high impedance voltmeter. The voltmeter shall be calibrated before and after the measurement. The voltage across any disc shall not exceed 9% of the applied voltage for 400 kV suspension string & 10% for double tension insulator strings.

e) Corona test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 kV (rms) for 400 kV to ground under dry conditions. There shall be no evidence of corona on any part of the sample when all possible sources of corona are photographed in a darkened room.

f) RIV Test (Dry)

Under the conditions as specified under (e) above the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC line to ground voltage of 320 kV for 400 kV. The test procedure shall be in accordance with IEC-437.

g) Mechanical strength test

The complete insulator string along with its hardware fitting 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 in 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 the period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.2.14.2 Type test on Disc Insulators

a) Mechanical Performance tests as per IEC : 575, clause

1.2.14.3 Acceptance Tests for Disc Insulators:

a) Visual examination
b) Verification of Dimensions as per Cl. No. 10.5 of IS: 731
c) Temperature cycle test as per Cl. No. 10.6 of IS : 731
d) Puncture Test as per Cl. No. 10.10 of IS: 731
e) Galvanizing Test as per Cl. No. 10.12 of IS: 731
f) Mechanical performance test as per IEC-575 Cl. 4
g) Test on locking device for ball and socket coupling as per 372 (2)
h) Porosity test as per Cl. No. 10.11 of IS: 731

1.2.14.4 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 ways 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: 372 (2).

1.2.14.5. Routine Test on Disc Insulator/ long rod insulator.

a) Visual Inspection as per Cl. No. 10.13 of IS: 731
b) Mechanical Routine Test as per Cl. No. 10.14 of IS: 731
c) Electrical Routine Test as per Cl. No. 10.15 of IS: 731

1.2.14.6 Routine Test on hardware fittings

a) Visual examination as per cl 5.10 of IS: 2486 (Part-I)
b) Mechanical strength Test as per Cl. 5.11 of IS: 2486 (Part-I)

1.2.14.7 **Test during manufacture on all components as applicable on Disc insulator.**

a) Chemical analysis of zinc used for galvanising:

Samples taken from the zinc ingot shall be chemically analyzed as per IS : 209. 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 Purchaser in Quality Assurance Program.

1.2.14.8 **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 as per IS: 209. 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 Purchaser in Quality Assurance Programme.

c) Chemical anlysis 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 Purchaser in Quality Assurance Programme.

2.0 **Bus Bar Conductors**

2.1 Details of Conductor

2.1.1. For 400 kV System ACSR MOOSE Conductor (Quadruple & Twin) and for 220kV system ACSR ZEBRA & AAC Tarantulla (Twin) shall be used. Their specification is as under:-

| S.No. | Item | Moose | Tarantulla |
|---|---|---|---|
| 1. | Type | ACSR | AAC |
| 2. | BIS to which material shall conform / comply | IS:398 (Pt-V) | IS:398 (Pt-V) |

| | | | |
|---|---|---|---|
| 3. | Resistance at 20 deg. ohms / km | 0.5552 | 0.0367 |
| 4. | Approx. Current carrying capacity at 75 deg. C with peak ambient temp. of 50 deg. C and without solar heating, AMp. | 830 | 1169 |
| 5. | No. of wires | | |
| | a) Aluminium | 54/3.53 | 37/5.23mm |
| | b) Steel size | 7/3.53 | |
| | | 597mm2 | 485mm2 |
| 6. | Diameter of wire (mm) | | |
| | a) Aluminium | 3.53 | 5.23 |
| | b) Steel size | 3.53 | |
| 7. | Dia of conductor mm | 31.77 | 36.61 |
| 8. | Sectional area mm2 Total | 597.0 | 778 |
| | Aluminium | 528.5 | 778 |
| | | | |
| 9. | Weight of conductor kg / km | 2004 | 2197 |
| 10. | Breaking load of conductor | 161.20 | 123 |

2.2 **Workmanship**

2.2.1 The finished conductor shall be smooth, compact, uniform and free from all imperfections including spills, die marks, scratches, abrasions, scuff marks, kinks (protrusion of wires), dents, press marks, cut marks, 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 spots (on account of reaction with trapped rain water etc.) dirt, gril etc.

2.2.2 All the aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, diemarks, scratches, abrasions and kinks after drawing.

2.2.3 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating of 260 gm/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 after stranding 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.

2.2.4 The Steel strands shall be preformed and postformed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid damage to galvanization during performing and postforming operation.

2.3 **Stranding**

2.3.1 The wires used in manufacture of a stranded conductor shall before stranding, satisfy all requirement of IS:398 (Part I & V) or any other authorative standard as modified by this specification. For steel-reinforced aluminium conductors the lay ratio of the direct layers shall be within the limits given below:-

2.3.2 In all construction, the successive layers shall have opposite directions of lay, the outer-most layer being right handed. The wires in each layer shall be evenly and closely stranded.

2.3.3 In conductors having multiple layers of aluminium wires the lay ratio of any aluminium layer shall not be greater than the lay ratio of the aluminium layer immediately beneath its.

2.3.4 Lay Ratio : As per IS:398 (Part I, II & V)

2.3 **Joints in Wires**

2.3.1 **Aluminium Wires**

No joint shall, be permitted in the individual wires in the outermost layer of the finished conductor. However, joints in the 12 wire and 18 wire inner layers of the conductor shall be allowed but these joints shall be made by cold pressure butt welding and shall be such that no such joints are within 15 metres of each other in the complete stranded conductor.

2.3.2 **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 splices in any length of the completed stranded steel core of the conductor.

2.5 **Materials**

2.5.1 **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%.

2.5.2 **Steel**

The steel wire strands shall be drawn from high carbon steel wire rods and shall conform to the following chemical composition:

| Element | % Composition |
|---|---|
| Carbon | 0.50 to 0.85 |
| Manganese | 0.50 to 1.10 |
| Phosphorous | Not more than 0.035 |
| Sulphur | Not more than 0.045 |
| Silicon | 0.10 to 0.35 |

2.5.3 **Zinc**

The zinc used for galvanising shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209-1979

2.6 **Standard Length**

2.6.1 The Conductor shall be supplied in standard length of 1500 / 1800 metres as required. No joint shall be allowed within a single span of stringing.

2.7 **Tests:**

2.71 The following type, acceptance & routine tests and tests during manufacturing shall be carried out on the conductor.

2.7.2 **Type tests**

The following type tests shall be conducted on samples of conductor.

| | | |
|---|---|---|
| a) | UTS test on stranded conductor | The number of samples shall be mutually agreed between Contractor and Purchaser |
| b) | Corona extinction voltage test (dry) | As per Annexure-A |
| c) | Radio interference voltage test (dry) | As per Annexure-A |
| d) | DC resistance test on stranded conductor | As per Annexure-A |

2.7.3 **Acceptance Tests**

| | | |
|---|---|---|
| a) | Visual check for joints, scratches etc. and lengths of conductor | As per Annexure-A |
| b) | Dimensional check on steel and aluminium strands | As per Annexure-A |
| c) | Check for lay ratios of various layers | As per Annexure-A |
| d) | Galvanising test on steel strands | As per Annexure-A |
| e) | Torsion and Elongation test on steel strands | As per Annexure-A |
| f) | Breaking load test on steel and aluminium strands | As per Annexure-A |
| g) | Wrap test on steel and aluminium strands | IS: 398 (Part V) 1982 clauses 12.5.2, 12.7 & 12.8 |
| h) | DC resistance test on aluminium strands | ---do-- |
| i) | UTS test on welded joint of aluminium strands | As per Annexure-A |

Note: All the above tests except test mentioned at (i) shall be carried out on aluminium and steel strands after stranding only.

2.74 **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.

2.7.5 **Test During Manufacture**

| | | |
|---|---|---|
| a) | Chemical analysis of zinc used for galvanising | As per Annexure - A |
| b) | Chemical analysis of aluminium used for making aluminium strands | As per Annexure-A |
| c) | Chemical analysis of steel used for making steel strands | As per Annexure-A |

2.7.6 **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 Purchaserôs Quality Assurance Department. The sample shall be manufactured strictly in accordance with the Quality Assurance Plan approved by Purchaser.

3.0 **GALVANISED STEEL EARTHWIRE**

3.1 Details of Earthwire

3.1.1 The galvanized steel earthwire shall generally conform to the specification of ACSR core wire as mentioned in IS : 398 (Part-II) - 1976 except where otherwise specified herein.

3.1.2 The details of the earthwire are tubulated below:

| | | |
|---|---|---|
| a) | Stranding and wire diameter | 7/3.66 mm steel |
| b) | Number of strands | |
| | Steel core | 1 |
| | Outer Steel Layer | 6 |
| c) | Total sectional area | 73.65 $mm^2$ |
| d) | Overall diameter | 10.98 mm |
| e) | Approximate weight | 583 Kg/km |
| f) | Calculated d.c. resistance at 20° C | 2.5 ohms/km |
| g) | Minimum ultimate tensile strength | 68.4 kN |
| h) | Direction of lay of outer layer | Right hand |

3.2 **WORKMANSHIP**

3.2.1 All steel strands shall be smooth, uniform and free from all imperfections, such spilts and splits, die marks, scratches, abrasions and kinks after drawing also after stranding.

3.2.2 Finished material shall have minimum brittleness as it will be subjected to approximate vibration while in use.

3.2.3 The steel strands shall be hot dip galvanised (and shall have a 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 imperteons and shall withstand three and a half dips after stranding in standard 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 characterisitcs in ASTM designation B 498-74.

3.2.4 The steel strands shall be performed and postformed in order to prevent spreading of strands while cutting of composite earthwire. Care shall be taken to avoid damage to galvanisation during performing and postforming operation.

3.2.5 To avoid susceptibility towards wet storage stains (white reset) the finished material shall be provided with a protective coating.

3.3 JOINTS IN WIRES

There shall be no joints of any kind in the finished steel wire strand entering into the manufacture of earthwire. There shall be no strand joints or strand splices in any length of the completed stranded earthwire.

3.4 **TOLERANCES**

The manufacturing tolerances to the extent of the following limits only shall be permitted in the Diameter of the individual steel strands and lay length of the earthwire:

| | Standard | Maximum | Minimum |
|---|---|---|---|
| Diameter | 3.66 mm | 3.75 mm | 3.57 mm |
| Lay length | 181 mm | 198 mm | 165 mm |

3.5 **MATERIALS**

3.5.1 **Steel**

The steel wire strands shall be drawn from high carbon steel rodes and shall conform to the following requirements as to the chemical co,position:

| Element | % Composition |
|---|---|
| Carbon | Not more than 0.55 |
| Manganese | 0.4 to 0.9 |
| Phosphorous | Not more than 0.04 |
| Sulphur | Not more than 0.04 |
| Silicon | 0.15 to 0.35 |

3.5.2 **Zinc**

The zinc used for galvanising shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS: 209-1979

3.6 **STANDARD LENGTH**

3.6.1 The earthwire shall be supplied in standard drum length of manufacturer as per actual requirement.

3.7 **TESTS**

3.7.1 The following type, routine & acceptance tests and tests during manufacturing shall be carried out on the earthwire.

3.7.2 **TYPE TESTS**

The following type tests shall be conducted on samples of earthwire. The number of samples shall be mutually agreed between Contractor and Purchaser.

| | | |
|---|---|---|
| a) | UTS test | As per Annexure - B |
| b) | DC resistance test | As per Annexure - B |

3.7.3 **ACCEPTANCE TESTS**

| | | |
|---|---|---|
| a) | Visual check for joints, scratches etc. and of earthwire | As per Annexure - B |
| b) | Dimensional check | As per Annexure - B |
| c) | Galvanising test | As per Annexure - B |
| d) | Lay length check | As per Annexure - B |
| e) | Turbon test | As per Annexure - B |
| f) | Elongation test | As per Annexure - B |
| g) | Wrap test | As per Annexure - B |
| h) | DC resistance test | IS : 398 (Part-III) 1976 |
| i) | Breaking load test | IS : 398 (Part-III) 1976 |
| j) | Chemical Analysis of steel | IS : 398 (Part-III) 1976 |

3.7.4 **ROUTINE TESTS**

a) Check that there are no cuts, fins etc. on the strands.
b) Check for correctness of stranding.

3.7.5 **TESTS DURING MANUFACTURE**

| | | |
|---|---|---|
| a) | Chemical analysis of zinc used for galvanizing | As per Annexure - B |
| b) | Chemical analysis of steel | As per Annexure - B |

3.7.6 **SAMPLE BATCH FOR TYPE TESTING**

The Contractor shall offer material for sample selection for type testing, only after getting quality assurance programme approved by the Purchaser. The samples for type testing shall be manufactured strictly in accordance with the quality Assurance Programme approved by the Purchaser.

## 4.0 TUBULAR CONDUCTORS

### 4.1 114.2 mm OD & 73.03 mm OD Aluminium Tubes

4.1.1 Aluminium used for the manufacuring of aluminium tubes shall be of grade 63401-WP conforming to IS:5082 (latest edition) and shall confirm to other technical requirement herein at

4.2. The seamless tube shall be manufactured by either of the following processes:-

a) Hot extrusion process through die and mandrel (Hollow billet process). Heat treatment shall be done after hot extrusion of tube.

b) Bridge extrusion process and then cold drawn. Heat treatment shall be done after cold drawing of tube.

4.1.2 The Aluminium alloy tubes to be supplied shall be free from any abrasion, dent, deformation and deviation from strightness.

**DIMENSIONAL TOLERANCES:**

There shall be no plus tolerance for inner diameter of tubes and there shall be no minus tolerance for otuer diameter of the tubes. Other requirement being as per IS:2678 and IS:2673. The tubes to be supplied shall be atleast of 6 metre lengths.

### 4.2 PARAMETERS

| | | | |
|---|---|---|---|
| a) | Size | 4" IPS (EH Type) | 3" IPS (EH Type) |
| b) | Outer diameter (mm) | 114.2 | 73.03 |
| c) | Thickness (mm) | 8.51 | 7.62 |
| d) | Cross-sectional area (Sw.mm) | 2825.61 | 1946 |
| e) | Weight (kg/m) | 7.7 | 5.267 |
| f) | Standard to which aluminimum alloy tube confirmed | IS:5082 IS:2673, IS:2678 | IS:5082 IS:2673, IS:2678 |
| g) | Chemical composition percentage | Cu 0.05 Max.<br>Mg0.4 to 0.9<br>Si 0.3 to 0.7<br>Fe 0.5 max<br>Mn 0.03max<br>Al Remainder | Cu 0.05 Max.<br>Mg0.4 to 0.9<br>Si 0.3 to 0.7<br>Fe 0.5 max<br>Mn 0.03max<br>Al Remainder |
| h) | Tensile strength | 200 MPA i.e. 20.4 kg/mm 2 (min) | 200 MPA i.e. 20.4 kg/mm 2 (min) |
| i) | 0.2% proof stress | 170 MPS i.e. 17.34 kg/mm 2 (min) | 170 MPS i.e. 17.34 kg/mm 2 (min) |
| j) | Minimum Elongation percent on 50mm | 10% | 10% |
| k) | Co-efficient of linear expansion per degree centigrade | 0.000023 | 0.000023 |
| L | IACS conductivity | 55% min. | 55% min. |

### 4.3 HEAT SHRINKABLE TUBES:-

4.3.1 The outer 33 kV bus bar of 73.03 mm OD aluminium alloy tube shall be insulated using heat shrinkable tube suitable for outdoor use and aluminum alloy tube temperature normally varying from 0 deg. to 90 deg.C. Appropriate diameter tubes shall be of length 1.0 to 2.5 metre. On being heated using ordinary kerosene stove tubing or their cut lengths will shrink in diameter to insulate 73.03mm outer tube by 2.5mm with dielectric strength of insulation not less than 10 kV (rms) per mm. No longitudinal joints will be necessary. Transverse joints of tubing should be feasible by overlapping of lengths. Should it require heat shrinkable tapes (shrinking only in thickness), the lengths of tape required to make about 120 such joints shall be quoted. Tubings and tapes are required to be fire resistant.

4.3.2 33 kV Aluminum Alloy tubular bus bars will be supported by fixed or sliding clamps or expansion joints at approximately 2.5 metre spacing. To prevent phase to phase or phase

to earth faults (e.g. bird faults), to allows for expansion of tubes due to temperature variation, clamp / joint temperature, and also to have ease of maintenance of these clamps / joints, it is proposed to envelope these joints / clamps by providing non-heat shrinkable non-inflammable transparent 2.5mm thick and 500mm long plastic tubes of 300mm inner diameter with 300x150mm flat base with 4 nos. 18 mm dia fixing holes at 127mm P.C.D.

4.4 TESTS

4.4.1 The aluminium tubes shall be subjected to the following tests:-

i) The tubular bus conductors shall be subjected to routine tests as per IS:5082.
ii) Test to check mechanical properties (i.e. tensile test and percentage elongation test) shall be carried out in accordance with IS: 1816 and the test results shall be in accordance with Table-I of IS:5082.
iii) The electrical resistivity of tube shall be determined as per IS:3635.
iv) Measurement of ovality as per IS:2673 by ultrasonic method.
v) Measurement of wall thickness atleast at ten locations alongwith the length of each tube by ultra sonic method.
vi) Visual inspection for freedom from surface defects like scraches, dents etc. on each tube.
vii) In addition to the above test, 0.2% proof tests on both parant metal and Aluminium tube after weldig shall be conducted.

4.4.2 Selection of test samples shall be made as per IS:5082.

## 5.0 EARTHING CONDUCTOR

5.1 General

All conductor buried in earth and concrete shall be of mild steel. All conductors above ground level and earthing leads shall be of galvanised steel, except for cable trench earthing. The minimum sizes of earthing conductor to be used are as indicated in clause 8.4 of this Section.

**5.2 Galvanised Steel**

a) Steel conductors above ground level shall be galvanised according to IS: 2629
b) The minimum weight of the zinc coating shall be 618 gm/sq. m. and minimum thickness shall be 85 microns.
c) The galvanised surfaces shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surfaces of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spether which is loosely attached to the steel globules, spiky deposits blistered surfaces, 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.

5.3 **TESTS**

The galvanised steel shall be subjected to four one minute dips in copper sulphate solution as per IS : 2633.

6.0 SPACERS

6.1 General

The spacers shall conform to IS: 10162. The spaces are to be located at a suitable spacing to limit the short circuit forces and also to avoid snapping of subconductors

during short circuit conditions. Necessary spacer span calculation shall be provided by the Contractor during detailed engineering for the approval of purchaser.

6.2 Constructional Features

The spacers shall be suitably designed to prevent clashing of conductors and minimise the effect of short circuit forces between quadruple & twin conductors on structures. They shall be capable of withstanding electro magnetic and electrostatic forces during short circuit without deformation or damage to the conductor or spacer. Moreover spacers shall permit following relative axial and torisional movements of sub conductors and maintain their correct separation without wear /fatigue, lubrication and maintenance.

| | | 400 kV Spacer | 220 kV spacer |
|---|---|---|---|
| i) | Longitudinal movement parallel to the conductor. | ± 50mm | ±33mm |
| ii) | Vertical movement at right angle to the conductor | ± 25mm | ±15mm |
| iii) | Torsional angular movement in a vertical plane parallel to the conductor. | ± 50mm/±50 | ±33mm/±50 |

Spacer shall withstand without failure, the minimum Tensile and compressive loads of 750 kgs. applied on he spacer between 31.77mm and 36.61mm diameter test bars and held for one minute.

Spacer shall preferably be of one piece construction and shall not have separate components. All bolts shall be captives, nuts shall only need slackening not removal in order to fit the spacr to the sub conductor. Installation of the units shall be simple and achieved without the use of special tools.

The material used in spacers shall be corrosion resistant and the body shall be made of aluminium alloy of an approved type. All ferrous metal parts shall be galvanised, conforming to IS:2633. Other materials may be used subject to satisfactory evidence being given to the purchaser that all components shall be suitably corrosion resistant and shall not cause any other components or the conductor to corrode and shall not otherwise unduly deteriorate in service.

No rubbing, other than the conductor clamp hinges or clamp's swing bolts shall take place between any part of the spacer. Relative movement of the conductor shall be accommodated without wearing of spacer's parts.

The spacer shall not damage of chafe the conductor in any way which might effect its mechanical strength or corona extinction voltage.

Any nuts on spacers shall be locked in any approved manner against vibration loosening.

The corona extinction voltage of the spacers shall not be less than 320 kV rms specified in Annexure-I. It shall not have any projections, cuts, abrasions etc. or chattering parts which might cause radio interference. It shall also have strength enough to resist deformations which might change the radio interference performance of the spacer The spacer shall have radio interference voltage level below 500 micro volts at 1.10 times the highest system phase to earth. Volttage (i.e. 266 kV rms for 400 kV spacers)

The spacers should be aesthetically attractive. Ferrous parts, if used in spacer shall not have magnetic losses more than 5 watts for 50 cycles / second. A.C. current at 25%

higher rated volttage. Elastometers if used shall be resistant to ozone, sunshine and ageing and shall have good faitgue and work softening characteristics.

With spacers installed on new clean conductor, tensioned to EDC and the spacer bolts tightened to exactly the recommended installation torque, an initial minimum axial load of 200 KG. shall be required to cause slip along the conductor.

## 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

a) Clamp slip tests

a) The sample shall be installed on test span of twin conductor bundle string or quadruple conductor bundle string (as applicble) 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 as per Cl 5.14.2 of IS: 10162

c) Corona Extinction Voltage Test (Dry)

This test shall be performed as per procedure mentioned at Annexure-A, Section-2. Minimum Corona Extinction voltage shall be 320 kV (rms) line to ground.

d) RIV Test (Dry)

This test shall be performed as per procedure mentioned at Annexure-A, Section -2. Maximum RIV level at 305 kV (rms) line to ground for 400 kV and shall be 1000 micro volts, across 300 ohm resistor at 1 MHz.

e) Resilience test (if applicable)

f) Tension Test

g) Log decremant test (if applicable)

h) Compression test

i) Galvanising test

### 6.3.2 Acceptance Test (As per IS: 10162 (Latest Version)

a) Visual examination

b) Diemnsional 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 shsore hardness meter 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 IS: 2544, IEC-168 and IEC-815

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-815 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 coductors 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 lea to deterioration.

7.1.7 All ferrous parts shall be not dip galvanised in accordance with the latest edition of IS: 2633 & IS: 4579. The zinc used for galvanising shall be grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky whit e deposits and blisters. The metal parts shall not produce any noise generating corona under the oerating conditions.

7.1.8 a) Every bolt shall be provided with a steel washer under the nut so that part of the threaded port ion of the bolts is wit hin 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 suuitable 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 galvanised. 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.

7.1.10 Tests

The post insulators shall be subject to type, acceptance, sample and routine tests as per IS: 2544 and IEC-168.

In addition acceptance/ sample/routine tests as per IS:2544 and IEC 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 tests as acceptance test.

c) All hot dip galvanised components shall be subject to check for uniformty fo 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 The post insulators shall be subjected to following type tests:-

a) Power frequency withstand test (dry & wet)

b) Lightning impulse test (dry)

c) Switching impulse test (wet) (For 420 kV insulator only)

d) Measurement of R.I.V (Dry)
As per Annexure -A, Section - 2

e) Corona extinction voltage test (Dry)
As per Annexure-A, Section-2

f) Test for deflection under load

g) Test for mechanical strength.

7.3 Technical Parameters of Bus Post Insulators.

| | | | |
|---|---|---|---|
| a) | Type | Solid core | |
| b) | Voltage class (kV) | 420 | 220 |
| c) | Dry and wet one minute power frequency withstand voltage (kV rms) | 680 | 460 |
| d) | Dry lightning impulse withstand Voltage (kVp) | ± 1425 | ±1050 |
| e) | Wet switching surge withstand voltage (kVp) | ± 1050 | - |
| f) | Max. radio interference voltage (in microvolts) for any frequency between 0.5 MHz to 2 MHz at voltage of 1.1 pu kV (rms) between phase to ground | 500 | 500 |
| g) | Corona extinction | 320 (Min.) | 156 (Min.) |

| | | | |
|---|---|---|---|
| | voltage (kV rims) | | |
| h) | Total minimum cantilever strength (Kg) | 800 | 800 |
| i) | Minimum torsional moment | As per IEC -273 | As per IEC -273 |
| j) | Total height of insulator (mm) | 3650 | 2300 |
| k) | P.C.D. | | |
| | Top (mm) | 127 | 127 |
| | Bottom (mm) | 300 | 254 |
| l) | No. of bolts | | |
| | Top | 4 | 4 |
| | Bottom | 8 | 8 |
| m) | Diameter of bolt/holes (mm) | | |
| | Top | M16 | M16 |
| | Bottom dia | 18 | 18 |
| n) | Pollution level as per IEC -815 | Heavy (III) | Heavy (III) |
| o) | Minimum total chreepage distance for heavy pollution (mm) | 10500 | 6125 |

7.4 If corona extinction voltage is to be achieved with the help of corona ring or any othe similar device, the same shall b deemed to be included in the scope of the Contractor.

7.5 **POST INSULATOR CLAMPS**

7.5.1 Expansion Joints:

The expansion joints for aluminium alloy tube (suitable for 114.2mm & 73.03mm diameter aluminium tube shall be of aluminium alloy 4600 (A6) to IS:617 and shall be suitable for installation on post insulators with P.C.D of 127mm. Expansion joint shall allow expansion/construction of tube at one end and fixed support at other end. It is proposed to install these joints at 50 meter interval as such joints shall be designed so as to provide for expansion/construction, corresponding to the temperature difference to which the bus bar may be subjected. The expansion joint shall be capable of taking bus bar constricition/expansion of atleast 100mm for 400 kV on one end with outer end fixed. The expansion joints shall provide for angular deviation of 5 deg. to aluminium alloy tube in the vertical and horizontal plane to permit for any misalignments of tubular buses. These deviations shall be applicable for both fixed as well as sliding bus bar tubes. The expansion joints shall have the following components (or their evuivelents).

a) Connector on Bus Bar: Expansion bus coupler shall consist of two connectors each consisting of a body piece and a clamping piece. Body piece with appropriate number of AAC Tarantulla conductor (size 37/5.23mm) in the shape of circular are (i.e. bow) shall be embedded and factory welded. On clamping, the connector on aluminium tube, AAC Conductor bow shall form flexible connection between tubes as shown in sketch EHV/1 at Appendix-A . The continuous and short circuit current rating of this flexible connection shall be 3600 Amps. (at 75 deg C & without solar heating and 40 KA rms for

one second respectively. The adequate number of bolts and nuts shall be approved on each piece so that these can be properly clamped on the tube.

b) Support on Post Insulators : Each expansion joints shall have one number post insulator support of aluminium alloy 4600 (A6) to IS:617 fixed on post insulator with 8 bolt holes at 127 mm P.C.D. This support will have lower part of two clamps integrally casted with the support. Lower part of clamp with upper clamping piece shall form fixed/sliding type of connector conforming to clause 7.5., one of them will be used as a sliding type clamp and other as fixed type clamp.

7.5.2 Fixed/Sliding type post insulator clamps.

400 kV Bus Bar and 33kV Bus bar of aluminium alloy tube shall be provided with expansion joints at an spacing of about 50 meter to 25 meter vide clause no. 7.5 and at an intermediate post insulator supports, it shall be supported by sliding type post insulator clamps.For bay bus bars, one end shall be fixed and other will be free to expand/contract. Fixed/sliding type post insulator clamps shall be capable of being used as either fixed type or sliding type clamp. When used as sliding clamp, it shall permit the movement of tube due to expansion/contraction. When used as fixed type clamp it shall hold the tube firmly and will not permit its movement clamp body shall have groove in the centre or some arrangement to fix leaf spring (When using as a sliding clamp) to press the upper side of the tube effectively to suppress the low frequency vibration in the tube.

7.5.3 Post Insulator clamp for conductors.

Clamp shall be used to hold twin ACSR Moose conductor straight through or at 90 deg. on Post insulaor at PCD 127 mm at bundle spacing of 450mm.

The compressing / tensile strength of clamp between conduction holding points shall not be less than 900 kg. Slipping strength of the clamp may be indicated.

7.5.4 Material of bolt, nuts and lock nuts etc. (Min. M12) shall be of stainless steel.

7.5.5 **TESTS**

All post Insulator clamp / connectors suitable for conductor and aluminium tube (expansion joint, etc.) shall comply with the requirements of type test, routine test and acceptance test as per IS:5561. All 400 kV Post Insulators clamp / connectors shall be subjected to corona extinction voltage test at 320 kV rms and RIV test at 266 kV (rms) as per the procedure detailed in annexure-I. The bidder shall indicate slipping strengths of clamps and joints and shall submit test certificate.

## 8.0 EARTHING

8.1 The earthing shall be in accordance with requirements given hereunder. The earthmat design shall be done by the Contractor as per IEEE-80. The soil resistivity measurement shall also be done by the Contractor. Max. earth fault current 40kA for 1 sec. shall be considered for earth mat design.

8.2 Neutral points systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

8.3 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian standards and Codes of practice and Regulations existing in the locality where the system is installed.

a) Code of practice for Earthing IS : 3043
b) Code of practice for the protection of Building and allied structures against lightning IS: 2309
c) Indian Electricity Rules 1956 with latest amendments.
d) National Electricity Safety code IEEE - 80.

8.4 **Details of Earthing System**

| | Item | Size | Material |
|---|---|---|---|
| a) | Main Earthing Conductor to be buried in ground | 40 mm dia | Mil Steel rod |
| b) | Conductor above ground and up to main earthing conductor & earthing leads (for equipments) | 75 x 12 mm G.S. flat | Galvanised Steel |
| c) | Conductor above ground and up to main earthing conductor & earthing leads (for columns & aux. Structures) | 75 x 12 mm G.S. flat | Galvanised Steel |
| d) | Earthing of indoor LT panels, control panels and out door marshalling boxes, MOM boxes, junction boxes & lighting Panels etc. | 50x6 mm G.S. flat | Galvanised Steel |
| e) | Rod Earth Electrode | 40mm dia, 3200 mm long | Mild Steel |
| f) | Pipe Earth Electrode (in treated earth pit) as per IS. | 40 mm dia, 3000 mm long | Galvanised steel |
| g) | Earthing for motors | 25x3 mm GS flat | Galvanised Steel |
| h) | Earthing conductor along outdoor cable trenches | 50x6 mm MS flat | Mild Steel |
| i) | Down conductor from earthwire peak | 75 x 12 mm G.S. flat | Galvanised Steel |

8.5 **EARTHING CONDUCTOR LAYOUT**

8.5.1 Earthing conductors in outdoor areas shall be buried at least 600 mm below finished ground level unless stated otherwise.

8.5.2 Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be re-routed in case it fouls with equipment/ structure foundations.

8.5.3 Tap-connections from the earthing grid to the equipment/ structure to be earthed, shall be terminated on the earthing terminals of the equipment structure as per ñEarthing Detailsò.

8.5.4 Earthing conductors or leads along their run on cable trench ladder columns, beams, walls etc. shall be supported by suitable welding/ cleating at intervals of 750 mm. Wherever it passes through walls, floors etc. galvanised iron sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

8.5.5 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building. In case high temperature is encountered at some location, the earthing conductor shall be laid minimum 1500 mm away from such location.

8.5.6 Earthing conductors crossing the road shall be laid 300 mm below road or at agreed depth to suit the site conditions.

8.5.7 Earthing conductors embeded in the concrete shall have approximately 50 mm concrete cover.

## 8.6 EQUIPMENT AND STRUCTURE EARTHING

8.6.1 Earthing pads shall be provided for the apparatus/ equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with Purchaser. The support structures shall be separately earthed by two direct earthing leads on diagonally opposite end of the structure . In all cases each of the two earthing leads shall be connected on different runs of the earthmates.

8.6.2 Whether specifically shown in drawings or not, steel/ RCC columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of hand-rails and metallic stairs.

8.6.3 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

8.6.4 Metallic conduits shall not be used as earth continuity conductor.

8.6.5 A separate earthing conductor shall be provided for earthing lighting fixtures, receptacles, switches, junction boxes, lighting conduits etc.

8.6.6 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits etc. and steel reinforcement in concrete it shall be bonded to the same.

8.6.7 Light poles, junction boxes on the poles, cable and cable boxes/ glands, lockout switches etc. shall be connected to the earthing conductor running alongwith the supply cable which inturn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.

8.6.8 Railway tracks within switchyard area shall be earthed at a spacing of 30 m and also at both ends.

8.6.9 Earthing conductor shall be buried 2000 mm outside the switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid.

8.6.10 Flexible earthing connectors shall be provided for the moving parts.

8.6.11 All lighting panels, junction boxes, receptacles fixtures, conduits etc. shall be grounded in compliance with the provision of Indian Electricity Rules.

8.6.12 A continuous ground conductor of 16 SWG Gl wire shall be run all along each conduit run and bonded at every 600 mm by not less than two turns of the same size of wires. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, lighting fixtures etc. shall be connected to this16 SWG ground conductor.

8.6.13 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Post Office red enamel paint.

## 8.7 JOINTING

8.7.1 Earthing connections with equipment earthing pads shall be bolted type contact surfaces shall be free from scale, paint, enamel, gtease, nut or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anticorrosive paint/ compound.

8.7.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red lead and afterwards coated with two layers bitumen comoind to prevent corrosion.

8.7.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingression.

8.7.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

8.7.5 All ground connections shall be made by electric are welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

8.7.6 Bending of earthing rod shall be done preferably by gas heating.

8.7.7 All arc welding with large dia conductors shall be done with low hydrogen content electrodes.

8.7.8 The 75 x 12mm GS flat shall be clamped with the equipment support structures at 1000 mm interval.

8.8 **POWER CABLE EARTHING**

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and swich gear end. Sheath and armour of single power cables shall be earthed at switch gear end only.

8.9 Specific Requirement for Earthing Systems

8.9.1 Each earthing lead from the neutral of the power transformer/ reactor shall be directly connected to two pipe electrodes in treated earth pit separately (as per IS) which in turn, shall be buried in Cement Concrete pit with a cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer/ reactor like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.

8.9.2 Earthing terminal of each lightning arrester & capacitor voltage transformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.

8.9.3 Auxiliary earthing mat comprising of closely spaced (300 mm x 300 mm) conductor shall be provided at depth of 300 mm from ground level below the operating handles of the M.O.M. boxes shall be directly connected to the auxiliary earthing mat.

9.0 **MAIN BUS BARS**

The brief description of the bus switching scheme, bus bar layout and equipment connection to be adopted are indicated in Section-1. The bus bar arrangements are shown in drgs enclosed with the bid documents.

9.1 the Contractor shall furnish supporting calculations for the bus bars/ conductors to show adequacy of design parameters for.

a) Fibre stress

b) Cantilever strength of post insulators

c) Aeolain 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 Purchaserôs 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 and connectors.

9.1.3 Details of past experience of the persons proposed to be employed for Aluminum 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 CLAMPS & CONNECTOR

BUS BAR Conductor Accessories.

Jumper Tee Clamps and PG clamps specification

| S.No. | Item | Specification |
|---|---|---|
| 1. | Type | Bolted type |
| 2. | Material of clamp | Aluminium Alloy (4600 (A6) to IS:617) |
| 3. | Suitable for conductor | Suitable for use on the ACSR Moose conductor (OD) 31.77mm or AAC Tarantulla conductor (OD 36.61mm) |
| 4. | Normal current rating | Not less than 3600 Amp. (at 75 deg. C and without solar heating) |
| 5. | Short time current rating | 40 KA rms for one second |
| 6. | Shielding (for Moose conductor clamps) | Self shielding or shielding shall be provided in order to deep corona extinction voltage equal or higher than 320 kV rms (phase to phase) and RIV level below 500 micro volts at 266 rms. |
| 7. | Material of bolts, nuts and lock nuts etc. (Min. M-12) | Stainless steel |

10.1.2 Conductor Accessories Constructional Features.

10.1.2.1 Jumper Tee Clamp

Jumper tee clamp shall comply with relevant Indian Standard Specification as amended upto date. Jumper T- Clamp for 420 kV system shall not bolt heads, nuts and threaded parts of the bolt, shielded by the clamp body itself. The clamp shall be supplied with stainless steel bolts, nuts, lock nuts of the correct size (Minimum M12) to exert and maintain correct pressure required to ensure a good tight joint of low resistance.

10.1.2.2 PG Clamps.

PG clamps for ACSR conductors shall be extruded type and shall have smooth surface with all edges rounded off. Both halves of clamps shall be of identical shape. The electrical resistance of the clamp shall be less than that of equivalent length of the conductors with which it is to be used. The clamps shall be supplied with stainless steel bolts, nuts, lock nuts of the correct size(Minimum M12) and strength for good tight joint of low resistance. P.G. clamps for 420 kV system shall have bolt heads, nuts and threaded part of bolt, shielded by the clamp body itself.

10.2 Earth Wire Accessories.

10.2.1 i) Dead End assembly for Earth wire

ii) Earthing Clip for earth wire

iii) PG clamps.

| S.No. | Item | Specification |
|---|---|---|
| 1. | Dead End Assemblies | |
| | i) Type | Compression |
| | ii) Suitable for | 7/3.66mm (110kgf/mm2 quality) GSS Groundwire |
| | iii) Material<br>a) Body | Stainless steel confirming to relevant Indian standard |
| | b) Bolts & Nuts | Galvanised steel |
| | iv) Electrical resistance | Not more than equivalent length of groundwire. |
| | v) Minimum slip strength | 90% of breaking load of groundwire. |
| | vi) Galvanisation: | |
| | a) Spring washers | Electro galvanized for service condition no. 3 as per IS:1573 |
| | b) Other ferrous parts | Hot dip galvanized 6 nos. 1 minute dips. |
| | c) Quality of zinc | Zn 98 of IS:209 |
| 2. | Earthing clips | |
| | i) Material | M.C.I. |
| | ii) Suitable for | 7/3.66mm (110kgf.mm2 quality) GSS Groundwire. |
| | iii)Slipping strength | No slippage at 110 kg. |
| | iv) Galvanisation: | |
| | a) Spring washers | Electro galvanized for service condition no. 3 as per IS:1573 |
| | b) Other ferrous parts | Hot dip galvanized 6 nos. 1 minute dips. |

| | | |
|---|---|---|
| | c) Quality of zinc | Zn 98 of IS:209 |
| 3. | P.G. Clamps | |
| | i) Material | M.C.I. |
| | ii) Suitable for | 7/3.66mm (110kgf.mm2 quality) GSS Groundwire. |
| | iii)Slipping strength | No slippage at 110 kg. |
| | iv) Resistance | Not more than corresponding equal length of groundwire. |
| | a) Spring washers | Electro galvanized for service condition no. 3 as per IS:1573 |
| | b) Other ferrous parts | Hot dip galvanized 4 nos. 1 minute dips. |
| | c) Quality of zinc | Zn 98 of IS:209 |

10.2.2 Ground Wire Accessories Constructional features.

Ground wire accessories (i.e. Dead end Assemblies, earthing clips and PG Clamps, offered shall be suitable for groundwire as per the clause 3.2. The materials employed in the manufacture of accessories shall have requisite mechanical strength, corrosion resistant and machinable. The composition of material to be used shall be made available to the purchaser if required for verification. The design, manufacturing process and individual control of all accessories shall be such as to give maximum factor of safety with minimum weight in respect of maximum working load, highest mobility, maximum possible elimination of sharp edges corners abrasions or projections and free from linequalities, spills, splits or other defects and shall be smooth, close grained and of the true forms and in dimensions.

10.2.2.2 Dead End Assembles

The dead end assemblies are required for use on the substation towers. The dead end assemblies shall be supplied complete with jumper terminals, nuts and bolts, suitable link pieces between steel clevis and a tower strin plate so as to provide sufficient flexibility to the attachment. Dead end assemblies shall have tensile strength not less than 95% and the minimum slip strength not less than 90% of the breaking load of the groundwire.

The main body should be of malleable cast iron confirming to relevant Indian standard. The material used for bolts and nuts shall be galvanized steel. The spring washers shall be electro galvanized and other ferrous parts hot dip galvanized. The bidders are required to submit with their bid a detailed assembly drawing of the complete dead end assembly alongwith details of individual parts indicating the materials to be used, complete detailed instructions for mounting a dead end assembly shall be supplied by the successful bidder.

10.2.2.3 Earthing Clips

Groundwire earthing clips are required for establishing a good electrical contact between the groundwire jumper connecting the dead end assemblies and the tension tower leg . Earthing clips bonds shall be suitable for mounting directly on the tower leg without any other accessories. The bidders are required to submit with their bid a detailed assembly drawing of the complete earthing clip and details of individual parts indicating clearly, the material to be used.

10.2.2.4 P.G. Clamps

Parallel groove claps shall be hot dip galvanished iron and shall have well finished surface with all edges rounded off. Both halves of the clamps shall be identical in shape. The clamp shall be provided with minimum two bolts with necessary flat and spring washers and are required for establishing a good electrical contact between the ground wire jumper of two dead end assemblies. The resistance of the clamp shall not be more than measured resistance of equal length of earthwire. The design of the clamps shall be such that it does not allow the ground wires to slip below a tensile load of 110kg.

10.3 Aluminimum Tube Accessories.

10.3.1 Aluminium Tube (114.2mm O.D) accessories are:-

1 Coupler
a) Strainght Run Coupler
b) Angle Coupler

Connectors.

a) 20 deg. Angle (V) connectors.
b) 80 deg. Angle connectors.
c) 90 deg. Angle connectors.
d) 90 deg. Connectors (for connecting 114.2mm OD aluminimum tube and quadruple & twin moose conductor at sub-spacing of 450mm and suitable for horizontal takeoff).
e) 90 deg. Angle connectors (for connecting 114.2mm OD tube and quadruple & twin moose conductor at sub-spacing of 450 mm conductor and tube parallel to each other).

10.3.2.1 Coupler:

a) Stainght Run Couplers

The straight run couplers shall be made of aluminum alloy 4600(A6) to IS:617 (latest edition) and shall have length not less than 6 time the diameter of Aluminium Tube, to ensure correct alignment of Aluminium alloy Tube during welding. Both ends of couplers shall be chamfered for easy insertion into aluminium alloy tube. The straight run coupler shall be slit and designed so that after insertion, it shall fit fightly to aluminium alloy tube whose inner diameter may range from 92.78mm to 97.18mm for 114.2mm tube. Pin of atleast 5 mm diameter or any other suitable device shall be provided for fastening and accurate centering of the coupler .Tapered pin shall be provided for expanding the coupler to fit fighting inside the Al tube.

b) 110 deg/135 deg. Angle Coupler

Angle tee coupler (110 deg/135 deg.) shall be suitable for connection between aluminium alloy tubes at 110 deg. Or 135 eg. As the case may be. The internal diameter of the coupler shall be such that it facilitates easy insertion of aluminium tubes of outer dia at 114.2mm to be coupled at an angle of 110 deg. Or 135 deg.

10.3.2.2 Connectors

i) Connectors shall be suitable for teeing off from main ACSR quadruple Moose 450mm sub conductor spacing (square formation) & 33kV tublar bus (73.03mm OD) and for connectors shall have sufficient depth/width to make up for errors in out-off length of the tubs and shall have inside diameter suitable ACSR quadruple Moose 450mm sub conductor spacing (square formation) and 33kV tublar bus (OD 73.03mm). The run saddle shall be designed for an adequate longitudinal weld shall be designed for an adequate longtidudianweld (eliminating welding around rest of the periphery of saddle). Connectors shall be of following types.:-

ii) 20 deg. Angle connector suitable for connection between two aluminium alloy tubes at 20 deg. Teeing off from another aluminium alloy tube, at right angle to both tubes.

iii) 80 deg. Angle connector suitable for connection between teeing of aluminium alloy tube from another in same plane, with acute of 80 deg. (and obtuse angle of 100 deg.).

iv) 90 deg. Angle connector suitable for connection between aluminium alloy tube of outer dia 114.2mm to twin moose conductor (OD 31.77mm and at sub spacing of 450mm) parallel to each other.

v) 90 deg. Angle connector suitable for connection between aluminium alloy tube of outer dia 114.2mm to twin moose conductor (OD 31.77mm and at sub-spacing of 450mm) and for horizontal take off .

vii) Bus End Shields:

Bus end shield shall be mounted at the end of tubular bus to prevent formation of corona at the edges of the tube. It shall be so designed that it can be screwed to tapped hole on tube or removed without damaging or deforming the tubes.

10.4 Test on Conductor Accessories

10.4.1 All conductor accessories shall be subjected to corona extinction voltage test procedule detailed in Annexure. Conductor accessories (i.e. clamps & connectors) shall comply with the requirements of type, routine and acceptance test as per IS:5561.

10.4.2 Test on Alluminium Tube Accessories:- Aluminium tube current carrying accessories i.e coupler and connectors shall comply with the requirement of type, routine and acceptance tests as per IS:5561. All accessories except straight run coupler shall be subjected to corona extinction voltage test at 320 kV rms and RIV test at 266 kV (Rms) as per the procedure detailed in Annexure-I. The bidder shall indicate slipping strength of clamps and joints and shall submit test certificate.

10.4.3 Test on Earthwire Accessories

Earthwire accessories shall comply with the requirement of type, routine and acceptance test as per IS:2486-Pt-I.

## 11.0 PROTECTION

11.1 lighting protection (DSLP) shall be provided in the EHV switchgear by shield wires. The layout drawings enclosed indicate the tentative arrangement. The final arrangement shall be decided after approval of the DSLP calculations.

11.2 The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.

11.3 A 40 mm dia. 3000 mm long MS earth electrode with test links, Cl frame & cover shall be provided to connect down conductor of Lightning masts & towers with peak.

11.4 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

11.5 Down conductors (GS Flat 75X12mm) used for lightning protection shall be cleated on the structures at 2000 mm interval.

11.6 Connection between each down conductor and rod electrodes shall be made via test joint ( pad type compression clamp) located approximately 1500 mm above ground level.

11.7 Lightning conductors shall not pass through or run inside G.l. conduits.

11.8 All metallic structures within a vicinity of 2000 mm in air and 5000 mm below ground shall be bound to the conductors of lightning protection system.

## 12.0 TERMINAL POINTS

The terminal points for the scope of work of switchyard are given below:

12.1 Line Feeders

112.1.1 The transmission line shall terminate on line side gantry structure. The supply and erection of tension insulator string for the termination and tension clamps for earth wire termination are included in the scope of the Bidder.

12.1.2 Lightning protection down conductor at this end, tap offs and jumper connections from this dead end to all equipment in the switchyard are also in the Bidderôs scope.

## 13.0 EQUIPMENT ERECTION NOTES

13.1 All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.

13.1.1 The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.

13.1.2 Handling equipment, sling ropes etc. should be tested periodically before erection for strength.

13.1.3 Bending of 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.

13.1.4 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.

13.1.5 Mulsin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.

13.1.6 All the equipment, instruments and auxiliaries required for testing and commissioning of equipment shall be arranged at site by the Contractor.

## 13.2 STORAGE

13.2.1 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 of accidents. The equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instructions of the equipment manufacturer / purchaser shall be strictly adhered to.

## 14.0 CABLE TAGS AND MARKERS

14.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

14.2 The tag shall be of aluminum with the number punched on it and securely attached to the cable conduit by not less that two turn of 20 SWG GI wire conforming to IS:280. Cable t age shall be of rectangular shape for power cables and of circular shape for control cables.

14.3 Location of cables laid directly underground shall be clearly indicated with cable marker made of galvanisied iron plate.

14.4 Location of underground cable joints shall be indicated with cable marker with an additional inscription "Cable joints".

14.5 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.

14.6 Cable tag shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall floor crossing, on each duct / conduit entry and at every twenty metres (20 m) 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.

## 14.7 STORAGE AND HANDLING OF CABLE DRUMS

14.7.1 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. In absence of any indication the drums may be rolled in the same direction as it was rolled during taking up the cables.

## 14.8 CABLE SUPPORTS AND CABLE TRAY ;MOUNTING ARRANGEMENTS

14.8.1 The contractor shall provide embedded steel inserts on concrete floors / walls to secure supports by welding to these inserts or available building steel structures, for the purpose of casting in the control room.

14.8.2 The supports shall be fabricated from standard structural steel members.

14.8.3 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.

## 14.9 CABLE TERMINATION AND CONNECTIONS

14.9.1 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 Purchaser.

14.9.2 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.

14.9.3 Supply of all consumable material shall be in the scope of contractor.

14.9.4 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.

14.9.5 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.

14.9.6 The contractor shall tag / ferrule control cable cores at all terminations, as instructed by the Purchaser. 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.

14.9.7 Spare cores shall be similarly tagged with cable numbers and coiled up.

14.9.8 All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.

14.9.9 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.

14.9.10 The cable glands shall be tested as per BS:6121. They shall comprise of heavy duty brass casting, machine finished and nicket 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.

14.9.11 The cable glands shall also be tested for dust proof and weather proof termination. The test procedure has to be discussed and agreed to between Purchaser and cable gland manufacturer.

14.9.12 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 purchaser.

14.9.13 Crimping tool used shall be of approved design and make.

14.9.14 Cable lugs shall be tinned copper solderless crimping type conforming to IS-8309 and 8394. Cable lugs shall be of approved make.

14.9.15 Solderless crimping of terminals shall be done by u sing corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.

## 15.0 DIRECTLY BURIED CABLES

15.1 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, if he feels, before submitting the bid.

15.2 The cable (power and control) between LT station, control room, DG set building 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, where cable trenches are not provided.

15.3 Cable route and joint makers and RCC warning covers shall be provided wherever required. The voltage grade of cables shall be engraved on the marker.

## 16.0 INSTALLATION OF CABLES

16.1 Cabling shall be on cable racks, in built-up trenches, vertical shafts, excavated trenches for direct burial, pulled through pipes and conduits laid in concrete ducts, run bare and clamped on wall / ceiling / steel structures etc. as shown in the drawings in detailed Engineering stage. Where specific cable layouts are not shown on drawings, contractor shall route these as directed by the Purchaser. Cables in cable vault provided below control room shall be laid in cable trays.

16.2 The contractor shall fabricate and install mounting arrangements for the support and installation of all the cables on angles at 750 mm spacing in the trenches. These mounting structures / cable racks shall be fabricated from structural steel members (channels, angles and flats) of the required size. The fabrication, welding and erection of

these structures shall conform to the relevant clauses of chapter - Structures, in addition to the specification given herein.

16.3 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 aluminum paint. The red oxide and zinc chromate shall conform to IS:2074. All welding works inclusive of the consumables required for fabrication and installation shall be in the scope of the Contractor.

16.4 All cables from cable trench to equipment control cubicles (both power and control) for all equipment, shall be through PVC pipes of 50/100/200 mm diameter alongwith required bend, end seals etc, as per IS:4985.

16.5 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor. In the case of equipment 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 connecting the cable trench and the equipment or in case the distance is small, notch / opening on the floor shall be provided. In all these cases necessary bending radius as recommended by the cable contractor shall be maintained.

16.6 Suitable arrangement should be used between fixed pipe / cable trays and equipment terminal boxes, where vibration is anticipated.

16.7 Power and control cables 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.

16.8 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.

16.9 Trefoil clamps for single core cables shall be of pressure die cast aluminum (LM-6), Nylon-6 or fibber glass and shall include necessary fixing GI puts, bolts, washer etc. These are required at every 2 metre of cable runs.

16.10 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 aluminum strip clamps at every 2 m.

16.11 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows :

Table of cable and minimum bending radius.
Power cable 12 D
Control cable 10 D
D is overall diameter of cable.

16.12 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.

16.13 In each cable run some extra length shall be kept at a suitable point to enable one (for LT cables) / two H.T. cables) straight through joints to be made in case the cable develop fault at a later date.

16.14 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 Purchaser. If straight through joints are unavoidable, the contractor shall use the straight through joints kit of reputed make.

16.15 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.

16.16 Metal screen and armour of the cable shall be bounded to the earthing system of the station, wherever required by the Purchaser.

16.17 Rollers shall be used at intervals of about two metres while pulling cables.

16.18 All due care shall be taken during unrelling, laying and termination of cable to avoid damage due to twist, kinks, sharp bends etc.

16.19 Cable ends shall be kept sealed to prevent damage.

16.20 Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS:1255 and other Indian Standard Codes of Practices.

16.21 Wherever cable pass through floor or through wall openings or other partitions, wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, instlaled and properly sealed by the Contractor at ano extra charges.

16.22 Contractor shall remove the RCC / steel trench covers before takiang 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.

16.23 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, alongwith the marked up copy of the cable schedule and interconnection drawing wherever any modifications are made.

16.24 Contractor shall paint the tray identification number on each run of trays at an interval of 10 m.

16.25 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 purchaser. 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 purchaser, i.e. the contractor shall not be paid for installation and removal of the damaged cable.

16.26 All cable terminations shall be appropriately tightened to ensure secure and relilable connections. The contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.

16.27 **TESTS ON CABLE TRAYS**

The contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all t es ts as per specification and equipment shall comply with all requirements of the specification.

a) Test for galvanising (Acceptance Test)
The test shall be done as per approved standards.

b) Deflection Test : (Type Test).

A 2.5 metre straight section of 300 mm, 600 mm wide cable tray shall be simply supported at two ends. A uniform distributed load of 76 kg/m shall be applied alongwith the length of the tray. The maximum deflection at the mid-span shall not exceed 7 mm.

16.28 **CONDUITS, PIPES AND DUCT INSTALLATION**

16.28.1 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 et c. 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.

16.28.2 contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts and threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be applied at all field threaded portions.

16.28.3 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.

16.28.4 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.

16.28.5 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.

16.28.6 Each conduit run shall be painted with its designation as indicated on the drawings such that it can be identified at each end.

16.28.7 Embedded conduits shall have a minimum concrete cover of 50 mm.

16.28.8 Conduit run sleeves shall be provided with the bushings at each end.

16.28.9 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.

16.28.10 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.

16.28.11 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.

16.28.12 For underground runs, contractor shall excavate and back fill as necessary.

16.28.13 Contractor shall supply, unload, store and install conduits required for the lighting installation as specified. Al 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.

16.28.14 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.

16.28.15 Exposed conduits shall be run in straight lines parallel to building column, beams and walls. Unncessary bends and crossings shall be avoided to present a neat appearance.

16.28.16 conduit supports shall be provided at an interval of 750 mm for horizontal runs and 1000 mm for vertical runs.

16.28.17 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 masonary or concrete for conduit support is not acceptable.

16.28.18 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.

16.28.19 Spacing of embedded conduits shall be such as to permit flow of concrete between them and in no case shall be less than 38 mm.

16.28.20 Where conduits are alongwith cable trays, they shall be clamped to supporting steel at an interval of 600mm.

16.28.21 For directly embedding in soil, the conduits shall be coated with an asphaltbase compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

16.28.22 Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.

16.28.23 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.

16.28.24 Slip joints shall be provided when conduits cross structual 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.

16.28.25 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

16.28.26 conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

16.28.27Conduits 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.

16.28.28 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.

16.28.29 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.

16.28.30 After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

16.28.31 Lighting fixtures shall not be suspended directly from the junction box in the main conduit run.

## 17.0 **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 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.

d) **CT and CVT Junction Box:**

Junction Boxes with IP:55 degree of protection, shall comprise of a case with hinged door constructed from cold rolled sheet steel of minimum thickness 2mm. Top of the boxes shall be arranged to slope towards rear of the box. Gland plate shall be 3mm thick sheet steel with neoprene/synthetic rubber gaskets. All junction boxes shall be of adequate strength and rigidity, hot dip galvanised as per relevant IS, and suitable for mounting on wall, columns, structures etc. The boxes shall include brackets, bolts, nuts, screws M8 earthing stud etc. required for installation

Terminal blocks shall be 1100/650 volts grade, rated for 10 Amps and in one piece moulding. It shall be complete with insulating barriers, Klip-on-type terminals and identification strips. Marking on terminal strip shall correspond to the terminal numbering on wiring diagrams. It shall be Elmex type CSLT-1 with insulating material of Melamine conforming to ESI Standard 12.1 or equivalent. Terminal block shall be suitable for terminating 2 wires of 2.5 sq mm. on both sides arranged to facilitate easy termination. The terminal blocks for CTs and VTs shall be provided with test links and isolating facilities. The CT terminal blocks shall be provided with short circuiting and earthing facilities. Number of terminals shall be 33 nos. in each terminal block. There shall be 3 nos. such Terminal Block.

## 18.0 MARSHALLING KIOSKS/BOXES

Marshalling Kiosks shall be suitably located for termination of connections for auxiliary and control supplies to the main equipment and connections to instrument transformers etc.

18.1 Marshalling Kiosk shall be furnished for each bay. It is intended to have all interlocking circuits of the bay through this cubicle. For this purpose, terminals shall be provided in this cubicle including 20% additional spare terminals.

18.2 Marshalling kiosk shall be provided with aprons which shall extend from the lower edge of the doors to the level of mounting feet.

18.3 Each Marshalling kiosk shall be self-supporting and provided with appropriate number of foundations bolts for fixing it.

18.4 Marshalling kiosk shall be sheet enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be at least 2.0mm thick cold rolled/2.5 mm hot rolled and properly braced to prevent wobbling.

18.5 The enclosures of the marshalling kiosk shall provide a degree of protection against rain/weather of not less than IP: 55 (as per IS: 2147) and tested for the same.

18.6 Marshalling kiosk shall be of freestanding floor mounting type or pedestal type as per requirement.

18.7 Marshalling kiosk shall be provided with double-hinged doors with padlocking arrangements (permanently fixed). The distance between two hinges shall not exceed 350mm to ensure uniform sealing pressure against atmosphere

18.8 All doors, removable cover and plates shall be gasketed all around with neoprene gaskets. Ventilating louvers, if provided, shall have screen and filters. The screen shall be fine

wire mesh made of brass or G.I. wires. The Neoprene gaskets shall be tested in presence of NIGAMôs representative.

18.9 The cable entries to the marshalling kiosk shall be from the bottom. Suitable cable gland plate, projecting at least 150 mm above the base of the marshalling kiosk shall be provided for this purpose. Necessary number of cable glands shall be supplied and fitted on this gland plate. The gland shall project at least 25 mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The 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 twin earthing tag. The glands shall conform to BS: 4121 and shall be cadmium plated.

18.10 All sheet steel work shall be degreased, pickled, phosphate as per IS: 6005. Oil, grease and dirt shall be thoroughly removed by emulsion cleaning. Rust and scales shall be removed by picking with dilute acid followed by washing with running water rinsing with slightly alkaline hot water and drying. After phosphating, thorough rinsing shall be carried out with clean water followed by final finishing with dilute dichromate solution and oven drying. Then two coats of zinc chromate primer and two coats of oil and weather resistant varnish of a colour different form weather resistant varnish of a colour different from primer shall be applied. Final coats of glossy, oil and weather resistant, non fading paint (light gray) in accordance with shade no 697 of IS: 5 outside and inside glossy white anti-condensation type shall be applied. Primer paint shall be as per IS: 194 and intermediate and final coat of paint shall be as per IS: 2932. Al paints shall be carefully selected to withstand heat and extremes of weather. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

18.11 Suitable space heaters shall be mounted in every compartment of the Kiosk so that the cubicle temperature is always maintained approximately 10º C above the outside air temperature to prevent condensation. Thermostat if necessary to maximum 10º C rise shall be provided. Of-off switched and fuses shall be provided with each space heater. Heat shall be suitable for 240 V AC supply voltage.

18.12 Marshaling Kiosk shall be supplied complete with interconnection wiring provided between all electrical devices mounted therein. All internal wiring shall be carried out with 1100 V grade single core 2.5 sq.mm. stranded copper conductor, PVC insulated wire. The internal wiring shall be securely supported neatly arranged and readily accessible in addition to the provision of MCBôs required. The wiring shall be colour coded. The illumination each compartment of the kiosk shall be provided with door switch controlled incandescent lamp. The marshalling kiosk shall also be provided with incoming MCB and one 15 Amp interlocked switched socket in addition to the MCB.

18.13 The terminals shall be numbered as desired by NIGAM and shall be so staggered that the connection of external cable to any terminal block should be possible without disturbing the rest of the connection. The terminal block arrangements shall by such as to provide maximum accessibility to all conductor terminations and any arrangement preventing ready access to other terminal screws for external circuit wire connections, a white marking strip for circuit identification and molded plastic cover. All terminals shall be clearly marked with identification numbers of letter to facilitate connection to external wiring. Terminals shall be of non-disconnecting stud type. The type and make of terminal block shall be approved by the NIGAM.

18.14 The terminal block shall be of extensible design and shall have locking arrangement to prevent its escape from the mounting rails. The terminals shall be rated to carry continuously and maximum current expected to be carried by them and shall be provided with marking tags for wire identification.

18.15 Doors of marshalling kiosks should be earthed properly, connected to marshalling kiosk body with flexible copper braids.

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

18.17 Bay marshalling kiosk shall have three separate distinct compartments for the following purposes:

i) To receive two incoming 415V, 3 phases, 63 Amps AC supplies with Auto changeover and MCB units and distribute five outgoing supplies 15 Amps, each controlled by MCB with fuse failure remote indication.

ii) To distribute ten out going 240 V 10 Amps single phase supplies to be controlled by switch fuse/MCB to be drawn from above 3-phase incomers.

18.18 The marshalling kiosk shall also provide for DC control supply distribution. The details will be finalized during detailed Engineering.

**18.19 Tests:**

a) The Marshalling kiosks shall be subject to routine tests as per IS: 5039. Protection degree test IP: 55 shall be conducted on one of the marshalling kiosks as per IS: 2147 in the presence of NIGAM. After protection degree test on marshalling kiosk, 2.0 KV rms for 1 minute, insulation resistance and functional test shall be conducted. The Bidder shall offer type tested (IP: 55) Marshalling kiosks. In case this has not been subjected to IP: 55 tests, the same shall be carried out by the Contractor at his cost.

b) The following routine tests shall be conducted.

i) Check for wiring

ii) Visual and dimension check.

**18.20 Equipment Requirements.**

Outdoor type marshalling kiosks are intended for auxiliary power and dc control supply distribution and interlocking facilities.

**18.21 Bid drawings.**

The following drawings shall be submitted by each Bidder with his bid.

a) General outline drawings showing all dimensions, net weight, and foundation plan, etc.

b) Interior views showing all the elements in position within the marshalling kiosks.

c) Circuit diagrams.

d) Any other detailed description or drawing which the Bidder considers necessary.

## 19.0 TESTING AND COMMISSIONING

19.1 An indicative list of tests 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 purchaser without any extra cost of 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.

### 19.2 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 lpaint over weld joint of galvanised surfaces.
(g) Check cleanliness of insulator land 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 1.5 times the rated pressure shall be conducted.

19.3 **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 glavanised surfaces.
(e) Dip test on earth conductor prior to use.

19.4 **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.

19.5 **ALUMINUM 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.
(d) Test check on 5% sample joints after cutting the well piece to observe any voids etc.

19.6 **INSULATORS**

Visual examination for finish, damage, creepage distance etc..

## 19.7 CIRCUIT BREAKERS

a. Insulation resistance of each pole.
b. Check adjustments, if any, suggested by manufacturer.
c. Breaker closing and tripping time.
d. Slow and power closing operation and opening
e. Trip free and anti pumping operation.
f. Minimum pick up volts of coils
g. Contact resistance
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.

19.8 **ISOLATORS**

a. Insulation resistance of each pole
b. Manual and electrical operation on interlocks
c. Insulation resistance of control circuits and motors.
d. Ground connections

e. Contact resistance
f. Proper alignment to minimise the vibration to the extreme possible during operation.
g. Measurement of operating torque for isolator and Earth switch
h. Resistance of operating and interlocking coils.

## 19.9 CURRENT TRANSFORMER

a. Insulation Resistance test
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. Magnetising characteristics test.

## 19.10 VOLTAGE TRANSFORMERS

a. Insulation Resistance test
b. Polarity test
c. Ratio test
Dielectric test of oil (if applicable)

## 19.11 SURGE ARRESTOR

a. Grading leakage current
b. Resistance of ground connection.

## 19.12 CONTROL AND PROTECTION

All checks for all the systems under scope shall be carried out.

## 19.13 INSULATION RESISTANCE TEST

The insulation resistance test shall also be carried out on the following equipment

(a). 400 kV Bus installation by 5000 Volt motor operated meggar.
(b). 415 Volt power circuits by 1000 Volt meggar.
(c). 220 Volt D.C. Control circuits by 500 Volt meggar.

## 19.14 CABLES

a) Check for physical damage
b) Check for insulation resistance before and after termination / jointing.
c) Check of continuity of all cores of the cables.
d) Check for correctness of all connections as per relevant wiring diagrams. Any minor modification to the panel wiring like removing/inserting, shorting, change in terminal connections, etc., shall be carried out by the Contractor.
e) Check for correct polarity and phasing of cable connections.
f) Check for proper earth connections for cable glands, cable boxes, cable armour, screens, etc.

g) Check for provision of correct cable tags, core ferrules, and tightness of connections

## 19.15 CABLE TRAY SUPPORT AND ACCESSORIES

a) Check for proper galvanizing/painting and identification number of the cable trays/supports and accessories.
b) Check for continuity of cable trays over the entire route.
c) Check that all sharp corners, burrs, and waste materials have been removed from the trays supports.
d) Check for earth continuity and earth connection of cable trays.

## 19.16 RECOMMENDED PRE-COMMISSIONING CHECKS/ TESTS ON 400/220 KV AUTO- TRANSFORMER:

a) Check the colour of Silicagel breather.
b) Check the oil level in the breather housing, conservator tanks, cooling system, condenser bushing etc.
c) Check the bushing for conformity of connection to the lines etc. and Tan delta test for bushings at 10 kV (min.).
d) Check for correct operation of all protection and alarm.
   i) Buchholz relay
   ii) Excessive winding temperature.
   iii) Excessive oil temperature.
   i) Low oil flow.
   ii) Low oil level indication.
   iii) Fan and pump failure protection.
e) Check for the adequate protection on the electric circuit supplying the accessories.
f) Check resistance of all windings on all the taps.
g) Insulating resistance measurement of :-
   i) Control wiring.
   ii) Tap changer motor and control.
   iii) Cooling system motor and control
   iv) Main windings
h) Check for cleanliness of the transformer and the surroundings.
i) Continuously observe the transformer operation at no load for 24 hours.
j) Gradually put the transformer on load, check and measure increase in temperature in relation to the load and check the operation with respect to temperature rise, noise level etc.
k) Phase sequence and vector group test.
l) Ratio tests on all taps.
m) Magnetising current test.
n) Tan delta measurement of winding.

## 19.17 RECOMMENDED CHECKS FOR 400 KV SHUNT REACTORS:

19.17.1 Receipt and Storage Checks

- Check and record condition of each package, visible part of the reactors etc. for any damage.
- Check and record the gas pressure in the reactor tank as well as in the cylinder.

- Visual check for wedging of core and coils before filling up with oil and also check for condition of core and winding in general.
- Check and record reading of impact recorders at receipt and verify the allowable limits as per manufacturer's recommendation.

19.17.2 Installation Checks

- Check the whole assembly for tightness, general appearance etc.
- Oil leakage test
- Leakage test on bushing before erection.
- Measurement of capacitance and tan delta of the bushings before fixing/connecting to the reactor. Contractor shall furnish these values for site reference.
- Measure and record the dew point of nitrogen in the main tank before assembly.

19.17.3 Commissioning Checks

- Check the colour of silicagel breather.
- Check the oil level in the breather housing, conservator tank, cooling system, condenser bushing etc.
- Check the bushings for conformity of connection to the line etc.
- Check for correct operation of all protection devices and alarms.
    (a) Buchholz relay
    (b) Excessive winding temperature
    (c) Excessive oil temperature
    (d) Low oil flow
    (e) Low oil level indication
- Check for adequate protection of electric circuit supplying the accessories.
- Insulation resistance measurement for:
    (a) Control wiring
    (b) Main winding
    (c) Bushing current transformer
- 2kV/minute test between bushing CT terminal and earth.
- Check for cleanliness of the reactor and the surrounding.
- Measure vibration and noise level
- DGA of oil sample just before commissioning and after 24 hours of commissioning.
- Capacitance and tan delta measurement of winding & bushing.
- Contractor shall prepare a comprehensive commissioning report including all commissioning test results and forward to owner for future record.

## 20.0 36kV (52kV CLASS) VOLTAGE TRANSFORMER FOR PROTECTION OF LV OF AUTO TRANSFORMER

20.1

The 36 kV (52 kV class), single phase, self supporting, pedestal mounted, oil immersed, self cooled, outdoor type voltage transformer (conforming to IS: 3156 amended upto date) shall be of Electro Magnetic type and shall be connected to 33 kV Bus on tertiary windings of 315/315/105MVA, 400/220/33 kV transformer for measuring and relaying purpose. The voltage transformer shall be so designed that it will continuously withstand 1.2 times the rated voltage continuously and 1.9 time the rated voltage for 8 hours with 400 kV and 220 kV side of

400/220/33 kV transformerôs breaker open. Primary winding of voltage transformer shall be capable of discharging upto 105 MVAR capacitor banks or shunt reactors installed on 33 kV tertiary bus. The VTs offered shall be suitable for loaded as well as unloaded tertiary conditions. Under unloaded conditions, the primary winding of voltage transformer shall withstand and discharge to the ground, the switching surge voltage and transferred surge voltage on tertiary winding respectively due to switching and lightening impulse voltage on HV or IV terminals of 315 MVA transformer.

20.2The voltage transformers will be so designed that no neutral inversion or Ferro resonance taken place during its operation due to interaction of inductance and capacitanceôs of its primary winding with those of unloaded tertiary winding of the transformer etc. Measures adopted to ensure neutral stability will be indicated by the Bidder.

20.3 PRIMARY WINDING OF VOLTAGE TRANSFORMER

The primary winding shall consist of suitable number of turns of paper insulated copper wire. The resistance of HV winding shall be as small as consistent with good design and permissible limits of errors. The insulation shall be special paper having high mechanical, electrical and dielectric strength and good ageing quality. The paper shall be carefully impregnated in oil under vacuum. The turns of HV windings shall be transposed as to give uniform distribution of capacitance throughout the winding so as to keep the winding safe against power frequency and transferred impulse voltage surges of tertiary winding during normal operation. The HV coil shall be so arranged as to avoid the formation of oil gaps in voltage transformer.

20.4 LV WINDINGS OF VOLTAGE TRANSFORMER

The LV winding (two numbers) shall consist of suitable number of turns of paper insulated copper wire. The LV windings shall be placed close to the HV windings so as to minimize magnetic leakage between the windings thereby to keep the voltage ratio and phase angle errors within the specified limits. The wave shape of voltage across secondary terminals, in case of winding meant for protection shall be accurate reproduction of primary voltage, even when short circuit occurs in the immediate vicinity of voltage transformer.

20.5 CORES OF VOLTAGE TRANSFORMER

All cores shall be formed out of high grade, non-ageing, high permissibility, low hysteriesis loss silicon steel laminations. The reluctance of cores and flux density in cores shall be consistent with the requirement of specified voltage factor and specified ratio and phase angle errors.

20.6 BUSHINGS OF VOLTAGE TRANSFORMER

The condenser bushings shall be used with voltage transformers and shall be made of porcelain of best quality. The bushing shall have sufficient mechanical and electrical strength as per IS: 2099 (amended upto date). Bushing shall have separate oil and shall be hermetically sealed.

20.7 HERMETIC SEALS

Each voltage transformer shall be supplied, duly filled with insulating oil and shall be hermetically sealed so as to avoid oil filtration and changing of oil at site. However, facility shall be provided on the VT for changing the oil in the field. In case bidder intent to use nitrogen or any other gas above the oil level, same may be stated in the tender.

## 20.8 ACCESSORIES OF VOLTAGE TRANSFORMER

Following accessories shall be provided in each VT:-

i) An oil level gauge to show the oil level in voltage transformer.

ii) An oil drain cock alongwith a stop cock on the bottom flange for taking out the samples of oil for test.

iii) Pressure relieving device to prevent the bursting of the equipment even under most unfavorable conditions.

iv) Terminal connectors suitable for receiving 73.03 mm to 74.23 OD Al. Tube horizontally.

## 20.9 TEMPERATURE RISE OF VOLTAGE TRANSFORMER

20.9.1 Maximum temperature attained by any of the equipment, when in service, at rated thermal burden under site conditions shall not exceed the limits specified at table 2 of IS: 3156 (Part-I) corrected for ambient temperatures as per Note- 1 of said table. The temperature rise at 1.2 times of the rated primary voltage when applied for 8 hours at rated frequency and rated thermal burden, starting from the previous stable operating conditions at rated frequency and rated thermal burden, shall not exceed the above temperature limit by more than 10°C.

20.9.2 The rated thermal burden shall not be less than the value indicated by the following formula or rated burden whichever is higher :-

$$\text{Rated Thermal Burden} = \frac{110 \times 110}{R}$$

Where R = 100 x L / (NxN)

L = Air core reactance of primary winding (Measured, calculated or extrapolated from model), in milli henries.

N = Voltage transformer turns ratio.

20.9.3 The voltage transformers offered shall conform to various technical particulars as given below:

The 36kV (52 kV class) voltage transformers shall conform to the following parameter :-

| | | |
|---|---|---|
| 1. | Nominal system voltage | 33 kV phase to phase |
| 2. | Highest system voltage | 36 kV phase to phase |
| 3. | Rated frequency | 50 Hz. |
| 4. | Neutral earthing | Solidly earthed. |
| 5. | Number of secondary windings | Two |
| 6. | Insulation levels for primary and neutral : | |
| a) | 1.2/50 microsecond lightning impulse withstand voltage (kVP) | 250 kV (Peak) |

| | | | |
|---|---|---|---|
| b) | Dry and wet one minute power frequency withstand test voltage (kV rms) | 95 kV (rms) | |
| 7. | One minute power frequency withstand test voltage for secondary and its terminal (kV rms) | 2 kV (rms) | |
| 8. | Rated voltage factor with time | 1.2 Continuous and 1.9 for 8 hours. | |
| 9. | Short circuit current rating for secondary winding | Not less than 20 times the rated secondary current. | |
| 10. | Rated primary voltage | $\frac{33\ kV}{\sqrt{3}}$ | |
| 11. | Rated secondary voltage | Winding-I | Winding-II |
| | | $\frac{110\ V}{\sqrt{3}}$ | $\frac{110\ V}{\sqrt{3}}$ |
| 12. | Open delta voltage (under operation with transformer) | Not exceeding 4.3 volts | |
| 13. | Rated output per phase | 50 VA | 50 VA |
| 14. | Rated thermal rating of VT | To be specified but not less than the value worked out vide Clause 21.9.2. | |
| 15. | Accuracy class | Winding-I shall conform to accuracy class 0.5 of IS:3156 Part-II | Winding-II 6 P as per IS:3156 Part-III |
| 16. | Whether one terminal of the secondary winding to be earthed | Yes | One vertex of winding connected in delta will be earthed. |
| 17. | Utilization of winding | Metering and protection | Open delta protection. |

20.9.4 TERMINAL BOX FOR VOLTAGE TRANSFORMER

All secondary terminals shall be brought out in a compartment on one side or each voltage transformer. The exterior of this terminal box shall be hot dip galvanised. A cable box alongwith necessary glands for receiving control cables, for mounting on the bottom of terminal box shall be included in the contractorôs scope of supply. Suitable fuses or any other protective devices shall be provided in the terminal box for protection of secondary windings of the VTs.

20.9.5 TERMINAL CONNECTIONS OF VOLTAGE TRANSFORMER

Each voltage transformer shall be provided with an appropriate number of solderless clamp type terminal connectors suitable to be connected to 73.03 mm to 74.23 mm outer dia aluminum alloy tube.

20.9.6 METAL PARTS FOR VOLTAGE TRANSFORMER

All ferrous parts of voltage transformers shall be hot dip galvanised. All current carrying parts shall be of non-ferrous metals or alloys and shall be designed to eliminate sharp points, edges and sharp faces.

20.9.7 INSULATING OIL FOR VOLTAGE TRANSFORMER

Each voltage transformer shall be supplied duly filled with oil. The EHV grade oil shall conform to the requirements of IS: 335 (latest amendment).

## 21.0 PROGRESS REPORTS:-

Weekly progress reports showing the actual progress made in the receipt of the materials by the contractor and in completion of various works shall be regularly submitted in duplicate by the contractor to the NIGAM. The performance monitoring shall be carried out with the help of computer aided system on MS project and Excel etc.

ANNEXURE ñ1ò

**(TESING PROCEDURE FOR ACSR 'MOOSSE' CONDUCTOR)**

1.0 UTS TEST ON STRANDED CONDUCTOR

Circles perpendicular to the axis of the conductor shall be market at two places on a sample of conductor of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate upto 80 kN and held for one minute. The circles drawn shall not be distorted due to Relative movement of strands. The applied load shall then be increased until the failing load is reached and the value recorded.

2.0 CORONA EXTINCTION VOLTAGE TEST

Two samples of conductor of 5 m length shall be strung with a spacing of 450 mm between them at a height not exceeding 8.0 m above ground. This assembly shall be tested as per Annexure - A, Section-2. Corona extinction voltage shall not be less than 320 KV (RMS) Line to ground.

3.0 RADIO INTERFERENCE VOLTAGE TEST

The sample assembly similar to that specified under (2.0) above shall be tested as per Annexure - A of Section - 2. Maximum RIV level (across 300 ohm resistor at 1 MHz) at 305 KV (RMS) line to ground voltage shall be 1000 micro volts.

4.0 D.C.RESISTANCE TEST ON STRANDED CONDUCTOR

On a conductor sample of minimum 5 m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kalvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average vlaue recorded. The value obtained shall be corrected to the value at 20°C shall conform to the requirements of this specification.

5.0 CHEMICAL ANALYSIS OF ZINC

Samples taken from the zinc ingots shall be chemically / spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

6.0 CHEMICAL ANALYSIS OF ALUMINUM AND STEEL

Samples taken form the aluminium ingots / coils / strands shall be chemically / spectrographicallfy analysed. The same shall be in conformity to the requirements stated in this specification.

7.0 VISUAL CHECK FOR JOINTS, SCRATCHES ETC.

Conductor drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and that the conductor generally conform to the

requirements of this specification. The length of conductor wound on the drum shall be measured with the help of counter meter during rewinding.

8.0 DIMENSIONAL CHECK OF RSTEEL AND ALUMINUM STRANDS

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

9.0 CHECK FOR LAY-RATIOS OF VARIOUS LAYERS

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this specification ;and Clause No.9.4 and 9.5 of IS-398 (Part -V) 1982.

10.0 GALVANISING TEST

The test procedure shall be as specified in IS:4826-1968. The material shall conform to the requirements of this specification.

11.0 TORSION AND ELONGATION TESTS ON STEEL STRANDS

The test procedures shall be as per relevant clause of IS:398 (Part V), 1982. In torsion test, the number of complete, twists before fracture shall not be less than 18 on a length equal to 100 times the standard diameter of the strand before stranding & 16 after stranding. In case test sample length of less or ;more than 100 times the standard diameter of the strand the minimum number of twist will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elogation test, the elongation of ;the strand shall not be less than 4% for a gauge length of 200 mm.

12.0 BREAKING LOAD TEST ON WLEDED ALUMINUM STRAND

Two aluminum wires, shall be welded as per the approved quality plan and shall be subjected to tensile load. The welded point of the wire shall be able to withstand the minimum breaking load of the individual strand guaranteed by the bidder.

**ANNEXURE "2"**

## (TESTING PROCEDURE FOR GALVANISED STEEL EARTHWIRE)

1. UTS TEST

Circles perpendicular to the axis of the earthwire shall be market at two places on a sample of earthwire of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate upto 34 KN and held for one minute. The circles drawn shall not be distorted due to Relative movement of strands. Thereafter, the load shall be increased at a steady rate of 68.4 KN and held for one minute. The earthwire sample shall not fail during this period. The applied load shall be increased until the failing load is reached and value recorded.

2. RESISTANCE TEST

On an earthwire sample of minimum 5 m length, two contact clamps shall be fixed with a predetermined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart, the test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C shall conform to the requirements of this specification.

3. VISUAL CHECK FOR JOINTS, SCRATCHES ETC. AND LENGTH OF EARTHWIRE

Earthwire drums shall be rewound in the presence of the inspector. The inspector shall visually check for scratches, joints, etc. and see that the earthwire generally conforms to the requirements of this specification. The length of earthwire wound on the drum shall be measured with the help of counter meter during rewinding.

4. TORSION AND ELONGATION TESTS

The test procedures shall be as per relevant clause of IS:398 (Part V). The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twist will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 64% gor a gauge length of 200 mm.

5. DIMENSIONAL CHECK

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

6. LAY LENGTH CHECK

The lay length shall be checked to ensure that they conform to the requirements of this specification.

7. GALVANISING TEST

The test procedure shall be as specified in IS:4826-1968. The material shall conform to the requirements of this specification.

8. CHEMICAL ANALYSIS OF ZINC USED FOR GALVANISING

Samples taken from zinc ingots shall be chemically / spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

9. CHEMICAL ANALYSIS OF STEEL

Samples taken from steel ingots / coils / strands shall be chemically / spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

**ANNEXURE "3"**

## CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. GENERAL

unless otherwise stipulated, all 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 spec. ï committee on Radio Interference (CISPR) Publication 16-1 (1993) Part measuring circuit shall preferably be runed 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%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400 KV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvotls.

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 noisel 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 and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. 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%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. At least two news 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 nterfere connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position wit 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 at least 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 Employerôs inspector, after determining the best camera locations by trial energisation of test object at al 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 Employerôs 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 :

Background noise before and after test.
Detailed procedure of application of test voltage.

Measurements of RIV levels expressed in micro volts at each level.
Results and observations with regard to location and type of interference sources detected at each step.
Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
Onset and extinction of visual corona for each of the four tests required shall be recorded.

**Annexure-4**

## Guaranteed Technical Particulars for the Galvanised Steel Ground Wire

| | |
|---|---|
| Makerĉs Name, Address & Country | |
| Percentage of carbon content of the steel wire | |
| Particulars of each steel strands | |
| a) No. of strands | |
| b) Diameter mm | |
| c) Standard sectional area $mm^2$ | |
| d) Minimum ultimate tensile strength $Kg/mm^2$ | |
| e) Minimum breaking load | |
| a) Uniformity of coating number and duration of dips | |
| 1.Minuts | |
| 2No of dips | |
| Standard overall dia of conductor | |
| Area of section of ground wire, mm | |
| Guaranteed ultimate tensile strength of ground wire $Kg/mm^2$ | |
| Minimum breaking load of stranded wire Kg. | |
| Maximum breaking tension. | |
| Resistance in ohms per KM at $20^oC$ | |
| Standard length of ground wire KM | |
| Tolerance if any on standard length. | |
| Final modulus of elasticity of ground wire $Kg/Cm^2$ | |
| Weight of ground wire Kg/KM | |
| Tensile strength of joints expressed as a % of the strength of ground wire | |
| Standard length of ground wire in each drum KM | |
| Standard weight of ground wire on the drum, Kg. | |
| Weight of drum in Kgg. | |
| Gross weight of the drum | |
| Dimension of the drum | |
| Other particulars if any. | |

**Annexure-5**

## Guaranteed Technical Particulars of the Ground Wire Accessories

| | | |
|---|---|---|
| I | **Dead End Assemblies** | |
| 1. | Makers Name & Address | |
| 2. | Type | |
| 3. | Suitable for | |
| 4. | Material | |
| | a) Body | |
| | b) Bolts and nuts | |
| 5. | Weight of dead end assembly | |
| 6. | Minimum failing load, Kg. | |
| 7. | Minimum Slip strength | |
| 8. | Galvanisation | |
| | a) Method of galvanisation | |
| | i. Spring washers | |
| | ii. Other ferrous part | |
| | b)No. of dips | |
| , | 1 minute | |
| | ½ minute | |
| | i. Other nterfe parts | |
| | c) Minimum weight of zinc coating g/$m^2$ | |
| | d) Quality of Zinc | |
| 9. | Electrical resistance after compression | |
| | expressed as % of corresponding resistance | |
| | of equipment length of GSS ground wire. | |
| 10. | Dimension | |
| | Before Compression | |
| | After Compression | |
| | a) Internal dia, mm | |
| | b) External dia,mm | |
| | c) Length mm (Face to face) | |
| | ( centre to centre) | |
| 11. | Governing standards | |
| 12. | Packing details | |
| 13. | List of test certificate enclosed | |
| 14. | Whether drawing attached Yes/No | |
| | No. & date of licence issued by ISI | |
| | for the use of ISI certification made. | |
| II. | **Earthing Clips** | |
| 1. | Makers name and address | |
| 2. | Type | |
| 3. | Suitable for | |
| 4. | Weight of earthing clip | |
| 6. | Slip strength of earthing clip | |
| 7. | Galvanisation | |
| 8. | a) Method of galvanisation | |

| | | |
|---|---|---|
| | i. Spring washer | |
| | ii. Other ferrous part | |
| | b) No. of dips | |
| | 1 minute dip | |
| | ½ minutedip | |
| | i. Other ferrous parts | |
| | c)Minimum weight of zinc coating g/$m^2$ | |
| | d) Quality of zinc 8. Governing standard | |
| 9. | Packing details | |
| 10. | List of test certificate enclosed | |
| 11. | Whether drawing attached Yes/No | |
| 12. | No. & date of licence issued by ISI | |
| | for the use of ISI certification made. | |
| 13. | Other particulars if any. | |
| III. | **P.G. Clamps** | |
| 1. | Makers name and address | |
| 2. | Type | |
| 3. | Suitable for | |
| 4. | Material of each component | |
| 5. | Weight of P.G. Clamps | |
| 6. | Slip strength | |
| 7. | Resistance | |
| 8. | Galvanisation | |
| . | a) Method of galvanisation | |
| | i. Spring washer | |
| | ii. Other ferrous part | |
| | b) No. of dips | |
| | 1 minute dip | |
| | ½ minutedip | |
| | i. Other ferrous parts | |
| | c)Minimum weight of zinc coating | |
| | d) Quality of zinc | |
| 9. | Governing standard | |
| 10. | Range of earthwire size for which clamps is suitable | |
| 11. | Packing details | |
| 12. | List of test certificate | |
| 13. | Whether drawing attached Yes/No | |
| 14. | No. & date of licence issued by ISI | |
| | for the use of ISI certification made. | |
| 15. | Other particulars if any. | |

**Annexure-6**

**Guaranteed And Other Technical Particulars of 114.2 mm outer Dia and 73.03mm outer Dia Aluminium Tube**

| | | |
|---|---|---|
| 1. | Type, Designation of Alloy as per IS:5082 | |
| 2. | Chemical composition of alloy: | |
| | i) Cu 0.05% maximum. | |
| | ii) Mg 0.4 to 0.9% | |
| | iii)Si 0.3 to 0.7% | |
| | iv) Fe 0.5% maximum | |
| | v) Mn 0.03% maximum | |
| | vi) Al. Remainer | |
| 3. | Nominal outside diameter, mm | |
| 4. | Nominal Thickness, mm | |
| 5. | Nominal internal diameter, mm | |
| 6. | a) Tolerance on outside diameter, mm | |
| | b) Tolerance on inside diameter , mm | |
| | c) Tolerance on thickness, mm | |
| 7. | Guaranteed resistivity of tube material, ohm metre. | |
| 8. | Guaranteed Tensile strength, $Kg/mm^2$ | |
| 9. | 0.2% proof stress, $Kg/mm^2$ | |
| 10. | Elongation percent on 5.65 _/So | |
| 11. | Density in $gms/cm^3$ | |
| 12. | Weight per metre of tube in Kg. | |
| | i) Nominal weight | |
| | ii) Maximum weight considering tolerance, if any. | |
| 13. | Co-efficient of linear expansion per degree centigrade | |
| 14. | Standards to which aluminium alloy tube confirms | |
| 15. | standard length of each tube. | |
| 16 | Testing facility available for;- | |
| | a) Electrical resistivity measurement. | |
| | b) Chemical composition determination. | |
| | c) Mechanical properties measurement. | |
| | d) ultra Sonic Tests. | |
| 17. | Recommended Electrode for welding of tubes. | |

**Annexure-7**

## Guaranteed And Other Technical Particulars Of Conductor

| | | |
|---|---|---|
| 1. | Makerĉs Name, address and country | |
| a) | Aluminium rods. | |
| b) | Steel wire/rods. | |
| c) | Complete conductor. | |
| d) | Zinc. | |
| . | Chemical Composition | |
| a) | Aluminium Wire | |
| b) | Steel Wire | |
| c) | Zinc | |
| 3. | Steel Wire (Strand) | |
| | a) Diameter,mm | |
| | Nominal dia | |
| | Max. dia | |
| | Min. dia | |
| b) | Nominal area of cross section, $mm^2$ | |
| c) | Weight of nominal dia wire per Km, Kg. | |
| d) | Minimum ultimate tensile stress($KN/mm^2$). | |
| | i) Before Stranding | |
| | ii)After Stranding | |
| e) | Minimum breaking load, KN. | |
| | i)Before Stranding | |
| | ii)After Stranding | |
| f) | Minimum elongation in 250mm long steel wire. | |
| g) | Coefficient of linear expansion per degree celsius | |
| h) | Modulus of elasticity, $Kg/mm^2$ | |
| | i) Initial | |
| | ii)Final | |
| i) | Normal length without joint | |
| j) | Joint in strands | |
| k) | Density of galvanized steel wire, $gm/cm^3$ | |
| l) | Galvanisation | |
| | i) Method of galvanisation | |
| | ii)Number of dips. | |
| | 1 minute | |
| | ½ minute | |
| | iii)Minimum weight of zinc coating, $gm/cm^2$ | |
| | iv) Purity of zinc | |
| | v) Adherence of zinc coating. | |
| m) | Maximum resistivity at $20^o$ C, | |
| 4. | Aluminium Wire Strands | |
| | a) Diameter,mm | |
| | Nominal dia | |
| | Max. dia | |
| | Min. dia | |

| | | |
|---|---|---|
| b) | Nominal area of cross section, $mm^2$ | |
| c) | Weight of nominal dia wire per Km, Kg. | |
| d) | Minimum ultimate tensile stress($KN/mm^2$). | |
| | i) Before Stranding | |
| | ii)After Stranding | |
| e) | Minimum breaking load, KN. | |
| | i)Before Stranding | |
| | ii)After Stranding | |
| f) | D.C. resistance in ohm per Km at$20^o$ | |
| g) | Minimum elongation in 250mm long steel wire. | |
| h) | Coefficient of linear | |
| | expansion per degree celsius | |
| i) | Modulus of elasticity, $Kg/mm^2$ | |
| | i) Initial | |
| | ii)Final | |
| j) | Normal length without joint | |
| k) | Joint in strands | |
| l) | Method of making joint. | |
| m) | Ultimate tensile strength of joint | |
| n) | Density of aluminium wire $gm/Cm^3$ | |
| o) | Maximum resistivity of aluminium at $20^oC$, micro | |
| | ohmsxcm | |
| 5. | Aluminium Conductor, Galvanised steel reinforced | |
| a) | Copper nterferen area, $mm^2$ | |
| b) | Calculated equivalent aluminium area, $mm^2$ | |
| c) | Stranding & wire size | |
| d) | Actual aluminium area, $mm^2$ | |
| e) | Overall diameter, mm | |
| f) | Cross sectional area, $mm^2$ | |
| g) | Guaranteed ultimate tensile strength | |
| | of conductor in Kg. | |
| h) | Weight in Kg per Km., Kg. | |
| i) | D.C. resistance at $20^oC$, ohms/Km. | |
| j) | Modulus of elasticity, $Kg/mm^2$ | |
| | i) Initial | |
| | ii)Final | |
| k) | Coefficient of linear expansion | |
| | per degree nterfe. | |
| l) | i) Lay ratio Steel/wire layer maximum minimum | |
| | Aluminium | |
| | 14 wire layer | |
| | 20 wire layer | |
| | ii) Direction of lay. Of outermost layer. | |

| | | |
|---|---|---|
| m) | i)Standard length, Km. | |
| | ii) Random length, Km.% of standard length | |
| | iii)Random length, % of lengths on order | |
| | iv) Tolerance, if any, on standard length. | |
| n) | Corona voltage | |
| | i) Inception | |
| | ii)Extinction | |

**Annexure-8**

## Guaranteed Technical Particulars Of Insulators Hardware Fittings

| | | |
|---|---|---|
| 1. | Makerĉs Name & address | |
| 2. | Size and designation of ball and socket | |
| | with standard to which it will conform | |
| 3. | Type of suspension clamp. | |
| 4. | Material of suspension clamp. | |
| 5. | Material of Tension clamp | |
| 6. | Material of Anchor Shackles | |
| 7. | Material of combined corona and | |
| | grading rings. | |
| 8. | Material of security clips and pins used. | |
| 9. | Material of all other hardware fittings. | |
| 10. | Weight of suspension clamp, Kg. | |
| 11. | Weight of tension clamp, Kg. | |
| 12. | Total weight of hardware fittings, Kg. | |
| 13. | Breaking strength of | |
| | a) Suspension clamp, kg. | |
| | b) Tension clamp, Kg. | |
| 14. | Slipping strength of | |
| | a) Suspension clamp, Kg. | |
| | b) Tension clamp, Kg. | |
| 15. | Dimensions of | |
| | a) Suspension clamp | |
| | b) Tension clamp. | |
| 16. | Corona & P.I. performance of hardware fittings. | |
| 17. | Standard specification to which hardware | |
| | fitting and galvanizing will conform. | |
| 18. | a) Whether a graph showing the | |
| | power loss in watts against Yes/No | |
| | current in amps for the suspension | |
| | clamp is enclosed | |
| | b)Guaranteed maximum magnetic power loss | |
| | for suspension clamps in watts. | |
| 19. | Guaranteed conductivity of dead end clamp | |
| | a) Results of heating cycle test carried out if any | |
| | b) Value of electrical resistance. | |
| 20. | Distance between arching horn tips mm | |
| 21. | Size of corona control ring arching horn | |
| 22. | Whether arching horn flat/rod type | |
| 23. | Whether adjustable type arching horn offered Yes/No. | |
| 24. | Manufacturing process of dead end clamps | |
| 25. | Angle of inclination of jumper terminal in case of | |
| | dead end clamps. | |
| 26. | Make of Bolt & Nut used. | |

**Annexure-9**

**Guaranteed and other technical particulars of T-clamps, P.G. Clamps and post insulator clamps**

| | | |
|---|---|---|
| 1. | Name of manufacturer | |
| i. | Office | |
| ii. | Works | |
| 2. | Standard to which the material shall | |
| | conform | |
| 3. | Material used in manufacture | |
| | and reference of ISS to which | |
| | the material shall conform. | |
| 4. | Method of casting. | |
| 5. | Rated normal current of the | |
| | connector/clamps. | |
| 6. | Rated short time current of | |
| | the connector and spacer clamp(KA) | |
| 7. | Temp rise limit when carrying | |
| | normal current. | |
| 8. | Weight of one connector/ clamp | |
| | P.G. clamps | |
| | T | |
| | P.I. | |
| | a) Aluminium | |
| | b) Steel | |
| | c) Total | |
| 9. | i) Min. thickness of | |
| | metallic part | |
| 10. | P.G. Clamp | |
| | T-Clamp | |
| | a) Morculla | |
| | b) Tarantulla | |
| | ii) Min. length of P.G. Clamp | |
| | and of keeper of T-clamp for | |
| | a) Moose | |
| | b) Zebra | |
| | iii) No.of bolts alongwith lock nuts plain washer | |
| | and spring washer | |
| | P.G. clamp | |
| | T- Clamp | |
| | iv) Size of bolts. | |
| 11. | Dimension of P.I. Clamps for | |
| | Zebra conductor | |
| | i) Keeper length minimum | |
| | ii)Minimum thickness of metallic r part | |
| | iii)Base dia | |
| | iv) No.of bolts & size of | |
| | bolts alongwith lock nuts plain | |

| | | |
|---|---|---|
| | washers and spring washers. | |
| 11. | Particulars of galvanisation | |
| 12. | Marking | |
| 13. | Packing details | |
| 14. | Drawing to which the clamps | |
| | shall conform | |
| 15. | Any other information which | |
| | the manufacturer may wish | |
| | to furnish. | |

**Annexure-10**

## Guaranteed and other technical particulars of Spacers for 400 kV & 220kV

| | | |
|---|---|---|
| a) | ACSR Moose | |
| 1. | Name and address of | |
| | manufacturer | |
| | a) Office | |
| | b) Works. | |
| 2. | ISS to which material | |
| | shall conform | |
| 3. | Sub spacing (mm) | |
| 4. | Material used in spacers | |
| 5. | Galvanisation shall conform to | |
| 6. | Whether spacer assembly is | |
| | flexibile/rigid, solid/hollow | |
| 7. | Limit of electrical resistance | |
| | between the conductors and | |
| | components of the spacer. | |
| 8. | Whether elastometers have been | |
| | used if yes whether it is resistant | |
| | to ozone, low temp. nterferenc radiation | |
| | and conductor temp upto 66$^{O}$C | |
| 9. | Limit of magnetic power loss | |
| | at a constant room temp. | |
| 10. | Tensile load capacity | |
| 11. | Corona inception voltage | |
| 12. | Radio interference voltage | |
| 13. | Short circuit current rating | |
| 14. | Complete weight of spacer | |
| | Aluminium | |
| | Steel | |
| | Total | |
| 15. | Dimension of Bus Bar spacer | |
| | i)Solid & rigid spacer | |
| | bar dia | |
| | ii)Thickness of mattalic part | |
| | iii)Size of bolts alongwith | |
| | lock nuts plainwashers and | |
| | spring washers. | |
| 16. | Drawing to which material shall conform | |
| 17. | Marking | |
| 18. | Packing | |
| 19. | Any other information | |
| | which the tenderer may wish | |
| | to furnish. | |
| | (b) for AAC Tarantulla | |
| 1. | Name and address of | |

| | | |
|---|---|---|
| | manufacturer | |
| | a) Office | |
| | b) Works. | |
| 2. | ISS to which material | |
| | shall conform | |
| 3. | Sub spacing (mm) | |
| 4. | Material used in spacers | |
| 5. | Galvanisation shall confrom to | |
| 6. | Whether spacer assembly is | |
| | flexibile/rigid, solid/hollow | |
| 7. | Limit of electrical resistance | |
| | between the conductors and | |
| | components of the spacer. | |
| 8. | Whether elastometers have been | |
| | used if yes whether it is resistant | |
| | to ozone, low temp. ultravoilet radiation | |
| | and conductor temp upto $66^{O}C$ | |
| 9. | Limit of magnetic power loss | |
| | at a constant room temp. | |
| 10. | Tensile load capacity | |
| 12. | Radio interference voltage | |
| 13. | Short circuit current rating | |
| 14. | Complete weight of spacer | |
| | Aluminium | |
| | Steel | |
| | Total | |
| 15. | Dimension of Bus Bar spacer | |
| | i)Solid & rigid spacer | |
| | bar dia | |
| | ii)Thickness of mattalic part | |
| | iii)Size of bolts alongwith | |
| | lock nuts plainwashers and | |
| | spring washers. | |
| | 16. Drawing to which material shall conform | |
| 17. | Marking | |
| 18. | Packing | |
| | which the tenderer may wish | |
| | to furnish. | |

**Annexure-11**

## Guaranteed and other technical particulars of tube Accessories

| | | |
|---|---|---|
| I | **Connectors** | |
| 1. | Name of Manufacturer | |
| | i) Office | |
| | ii) Works | |
| 2. | Standard to which the material | |
| | shall conform | |
| 3. | Material used in manufacture | |
| 4. | Method of casting | |
| 5. | Rated normal current of the connector | |
| 6. | Rated short time current | |
| | of the connector. | |
| 7. | Temp rise limit when carrying | |
| | normal current | |
| 8. | Weight of one connector | |
| | a) Aluminium | |
| | b) Steel | |
| | c) Total | |
| 9. | Dimension of the connector | |
| 10. | Corona inception voltage | |
| 1. | Radio inteference voltage | |
| 12. | Marking | |
| 13. | Packing. | |
| 14. | Drawing no. to which material | |
| | shall conform | |
| 15. | Any other information which the | |
| | tenderer may wish to furnish | |
| II. | **Coupler** | |
| 1. | Name of Manufacturer | |
| | i) Office | |
| | ii) Works | |
| 2. | ISS to which the material | |
| | shall conform | |
| 3. | Rated normal current of the coupler | |
| 4. | Rated short time current of | |
| | the coupler | |
| 5. | Temp rise limit when carrying | |
| | normal current | |
| 6. | Weight of coupler | |
| 7. | Composition of material | |
| | of coupler | |
| 8. | Outer dia of the straight run | |
| | Coupler | |
| 9. | Inner dia of the $110^{o}/135^{o}$ | |
| | Coupler. | |
| 10. | Procedure of welding | |

| | | |
|---|---|---|
| 11. | Dimension of the coupler | |
| 12. | Marking | |
| 13. | Packing details | |
| 14. | Drawing No. to which the | |
| | coupler shall conform | |
| 15. | Any other information which the manufacturer may wish to | |
| | furnish. | |

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**LT Transformer**
**Part- 18**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

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**VOLUME-II PART-18**

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**VOLUME-II, PART-18**

**Technical Specification for LT Transformer**

**1.0** SCOPE:-

1.1 This specification covers design, engineering, manufacture, assembly, stage testing, inspection and testing before supply, delivery, erection & commissioning at site of 630 KVA /800KVA, 33/0.433 kV LT Transformers complete with all fittings accessories, associated equipment and mandatory spares specified herein which are required for efficient and trouble free operation as specified hereunder.

1.2 It is not the intent to specify completely herein all the details of the design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous operation upto the Bidderôs guarantee, in a manner acceptable to the purchaser, who will interpret the meanings of drawings and specifications and shall have the power to reject any work or material which, in his judgement, is not in accordance there with. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidderôs supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

2.0 STANDARDS

The transformers and associated accessories shall conform to the latest issues of standards as given below, except to the extent explicitly modified in the specification.

| Indian Standard No. | Title |
|---|---|
| IS-2026 | Power Transformers |
| IS-3639 | Fittings & Accessories for power transformers |
| IS-335 | Insulating oils for Transformers and switchgear |
| IS-2099 | Bushings for alternating |
| IS-3347 | Voltage above 1000V |
| IS-2070 | Method of impulse voltage testing |
| IS-6600 | Guide for loading of oil immersed transformers |
| IS-5 | Colour for ready mix paints. |
| IS-3637 | Gas Operated relay |
| IS-1554 | PVC cable |
| IS-5561 | Power Connectors |
| IS-2705 | Current Transformers |

2.1 In case equipment conforms to other International Standards which ensure equivalent or better performance than that specified under clause 2.0 then the English version of such standards or the relevant extracts of the same shall be forwarded with the bid and the salient features of comparison shall be brought out separately in additional information schedule.

2.2 The electrical installation shall meet requirements of Indian Electricity Rules, 1956 and IS-1886, ñCode of practice for installation & maintenance of Transformersò as amended till date.

## 3.0 PRINCIPAL PARAMETERS

The transformers shall conform to the following specific parameters :

| S.No. | Description | Parameters | |
|---|---|---|---|
| a) | Type | Two winding | |
| b) | Service | Outdoor | |
| c) | Number of Phases | Three | |
| d) | Frequency | 50 Hz | |
| e) | Type of cooling | ONAN | |
| f) | Rating | 630 kVA & 800 kVA | |
| g) | Impedance at 75degree C with tolerance | 0.05±10% | |
| h) | Duty | Continuous | |
| i) | Overload | As per IS:6600 | |
| j) | Maximum temp. rise over 50 degree C ambient | | |
| i) | Oil (Temp. rise measurement by thermometer) | 50 degree C | |
| ii) | Winding (Temp. rise measured by resistance method) | 55 degree C | |
| k) | Windings | 33 kV<br>630 kVA/ | 33 kV<br>800 kVA |
| i) | System Apparent short circuit level (KA) | As per IS:2026 (Part-I) | |
| ii) | Winding connection | Delta | Delta |
| iii) | Vector Group | Dyn1 | Dyn1 |
| iv) | Insulation | Uniform | Uniform |
| v) | Insulation level (KV) | 36 | 52 |
| a) | Power frequency test level (KV rms) | 70 | 95 |
| b) | Basic impulse level (KV peak) | 170 | 250 |
| vi) | Highest voltage (KV) for each winding | 36 | 52 |
| vii) | Method of earthing | Solidly earthed | Solidly earthed |
| l) | Tap Changer | | |
| i) | Tap range | +5%/ - 10% in steps of 2.5% on HV side | |
| ii) | Tap control | Off circuit tap change switch | |
| m) | HV Bushings | 630KVA | 800 kVA |
| i) | Rated voltage, kV | 36KV | 52 |
| ii) | Rated current, kV | 100A | |
| iii) | Basic impulse level (kV) | 170 | 250 |
| iv) | Wet & dry power frequency withstand voltage (KV rms) | 70 | 95 |
| v) | Minimum total creepage distance (mm) | 900 | 1300 |
| vi) | Mounting | Tank / transformer body | |
| n) | LV and Neutral bushing | | |
| i) | Rated voltage (volts) | 1100 | 1100 |

| | | | |
|---|---|---|---|
| ii) | Rated current (Amps | 2000 | 1000 |
| o) | Terminal details | | |
| i) | High voltage | Suitable for 33 kV cable or O/H conductor | |
| ii) | Low voltage phase and neutral | Cable box | |
| p) | Minimum clearance (mm) in AIR | 33 kV<br>630 kVA | 33 kV<br>800 kVA |
| i) | Phase to Phase | 350 | 530 |
| ii) | Phase to Earth | 320 | 480 |

4.0 GENERAL TECHNICAL REQUIREMENTS

4.1 Duty Requirements

4.1.1 The transformers shall be capable for withstanding thermal and mechanical stresses for a duration of 3 seconds caused by symmetrical or asymmetrical terminal fault on any of the winding i.e. HV or LV. The capability of the transformer to withstand the thermal and mechanical stresses under short circuit shall be demonstrated by calculations.

4.1.2 The transformer shall be capable of being loaded in accordance with IS:6600 upto loads of 150 % . There shall be no limitation imposed by bushings, tap changer etc.

4.1.3 The transformer shall be capable of being operated without danger on any tapping at the rated kVA with system voltage of 36 kV rms.

4.1.4 The operation of the transformer other than rated voltage and frequency shall comply to clause 4.3 of IS:2026 Part-I.

4.2 Transformer Losses

4.2.1 Losses for evaluation of bid: For capitalization of losses and treatment of loss figures for the purpose of bid evaluation the rate of capitalization shall be Rs. 2,76,000/- for differential Iron Losses and Rs. 1,13,000/- for the differential Copper Losses.

4.2.2 Liquidated damaged for excessive losses : On testing, if it is found that actual losses are more than the value quoted including maximum losses specified if any, undisputed liquidated damages shall be recovered from the contractor at the cost of losses arrived at as per clause 4.2.1 . For fraction of a kW evaluation will be on prorata basis.

Purchaser reserves the right to reject the transformer if the losses exceed declared losses beyond tolerance limits, or the temperature rises of oil and winding exceed the guaranteed values or impedance values differ from the guaranteed values including tolerance.

Purchaser also reserves the right to retain the rejected transformer and take it into service until the contractor replaces it with a new transformer at no extra cost. Alternatively the contractor shall repair or replace the transformer in a reasonable period as decided by the purchaser to the purchaserôs satisfaction at no extra cost.

4.3 DESIGN

4.3.1 The transformers and accessories shall be designed according to modern practice to facilitate easy inspection, cleaning and repairs and for operation with minimum supply interruptions as

continuity of supply is the primary consideration. All apparatus shall be designed to ensure satisfactory operation under such sudden variations of load and voltage as may be met with under working conditions in the system, including these due to short circuit.

4.3.2 All materials used shall be of the best quality and of the class most suitable for working under the conditions specified without undue distortion or deterioration or the setting up of undue stresses in any part and also without affecting the strength and suitability for the various parts for the work which these have to perform.

4.3.3 All outdoor apparatus including bushing insulators with their mountings, shall be designed so as to avoid pockets in which water can collect. All connections and contacts shall be of ample cross sections and surface for carrying continuously, the specified currents without undue heating and fixed connections shall be secured by bolts or set screws of ample size and adequately locked. Lock nuts shall be used on stud connections carrying current.

4.4 CORE

4.4.1 Core shall be built up with thin laminations of high grade, nonageing, low loss, high permeability, cold rolled grain oriented silicon steel. The particulars of laminated silicon steel to be employed shall be supplied with the tenders alongwith DC Magnetisation, B.H. and Iron loss curves.

4.4.2 After being sheared the laminators shall be treated to remove all burrs and shall be reannealed to remove all residual stresses. Each lamination shall be insulated with a material that will not deteriorate due to pressure and the action of hot coil.

4.4.3 The core and coil assembly shall be securely fixed in position so that no shifting or deformation occurs during movement of transformer or under short circuit stresses. The core shall be securely grounded directly to the tank in such a way that the ground connection can be detached, whenever required. Yoke bolt should not be used since these lead to transformer failure.

4.4.4 The core shall be provided with lugs suitable for lifting the complete core and oil assembly of the transformer.

4.4.5 i) The transformer shall be designed in such a way that the flux density in the steel core, at the maximum operating voltage of 36 kV rms on HV and at the rated frequency and lowest tap shall not exceed 1.65 tesla and at other operating voltage it shall not exceed the following value.

ii) System voltage of 33 kV and lowest tap = 1.5 tesla
Highest system voltage of 36 kV and lowest tap = 1.65 tesla

System voltage of 33 kV and rated tap =1.575 tesla
Highest system voltage of 36 kV and rated tap = 1.74 tesla.

4.4.6 The design of magnetic circuits shall be such as to eliminate the occurrence of static discharges, development of short circuit paths within itself or to the earthed clamping structure and the production of flux components at right angles to the plans of laminations which may cause local heating.

4.4.7 Every care shall be exercised in the treatment and handling of core steel to ensure that the laminations are flat and that the finally assembled core is free from distortions.

4.4.8 The supporting frame work of the core shall be so designed as to eliminate the presence of pockets which may prevent complete emptying of the tank through the drain valve or cause trapping of air during filling.

4.4.9 Oil ducts shall be provided where necessary to ensure adequate cooling. The winding structures and major insulation shall not obstruct the free flow of oil through such ducts. When the magnetic path is divided into pockets by cooling ducts parallel to the plane of the laminations or by insulating material above 0.25mm thick, tinned copper strip bridging pieces shall be inserted to maintain electrical continuity between pockets.

4.4.10 The insulation of core to bolts and core to clamp plates shall be able to withstand a power frequency voltage of 2 kV rms for one minute.

4.4.11 Cores and windings shall be capable of withstanding shocks during transport, installation and service. Adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.

4.4.12 All steel sections used for supporting the core shall be thoroughly sand /shot blasted, after cutting, drilling and welding.

4.5 WINDINGS

4.5.1 The winding shall be of copper and shall be pre-shrunk during manufacture so that it is extremely unlikely that any further shrinkable takes place in service Copper current density in winding shall not exceed 3A/mm2. Wire used shall conform to relevant IS. The voltage between adjacent coils shall be kept as low as is consistent with good design. The winding shall be so designed that all coil assemblies of identical voltage ratings shall be interchangeable and field repairs to the windings can be made readily without special equipment and also the out of balance forces in the transformer are reduced to the minimum at all voltage ratios. The coils shall be supported between adjacent sections by insulating spacers and barriers. Bracings and insulation used in the assembly of the windings shall be arranged to ensure a free circulation of oil and minimize hot spots in the windings. Proper attention shall be given to the elimination of corona discharge within the transformer at test voltage.

4.5.2 The insulation of coils may be dried impregnated by an appropriate process to develop the electrical strength of the windings. The insulation of transformer windings and connections shall be non catalytic and chemically inactive in the transformer during service and shall be free from insulating composition which is liable to soften, coze out, shrink or collapse.

4.5.3 All threaded connections shall be provided with locking facilities. All leads from the windings to the terminal boards and bushings shall be rigidly supported to prevent injury from vibrations. Guide tubes shall be used where practicable.

4.5.4 The windings shall be clamped securely in place so that these are not displaced or deformed during transit or short circuits. Insulated shields / barriers shall be provided between the windings of different phase so that before any short circuit between phases, phases to ground fault occurs. The assembly of core and windings shall be vacuum dried and/or suitably impregnated before removal from the treating tank. The copper conductor used in the coil structure shall be the best suited to the requirements and shall be free from scales, burrs etc. and shall have properly rounded corners to reduce electrostatic flux concentration. All permanent current carrying joints in the windings and the leads shall be made as per the best manufacturing practice and shall be capable of giving trouble free service.

4.5.5 End turns of HV & LV windings shall be given extra insulation to enable safe operation of transformer against lightning surges. LV winding shall be near to the core.

4.5.6 The basic insulation level of 250 kVP for HV winding have been specified to be matching with the tertiary winding of 400/220/33 kV transformer for 400 kV substation. So that the auxiliary transformer may be capable of being used on 33 kV testing bus of 400 kV transformer.

4.6 TANK

4.6.1 The transformer tank and cover shall be fabricated from good commercial grade carbon steel of tested quality and of adequate thickness. The tank and the cover shall be of welded construction. All seams, flanges, lifting lugs, braces and permanent parts attached to the tank shall be welded and where practicable they shall be attached to the tank shall be welded and where practible they shall be double welded. All joints which may have to be opened from time to time in the course of operation shall be of a design which permits their being made oil tight in reassembly easily. The tank shall be reinforced by stiffners of structural steel for general rigidity. The tank shall have sufficient strength to withstand without permanent distortion :

i) Full vacuum
ii) Continuous internal gas pressure of 35 KN/m2 with oil at operating level and
iii) Mechanical shock during transportation.

4.6.2 Suitable guides shall be provided for positioning the various parts during assembly or dismantling. Adequate space shall be provided between the cores and the windings and the bottom of the tank for collection of any sediment.

4.6.3 The tank shall be provided with two suitable lugs for the purpose of grounding.

4.6.4 The transformer tank, fittings, and all accessories shall be designed to withstand seismic acceleration of 0.3 g. horizontal and 0.15g. vertical. Special steps shall be taken to avoid maloperation of bucholoz relay under such conditions.

4.6.5 The transformer tank shall be equipped with the following valves with standard screw connections for external piping :-

i) Drain valve with padlocking arrangement.
ii) Two filter valves on diagonally opposite ends ï one at the top and other at the bottom with padlocking arrangement in bottom valve.
iii) Two sampling valves at the top and bottom of the main tank.

4.6.6 All bolts and nuts used in the connection with the tank fittings shall be galvanized.

4.6.7 As far as possible the transformer tank and its accessories shall be designed without pockets where gas may collect. Where pockets can not be avoided pipes shall be provided to vent the gas.

4.6.8 The tank cover shall be of adequate strength and shall not distort when lifted and shall be slopped to prevent retention of water.

4.6.9 The tank covers shall be fitted with pockets at the position of maximum oil temperature at MCR (Maximum Continuous Rating) for inserting bulbs of oil and winding temperature indicator. It shall be possible to remove these bulbs without lowering the oil in the tank.

4.6.10 Bushings, thermometer pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.

4.6.11 All bolted connections shall be fitted with weather proof, hot oil resistant and resilient gasket, in between for complete oil tightness. Special attention shall be given to methods of making the hot oil tight joints to ensure that the joints can be remade satisfactorily and with ease with the help of semi-skilled labour. If necessary metallic stops shall be provided to prevent over compression.

4.6.12 Lifting eyes or lugs shall be provided on all parts of the transformer requiring independent handling during assembly or dismantling. The transformer tank shall be provided with lifting lugs.

4.7 UNDER CARRIAGE

4.7.1 The transformer shall be supported on strong structural steel base fitted with forged steel of cast steel bidirectional rollers suitable for moving the assembled transformer filled with oil. The number and the spacing of the rollers shall be specified on a drawing to be submitted with the bid. Means shall be provided for locking the swivel movements of rollers in position parallel to and at right angles to the longitudinal axis of the tank so as to permit movement of the transformer in both directions. The transformer during operation shall rest on rollers.

4.7.2 Four jacking pads shall be provided to enable the direction of the wheels being changed through 90 deg. C when the transformer is lifted on jacks.

4.7.3 Pulling eyes shall be provided to facilitates haulage of the transformer and they shall be suitably braced in a vertical direction so that bending does not occur when the pull has vertical component.

4.7.4 The shape and size of the under carriage shall be such as to permit the complete transformers tank to be moved into /out of its position without any hindrance, after all foundations have been casted and are read with their embedments /fixtures in position.

4.7.5 Suitable locking arrangement shall also be provided for rollers to prevent movement of transformer either accidentally or during earthquake.

4.8 RADIATORS

4.8.1 The transformer shall be equipped with radiators made from pressed steel. Radiators shall be mounted on tank.

4.8.2 Each radiator bank shall be provided with the following accessories :-

i) Top and bottom shut-off valves.
ii) Drain valve
iii) Air release plug
iv) Lifting lugs.

4.9 TYPE OF TRANSFORMER

The transformers shall be of core or shell type construction, oil immersed and ONAN cooled and shall be suitable for outdoor service.

4.10. INSULATING OIL

4.10.1 The insulating oil to be used in the transformer shall generally conform to IS:335.

4.10.2 Transformer shall be supplied duly filled with transformer oil with 10% extra quantity in non returnable steel drums. This 10% oil quantity shall be determined by refilling the fully drained transformer upto normal oil level in the conservator.

4.11 INSULATION

4.11.1 The dielectric strength of winding insulation and of the bushing shall meet the requirements of the relevant IS.

4.12 TEMPERATURE RISE

4.12.1 The transformer shall be capable of operating continuously at its normal rating without exceeding the temperature limits as per IS:2026 with reference to the ambient temperature indicated.

4.12.2 The temperature rise of the top oil refers to the rated load on transformer at the tap position which gives highest losses. Individual winding temperature rises shall be considered relative to rated current of the winding.

4.12.3 Guaranteed temperature rise limits shall be valid for all the tappings.

4.13 FREQUENCY

4.13.1 The transformer shall be suitable for continuous operation with a frequency variation of ± 5% from normal value of 50 Hz without temperature rise, exceeding the specified limit.

4.14 NOISE AND VIBRATION

4.14.1 The transformer and accessories shall be designed, manufactured and assembled so that vibration effect is the least and the transformer can withstand the vibration that does occur during the expected life of the transformer without damage.

4.15 PARALLEL OPERATION

4.15.1 The similar ratio transformer shall operate satisfactorily in parallel with each other and shall share the load approximately equal on all taps upto their rated capacity.

4.16 OFF LOAD TAP CHANGER

4.16.1 Transformer shall be provided with 5% off load tap in the steps of 2.50% on high voltage winding. Off load tap changers will be 3 phases gang operated type. There shall be no phase displacement as a result of tap changing. All tapping & neutral connection shall be brought out and tap changing shall be effected by off load tap changer or bolted links. Rating & diagram plates shall indicate position and designation of each terminal and connections to achieve desired voltage tap. Off load tap changer shall be so located on the transformer so that it can be operated by a man standing at the level of transformer track. The tap changing equipment shall be strong construction and shall be provided with low resistance contacts.

4.16.2 Transformer shall give full load output on all taps. Tap changing equipment should be capable of carrying the external short circuit current, which can be carried by the winding.

4.17 OIL PRESERVATION SYSTEM

4.17.1 Oil preserving equipment shall be conservator or expansion tank type. The oil level in the conservator or expansion tank shall not be below the level of the bushing flanges.

4.17.2 The conservator or expansion tank shall also have a shut off valve so arranged as not to interfere with oil lines. Oil conservator or expansion tank shall be located well clear of the bare connections from the transformer terminals. The conservator tank shall be a capacity between highest and lowest permissible levels of not less than 7 ½% of the total cold oil volume in the transformer and cooling equipment.
An oil level gauge shall be provided on the conservator expansion tank at a convenient height for reading from ground level. Dehydrating type of breather shall be provided on the conservator tank, the conservator shall be of bolted construction to facilitate cleaning of the conservator. A protion of the oil pipe line connecting the transformer tank with the

conservator shall be arranged at a rising angle of 3 to 7 degrees to the horizontal and shall consist of adequate size pipe to facilitate housing of the oil and gas operated relay.

4.18 TERMINAL BUSHING

| | | |
|---|---|---|
| a) | HV Terminal | 52 kV porcelain bushing & arcing horns shall be provided. |
| b) | LV Terminal | 1.1 kV porcelain bushing with cable box. |

4.18.1 HV bushing shall be provided with terminal connectors to receive AAC Tarantulla/ACSR Moose/3ðIPS Al. tube. LV bushing shall be provided with cable box suitable for 3 ½ core 350 Sq.mm Aluminum cable (Twin lengths).

4.18.2 HV bushing or HV lead shall be provided with 50/1,1,1 Amps CT with cores having 1.0, 5P 10 & 5 P 10 accuracy. CT shall have rated short time current of 16 kA (rms) for 3 seconds. Instrument security factor for metering core shall not exceed 5.

4.18.3 LV bushing or LV lead shall be provided with 1000/1 Amp. CT having accuracy class of cores as 1.0. The CT shall have rated short time current of 16 kA (rms) for 3 seconds. Instrument security factor for metering core shall not exceed 5.

4.18.4 All porcelain used in bushing shall be of the wet process homogenous, impervious to moisture, free from cavities or other flaws and thoroughly vitrified and smoothly glazed. The glazing shall be in uniform brown colour and free from blister, burrs and other defects.

4.18.5 The bushings and fittings shall be unaffected by atmosphere conditions e.g. weather, fumes, ozone, acids, stresses due to expansion and contraction in any part of the bushing insulator shall not lead to development of defects. The bushings shall have high factor of safety against earthquake and other loads.

4.18.6 Porcelain shall not engage directly with hard metal and where necessary, gasket shall be interposed between porcelain and the fittings. All porcelain clamping surface in contact with gas kit shall be accurately ground and shall be free from glaze.

4.18.7 Fixing material/cement shall not enter into chemical action with metal parts or cause fracture by expansion in service. Cement thickness shall be as small as possible and proper care shall be taken to centre and locate individual parts correctly during cementing.

4.18.8 Each porcelain bushing shall have marked upon it the manufacturerôs name and such other marks.

4.18.9 All ferrous parts, clamps and fittings made of steel or malleable iron shall be galvanized. All bolts threads shall be greased before erection. The terminal connectors shall be of aluminium alloy. Bimetalic strips as required to avoid electrolytic action with the material of bushing stems, shall also be supplied with the connectors.

4.18.10 All bushing shall be detachable and replaceable with out disturbing internal connections and removing the transformer cover.

4.18.11 Overall transformer insulation shall be so coordinated with the transformer insulation, that all flashovers will occurs outside the tank.

4.18.12 All terminals (including neutral) shall be distinctly marked as per IS:2026 (amended upto date) and coloured for phase voltage (i.e. Red, Yellow, Blue) and phase rotation on the primary and secondary sides in accordance with the diagram of connection supplied with the transformer.

4.18.13 All porcelain insulators shall be designed to facilitate natural cleaning.

4.18.14 All outdoor type bushing through which the main winding and neutral leads are brought out shall be so located that the phase to ground clearances obtainable are adequate to ensure availability of the full flashover strength of the bushing. Main terminals shall be of approved design.

4.18.15 All bushing shall have puncture strength value greater than the dry flashover value.

4.18.16 The bushing shall be so located as to provide adequate electrical clearance between bushing of various voltages and between bushings and grounded parts. Bushings of identical voltage rating shall be interchangeable. The insulation class of the high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the high voltage winding.

4.19 CENTRE OF GRAVITY

4.19.1 The centre of gravity of the assembled transformer shall be as low and as near the vertical centre line as possible. The transformer shall be stable with and without oil. The location for the centre of gravity shall be clearly marked in the outline drawing.

4.20 ACCESSORIES AND FITTINGS

4.20.1 Each transformer shall be provided with the following accessories :-

i) One 140mm dial type temperature indicator with maximum reading pointer for oil, mounted on the side of the transformer at a convenient height to read the temperature of the hottest part of oil. It shall be fitted with alarm contacts. The rating of contacts shall be 5 Amp, 220 Volts DC.

ii) 140mm dial type winding hot spot temperature indicators with maximum reading pointer, one for each winding (i.e 33 kV and 433 Volts) of the transformer shall be provided. These shall be of the indicating type, responsive to the combination of top oil temperature and HV/LV winding current, calibrated to follow the hottest spot temperature of the transformer winding. The winding temperature detectors shall operate a remote alarm in the event of the hottest spot temperature reading a dangerous value. These indicators shall be fitted with trip contracts.

iii) Pocket on tank cover for thermometer.

iv) Oil and gas relay with alarm and trip contacts (rating 1 Amp. 220 Volts DC) shall have-one number shut off valve on conservator side-Test cock.

v) Conservator with oil filling hole, cap and a drain valve (size :25mm)

vi) Safety valve of chimney type (i.e. explosion vent) shall be provided to operate at a static pressure less than the pressure at which transformer tank shall be pressure tested under clause 4.6.1 . The safety valve pipe shall preferably take off from the side of transformer tank near to tank cover and not from the top of tank cover with a view to prevent gases formed in the tank from rising into the safety valve pipe thereby by passing the gas and oil operated relay. Safety valve shall be provided with an equalizer pipe, interconnecting the top of conservator and upper most part of safety valve so as to prevent rise of oil in the safety valve pipe.

vii) Valve:-

- Drain valve with padlocking arrangement.
- Two filter valves on diagonally opposite ends-one at top and other at bottom with padlocking arrangement on bottom valve.
- Two sampling valves at top and bottom filter valves.

viii) Two earthing terminals.

ix) Diagram and rating plate.

x) Valve schedule plate.

xi) Jacking pads.

xii) Lifting ballards

xiii) Haulage lugs.

xiv) Cover lifting lugs.
xv) Provision for mounting bi-directional rollers with locking and bolting device.
xvi) Weather proof terminal box for housing terminal connection.
xvii) Air release devices.
xviii) Wiring upto marshalling box with PVC SWA copper cables of 650/1100 volts grade.

4.20.2 The equipment and accessories furnished with the transformer shall be suitably mounted on the transformer for ease of operation, inspection and maintenance and the mounting details shall be subject to approval of the purchaser. All valves shall be provided either with blind companion flanges or with pipe plugs for protection.

4.20.3 Any other accessories or appliances recommended by the manufacturer for the satisfactory operation of the transformer shall be supplied without any extra cost to the purchaser.

4.21 TERMINAL MARKING

4.21.1 Each terminal (including the neutral) shall be distinctly marked on both the primary and secondary sides in accordance with the diagram of connections supplied with the transformer.

4.22 TERMINAL BOX

4.22.1 All wiring from transformer accessory equipment (i.e. temperature indicators, alarm/trip contact) bucholz relay etc. shall be wired though terminal box (i.e. local marshalling box) with 650/1100 V grade PVC insulated, PVC sheathed, unarmoured cable, run in GI/flexible conduits.

4.22.2 Local marshalling box shall be fabricated from heavy gauge M.S. sheets of atleast 2mm thick which shall be spray painted with special zinc rich paint. No rain water or dust shall enter the boxes which shall also be vermin proof. The door to be provided shall be securely hinged, lined with strong rubber seal all around and fitted with lockable handle.

4.23 CLEANING AND PAINTING

4.23.1 Before applying antirust primary coats all ungalvanised parts shall be completely cleaned and shall be free from rust, scale and grease and all external rough surface on casting shall be filled by metal deposition. Unexposed welds need not be painted.

4.23.2 The interior of all transformer tanks and other oil filled chambers and internal structural steel works shall be cleaned of all scales and rush by shot or send blasting and given anticorrosion treatment against any chances of rust. Painting material shall be heat resistance and insoluble in oil.

4.23.3 Except for nuts, bolts and washers which shall be galvanized all steel surfaces exposed to weather shall receive minimum of three coats of paints.

4.23.4 The primary coat of zinc chromate shall be applied immediately after cleaning. The second coat shall be of an oil and weather resisting nature and of a shade of colour easily distinguishable from the primary and final coats and shall be applied after the primary coat has been touched-up where necessary. The final two coats shall be of glossy and oil and weather resisting non fading paint on exterior as per shade no. 631 of IS 5 and glossy white paint on the interior surfaces.

4.24 JOINTS AND GASKETS

4.24.1 All gaskets used for making oil tight joints shall be proven material such as granulated cork bonded with synthetic rubber.

4.25 VALVES

4.25.1 All valves shall be of gun metal or cast steel or cast iron bodies with gun metal fittings. They shall be of full way type with internal screws and shall open when turned counter clock-wise when facing the hand wheel.

4.25.2 Means shall be provided for padlocking the filter and drain valves in the closed positions.

4.25.3 Every valve shall be provided with flanges having machined surfaces.

4.25.4 Flanges for valves and oil and gas relay, and threads for valves and pipes shall comply with the requirements of IS:3639 and IS:554 respectively.

4.26 DRYING AND FILLING OF OIL

4.26.1 The transformer shall be dried out by an appropriate method at the manufacturerôs works. The bidder shall furnish complete details of method, tests, etc. recommended for oil filteration etc., necessary at site before commissioning.

4.26.2 Clear instructions shall be include in the maintenance manual regarding special precautionary measures which must be taken before applying the specified vacuum treatment and oil filling. The maximum vacuum which the complete transformer filled with oil can safely with stand without any special precautionary measures, shall also be stated in the bid.

5.0 TESTS

a) The supplier shall carry out all type tests and routine tests on the transformers as per the relevant standard. Type tests shall be carried out on one transformer and routine tests on all transformers. Additional tests required to be carried out are listed hereunder. If type tests are already carried out on transformers of similar rating, copies of test reports shall be furnished alongwith bid. All the type tests mentioned in clause No. 5.1 shall be carried out free of cost.

b) Special tests other than type and routine tests, as agreed between purchaser and supplier shall also be carried out as per IS:2026.

c) The charges for conducting special test shall be indicated separately in the bid.

d) The preshipment checks to be carried out by the supplier are given under clause 6.0 ñInspectionò.

e) Each transformer shall be assembled and tested at the manufacturerôs works for all tests as per clause 5.1 in conformity with this specification. Unless otherwise agreed, all equipment shall be inspected and test witnessed by the purchaserôs representative.

f) Bushings, transformer, Gas and oil operated relay shall comply with the requirement of type and routine tests specified respectively in IS:2099, IS:335 & IS:3637. The contractor shall furnish factory test results to the purchaser for approval.

g) Any routine or type test required under this specification for which facilities are not available at his own works, the bidder shall clearly indicate in his offer the alternative arrangements made or to be made for getting such tests conducted at his own cost.

5.1 TESTS ON TRANSFORMER

5.1.1 Type Tests

5.1.1.1 Transformer shall conform to type test as per IS:2026 (Part-I) (latest edition) including short circuit test. Measurement of auxiliary losses shall be made alongwith the type tests for temperature rise. The temperature rise test shall be carried out at the lowest tap.

5.1.2 Additional Type tests

5.1.2.1 Following additional type tests shall be conducted on the transformer tank or their test reports furnished.

a) Vacuum Test

Transformer tank shall withstand full vacuum pressure under which transformer tank (without oil) will be vacuum tested for one hour shall be that required for drying & oil filling at site but shall not be more than 3.33 KN/M2. The permanent deflection of flat plates after the vacuum has been released shall not exceed the values specified below and the performance of the transformer shall not be affected in any way.

| Horizontal length of flat plate (mm) | Permanent deflection (mm) |
|---|---|
| Upto and including 750 | 5 |
| 751 to 1250 | 6.5 |
| 1251 to 1750 | 8 |
| 1751 to 2000 | 9.5 |
| 2001 to 2250 | 11 |
| 2251 to 2500 | 12.5 |
| 2501 to 3000 | 16 |
| Above 3000 | 19 |

b) Pressure Test

One transformer tank together with its radiators conservator vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 kN/M2 whichever is lower. The applied pressure shall be measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after excess pressure has been released shall not exceed the values specified at 5.1.2.1(a).

5.1.2.2 Relief Device

The diaphrgam of explosion vent shall be subjected to increasing oil pressure. It shall operate before reaching the test pressure specified in the test at 5.1.2.1(b).

5.1.3 Routine Tests

5.1.3.1 The routine tests shall be carried out as per IS:2026 (Part-I).

5.1.3.2 Measurement of exciting current and excitation losses at no-load current shall be carried out at 90%, 100% of rated voltage as per IS:2026 (Part-I). No saturation core should be indicated by test results.

5.1.4 Additional Routine Tests

In addition to the routine tests mentioned in IS:2026 (Part-I), the following additional routine tests shall be carried out:-

a) All welds shall be tested by the manufacturer for leaks by a standard practice like dye penetration test etc. and the factory test result shall be furnished.

b) Oil leakage test on transformer tank and cooling tube.

All tanks, cooling tubes and oil filled compartments shall be tested for oil tightness by completely filling the tank with air/oil of viscosity not greater than that of insulating oil conforming to IS:335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35KN/M2 (5 1bs/sq. in) measured at the base of the tank. This pressure shall be maintained for a period of not less than twelve hours for oil and one hour for air, during which time no leakage shall occur at welds.

c) Magnetic Circuit Test

After assembly, each core shall be tested for one minute at 2000 Volts between all bolts, side plates and structural steel work. Immediately prior to the dispatch of the transformer from the manufacturerôs works, the magnetic circuit shall be pressure tested for one minute at 2000 volts A.C. between the core and earth.

5.1.5 Tests on Accessories

5.1.5.1 Auxiliary wiring and all equipment connected thereto shall be subjected to a test voltage of 2000 volts at 50 Hz for one minute.

5.1.6 Gas and Oil Operated Relay

5.1.6.1 The correct functioning of all apparatus fitted with alarm or tripping contacts shall be checked with a buzzer.

5.2 Further Tests

5.2.1 The purchaser reserves the right to have other reasonable tests carried out at his expense either before dispatch or at site to ensure that the transformer complies with the requirements of this specification.

5.3 TEST REPORTS

a) Six(6) sets of certified test reports shall be submitted for approval prior to dispatch of the equipment. The equipment shall be dispatched only when all the required type and routine tests have been carried out and test reports have been approved by the purchaser.
b) Six (6) copies of the test reports for the tests carried out on the ancillary apparatus shall be furnished to the purchaser for approval prior to dispatch.
c) All auxiliary equipment shall be tested as per the relevant standard. Test certificate shall be submitted for bought out items.

6.0 INSPECTION

6.1 During the course of manufacture, purchaserôs representative shall have the right to inspect the materials, workmanship, labour and the progress of manufacture of the equipment on order and may reject any item which is defective or unsuitable for the purpose intended or which is not in accordance with the intent of this specification. The contractor upon demand by the purchaser or his representative, shall rectify the defects or replace such defective or unsuitable material. Bidder shall provide all reasonable inspection facilities to purchaserôs Inspector.

6.2 The Contractor shall give at least 30 days notice of readiness for inspection of component parts and final assembly and tests, so that the purchaserôs representative, may witness the tests

before dispatch. Purchaserôs representatives may, at any time, inspect and copy any or all test data.

6.3 No material being furnished against this specification shall be dispatched until inspected and approved by the purchaser and/or his representative. Such inspection and approval shall not relieve the Tenderer of full responsibility for furnishing equipment conforming to the requirements of the specifications nor prejudice any claim, right or privilege which the purchaser may have, because of the use of defective or unsatisfactory equipment. Should the inspection be waived by the purchaser, such waival shall not relieve the tenderer in any way from his contractual obligations.

6.4 Equipment shall be capable of performing satisfactorily upto contractors maximum guarantee. All tests required by specification, including repeat tests and inspections, that may be necessary owing to failure to meet any tests specified shall be made at tendererôs expenses. If equipment fails to pass the specified tests, purchaser shall have option to reject the unit. Additional tests shall be made to locate the failure and after reconstruction, testing shall be repeated to prove that the rebuilt equipment meets the specification in all respects.

7.0 QUALITY ASSURANCE PLAN

7.1 The bidder shall invariably furnish following information alongwith his offer failing which the offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

i) Statement giving list of important raw materials, names of sub-suppliers for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw material in the presence of supplierôs representative, copies of test certificates.

ii) Information and copies of test certificates as in (i) above in respect of bought out items.

iii) List of manufacturing facilities available.

iv) Level of automation achieved and list of areas where manual processing exists.

v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

vi) Special features provided in the equipment to make it maintance free.

vii) The bidder should have adequate facilities to carryout accurately all required tests during manufacturing and routine/acceptance tests as per relevant ISS/IEC standards at the final end routine/acceptance. The supplier will ensure that all testing / measuring instruments/apparatus are calibrated at regular periodicity from reputed test house as per relevant standards and a certificate of testing authority is made available to purchaserôs inspector at the time of inspection. Such calibration certificates, in any case shall not older than one year on the date of such testsò.

viii) List of testing instruments and apparatus alongwith their last date of calibration, available with the bidder for testing of equipment specified and test plant limitation, if any, vis-a-vis the type, special acceptance and routine tests testing during manufacture specified in the relevant standards. These limitations shall be very clearly brought out in ñSchedule of Deviations.ò.

7.2 The supplier shall within 30 days of placement of order, submit the following information to the purchaser.

i) Name of the raw material as well as bought out accessories and the names of sub-suppliers selected form those furnished alongwith the offer.

ii) Type test certificates of the raw material and bought out accessories.

iii) Quality Assurance Plan (QAP) with hold points for purchaserôs inspection, the QAP and Purchaserôs hold points shall be discussed between the purchaser and the supplier before the QAP, is finalised.

7.3 The Supplier shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the fully assembled equipment.

8.0 DOCUMENTATION

8.1 i) The Supplier shall furnish alongwith the bid the dimensional drawings of transformer, LA and all other accessories.

ii) These drawings shall include the following information:

a) Detailed internal drawings of transformer clearly indicating insulation, core assembly and windings duly incorporating all important dimensions.
b) Tolerances on dimensions.
c) Material designation used for different components with reference to standards.
d) Fabrication details such as welds, finishes and coatings.
e) Catalogue or part numbers for each component and the total assembly with bill of materials.
f) Identification marking.
g) Weight of individual components and total assembled weight.

iii) The Assembly drawings shall include the following:-

a) Brief installation instructions.
b) Design installation torque for the bolt or cap screw.
c) Withstand torque that can be applied to the bolt or cap screw without failure of components or parts thereof.
d) Compression die number with recommended compression pressure.
e) Relevant technical details of significance.

8.2 Test Reports

8.2.1 After all the test have been completed , 6 certified copies of each test report shall be furnished. Each report shall supply the following information.

i) Complete identification data including serial number of the transformer/equipment tested.

ii) Method of application where applied, duration and interpretation of reslt of each test.

iii) Temp. dependent data corresponding to 75 deg. C routine test reports shall also furnish following information.

a) Calculated value of regulations at unity, 0.9, 0.8 lagging and 0.8 leading power factor.
b) Calculated value of positive, negative and zero phase sequence impedance of the transformer.
c) Calculated values of efficiency of transformer at 50,75 and 100% of rated capacity at 1.0 and 0.9 p.f.

iv) Six (6) copies of type test reports shall be furnished to the Purchaser within one month of conducting the tests. One copy will be returned duly certified by the purchaser to the supplier within three weeks thereafter and on receipt of the same supplier shall commence with the commercial production of the concerned material.

v) Six copies of acceptance test reports shall be furnished to the purchaser. One copy will be returned duly certified by the purchaser and only thereafter shall the materials be dispatched.

vi) All records of routine test reports shall be maintained by the supplier at its works for periodic inspection by the purchaser.

vii) All test reports for tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

## 9.0 PACKING AND FORWARDING

9.1 The loose equipment shall be packed in crates suitable for vertical / horizontal transport as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The Supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbol. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

9.2 Each consignment shall be accompanied by a detailed packing list containing the following information :-

a) Name of consignee
b) Details of consignment
c) Destination
d) Total weight of consignment
e) Sign showing upper/lower side of the crate.
f) Handling and unpacking instructions.
g) Bill of material indicating contents of each package.

The supplier shall ensure that the packing and bill of material are approved by the purchaser before dispatch.

9.3 The transformer shall be supplied filled with oil according to the standard practice of the supplier. If the transformers are desptached partly filled with oil, a suitable oil level gauge should be provided on the transformer tank to indicate oil level during transport.

## 10.0 QUANTITY REQUIREMENT

The scope of supply shall include a supply of 2.5% extra quantity of bolts, nuts, washers, split pins, cotter pins, and such other small loose items free of cost.

**Annexure-I**

**System Particulars**

The particulars of the system in which the equipment shall be used are detailed below:-

| | | | | |
|---|---|---|---|---|
| 1. | Highest System Voltage | 420/245/36 kV | | |
| 2. | System frequency | 50 Hz | | |
| 3. | No. of Phases | Three | | |
| 4. | System Earthing | Solidly grounded | | |
| 5. | Short Circuit level | i) | 400 kV | -40 kA |
| | | ii) | 220 kV | -40 kA |
| | | iii) | 33 kV | -40 kA |
| 6. | Auxiliary Power supply | i) A.C. 240 Volts Single phase and and 415 Volts 3 Phase 50 Hz. | | |
| | | ii) DC. 220 Volts | | |

**Notes:- The above auxiliary power supply are subject to the variation given below:-**

| | |
|---|---|
| AC Supply | -Voltage variation ± 10% |
| | -Frequency variation ± 5% |
| DC Supply | - Voltage variation ï 15% to +10% |

**Annexure-II**

(To be filled in by the bidder)

**Guaranteed and Technical Particulars for Transformer**

(Note:- Guaranteed particulars should be marked by *)

| | | | |
|---|---|---|---|
| 1. | Name of Manufacturer and country of origin | | |
| 2. | Governing standard | | |
| 3. | Service (Outdoor/Indoor) | | |
| 4. | Rated frequency | | |
| 5. | No. of cooling | | |
| 6. | No. of phases | | |
| 7. | No. of windings | | |
| 8. | Rating, kVA | HV | LV |
| 9. | Rated voltage, kV<br>i) HV<br>ii)LV | | |
| 10. | Connections<br>i) HV<br>ii) LV | | |
| 11. | Connection symbol | | |
| 12. | Temperature rise of oil above 0 reference peak ambient temp. | | |
| 13. | Temperature rise of winding by resistance above reference peak ambient temperature, deg. C. | | |

Note:- Guaranteed temperature rise limits shall be valid for all the taps.

| | | | |
|---|---|---|---|
| 14. | Temperature gradient between windings and oil, deg. C. | | |
| 15. | Limit of hot spot temperature for which the transformer is designed deg. C. (with reference to weighted ambient temperature of 35 deg. C) | | |
| 16. | **i) *a)** Guaranteed no load losses at rated voltage, normal ratio and rated frequency and 75 deg. C average winding temperature, KW<br>***b)** Tolerance, in any, KW<br>**ii)** No load losses at the highest voltage for the equipment, KW<br>**iii)** No load current at the highest voltage for the equipment | Main transformer | |
| 17. | Effieiencies at 75 deg. C at<br>At full load<br>At ¾ full load<br>At ½ full load | Unity p.f | 0.8p.f lagging |

18. Positive sequence impedance on rated MVA base at rated current and frequency and 75 deg. C winding temperature at.
    i) Principal tap, %
    ii) Highest tap, %
    iii) Lowest tap, %

19. Zero sequence impedance at principal tap, %

20. Reactance on rated kVA base at rated current and temperature, % — Unit Power factor — 0.9p.f (lagging)

    i) on 100% load
    ii) on 75% load
    iii) on 50% load

21. Maximum efficiency (percent) and the percentage load at which it occurs.

22. Regulation at full load at 75 deg.C expressed as a percentage of normal voltage at, %
    i) Unity power factor
    ii) 0.8 power factor(lagging)
    iii) 0.9 power factor(lagging)
    iv) 0.8 power factor (leading)

23. Core data

    i) Material for core laminations
    ii) Thickness of laminations, mm
    iii) Insulation between core laminations
    iv) Insulation of core bolts, washers and plates etc.
    v) Max. flux density in steel at rated voltage (33 kV) frequency and ratio.
    a) Core Tesla
    b) Yoke, Tesla
    vi) Number of limbs of the core
    vii) Magnetising current at normal ratio and at the frequency.
    a) 90% of rated voltage
    b) 100% of rated voltage
    c) 110 % of rated voltage
    viii) power factor of magnetizing current at normal voltage, ratio and frequency
    ix) Core bolt insulation withstand
    x) Voltage for one minute, kv
    xi) Time in second for which the Transformer can withstand the following Over fluxing condition.
    a) 125% Sec.

b) 145% Sec.
c) 150% Sec.

24. Date on winding

| | | | |
|---|---|---|---|
| i) | Max. current density at CMR and conductor area | Current density ($A/CM^2$) | Conductor area ($CM^2$) |
| | a) HV | | |
| | b) LV | | |
| ii) | Conductivity of copper used in HV and LV windings. | | |
| iii) | Type and material of windings | | |
| a) | HV | | |
| b) | LV | | |
| iv) | Insulating material used for | | |
| a) | HV winding | | |
| b) | LV Winding | | |
| v) | Insulation material used between | | |
| a) | HV & LV winding | | |
| b) | LV Winding & Core | | |
| vi) | Details of special arrangement provided to improve surge voltage distribution in the windings. | | |
| vii) | Extent of reinforced turns at HV/and adjacent to tapings. | | |
| viii) | Position of tapping on HV windings. | | |
| ix) | Inter-turn insulation reinforcement material. | | |
| x) | Type of axial coil supports for | | |
| a) | HV winding | | |
| b) | LV Winding | | |
| x) | Type of radial coil supports for | | |
| a) | HV winding | | |
| b) | LV Winding | | |
| xii) | Whether HV windings are inter-leaved. | | |
| xiii) | Maximum out of balance force in windings on short circuit at terminals. | | |

| | | | |
|---|---|---|---|
| xiv) | Min. factor of safety for windings against axial and radial force to short circuit. | HV | LV |
| 25. | Type of Joints:- | | |
| | i) Between core limb and yoke<br>ii) In windings. | | |
| 26. | Test Voltage for Windings | HV | LV |
| | i) Lighting impulse withstand test voltage, kV peak.<br>ii) Power frequency withstand test voltage, kV rms. | | |
| 27. | Cooling System | | |
| | i) Size of tube/radiator<br>ii) No. of tubes/radiators. | | |
| 28. | Off load tap changing gear | | |
| | a) Number of taps.<br>b) Step voltage in percentage for all taps.<br>c) Range of tap changer<br>d) Whether taps on HV/LV | | |
| 29. | Bushings<br>i) Make & type<br>ii) Rated voltage UM in kV<br>iii) Rated current, Amps.<br>iv) 1.2X50 micro second wave impulse withstand voltage kV peak.<br>v) Power frequency withstand test voltage.<br>a) wet for one minute, kV rms<br>b) Dry for one minutes, kV rms.<br>vi) Creepage distance in air, mm<br>vii) Quantity of oil in bushing and specification of oil used.<br>viii) Whether terminal connectors for HV bushings & cable box for LV Bushings included in the scope of supply.<br>x) Type of load and its material and size. | | |
| 30. | Conservator | | |
| | i) Total volume, litres.<br>ii) Volume between the highest and lowest permissible oil levels, litres. | | |
| 31. | Tank | | |

i) Material and thickness of plate for construction of tank, radiator.
a) Side plate
b) Bottom plate
c) Cover plate
d) Raidator tubes/fins
ii) Vacuum which the tank can be subjected to without distortion
iii) under Carriage
a) Number of bi-directional wheels provided
b) Spacing between

32. CTs on HV bushing/load

| | Core I | Core II | Core III |
|---|---|---|---|
| 1. Rated primary/current | | | |
| 2. Rated secondary current | | | |
| 3. Class of Accuracy | | | |
| 4. Accuracy limit factor | | | |
| 5. Instrument security factor | | | |
| 6. Knee point voltage, VK | | | |
| 7. Magnetisation current at VK/2,MA | | | |
| 8. Resistance of secondary windings. | | | |
| 9. Rated short time current, KA rma. | | | |
| 10. Duration short time current seconds. | | | |
| 11. Rated dynamic s.t. current, KA peak. | | | |

33. Details of oil preservation equipment offered.

34. Minimum clearances, mm

| | In Oil | | In Air | |
|---|---|---|---|---|
| | Between Phases | Phases to ground | Between phases | Phases to ground |
| a) HV | | | | |
| b) LV | | | | |

35. Weight and diamensions
i) Weights, MT
a) Weight of core
b) Weight of windings
HV
LV
c) Weight of core, winding & tank
d) Weight of completes transformer with oil and fittings.
e) Weight of copper in windings.
ii) Dimensions, meters
a) Overall height above track
b) Overall length
c) Overall breadth
iii) Weight of the heaviest package of the transformer arranged for trans-portation M.T.

iv) Dimensions of the largest package
of the transformer arranged for
transportation.

36. Type of winding temperature indicator
Whether grounded shield provided between
Adjeacent phases of windings & between
Leads of difference phases from bushing
To winding & leads from end of winding
To HV terminal of other winding.

37. Any other particulars considered
necessary by the tenderer.

NOTE:- All particulars bearing asterisk (*) mark
in this schedule shall be subject to guarantee

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**LT SWITCHGEAR**
**Part-19**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**PART-19 (Vol. II)**

**Technical Specification for LT SWITCHGEAR**

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**Technical Specification**

**LT SWITCHGEAR (Part-19)**

1.1 CONSTRUCTIONAL DETAILS OF SWITCHBOARDS AND DISTRIBUTION BOARDS

1.1.1 All boards shall be of metal enclosed, indoor floor mounted, compartmentalized construction and free-standing 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.

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, free from flaws, twists and bends. All cut-outs shall be true in shape.

1.1.5 All boards shall be of dust and vermin proof construction and shall be provided with a degree of protection of I P:52 as per IS 2147, are also acceptable where continuous bus bar rating exceeds 10000 Amps. Provision shall be made in all compartments for providing IP:52 degree of protection, when circuit breaker or module trolley, has been removed. All cut-outs shall be provided with neoprene / Synthetic rubber gaskets.

1.1.6 Provision of louvers on boards would not be preferred. However, louvers backed with metal screen are acceptable on the bus bar chambers where continuous bus bar rating exceeds 1000 Amps.

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.

1.1.9 Boards shall be supplied with base frames made of structural steel section, alongwith all necessary mounting hardware required for welding the base frames to the insert plates.

1.1.10 All boards shall be divided into distinct vertical sections, each comprising of :

I. A completely enclosed bus bar compartment for running horizontal and vertical bus bars. Bus bar chamber shall be completely enclosed with metallic portions. Bolted covers shall be provided for access to horizontal and vertical bus bars and all joints for repair and maintenance, which shall be feasible without distributing feeder compartment.

II. Completely enclosed switch-gear compartments (s) one for each circuit for housing circuit breaker or motor starter.

III. A compartment or alloy for power and control cables. Cable alloy door shall preferably be hinged. Cable alley shall have no exposed live parts, and shall have no communication with bus bar chamber.

IV. A compartment for relays and other control devices associated with a circuit breaker.

1.1.11 Sheet steel barriers shall be provided between two adjacent vertical panels running to the fill height of the switchboard, except for the horizontal bus bar 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 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, the main switch shall be operable from outside and will be interlocked with the compartment door such that the later can be opened only when the switch is off. However, it shall be possible to defeat this interlock and open and close the door with the switch ON. The main switch shall have the facility of being pad-locked in both ON and OFF positions. The switch handle shall clearly indicate the position of main switch.

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 bus bar 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 bus bars, shall be 25 mm. For all other components, the clearance between ñtwo live partsòñA live part and an earthed partòand 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 bus bar minimum clearance of 25 mm should be maintained even if they are sleeved.

1.1.15 The temperature rise of horizontal & vertical bus bars 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 single front boards shall be provided with removable bolted covers at the rear. The covers shall be provided with danger labels.

1.1.17 All identical circuit breakers and module chassis of the 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 draw-out 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 Whenever 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 draw-out contact system shall be silver plated. Both fixed and moving contacts shall be replaceable.

1.1.21 All AC & DC boards shall be of single front type.

1.1.22 AC & DC distribution boards shall be divided into vertical sections. Each vertical section shall be provided with a cable alley, which shall cover the entire height and shall be of atleast 350 mm width.

1.1.23 All module shall be fixed type except circuit breaker module and mother feeder modules, which shall be draw-out type.

1.1.24 The connections from bus bars to the main switch shall be fully insulated / shrouded, and securely bolted. The participation 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.

***1.1.25*** 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 bus bars and module components, for each type and rating for approval.***

1.1.26 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.

1.1.27 Adopter panels and dummy panels required to meet the various bus bar arrangements and layouts required shall be included in bidder's scope of work.

1.1.28 All sheet work shall be pretreated, in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by picking 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 "Class-C" as specified in IS: 6005. The phosphated 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 on panels shall be applied, Electrostatic painting / Powder coating shall also be acceptable.

1.1.29 Finishing paint on panels shall be shade 631 unless required otherwise by the PURCHASER. The inside shall be properly stoved. The paint thickness shall be coated by peelable compound by sparing method of protect the finished surtaces form scratches grease dirt and oily spots during testing, transportation, handling and erection.

1.2 DERATING OF EQUIPMENTS

1.2.1 The current ratings of all equipments as specified in the Bill of materials are the minimum standards current ratings at reference ambient temperature of 50°C.

1.2.2 The bidder shall indicate clearly the derating factors employed for each component and furnish the bais for arriving at these derating factors duly considering the specified ambient temperature of 50°C.

1.3 POWER BUS BARS AND INSULATORS

1.3.1 All AC Distribution Boards shall be provided with three phase buses and neutral bus bars and the DC distribution Boards, shall be provided with two bus bars.

***1.3.2*** All bus bars and jumper connections shall be of high conductivity aluminum / copper of adequate size the ***bus bar size calculation shall be submitted for approval.***

1.3.3 The cross-section of the bus bars shall be uniform through out 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 bus bar joints shall be adequately supported by non-hygro-scopic, non-combustible, track-resistant and high strength type polyester fiber glass moulded insulators, separate supports shall

be provided for each phase and neutral bus bar. If a common support is provided anti-tracking barriers shall be provided between the supports.

1.3.5 All bus bars 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 bus bars 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 bus bars shall be colour coded as per IS:375.

1.3.7 The bidder shall furnish calculations alongwith the bid, establishing the adequacy of bus bar 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 copper 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 as indicated in Bill of Materials 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 switch-gear 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 Each module frame shall get engaged to the vertical earth bus. Before the disconnecting contracts on these module are engaged to the vertical bus bar.

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 no less than 2.5 mm2. 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 earth connection 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 name plane ó Caution-Live Terminalsô shall be provided at all points where the terminals are like to remain live and isolation is possible only at remote end.

1.5 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 ñTechnical Parametersò. 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 alongwith it operating mechanism on a wheeled carriage. Suitable guides shall be provided to minimize misalignment of the breaker.

1.5.3 Three shall be service, test and fully withdrawn positions for the breakers. In test position that Circuit Breaker shall be capable of being tested for operation without energizing the power circuits. I é 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 the breaking. 10 Amps at 240 V AC and 1 Amps. (inductive) at 220 V DC.

1.5.5 Suitable mechanical indications shall be provided on all circuit breakers to show OPEN, CLOSE, SERVICE, TEST AND SPRING CHARGED position.

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 TST position shall not be possible unless it is in OPEN position. Attempted with 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 WIHTDRAWN 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 shutter internationally 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 shouded to prevent accidental operation.

1.5.14 Breaker controlled motors shall operate satisfactorily under the following :-

i. Director on-line staring o induction motors rated 110 kW to 220 kW with a locked rotor current of seven times the rated current and starting time of upto 30 seconds.

ii. Breaking on-load full load and locked rotor current of Induction Motors for rated 100 KW to 200 KW.

1.5.15 Means shall be provided to slowly close the circuit breaker in withdrawn position. If required for inspection and setting of contracts, 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 220 V 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 once 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 sequences of closing and opening operations shall be possible. After failure of power supply at least one open ï close ï 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 sof voltage between 85% tto 100% at rated control voltage. The trip coil shall operate satisfactorily under all values of supply voltage between 70% to 100% of rated control voltage.

1.5.22 Provision for mechanical closing of the breaker only in TEST and WITHDRAWN position 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 upstream and down stream 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 IS:13947 Part-2. All MCCB shall be of P2 duty.

1.6.2 MCCB shall be flush mounted on the AC / DC distribution boards.

1.6.3 MCCBs shall be provided with thermo-magnetic type release for over current and short circuit protraction. The setting of the thermal release shall be adjustable between 75% to 100% of the rated current. The magnetic release setting shall be adjustable between 300% to 600% of the thermal release setting at site.

1.6.4 MCCBs in AC application shall also be provided with under voltage release with time delay. MCCBs shall also have 2 NO and 2 NC auxiliary contact either built in or using auxiliary switch for purchaserôs use.

1.6.5 MCCBs shall be manually operated. The operating handle should give a clear trip indication.

1.6.6 Miniature circuit breaker (MCB shall conform to IEC-898-1987 and IS: 8828.

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 fromte front. They shall eight 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 cased.

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 atleast two potentially free output contacts. Relays shall have contracts 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 kVC (rms) for one minute.

1.7.6 Motor starters shall be provided with three element, ambient temperature compensated, time lagged, hand reset type of overload relays with adjustable settings. The setting ranges shall be properly selected to suit the motor ratings. These relays shall have a separate back coloured hand reset push button mounted on compartment door and shall have at least once changeover contact.

1.7.7 All fuse-protected contractor ï controlled motor shall have single phase protection, either at 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, electro-magneic type rated for uninterrupted duty as IS:13947 (Part-4).

1.8.2 Contactors shall be double break, non-gravity type and their main contracts shall be silver faced.

1.8.3 Direct on Jinc starter contactors shall be of utilisation category AC2. These contractors shall be as per IS:13948 (Part-4).

1.8.4 Each contractor 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 240 V AC unless otherwise specified elsewhere. The contactors shall operate satisfactorily between 85% to 110% of the rated voltage. The contractor 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 starpoint 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 HRC current limiting fuses 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 atleast 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.

1.10.3 All instruments shall have white dlals with black numerals and lettering. Black knife edge pointer with parallel free diarls 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 plats 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 contracts against dust ingress shall be preferred.

1.11.2 Circuit breaker selector switches for breaker controller motor shall have three stay put positions marked ôSwitchgearö Normal and trial respectively. They shall have two contacts of each of the 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 on circuiting of CT secondaries.

1.11.4 Contracts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service.

1.11.5 The contract ratings shall be at least the following :-

i) Make and carry continuously 10 Amp.

ii) Breaking current at 220 V DC 1 Amp. (Inductive)

iii) Breaking current at 240 V 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 IS:4064.

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 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 the 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 240 V and 0.5 A (inductive) at 220 V 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 is 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 filament type and 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.

1.14.2 Lamps shall have translucent lamps-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 ï 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 Bulbs and lmaps-covers shall be easily replaceable from the front the cubicle.

1.14.4 Indication lamps should be located just above the associated push button / control switches. Red lamps shall 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 alongwith the center 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 ï 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 415 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 swithgear.

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 ôELEMEXô standard type terminals, cage clamp type of Phoenix or WAGO or equivalent.

1.16.2 Terminals 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 earhing facilities. It shall be similarly to ôElemôôCTDô 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 atleast 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 240 V 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 upto the terminal blocks ready to receive Purchaserôs 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. Gland plates shall be factory-drilled according to the cable gland sizes and number which shall be informed to the contractor later. For all single core cables, gland plates shall be of non-magnetic material.

1.21 TEST AND REPORTS

1.21.1 Type test reports of circuit breakers, bus bars and panels, contractor and relays and all important components like instrument transformers, meters, isolating switches & fuses etc. shall be furnished by the successful bidder, before the fabrication of switchgear is started. The reports shall cover all applicable type tests listed in relevant Indian Standards for all component for each type and ratings being supplied.

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 lime manner so that it is level, plumb, square and properly aligned and oriented. Tolerance shall be as estalished in Contractorôs drawings or as stipulated by purchaser. No equipment shall be permanently bolted down to foundations until the alignment has been checked and fund 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 utilized to lift or erect any equipment without prior permission of purchaser.

1.22.6 All boards shall be installed in accordance with Indian Standards IS:3072 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 from 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, contractors 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 additional 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 shutter.

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 ï 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 Transformer

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 CR 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 rest 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 Total price of the special tools and tackles shall be included in the proposal sheets.

1.25 EQUIPMENT TO BE FURNISHED

1.25.1 The bidder shall quote for various AC / DC distribution boards as given in Bill of Materials and in accordance with this specification.

1.25.2 Standard scheme for 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 requirements. An 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 lams shall be provided as per scheme requirement. Any other item / component required with in 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) | Tripple 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. The earth fault relay shal be provided with a stabilising resistor. |

1.25.5 Module Type M1 (Circuit breaker controller motor feeder)

| | | |
|---|---|---|
| i. | One (1) | Tripple pole air circuit breaker complete with all accessories and power operated mechanism as specified. |
| ii. | One (1) | Three position 6 pole selector switch "SWITCHGEAR / NORMAL / TRIAL" |
| iii. | Three (3) | Curent transformer for metering |
| iv. | One (1) | Ammeter with selector switch |

| | | |
|---|---|---|
| v. | Three (3) | Current transformer for relaying. |
| vi. | One (1) | Tripple pole instantaneous over-current relay for providing positive swquence 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 ï 200 kW. The relay shall have an adjustable setting range of 50% - 200% of CT secondary current and time setting 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 s ec. |
| ix. | One (1) | Instantaneous earth faultl 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. |

1.25.6 Module G-1 (VT Module with under voltage relay)

| | | |
|---|---|---|
| i. | Three (3) | 415 / √3 / 110 / √3 volts single phase voltage transformer star / star connect with star point solidly earthed mounted on common drawout chassis. Accuracy class 0.5 for protection and metering with 50 VA 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 220 V DC. |
| vii. | One (1) | Auxiliary relay 220 V DC with 2 NO. Self reset contacts. |
| viii. | Three (3) | Indicating lamps with series resistor and colour lenses (Red, Blue & Yellow). |

1.25.7 Module Type G-2

| | | |
|---|---|---|
| i. | Three (3) | HRC Fuse |

| | | |
|---|---|---|
| ii. | One (1) | Voltmeter (0-500 V) |
| iii. | One (1) | Voltmeter selector switch four position (R-Y, Y-B, B-R OFF). |
| iv. | Three (3) | Indication lamps (Red, Blue & Yellow). |

1.25.8 Module Type II & II (BC) Isolating Switch Controlled Incoming circuit)

| | | |
|---|---|---|
| i. | One (1) | Four pole MCCB |
| ii. | One (1) | Red indicating lamp to indicate isolating switch closed position. |

1.25.9 Module Type S : (DC Metering and Protection Module)

| | | |
|---|---|---|
| i. | One (1) | Voltmeter 300-0-300 V DC for 220 V DC DB / Voltmeter 0-75 V DC for 50 V DCDB. |
| ii. | One (1) | Three (3) position voltmeter selector switch. |
| iii. | One (1) | Instantaneous under voltage relay with 95% of 20 DC. The resetting ratio 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 220 V 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 220 V DC system having adjustable pick up range between 3 to 7 milliamps the relay shall be suitable for 220 V DC / 240 V AC auxiliary supply. |

1.25.11 Module Type X

One (1) Double pole 250 V MCB

1.25.12 Module Type ï DC (Incomer from Battery & Chargers)

| | | |
|---|---|---|
| i. | Two (2) | Copper link for incomer from battery |
| ii. | One (1) | DC ammeter with shunt and range of 40-0-50 Amps. For 220 V DC DB and 60-0-150 Amp for 50 V DC DB. |
| iii. | Two (2) | Double pole 250 V DC MCCB / MCB. |
| iv. | One (1) | Double pole single throw 250 V DC air break switch connecting battery & charger sections to DC DB. |

1.25.13 Module Type H1

| | | |
|---|---|---|
| i. | One (1) | Double pole DC switch with pad locking facility in off position. |

1.25.14 Module Type EL

| | | |
|---|---|---|
| i. | One (1) | Four pole MCCB |
| ii. | One (1) | Connector |
| iii. | Two (2) | Electronic Timer suitable for continuous operation |
| iv. | Two (2) | (Toggle) control switch. |

1.26 PARAMETERS

1.26.1 Power Supply

1.26.1.1 AC System 3 Phase, 4 wire, solidly earthed.

| | | |
|---|---|---|
| a. | Voltage | 415 Volts, ± 10%. |
| b. | Frequency | 50 Hz ± 5%. |
| c. | Combined variation | ± 10% absolute sum in voltage & frequency. |
| d. | Fault Level | 20 kA (rms) |

1.26.1.2 DC System @ Wire, unearthed.

| | | |
|---|---|---|
| a. | System Voltage | 220 Volts, ± 10%. |
| b. | Fault Level | 4 kA |
| c. | System Voltage | 50 V ± 10%. |
| d. | Fault Level | - |

1.26.2 Control Supply Voltage

| | | |
|---|---|---|
| a. | Trip and closing coils | 220 V DC unearthed |
| b. | Spring charging | 220 V DC unearthed |

1.26.3 Cubicle Data

1.26.3.1 Bus bar rating

| | | |
|---|---|---|
| a. | Continuous for vertical panels | As specified in Bill of Materials. |
| b. | Short time (1 ec. KA rms) | 20 kA |
| c. | Momentary (kA) PEAK | 45 kA |
| d. | Ambient Temperature | 50°C |
| e. | One minute power frequency withstand | |
| i. | Power circuit | 2400 volts (rms) |

| | | |
|---|---|---|
| ii. | Control circuit | 2500 volts (rms) |

1.26.3.2 Cubic Colour Finish

| | | |
|---|---|---|
| a. | Interior | Glossy white. |
| b. | Exterior | Smoke gray shade No.692 of IS:5. |

1.26.4 Circuit Breaker

| | | |
|---|---|---|
| a. | Type | Air Break |
| b. | No. of Poles | 3 |
| c. | Voltage & Frequency | 415 ± 10%, 50 Hz + 5% |
| d. | Rated operating duty | B-3 Min. M-B-3 Min. MB |
| e. | Symmetrical interrupting rating | 20 kA (rms) |
| f. | Short circuit making current | 45 kA (peak) |
| g. | Short time withstand current for 1 sec. Duration | 20 kA (rms) for 1 sec. |
| h. | Operating mechanism current for 1 sec. Duration | 20 kA (rms) for 1 sec. |
| i. | No. of Auxiliary Contacts | 4 NO & 4 NC contacts for purchaserÕs use on fixed portion of the cubicle |
| j. | Short circuit breaking current | |
| | i. AC Component | 20 kA (rms) |
| | ii. DC Component | As per IS : 13947 (Part ï 2) |

1.26.5 MOULDED CASE CIRCUIT BREAKER

| | | Ac System | DC System |
|---|---|---|---|
| a. | No. of poles | 4 | 2 |
| b. | Voltage & frequency | 415 ± 10%, 50 Hz + 5% | 250V |
| c. | Rated operating duty | P2 | P2 |
| d. | Symmertrical interrupting rating | 20 kA (rms) | 4 kA |
| e. | Short circuit making current | 45 kA (peak) | - |
| f. | No. of auxiliary contacts | 2 NO & NC | 2 NO & NC |
| g. | Short Circuit breaking current | | |
| i. | AC Component | 20 kA (rms) | As per IS |
| ii. | DC Component | As per IS 13947 | As per IS 13947 |

1.26.6 Meters

| | | |
|---|---|---|
| a. | Accuracy | As per IS : 13947 (Part 2) |
| b. | One minute power frequency withstand test voltage in KV | 2.0 |

1.26.7 Current Transformers

| | | |
|---|---|---|
| a. | Type | Cast resin, Bar primary |
| b. | Voltage class and frequency | 650 V, 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 Raring (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 kA (rms) |

1.26.8 Voltage Transformer

| | | |
|---|---|---|
| a. | Type | Cast resin |
| b. | Rated voltage | |
| | Primary | 415 / √3 V |
| | Secondary | 110 / √3 V |
| c. | Method of connection | |
| | Primary | Star |
| | Secondary | Star |
| d. | Rated voltage factor | 1.1 continuous, 1.5 for 3 seconds |
| e. | Class on insulation | E or better |
| f. | One minute power frequency withstand voltage | 2.5 kV (rms) |

| | | | |
|---|---|---|---|
| | g. | Accuracy class | 0.5, not less than 20 VA |

1.26.9 Relay

| | | | |
|---|---|---|---|
| | a. | One minute power frequency withstand test | 2 kV (rms) |

1.27 AUTOMATIC CONTROL OF OUTDOOR LIGHTING

1.27.1 EL-type module of 415 V MAIN 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 415 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 ACDBs 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.

ANNEXURE-I

**GUARANTEED TECHNICAL PARTICULARS OF AC & DC DISTRIBUTION**

TYPICAL SWITCHGEAR AND AC AND DC DISTRIBUTION BOARD DATA

| Sl.No. | Particulars | Remarks |
|---|---|---|
| 1. | Manufacturerôs name and country of manufacture | |
| 2. | Whether requirements of LT Switchgear manufacturerôs furnished | YES / NO |
| 3. | Rated voltage | |
| a. | Symmetrical short circuit withstand at rated voltage of switchgear cubicle | |
| b. | Peak short circuit withstand current | |
| 4. | Degree of protection as per IS: 2147 | |
| a. | Breaker / MCC / AC & DC distribution cubicles | |
| b. | Bus bar chamber | |
| 5. | Cubicle sheet metal details | |
| a. | Cold rolled / hot rolled | |
| b. | Thickness (Structural frames and load bearing members) | |
| c. | Thickness (front and rear) | |
| d. | Thickness (sides and top) | |
| 6. | Painting shade as per IS:5 | |
| a. | External surfaces | |
| b. | Internal surfaces | |
| 7. | Clearance in air | |
| a. | Between phases | |
| b. | Between phase and earth | |
| c. | AC / DC distribution board | |
| 8. | Width of cable alley | |
| 9. | Earth bus bar size and material | |
| 10. | Approx. weight of one panel with circuit breaker | |
| 11. | Recommended dynamic loading for foundation design | |
| 12. | Approx. weight of one distribution panel | |
| | CIRCUIT BREAKER | |
| 13. | Makerôs name and country of manufacturer | |
| 14. | Manufacturerôs type and designation | |
| 15. | Voltage | |
| 16. | Rated operating duty | |

| | | |
|---|---|---|
| 17. | Rated current at design ambient temperature | |
| 18. | Design ambient temperature | |
| 19. | Derating factor for site operating conditions | |
| 20. | Continuous current at 50°C | |
| 21. | Rated symmetrical breaker current | |
| 22. | Rated peak making current | |
| 23. | Rated short time rating for (1 sec.) | |
| 24. | Rated peak momentary rating | |
| 25. | Maximum temperature rise of the main contacts when breaker is carrying continuous current (as derated for operating under site conditions) over specified ambient temperature of 50°C. | |
| 26. | Thickness of silver coating for main contacts | |
| 27. | Number of openings (the circuit breaker is capable of performing without inspection replacement of contacts or other parts at 100% rated breaking current) | |
| 28. | No. of breaker auxiliary contacts provided on fixed portion of breaker and their rating. | |
| 29. | Have trip free and anti-pumping features (furnish description) | |
| 30. | Power operating mechanism | |
| 21. | Spring charging motor details : | |
| a. | Type | |
| b. | Rating | |
| c. | Rated voltage | |
| d. | Class of Insulation | |
| e. | Time for fully charging the closing spring | |
| 32. | Emergency manual charging facility provided | Yes / No |
| 33. | Limits of voltage of satisfactory operation of the following devices, as percentage of normal voltage | |
| a. | Motor | |
| b. | Closing coil | |
| c. | Tripping coil | |
| 34. | Power required for closing at | |
| a. | Normal voltage | |
| b. | 85% of normal voltage | |
| 35. | Power required at tripping for | |
| a. | Normal voltage | |

| | | |
|---|---|---|
| b. | 70% of normal voltage | |
| 36. | Manual operating mechanism | |
| 37. | Spring charging handle provided | Yes / No |
| 38. | Type of releases provided | |
| 39. | Tolerances | |
| 40. | Whether indication of individual releases provided | Yes / No |
| | POWER BUS BARS AND INSULATORS | |
| 41. | Materials and applicable standards | |
| 42. | Bare / painted / epoxy / insulated / sleeved | |
| 43. | Bus joints silver faced | Yes / No |
| 44. | Minimum clearance | |
| a. | Phase to phase mm | |
| b. | Phase to earth mm | |
| 45. | Continuous current rating | |
| a. | At 40°C Ambient Amps. | |
| b. | At 50°C ambient amps | |
| 46. | Minimum cross section provided for | |
| a. | Horizontal bus bar mm | |
| b. | Vertical bus bar mm | |
| 47. | Temperature rise over design ambient temperature at 50°C for continuous current rating °C. | |
| 48. | One second current rating kA | |
| 49. | Dynamic current withstand rating kA peak | |
| 50 | Material of the support insulators. | |
| 51 | Tracking index of insulators | |
| | CONTACTS | |
| 52. | Make | |
| 53. | Type and applicable standards | |
| 54. | No. of Poles | |
| 55. | Rated voltage of main and auxiliary contacts | |
| 56. | Rated voltage of coils | |
| 57. | Limits of operation | |
| a. | Supply voltage variation ± % | |
| b. | Supply frequency variation for closing ± %. | |
| c. | Drop out voltage V | |
| 58. | Rated (Thermal) current A | |
| 59. | Rated duty | |
| 60 | No. of operations / hour capability | |
| 61. | Rated utilisation category as per IS 2459 | |

| | | |
|---|---|---|
| 62. | Rating breaking capacity kA. | |
| 63. | Rating making capacity kA | |
| 64. | Coil winding insulation class | |
| 65. | Max. recommended back up HRC fuse size | |
| | THERMAL OVERLOAD RELAY AND SINGLE PHASING PHEVENTER | |
| 66. | Type of overload relay | |
| 67. | Type of single phasing preventer | |
| 68. | No. of contacts available | |
| a. | O/L relay | |
| b. | Single phasing preventer | |
| | RELAYS | |
| 69. | Make | |
| 70 | Type | |
| 71. | Application | |
| 72. | Coil burden | |
| 73. | Setting range | |
| | AIR BREAK SWITCHES | |
| 74. | Make | |
| 75. | Type | |
| 76. | Application standard | |
| 77. | Rated current at design ambient temp. (Amps.) | |
| 78. | Design ambient temperature °C. | |
| 79. | Derating factor for use under size ambient conditions | |
| 80. | Rated breaking current kA | |
| 81. | Maximum through fault current withstand kA | |
| 82 | Maximum size of fuse recommended | |
| 83. | Temperature rise of contacts when carrying continuous rating current °C. | |
| 84. | Door interlock as specified has it ben provided | Yes / No |
| | FUSES | |
| 85. | Make | |
| 86. | Type | |
| 87. | Application Standard | |
| 88. | Rated Standards | |
| 89. | Reuptruing capacity kA | |
| 90. | Peak Cut-off current kA | |
| 91. | Whether mounted on as insulated carrier | Yes / No |
| | CURRENT TRANSFORMERS | |

| | | |
|---|---|---|
| 92. | Make | |
| 93. | Applicable standards | |
| 94. | Ratio | |
| 95 | Output | |
| 96 | Accuracy class | |
| 97. | Accuracy limit factor | |
| 98. | Instrument security factor | |
| 99. | Short time current for 1 Sec. kA | |
| 100. | Momentary | |
| 101. | Class of insulation | |
| | VOLTAGE TRANSFORMER | |
| 102. | Make | |
| 103. | Ratio | |
| 104. | Output | |
| 105. | Accuracy class | |
| 106. | Over voltage factor | |
| 107. | Class of insulation | |
| | AAUXILIARY CONTACTOR | |
| 108. | Make | |
| 109. | Type | |
| 110. | Coil voltage | |
| 111. | Coil burden | |
| 112. | Operating time | |
| 113. | No. of contacts | |
| a. | Normally open | |
| b. | Normally closed | |
| 114. | Contact rating | |
| | CONTROL / SELECTOR SWITCH | |
| 115. | Make | |
| 116. | Type designation | |
| 117. | Voltage grade | |
| 118. | Current rating | |
| | - MAKE , CARRY AND BREAK kA | |
| 119. | Spring return or stayout | |
| 120. | Type of handle | |
| 121. | No. of positions | |
| 122. | No. of poles / ways | |
| 123. | Contact materials and plating | |
| | VOLTMETER | |
| 124. | Make | |

| | | |
|---|---|---|
| 125. | Type | |
| 126. | Accuracy class | |
| 127. | Voltage coil rating | |
| 128. | Voltage coil burden | |
| 129. | Case size | |
| 130. | Angle of deflection | |
| 131. | Scale length | |
| | AMMETER | |
| 132. | Make | |
| 133. | Type | |
| 134. | Scale Range | |
| 135. | Accuracy class | L |
| 136. | Current coil rating | |
| 137. | Current coil burden | |
| 138. | Case size | |
| 139. | Case size | |
| | INDICATING LAMPS | |
| 140. | Make | |
| 141. | Type | |
| 142. | Voltage | |
| 143. | Series Resistor ï Rating and Value | |
| | PUSH BUTTONS | |
| 144. | MAKE | |
| 145. | Type designation | |
| 146. | Number of contacts (NO + NC) | |
| 147. | Contact rating amps. | |
| | SPACE HEATER (WHEREVER PROVIDED) | |
| 148. | Make | |
| 149. | Type | |
| 150 | Rated voltage | |
| 151. | Heater output (W) | |
| 152. | Thermostat setting range, °C. | |
| | WIRING AND TERMINAL BLOCKS | |
| 153. | Voltage grade off wires | |
| 154. | Insulation of wires | |
| 155. | Conductor material | |
| 156. | Minimum size of conductor for | |
| a. | Power wiring mm2 | |
| b. | Control wiring mm2 | |
| 157. | Type of control terminal block on | |

| | | |
|---|---|---|
| a. | Fixed portion and drawout portion | |
| b. | Switchgear and breaker | |
| 158. | Make and type of terminal blocks. | |
| 159. | Minimum current rating of terminal blocks | |

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**160 kVA DG SET**
**Part-20**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**Technical Specification of 160 kVA DG SET**
**Vol-II (Part-20)**

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**Vol.-II (Part-20 )**

**TECHNICAL SPECIFICATION FOR DG SET**

## 1. SCOPE :

The scope covers design, manufacture, supply, installation, testing and commissioning of noiseless Diesel Generator set of stationary type having a net electrical out put of 160KVA capacity at specified site conditions with all its accessories for installation at 400 kV substation.

## 2. SYSTEM PARTICUARS :

| | | |
|---|---|---|
| NORMAL VOLTAGE | | 415V |
| HIGHEST SYSTEM VOLTAGE | | 457V |
| NUMBER OF PHASES | | THREE |
| FREQUENCY | | 50 HZ |
| VOLTAGE VARIATION | (+ / - ) | 10% |
| FREQUENCY VARIATION | (+ / - ) | 5% |
| COMBINED VOLTAGE & FREQUENCY VARIATION | (+ / - ) | 5% |

## 3. STANDARDS:

Except where specified herein otherwise, all material, equipment & construction shall conform to the Indian Electricity Act & Rules & following standards with latest version :

| | | | |
|---|---|---|---|
| i) | Diesel Engine | : | IS:10002 /BS5514 |
| ii) | Alternator | : | IS: 4722 / BS2613 |

## 4. OPERATING CONDITIONS :

The DG Set shall be capable of working at any ambient temperature between 0-50 degree C and relative humidity upto 95%. Normally the set is to be operated under the following site conditions.

| | | |
|---|---|---|
| i) Altitude | : | 350 meter above sea level. |
| ii) Maximum summer temp. | : | 50 degree C |
| iii) Relative humidity | : | Upto95% (Average) |

## 5. PERFORMANCE REQUIREMENT

5.1 The working kVA rating of set shall be obtained at 0.8 power factor.

5.2 The period of operation :

The set may be idle for a long period except for switching on / off periodically. When there is an electrical main supply failure it will be required to work continuously for a period, which may even exceed 24 hours at a time.

5.3 Over load :

The set shall be capable of taking 10% over load for a period of one hour during any 12 hours period while operating continuously, at full rating load.

## 6. GENERAL TECHNICAL REQUIREMENTS:

### 6.1 Diesel Engine :

6.1.1 The engine shall be reciprocating compression ignition (diesel) engine, V type mult-cylinder. AMF operated, exhaust gas turbo charged after cooler with radiator, electric start and self starting type conforming to IS:10002. The engine shall be capable of delivering the required BHP in the operative conditions. The DG set shall be capable of generating 160 kVA / 128 kW at alternator panel at 1500 RPM, 0.8 power factor. 50 cycle per second, 415 volts 3 phase 4 wire, The bidder in his offer must furnish a detailed calculation justifying that the engine offered by bidder will meet the requirement of developing 160 kVA continuous net ouput at alternator panel.

The diesel engine shall be complete with following items :

i) Mechanical Governer (Class A1 governing as per BS5514)
ii) Oil bath air filter.
iii) Turbo charger and after cooler.
iv) Starter Motor 24 Volt.
v) Battery charging alternator 24V
vi) Gear pump for forced feed lubrication.
vii) Fuel injection pump Mico / Bosch make.
viii) Fuel filter- Double Bowl.
ix) Lub Oil Cooler
x) Lub Oil filter.
xi) Engine protection unit against High Water Temp and low Lub oil pressure complete with alarm and shut down facility.
xii) Instrument panel comprising of temp. guage for cooling water, techo cum hr. meter, Lub. Oil pressure guage, fuses and bettering charging ammeter.

6.1.2 Alternator :-

Only standard make alternator shall be preferred such as KIRLOSKAR / STAMPFORD / CROMPTON.

Above make brushless alternator in IP 23 enclosure rated for output of 160 kVA/128 kW at 0.8 pf. 415V, 3 phase, 4 wire, 1500 RPM. The voltage regulations should be within a 1% of rated voltage from no load to full load. Insulation should be class H/F. The alternator shall have provision for 10% over load for 1 hr. in every 12 hours running. The alternator shall conform to BS2613 / IS4722.

6.1.3 Base Plate : The engine and alternator should be mounted on common MS fabricated and all welded construction base plate.

6.1.4 Accessories

i) 2 Nos. 12V 180AH batteries with battery loads.
ii) 1 No. Fuel tank 12 hours capacity (Min.)
iii) Fuel prafiter and water separator.
iv) Heavy duty residential silencer.
v) 1 set of standard tools.
vi) Spare parts list.
vi) Operators manual.

6.1.5 Lubrication

Lubrication shall be positive pressure type and shall be lubricating all moving parts. No moving parts shall require lubrication by hand either prior to the starting of engine or while it is in operation. Lubricating oil filter shall be provided for operation at normal conditions for a period of 250 hours without any necessity of replacement or cleaning. Where lubricating oil cooling is used they shall be air cooled type. Temperature and pressure gauge shall be fitted to the lubricating system.

6.1.6 Fuel Tank

Each fuel tank shall be capable of storing fuel for 12 hours operation on a suitably fabricated steel platform. The tank shall be completed with level indicator marked in liters, 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 plant and shall be erected in accordance with Indian explosive act of 1932.

6.1.7 Cooling

Being water cooled engine it shall have Radiator with fan & mechanical water circulation pump as part of the Engine.

6.1.8 Speed and governing

The engine shall be supplied with mechanical governor. This governor shall be directly mounted on the engine to enable the speed variation from idling speed to the maximum load speed.

6.1.9 Engine Start

Engine shall be cold and self starting type. The starter battery shall be of sufficient capacity to meet the engine starting and control gear requirements. The DC equipment shall be complete for starting of engine and to meet other DC load if required. Two batteries each of 12 volts of suitable rating on ten hour basis shall be provided. The batteries shall be VRLA maintenance free type.

## 7. CONTROL AND INSTRUMENTATION

7.1 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 DG 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 IS:12063.

7.2 The DG sets shall be provided with automatic start facility to make it possible to take full load within 30 seconds of Power Supply failure.

7.3 Testing facility for automatic operation of DG set shall be provided in AMF panel.

7.4 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.

7.5 Following instruments shall be provided with Diesel Engine

a) Lub oil pressure gauge (engine panel)
b) Lum oil temperature thermometers (both on engine and at local panel)
c) Water temperature thermometers (both on engine and at local panel)
d) Exhaust gas pyrometer with temp. switch (at local panel)
e) Engine tachomerter / HR (engine panel)
f) Any other instruments necessary for DG set operation shall be provided.

7.6 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 415V ACDB). However, interlock shall be provided to prevent shutting down operation as long as DG Circuit breaker is closed.

7.7 The diesel generator shall commence a shut down sequence whenever any of the following conditions appear in the system.

a) Overspeed
b) Overload
c) High temperature of engine, cooling water and lubricating oil
d) Low Lub oil pressure
e) Generator differential protection
f) Short circuit protection
g) Under voltage
h) Over voltage
i) Further interlocking of breaker shall be provided to prevent parallel operation of

DG set with normal station supply.

7.8 The battery chargers of 24 V DC, 25 A shall be SMPS type with +V earthed. The charger shall be provided with a suitable DC voltmeter, Ammeter and output voltage control facility mounted on the control cubicle and shall be suitable for connection to single phase 240 V AC supply with + 10% voltage variation.

7.9 Following indication lamps for purposes mentioned as under shall be provided in AMF panel :

7.9.1 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

7.9.2 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
f) Low level in daily service fuel tank
g) Overspeed trip
h) Audio & visual Annunication for alternator fault.

7.10. 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.

7.11 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 CTs for metering
c) 3 Nos. (Provided by LT swgr manufacturer) single phase CTs with KPV 300V & RCT 0.25ohm for differential protection of DG set on neutral side.
d) One (1) DC Ammeter (0-40A)
e) One (1) DC Voltmeter (0-30A)
f) One (1) Voltmeter Selector Switch
g) One (1) AC Ammeter
h) One (1) AC Voltmeter
i) Three (3) Timers (24V DC)
j) Two(2) Auto / Manual Selector Switch
k) Two (2) Auto / test / Manual Selector Switch
l) Eleven (11) Aux. Contactors suitable for 24 V DC
m) One (1) Motorised potentiometer for voltage adjustment
n) Two (2) Set Battery charger as specified in Technical Specification
o) One (1) Set Phase & Neutral busbars
p) One (1) Any other item required for completion of Control scheme shall be deemed to be included.

## 8. INSPECTION AND TESTING

8.1 The type test reports for diesel engine and alternator as per the relevant IS / IEC standards are required to be submitted for approval prior to inspection. The type test conducted earlier should have either been conducted in accredited laboratory (Accredited based on ISO/IEC guide 25/17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by the representative(s) of RVPN. The test reports submitted shall be of the test conducted within last 5 years prior to the date of bid

opening. 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 additional type tests not carried out, same shall be carried out without any additional cost implication to the purchaser.

8.2 This shall be generally governed by the general conditions of contract. Standard test shall be performed.

The inspection and testing shall be done at manufacturers premises as per relevant Indian standards or as per manufacturers standard practices. However following tests have to be carried out :

i) Full load test
ii) Fuel consumption / efficiency test.
iii) Noise level test at a 3 mtr. Distance.
iv) Insulation test.
v) Over load test.

**9. GUARANTEED TECHNICAL PARTICULARS :**

The tenderer shall furnish the detailed guarantee technical particulars as per Annexure-A.

**10. CANOPY FOR NOISELESS OPERATION :**

The D.G. set shall be provided with sound proof, weatherproof and environment friendly, vibration free enclosure. The canopy shall be constructed from CRCA steel sheets and plates. It should have compact, modular construction and sleek design with low noise level 70-74 dB ï whisper soft or conform mandatory government noise level norms. The acoustic enclosure shall be lined with fireproof acoustic material and all joints shall be sealed with fire proof neoprene gasket which withstand high temperatures and pressures. The attenuators shall be placed in hot air outlets and cooling air inlet.

The sound proof enclosure shall be weather proof, acid proof, heat resistant, synthetic Enamel resin bonded automotive quantity paint after pretreatment for degreasing, derusting, phosphating etc. The sound attenuated enclosure shall be designed with forced air circulation & ventilation system to maintain safe operating temperature inside the enclosure.

The paint should be such that the same can be redone at site as & when required in future.

The sound proof enclosure shall have provision for removal of complete DG set without dismantling the canopy and there shall be ample space inside the canopy to carryout routine maintenance. The roof of canopy should be curved (Semi circular only to avoid water logging during rainy season). The doors should be provide with spring loaded heavy duty handles. The canopy should have its own base sturdy enough to mount the DG set on it.

**11. INSTALLATION AND COMMISSIONING**

11.1 Installation and commissioning shall be done by the Contractor. The installation of DG set shall include unloading, fixing of DG set on PCC floor, exhaust piping, fuel piping, cabling, earthing, battery charging and provision of mobil oil / diesel oil etc. The installation shall also include construction of PCC floor of adequate size as per requirement of DG set.

11.2 The contractor shall arrange satisfactory installation at site with following commissioning checks.

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.

11.2.1 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 carryout the test shall be provided by the purchaser.

11.2.2 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=2x(rated voltage in kV)+1.

11.2.3 Check of Fuel Consumption

A check of fuel consumption shall be made during the load run test. This test shall be conducted for the purpose of proper tuning of the engine.

11.2.4 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.

11.2.5 Functional Tests

a) Functional tests on control panel.
b) Functional test on starting provision on the engine.
c) Functional tests of the all Field devices.
d) Functional tests of AVR and speed governor.

11.2.6 Measurement of Vibration

The vibration shall be measured at load as close to maximum achievable load and shall not exceed 250 microns.

11.2.7 Noise Level (sound pressure level) check

11.2.8 Noise level measurement shall be done generally following the guidelines given in IS:12065. The measurement shall be carried out with a calibrated interacting sound level as per IS:9779.

11.2.9 Sound level shall be measured all round the Diesel Generator set at a distance of 1m. from the nearest surface of the machine and at a height of 1.5m. from the floor level as illustrated in IS:12065 for electrical machine.

11.2.10 A minimum of 8 points (5 around diesel engine and 3 around alternator) shall be covered for measurement. Additional measurement points shall be considered in case the criteria indicated in Cl. 3.3.3 of IS:12065 is not met.

11.2.11 The measurement shall be done with slow response meter on the A-weighting scale. The average of the A-weighted sound level measurement expressed in decibels to a reference of 0.0002 microbar.

11.2.12 The tests shall be carried out with the DG set operating at rated speed at maximum achievable load. Necessary correction for Test environment condition & background noise will be applied as per IS:12065.

After satisfactory installation as per Indian Electricity Rules, the contractor shall arrange necessary clearance and certificates from Electrical Inspector, Govt. of Rajasthan if required.

**12. MAKE OF STANDARD EQUIPMENTS /ACCESSORIES TO BE USED**

| | | |
|---|---|---|
| A. | DIESEL ENGINE | KIRLOSKAR / CUMMINS / GREAVES / RUSTON & HORNSBY |
| B. | ALTERNATOR | KIRLOSKAR / CROMPTON / STAMPFORD |
| C) | CONTROL RELAYS | CONTROL AND SWITCHGEAR / GE |
| D) | METERS | AUTOMATIC ELECTRIC / GEC / IMP / L&T MECO |
| E) | SMPS BATTERY CHARGER | CHABBI/ AMCO/ CALDYNE/ HBL NIFE/ STATCON / AE / AMARA RAJA / SELCON / OMGA / REDETRON |
| F) | VRLA BATTERY SET | STANDARD / AMARA RAJA / EXIDE PRESTOLITE/ AMCO/ UBMEC/ HBL NIFE |
| G) | CABLES | FINOLEX / POLYCAB / CCL / UNIVERSAL / RPG / NICCO / GLOSTER |
| H) | G.I. / MS PIPES | ZENITH / GST / BST / TATA |
| I) | CONTROL CABLES | FINOLEX / RR / NATIONAL |
| J) | CHANGEOVER SWITCH / CONTRACTORS | GEC/ AREVA / L&T / SIEMENS / MERLIN GERLIN |
| K) | VIBRATION PAD | DUNLOP / POLYBOND INDIA LTD. |
| L) | PUSH BUTTONS | L&T / SIEMENS /BCH |
| M) | CTS | KAPPA /EE / SIEMENS /AE |
| N) | ACB | L&T/CG/GEC/ AREVA /ABB |
| O) | SELECTOR SWITCH | KAYEE /L&T/AE |
| P) | INDICATION LAMP | BCH/L&T/ESSEN |
| Q) | HEAVY DUTY EXHAUST FAN | CROMPTON / AREVA / COOL HOME. |

The tenderer shall clearly specify in the guaranteed technical particulars about the make of above standard equipments and accessories. The bidder shall furnish the copy of bills / invoices of standard equipments and accessories used in DG set at the time of inspection.

**13. NAME PLATE MARKING :**

The name plate shall include the name of manufacturer details of month and year of manufactured, PO No. and date of supply and date of expiry of guarantee period. Other informations can also be marked as per manufacturerÕs standard practice.

**14. SPECIFIC FUEL CONSUMPTION :**

The tenderer shall furnish the datas of specific fuel consumption at full load (100% load) duly certified by the manufacturer otherwise their offer is liable to be rejected. The tenderer shall also furnish the complete technical details & leaflets alongwith their offer.

**GUARANTEED AND OTHER TECHNICAL PARTICULARS**
**OF 160 KVA NOISELESS DG SET**

| S.NO. | PARTICULARS | UNIT | TO BE FILLED BY BIDDER |
|---|---|---|---|
| **A.** | ENGINE | | |
| 1. | MAKE | | |
| 2. | MODEL | | |
| 3. | BHP | HP | |
| 4. | NO. OF CYLINDER | | |
| 5. | ARRANGEMENT OF CYLINDER | | |
| 6. | BORE XSTROKE | MM | |
| 7. | RPM | | |
| 8. | METHOD OF STARTING | | |
| 9. | ASPIRATION METHOD | | |
| 10. | TYPE OF GOVERNOR | | |
| 11. | FUEL CONSUMPTION | LTR/Hr. | |
| a) | AT 25% LOAD | | |
| b) | AT 50 % LOAD | | |
| c) | AT 90% LOAD | | |
| d) | AT 100% LOAD | | |
| 12. | LUB OIL CONSUMPTION | LTR/Hr. | |
| 13. | LUB OIL SUMP CAPACITY | LTR/Hr. | |
| 14. | BATTERY | | |
| a) | MAKE | | |
| b) | CAPACITY | | |
| 15. | SPECIFIC FUEL CONSUMPTION | Volts / BHP/ | |
| a) | AT 75% LOAD | | |
| b) | AT 100% LOAD | | |
| c) | WHETHER S.F.C. IS DULY CERTIFIED BY MANUFACTURER AND CERTIFICATE ENCLOSED | | |
| **B** | ALTERNATOR | | |
| 1. | MAKE | | |
| 2. | TYPE | | |
| 3. | OUTPUT IN KVA | kVA | |
| 4. | OUTPUT IN KW | kW | |
| 5. | RPM | | |
| 6. | FREQUENCY | HZ | |
| 7. | ALTERNATOR VOLTAGE REGULATION | | |
| 8. | TYPE OF EXCIATION | | |
| 9. | OVER LOAD CAPACITY | | |
| 10. | EFFICIENCY | | |
| a) | AT 25% LOAD | | |
| b) | AT 50 % LOAD | | |
| c) | AT 90% LOAD | | |
| d) | AT 100% LOAD | | |
| 11. | TYPE OF INSULATION | | |
| **C** | DG SET | | |
| 1. | WEIGHT | | |
| 2. | SIZE | | |
| 3. | CAPACITY OF FUEL TNAK | LTR. | |
| **D** | SOUND PROOF CANOPY | | |
| 1. | SIZE OF CANOPY ( Lx W x H) | MM | |
| 2. | GAUGE OF SHEET | | |
| a) | TOP | | |
| b) | BOTTOM | | |
| 3. | MAIN CHANNEL SIZE | | |
| 4. | NO. OF DOORS | | |

| | | | |
|---|---|---|---|
| 5. | EXHAUST SYSTEM | | |
| 6. | FACILITY FOR REMOVAL OF DG SET | | |
| 7. | SOUND PROOF SYSTEM | | |
| | (INSULATION) | | |
| a) | THICKNESS | | |
| b) | DENSITY | | |
| c) | MATERIAL | | |
| 8. | WEATHER PROOF ARRANGMENT | | |
| 9. | SURFACE TREATMENT | | |
| 10. | SOUND LEVEL AT 3 MTR. DISTANCE | | |
| 11. | TYPE OF SILENCER | | |
| **E** | CABLE SIZE | | |
| **F** | SIZE OF GI STRIPS | | |
| **G** | SIZE OF GI PLATE | | |
| **H** | MAKE OF STANDARD EQUIPMENT & ACCESSORIES | | |
| 1. | DISEL ENGINE | | |
| 2. | ALTERNATOR | | |
| 3. | CONTROL RELAYS | | |
| 4. | METER | | |
| 5. | BATTERY CHARGER | | |
| 6. | BATTERY | | |
| 7. | CABLES | | |
| 8. | GI / MS PIPES | | |
| 9. | CONTROL CABLES | | |
| 10. | CHANGE OVER SWITCH / CONTRACTOR | | |
| 11. | VIBRATION PAD | | |
| 12. | PUSH BUTTONS | | |
| 13. | CTS | | |
| 14. | ACB | | |
| 15. | SELECTOR SWITCH | | |
| 16. | INDICATION LAMP | | |
| **I** | ANY OTHER INFORMATIONS | | |

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

# OUTDOOR TYPE 6000 LPH CAPACITY TRUCK MOUNTED OIL FILTERATION MACHINE

**Part-21**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**TECHNICAL SPECIFCIATION**

**Part-21**

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**TECHNICAL SPECIFICATION FOR OUTDOOR TYPE 6000 LPH CAPACITY TRUCK MOUNTED OIL FILTERATION MACHINE**

## 1.0 SCOPE

1.1 This specification provides for the design, engineering, manufacture, assembly, inspection & testing at manufacturerôs works before dispatch, packing, forwarding and delivery of outdoor type 6000 LPH capacity edge type Oil Filtration Machine with Truck Mounted arrangement. These filter machines are required to be used at various 132 kV, 220 kV & 400 kV GSS in Rajasthan.

1.2 It is not the intent to specify completely herein all the details of design and construction of outdoor type 6000 LPH capacity edge type Oil Filtration Machine with Truck Mounted arrangement. However, material / equipment shall conform in all respects to the high standards of design and workmanship and be capable of performing in continuous commercial operation upto bidderôs guarantee in a manner acceptable to purchaser, who will interpret the meaning of drawing and specifications and shall have the power to reject any work or material which in his judgment are not in accordance therewith. The material / equipment offered shall be complete with all parts, necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of supply, irrespective of whether they are specifically brought out in the commercial order or not.

## 2.0 STANDARDS :

2.1 All the materials and equipment shall conform to relevant Indian Standard or equivalent IEC Standards, if any. Material / equipment meeting other authoritative standards, which ensure equal or better quality than the standards specified shall also be acceptable. In this case, an English translation of such standards or relevant extracts shall be forwarded with the bid.

2.2 The oil filtration plant shall conform to the latest editions and amendments available at the time of supply of the standards, listed hereunder :

| S.No. | Standard Ref. No. | Title |
|---|---|---|
| 1. | IS:6034 | Insulating oil conditioning plants specification. |
| 2. | IS:325 | Three phase induction motors |
| 3. | IS: 335 | New insulating oils |
| 4. | IS:6792 | Method for determination of electric strength of insulating oils |
| | | Indian Electricity Rules : 1956 |

3. **CLIMATIC CONDITIONS :**

3.1 The outdoor type 6000 LPH capacity Edge type Oil Filtration Machine with Truck Mounted arrangement shall be suitable for continuous satisfactory operation under climatic conditions listed below :

| | | |
|---|---|---|
| i) | Maximum ambient air temperature in shade | 50 Deg. C |
| ii) | Minimum ambient air temperature in shade | (-) 5 Deg. C |
| iii) | Maximum relative humidity | 100% |
| iv) | Minimum relative humidity | 10% |
| v) | Dust storms are liable to occur from the period from March to July | |
| vi) | Height above mean sea level | Less than 1000 M |
| vii) | Average number of thunder storms days per annum | 40 days |
| viii) | Average annual rainfall | 10 to100 cm (Depending on area) |
| ix) | Average number of months of tropical monsoon conditions p.a. | 4 |

All the electrical devices shall be given tropical and fungicidal treatment of enable their satisfactory operation in the above climatic conditions.

**4.0 GENERAL REQUIREMENTS :**

4.1 The materials and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment are deemed to be included in the scope of supply unless specifically excluded.

4.2 Unless otherwise brought out separately by the bidder in the schedule of deviations the material / equipment offered shall conform to the specification scrupulously. All deviations from the specification shall be brought out in the schedule of deviations. The discrepancies between the specification and the catalogues or literature submitted as part of the offer shall not be considered as valid deviations unless specifically brought out in the schedule of deviations.

4.3 Any deviation which has not been specifically brought out in the schedule of deviations of the bid proposal sheets, shall not be given effect to. The deviations brought out in the schedule shall be supported by authentic documents, standards and other references.

5.0 **TECHNICAL REQUIREMENT FOR TRUCK MOUNTED OIL FILTER MACHINE (6000 LPH):**

5.1 The filter machine is required to be used at various 132 kV, 220 kV and 400 kV Grid Sub-station in Rajasthan.

5.2 The plant should be suitable for treating transformer and switchgear oil by first heating it and then passing it through special designed filter packs and then subjecting it to vacuum treatment, which dehydrates and degassifies the oil to following specifications in single pass :

| Parameters | Before Processing | After Processing |
|---|---|---|
| Break down voltage | Around 20 kV | 70 kV or more (Across 2.5 mm Gap) |
| Moisture content | 100 ppm | 5 ppm |
| Gas content | 10% by volume | 0.1% by volume |
| Suspended particles | Many Microns | 1 Micron and less |

5.3 The oil filtration should be designed for HIGH VACUUM ï LOW TEMPERATURE processing of oil for achieving better results.

5.4 Apart from above the plant shall be suitable for carrying out following operation :

1) To effect continuous hot oil circulation with rated throughout capacity of 6000 LPH continuously for more than 72 hours.ô
2) To draw oil from transformer or shunt reactor under vacuum of 0.02 torr and to discharge it to storage thank. In this case, filter, heater and degassing apparatus of the plant may be capable of being by passed.

**5.5 CONSTRUCTION**

5.5.1 The oil filtration plant should be mobile, mounted on a new regular Truck chassis from either TATA or ASHOK LEYLAND, or equivalent make of not less than 10 tonn capacity. LPT or similar type having minimum wheel base 166ò (4200 mm).

5.5.2 While assembly of the plant on the truck sufficient area shall be provided for :

a) Seating of at least 4 persons, excluding driver and cleaner of the truck.
b) Necessary provision for placing of instruments such as Moisture content measuring apparatus and Break Down Voltage Tester etc., with lockable arrangements.
c) Necessary arrangement for storage of consumables such as vacuum pump oil, flanges, oil hoses, oil drums, cable etc.

5.5.3 The plant should be suitable for operation from within the truck i.e. control panel and valves shall be accessible from within the truck. The plant shall be suitably weather proofed with sheet paneling. Plant and body should be designed to run safely at the speed of 40 to 45 Kms. Per hour on motorable roads.

5.5.4 There shall be a full length wise seat, in parallel and behind the seating arrangement of the driver, forming a cabin. This cabin shall be interconnected

from the driver cabin as well as truck body to facilitate easy approach to the filtration unit. This additional cabin will be used for seating of operating personnel. Under the seating arrangement provided for the personals, an arrangement shall be provided for keeping the T&P / Equipments with locking provisions.

5.5.5 All components should have adequate strength and rigidity to withstand normal conditions of handling, transport and usages and should be free from edges or corners to avoid injury to operational personnel in normal condition of use. The design of the plant should be such that the defective parts would be easily removable in case of replacement / maintenance. Proper guarding arrangement should be provided on all such parts which due to their position and nature of operation are liable to cause accidents. No part of the plant should hang over outside the truck body / chassis.

5.5.6 The plant will be suitable for operation on 415 volts, 50 Hz, 3 Phase 4 wire system. All electrical equipments will be connected to a ground copper bus bar on the control panel with 2 nos. of copper wires of adequate size. The ground bus bar will have two terminals for receiving external earth connections.

The plant should comprise of the following :

## 5.6 INLET PUMP :

5.6.1 The inlet pump should have a capacity of 6000 LPH positive displacement gear type with built in relief valve to take care of accidental pressure increase. The pump should be thoroughly tested for vacuum and should be suitable for continuous trouble free operation. The pump should be provided with automatic protection against over-pressure build up. The level of pressure, at which this automatic device will operate, shall be indicated. Details of such protection device may also please be furnished.

5.6.2 Interlocking arrangement should be provided in between the oil inlet pump and the heater so that heater can not be energized unless oil actually flows through the heater tank. An interlock shall also be provided through flow switch so that pump is stopped automatically when oil flow through plant ceases or does not exist.

5.6.3 For adjustment of flow rate through filter, a flow control valve should be provided across the gear pump. The suction head of the inlet feed pump at atmospheric condition at inlet will be 4-5 mtrs. The inlet gear pump should be tested for a vacuum leak rate of less than $1x10^{-2}$ torr ltr. / sec.

## 5.7 DISCHARGE PUMP :

5.7.1 A centrifugal type discharge pump with a capacity of 6000 LPH suitable for sucking oil from a chamber held under vacuum should be provided. This should

be fully tested for vacuum, leak and pressure. The discharge head of this pump should be 6-8 mtrs. The discharge pump should be tested for a vacuum leak rate of $1x10^{-3}$ torr ltr. / sec.

5.7.2 Interlocking arrangement should be provided in the filter plant between the inlet pump and inlet valve to prevent mixing of treated and untreated oil in the event of supply failure.

## 5.8 VACUUM PUMPING SYSTEM :

5.8.1 The vacuum pump should be of sufficient capacity and should be imported on your import license. The vacuum pump should be suitable to remove dissolved water & gases from the oil in the degassing chamber. It should be equipped with mechanical non-return valve fro preventing of reversing stroke of oil.

5.8.2 A Roots-Rotary combination should be provided. This pumping system should be capable of achieving a vacuum of less than 0.5 torr in the degassing column during filtration and processing of oil. The supply to the motors used shall be through phase sequence reversal preventor so as to avoid the problems related with change of phase sequence.

5.8.3 The minimum specification & attainable vacuum levels in both stages of the vacuum pump shall preferably as under :

| | | |
|---|---|---|
| First Stage | - Rotary oil sealed vacuum pump | 1 No. |
| Ultimate vacuum with g.b. closed | | $5x10^{-3}$ torr |
| Ultimate vacuum with g.b. open | | $1x10^{-1}$ torr |
| Second stage | - Mechanical booster pump (Roots pump) | 1 No. |
| Ultimate vacuum | - | $10^{-4}$ torr |

5.8.4 Tenderers should clearly specify the makes of the vacuum pumps quoted and provide relevant catalogues. Both the Rotary oil sealed vacuum pump and Mechanical Booster pumps should preferably be of the same manufacturers.

5.8.5 The offer should be backed up by detailed calculations. All the dates appearing in the calculations must necessarily be supported by the references / catalogues / graphs. The assumption in considering margins in theoretical V/S practical values should be supported by necessary reference / charts / catalogues. Calculations have to be furnished for any system which has been considered by the tenderer suitable for achieving desired oil parameters after filtration.

## 5.9 HEATERS

5.9.1 Heaters should be of indirect type so as to avoid localized overheating, hot spot and breaking of oil. Heaters should be capable of raising the temperature of oil maximum upto 70 Deg. C. Each heater / heater stage shall be thermo statically

controlled. Total heater power should be adequately provided to be justified by the calculations.

5.9.2 Control switches / knobs of the thermostat should be housed in the control panel for easy operation and maintenance. Selector switch should be provided for 1/3, 2/3 and full load operation of heaters depending upon the temperature of oil.

5.9.3 Heater elements should be of Nichrome / Kanthal wire filament mounted on refractory formers enclosed in steel tubes. Design of the heater should be such that in case of change of heater elements, it should be easier and should not require any special tools.

5.9.4 Heaters should be interlocked with gear pump and should not be in ñONò position, unless the inlet pump is working. Heater tank should be adequately and thermally insulated to avoid dissipation of heat. Heater surface density should not be more than 1.5 watts/ sq.mm.

5.9.5 An additional safety thermostat should be provided to take care of any accidental rise of the temperature of oil and should put off the heaters in such eventuality. This thermostat will be set at high temperature. Thermostat setting shall have accuracy of not more than plus minus 2.0 Deg. C.

5.9.6 A dial type thermometer should be provided after the heater for indication of oil temperature i.e. at the outlet of heater tank.

5.9.7 One suitable pressure relief valve should be provided on the heater chamber to prevent any pressure rise above the acceptable limit. One drain valve in the heater tank should also be provided.

## 5.10 DEGASSING AND DEHYDRATION CHAMBER – TWO STAGE

5.10.1 The degassing chamber should function as degasser and dehumidifier and will be capable of removing large portion of dissolved impurities from oil. It should be of M.S. welded construction and should be provided with rust proof lid removable for maintenance. Preferably synthetic rubber óOôrings should be provided for the purpose of sealing. The chamber should be able to withstand the vacuum to which it will be subjected.

5.10.2 Efficiently spread raschig rings should be placed in the degassing column. The surface area for the degassing and dehydration afforded by the Raschig rings should be sufficient and efficiently expose transformer oil to vacuum and at the same time maintain the specified flow rate. A sight glass with illuminating lamp should be provided for observation of oil process. Raschig rings arrangement details be furnished.

5.10.3 One float switch on the degassing chamber should be provided for preventing excess rise of oil level. It should be electrically interlocked with inlet pump. Necessary Control devices for regulating the level of oil in the degassing chamber should be provided. Another low level switch shall be provided and interlocked with the centrifugal pump on discharge side. The plant must have such back preventation in case of supply failure.

## 5.11 FILTERATION SYSTEM :

5.11.1 Filtration system should consist of the following :

a) Preliminary filter.
b) Filter press.
c) Edge filter.

### 5.11.2 PRELIMINARY FILTER :

The main function of this filter should be to prevent any damage to the inlet pump. It should have strainers capable of retaining all particles above 1 mm size and also magnetic particles. Incoming oil should pass through this filter. Necessary by pass valve arrangement should be provided. Provision should be made for cleaning the strainer elements without dismantling the whole strainer from the pipe line. Duplicate strainer shall be employed so that one can be cleaned while other is in operation.

5.11.3 FILTER PRESS :

This will consist of filter papers held between metallic discs. Filter papers should be easily changeable. It should be suitable for removal of particles bigger than 5 microns. This should be useful for removal of sludge content in the used oil. A drain valve should also be provided for the filter.

5.11.4 EDGE FILTER

5.11.4.1 The edge type filter should comprise of treated paper discs mounted to form a candle. Filter packs should be treated, rendering the paper impervious to the action of moisture present in the transformer oil. It will be suitable for removal of particles upto 1 micron. Filter elements should be capable of preventing all solid impurities like dust, rust, metallic particles, scales, carbons, oxidation products etc. from entering into the degassing column.

5.11.4.2 Cleaning of filter candles should be effected either by reverse flow of compressed air or by back flushing. Separate air compressor unit with motor, air reservoir tank, safety valve should be provided for cleaning the edge filter packs. Filter packs should be held under spring compression and arrangement should be provided to adjust the spring pressure.

5.11.4.3 Pressure gauges on both sides of the filters shall be provided to indicate the need to clean / change filter paper packs. These pressure limits, at which filters are needed to be cleaned or changed, be indicated specifically. One drain valve to clean the chamber should also be provided.

## 5.12 ACCESSORIES AND FITTINGS :

### 5.12.1 THERMOMETERS :

One dial thermometer of 0-150 Deg. C should be provided at the inlet of heater tank and 1 No. at the outlet of the heater tank.

### 5.12.2 VACUUM GAUGES :

One capsule type vacuum gauge of range 0-50 mbar should be provided for the first stage and one Mcleod type vacuum gauge having a range of 10 torr to 0.01 mm of Hg should be provided for measurement of vacuum in the second stage of degassing chamber.

### 5.12.3 PRESSURE GAUGE :

One pressure gauge on the edge filter chamber should be provided.

Independent drives for oil discharge pump, oil inlet pump, vacuum pump should be provided.

### 5.12.4 MOTORS

Motors provided should generally conform to IS: 325 and should be of class E/B insulation. Starters should be of direct on line type.

### 5.12.5 SOLENOID VALVES AT THE INLET AND OUTLET

1 No. each solenoid valves at inlet and outlet should be provided. These should open automatically the moment oil inlet and outlet pumps are switched ON. In case of power failure, these should be capable of preventing the oil from entering into the plant and thus avoiding the possibility of mixing processed oil with unprocessed oil.

### 5.12.6 OIL SAMPLIGN VALVE

This valve should be provided to collect the sample of oil for testing, during operation.

5.12.7 OIL FLOW CONTROL VALVE :

One oil flow control valve should be provided across the oil inlet pump to control the flow rate of oil.

5.12.8 AIRING VALVE :

One airing valve for airing the degassing chamber and vacuum system should be provided. Necessary isolating arrangement, control valve, indicator wil be provided to enable the plant to fill the oil from one tank to other. All valves in the oil system should be of piston type and of M.S.

5.12.9 FLOAT SWITCH AND FLOW INDICATOR

High level float switch should be interlocked with inlet gear pump so that when the oil level in the degassing column rises above the pre-set level, it will automatically switch off the gear pump and when the oil level drops below this level, it will automatically switch on the gear pump.

Low level float switch should also be provided which should be interlocked with discharge pump, to avoid dry running of the discharge pump.

A flow indicator should be provided at outlet of the plant.

5.12.10 OIL HOSES ï 4 NOS.

4Nos. Nitrile rubber hoses each 15 Mtrs. long with flanged end connection on both sides should be provided. These will be suitably used for oil inlet and oil outlet. Oil hoses should be capable for handling the transformer oil at 100 deg. C (Max.) and vacuum.

5.12.11 IONIC REACTION COLUMN

An Ionic reaction column made out of M.S. and should have a capacity to put activated alumina, will be provided. This Ionic reaction column should have a provision of online attachment with the plant, when required. Arrangement should be made for bypassing the same with the provision of bypass valve.

The Ionic Reaction column should be capable of reducing the total acidity level and as per relevant IS for new oil.

5.12.12 TRANSFORMER EVACUATION SYSTEM

A separate transformer evacuation system with necessary vacuum pumps mounted alongside the filtration plant shall also be supplied with the plant. The minimum level and attainable vacuum level shall be as under:

| | |
|---|---|
| Rotary oil sealed vacuum pump | 1 |
| Ultimate Vacuum with g.b. closed | $5x10^{-3}$ torr |
| Ultimate Vacuum with g.b. open | $1x10^{-1}$ torr |
| Mechanical Booster Pump (Roots type) | 1 No. |
| Ultimate vacuum | $10^{-4}$ torr |

The vacuum pump shall be of a reputed International / equivalent make. Tenderers should clearly specify the makes of the vacuum pumps quoted & provide relevant catalogues. Both the rotatory oil seal vacuum pump & mechanically booster pump should be of the same manufacturers.

5.12.13 OIL TESTING INTRUMENTS :

The plant shall also be equipped with the following oil testing instruments.

a) Moisture contents measuring apparatus.

The moisture contents measuring apparatus shall be suitable to measure the moisture content in transformer oil giving full details / particulars. The instrument shall be of a very good quality.

b) Breakdown voltage tester.

A suitable breakdown voltage tester of range 0-100 KV shall be provided. This shall be capable of measuring the breakdown voltage of oil as per the relevant Indian Standard.

5.13 CONTROL PANEL :

5.13.1 All electrical control gear, main isolating arrangement, motors, starters, contactors, pilot lamp, push buttons, backup protection fuses, relays, indicating lamps and interlocking will be housed in a compact control panel and should be of M.S.

5.13.2 A mimic diagram with indicating lamps should be provided on the control panel.

5.13.3 All wiring should be neatly routed and all wire termination should be suitably identified with ferrules. Bulb should be provided for illumination.

5.13.4 Following visual and audio alarm annunciation have to be provided complete in all respect :

i) Loss of vacuum is degassing chamber.
ii) Loss of flow.
iii) High oil temp. in heater outlet.
iv) High oil temp. in vacuum pump.
v) High oil temp. in degassing chamber.
vi) Low oil temp. in degassing chamber.

vii) Filter chocked (operated by differential pressure between inlet and outlet of filter).

5.13.5 All HRC fuses should be preferably of ALSTOM Make and switchgear should be of Siemens / L&T Make. Temperature indicting controller should be preferably JN Marshall Make. Mains Isolating switch should be preferably of MCCB type and of ALSTOM / L&T Make.

5.14 The entire plant alongwith all components mounted should be tested for a total vacuum leak rate of less than a torr ltr./sec. Tenderers should confirm availability of all testing facility at their works for carrying out the following tests on the oil :

a) Breakdown voltage.
b) Moisture contents.
c) Suspended particles.

5.15 CLEANING AND PAINTING

Before dispatch form works, all exposed surfaces should be cleaned off rust, dirt, scale and foreign matter and should be applied with a coat of rust preventive compound before being painted with suitable colour of paint from outside.

6.0 TESTS :

6.1 Oil Filter Machine & accessories shall be tested and certified in accordance with the relevant I.S. and IEC requirements, or equivalent. A copy of all type tests previously carried out shall be enclosed with the bid documents. Bids without such test reports will be treated as non-responsive.

6.2 Routine tests to be carried out during manufacture shall be submitted with the bid and approved by the purchaser prior to delivery.

6.3 The purchaser reserves the right to witness all tests and the manufacturer shall provided all facilities for the purchaser authorized representative to have full and free access, at all reasonable times, to the suppliers works. If the supplier is not in a position to given those facilities, tests on such equipment will be arranged at no cost to the purchaser, with an appropriate testing authority in the presence of the purchaserôs representative.

6.4 In additional to above tests following tests shall be carried out as acceptance tests on each oil filtration sets.

i) Insulation measurement tests.
ii) Dielectric strength measurement of the filtered oil.
iii) Measurement of oil outlet pressure.
iv) Measurement of the flow rate of the oil being oil filtered.
v) Checking the performance of the plant as per guaranteed technical particulars.

vi) Checking the oil parameter as per Item No.23 of guaranteed technical particulars.
vii) Checking of vacuum pressure at first pass.
viii) High voltage (2 kV) test on electrical control panel wiring.
ix) Switch Board operating tests for contactors, relays thermostats, annunciation system, starters.
x) Checking of interlock.
xi) Checking of Items as per requirement of the purchase order.

7.0 INSPECTION

i) The purchaser shall have access at all times to the works and all other places of manufacture, where the material / equipment are being manufactured and the supplier shall provide all facilities for unrestricted inspection of the supplierôs works, raw materials, manufacture of the equipment, all the accessories and for conducting necessary tests as detailed herein.

ii) The supplier shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages so that arrangements could be made for inspection.

iii) No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iv) The acceptance of any quantity equipment shall in no way relieve the supplier of his responsibility for meeting all the requirements of this specification and shall not prevent subsequent rejection if such equipment are later found to be defective.

8.0 **QUALITY ASSURANCE PLAN**

8.1 The bidder shall invariably furnish following information alongwith his offer, failing which the offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

i) Statement giving list of important raw materials, names of sub-suppliers for the raw material, list of standards according to which the raw materials are tested, list of tests normally carried out on raw material in presence of supplierôs representative, copies of test certificates.
ii) Information and copies of test certificates as in (i) above in respect of bought out items.
iii) List of manufacturing facilities available.
iv) Level of automation achieved and list of areas where manual processing exists.
v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

vi) Special features provided in the equipment to make it maintenance free.

vii) List of testing equipments available with the supplier for final testing of equipment specified and test plant limitation, if any, vis-a-vis the type, special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

8.2 The supplier shall within 30 days of placement of order, submit following information to the purchaser.

i) List of raw material as well as bought out accessories and the names of material as well as bought out accessories and the name of sub-suppliers selected from those furnished alongwith offer.

ii) Type test certificates of the raw material and bought out accessories.

iii) Quality Assurance Plan (QAP) with hold points for purchaserôs inspection. The quality assurance plan and purchaserôs hold points shall be discussed between the purchaser and the supplier before the QAP is finalized.

8.3 The supplier shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the fully assembled equipment.

**9.0 DOCUMENTATION :**

9.1 The supplier shall provided with his bid, drawings, detailed with important dimensions and construction materials as appropriate, descriptive literature, operation & maintenance instructions and other information for a full understanding of the equipment offered.

9.2.1 All drawings shall conform to International Standards Organization (ISO) óAô series of drawing sheet / Indian Standards Specification. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

**9.3 TEST REPORTS :**

i) Four copies of test reports shall be furnished to the purchaser within one month of conducting the tests. One copy will be returned duly certified by the purchaser to the supplier within three weeks thereafter and on receipt of the same supplier shall commence with the commercial production of the concerned material.

ii) Four copies of acceptance test reports shall be furnished to the purchaser. One copy will be returned, duly certified by the purchaser and only thereafter shall the materials be dispatched.

iii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.

iv) All test reports of tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

10.0 PACKING & FORWARDING

10.1 The equipment shall be packed in suitable crates so as to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost.

10.2 Each consignment shall be accompanied by the detailed packing list containing the following information :

a) Name of the consignee.
b) Details of the consignment.
c) Destination.
d) Total weight of consignment.
e) Sign showing upper / lower side of the crate.
f) Handling and unpacking instructions.
g) Bill of materials indicating contents of each package.

10.3 The supplier shall ensure that the packing list and bill of material are approved by the purchaser before dispatch.

10.4 The material shall be transported within India to the respective destination by road Transport / Rail Transport as the case may be at the option of the purchaser.

11.0 SPARE PARTS :

11.1 List of spare parts alongwith their unit price and full details, required for operation / maintenance of equipment for a period of 2 years are required to be enclosed with bid document.

11.2 Suppliers shall have adequate facilities to repair and maintain the equipment offered and be prepared to supply spare parts and services as and when required. The bidder shall give details of his facilities to support this requirement with his bid.

## 12.0 TRAINING

12.1 The successful tenderer will be required to impart through training, to Two personnel of purchaser per equipment (to be supplied) free of charge at his works, and more particularly inter-manufacture, assembly, operation & maintenance of equipment included in this specification.

12.2 The bidder shall indicate in his offer, the list of training courses, duration required and scope of each training course including all other relevant information.

**ANNEXURE-I**

GUARANTEED TECHNICAL PARTICULARS FOR OIL FILTER MACHINE
(TO BE FILLED IN BY THE BIDDER)

| S.NO. | DESCRIPTION | |
|---|---|---|
| 1. | 2. | 3. |
| 1. | Makerôs Name | |
| 2. | Country of origin | |
| 3. | Type of filtration set | |
| 4. | Standard specification to which it conforms | |
| 5. | Capacity of filteration set at ambient temp of 50 deg. C. | |
| 6. | Max. temp. of oil leaving the filteration set | |
| 7. | Max. continuous operating period without loss in efficiency | |
| 8. | Dielectric strength of insulating oil in KV after single / two / three passes through filter plant at rated capacity B.D.V. to be determined as per the procedure laid down in IS:6792 (latest). The dielectric strength of oil before filtering being around 20 kV (rms) | |
| 9. | Purifier Unit | |
| a) | Type of purifier | |
| b) | No. of filtering elements | |
| c) | Total volume of purifier unit in liters | |
| d) | Material of filter packs | |
| e) | Means provided for cleaning clogged filter packs | |
| f) | Pressure of compressed air / oil for cleaning filter packs | |
| g) | Drain cock for withdrawing impurities provided or not | |
| h) | Material of filtering tank plate | |
| i) | Thickness of plate in mm | |
| j) | Quantity of oil which can be filtered without reconditioning the filtering elements (in lit.) | |
| k) | Size of smallest dust particle which can be removed during filteration | |
| l) | Detailed specification of filter paper to be used in filter machine | |
| m) | Metallic composition of filter pack / rod / pipe containing the filter packs | |
| 10. | VACUUM CHAMBER | |
| a) | Over all size | |
| b) | Thickness of plate material | |
| c) | Means adopted to increase the surface area in the tank | |
| d) | Max. vacuum pressure to which the chamber is subjected during the process | |

| | | |
|---|---|---|
| e) | Max. vacuum pressure to which the chamber can withstand safely | |
| f) | Suitable level indicator provided to the tank or not | |
| g) | Safe oil level | |
| h) | i) Arrangement provided to safe guard against the rise of oil level above a certain mark in vacuum chamber | |
| | ii) Means adopted in vacuum chamber to prevent the flow of water vapour & gases alongwith the clean oil | |
| i) | Low level switch interlocked with the centrifugal pump on discharge side provided or not | |
| j) | Specification of the paint applied in the vacuum chamber | |
| 11. | HEATING CHAMER | |
| a) | Type of heating (direct / indirect) | |
| b) | Medium of heating in case of indirect heating | |
| c) | No. of heating elements | |
| d) | Wattage o each heating elements and complete bank | |
| e) | Full load heater rating in kW | |
| f) | Whether heating elements are re-wireable type | |
| g) | No. of heating elements on each phase of 3 phase AC supply | |
| h) | Whether oil is in direct contact with heating elements | |
| i) | Whether thermostatic control for switching ON and OFF of heaters is provided f so itôs location | |
| j) | Temperature at which heaters will be switched off automatically | |
| k) | Temperature at which heaters will be switched on automatically | |
| l) | Whether suitable means for interlocking heater supply and inlet feed pump supply provided or not | |
| m) | Whether additional thermostat with alarm provided against fire to oil filter set in case of one thermostat failure with its type and location | |
| 12. | MOTORS | |
| a) | Makerôs name | |
| b) | No. of motors & HP of each motor | |
| c) | Total load of motors | |
| d) | Maxm. Temperature attained after continuous use under full load | |
| e) | Type of motor wound or squirrel cage | |
| f) | No. of phases | |
| g) | Speed of motor at full load (rpm) | |
| h) | Full load torque | |
| i) | Starting torque | |
| j) | Type of starting, direct form the line or through a starter | |
| k) | Type of bearings | |

| | | |
|---|---|---|
| l) | Type of casing | |
| 13. | OIL INLET PUMP (DIRTY OIL PUMP) | |
| a) | Makerôs name | |
| b) | Type of pump | |
| 16. | TRUCK | |
| a) | Details of the truck | |
| b) | Details of pneumatic tyres with nos. & size | |
| c) | Details of canopy material used. | |
| d) | Overall dimensions from grounded level (LxHxW) | |
| e) | Max. load on front axle | |
| f) | Max. load on rear axle | |
| g) | Gear box | |
| 17. | Type of casing (water or weather proof or otherwise) | |
| 18. | Special provisions for inspecting the moving parts provided or not | |
| 19. | Max. recommended speed of vehicle with which unit can be safely towed without nay damage due to jerks | |
| 20. | Weight (approx.) of the complete unit | |
| 21. | Details of cable provided i.e. copper or aluminum, size, armoured or unarmoured & length etc. & whose price included in the bid | |
| 22. | Net quantity of oil in ltr. required for filling of the oil filter set. | |
| 23. | Values of the insulating oil (filterate) coming of the filter set. The initial values of the oil to be cleaned being as per IS:335/1983 (latest). No of passes in which the values are achieved is to be shown : | |
| | i) B.D.V. in kV | |
| | ii) Water content in PPM | |
| | iii) Air or dissolved gasses in percent by volume | |
| | iv) Tan delta value | |
| 24. | Dimensions of oil filter set cabinet (showing separately the dimensions of leg supports & the hooks etc. for lifting arrangement) without truck. | |
| 25. | Whether facility provided for acidity correction? What is capacity? Give complete details. | |
| 26. | Whether filter set bears ISI certification mark | |

Name of the Firm_____
Signature of Bidder_____
Designation & Seal_____
Date _____

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

TURNKEY PROJECT
FOR
CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
AND
400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

# TRUCK MOUNTED SEMI MOBILE CRANES

**Part-22**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

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TECHNICAL SPECIFICATION FOR TRUCK MOUNTED SEMI MOBILE CRANES

1. **Scope :**

This specification provides for manufacture, testing before dispatch, supply and delivery of Truck Mounted Semi-Mobile Cranes.

2. **Standard :**

The Semi-Mobile Crane(s) shall conform to the latest revisions with amendments of standards as under unless specified otherwise. Equipment meeting any other authoritative standard which ensure equal or better quality than the standard mentioned below will also be acceptable. In such cases a copy of standard (English version) adopted, should be enclosed with the bid.

i) IS-4573-1982 "Code of Practice for design of Mobile Cranes"
ii) IS-807-1976 "Structural design, manufacturing, erection and testing".

All equipments shall have metal name plates fixed in suitable positions with full particulars indicated thereon in accordance with the requirements of the standard adopted. The silent points of difference between the standard / code of practice adopted and the provisions made in the equipment of offered shall be clearly stated in the bid.

3. **Climatic Conditions :**

| | | |
|---|---|---|
| i) | Peak ambient air temperature in shade | 50 Deg. C |
| ii) | Minimum ambient air temperature in shade | (-) 5 Deg. C |
| iii) | Maximum relative humidity | 100% |
| iv) | Minimum relative humidity | 10% |
| v) | Dust storms are liable to occur from the period from March to July | |
| vi) | Height above mean sea level | Less than 1000 M |
| vii) | Average number of thunder storms days per annum | 40 days |
| viii) | Average annual rainfall | 10-100cm (Depending of area) |
| ix) | Number of months of tropical monsoon conditions p.a. | 4 |

**4. General Technical Requirements**

The cranes shall be Truck Mounted Semi Mobile Type for quantities as per Schedule of Requirement of Section VI, full slewing, capable of slewing through unlimited revolution in either direction and shall be suitable for medium duty general use. Under service conditions the crane shall be able to withstand a steady wind pressure of 25 Kg. f/m2 and under static conditions it shall be capable of withstanding a steady wind pressure of 175 Kg f/m2 without load. The

crane shall be Diesel Hydraulic Drive Type. The rated lifting loads of the crane at specified radius shall not exceed 85% of the tipping load at specified radius.

**Job Requirement :**

The Truck Mounted Semi Mobile Cranes of approx. 8 M.T. capacity for lifting consignment of 3 MT with an approximate outreach of 2.25 Metres for a vertical height (clear lift of the hook from G.L.) of Approx. 7 Metres. This crane shall be used for erection of structures and equipment at various EHV Grid Sub-Stations as well as for loading and unloading of material. Accordingly, the lifting capacity of the crane shall be suitable to meet following job requirement :

| Size | Weight | Height of lift (clear lift of hook from G.L.) | Radii of lift |
|---|---|---|---|
| - | 1.0 MT | 12.5 M | 5.0 M |
| 0.5 M x 0.5 M x 6 M | 1.0 MT | 9.5 M | 10.0 M |
| 1M x 1M x 4M | 2.5 MT | 9.0 M | 5.0 M |
| 5M x 4M x 3M with a sling height of 2.0 Metres | 3.0 MT | 7.0 M min. | 2.25 Outreach Approx. |

**Technical Details of the Cranes :**

The crane shall be provided with limit switches or stops to prevent over-winding on the hoist motion and over derricking beyond prescribed limits. The crane shall be fitted with audible device to cut-off hoist and derrick circuits automatically at predetermined overload. Telescopic boom with jib extensions required to meet the job requirement shall be provided.

Necessary batteries for starting electric horns, head lights, tail lamps and lights on the rear and other equipments in accordance with traffic regulations shall be provided on the Mobile Crane. Provision for stepney complete in all respects shall be made and supplied with the crane. The cost of the tyres and tubes shall be indicated separately. The crane should be able to move with the above transformer loads for short- distance. Hook block with suitable hook shall form a part of the crane and shall be proof load tested to twice the S.W.L. as per BSS/ISS or any other recognized international standard.

The out-riggers as to be provided shall be hydraulic type. The number and location of out-riggers should be specified. It shall be clearly mentioned whether out-riggers are fixed or extended type and if extended whether the same are telescopic or otherwise. It may also be indicated as to whether the out-riggers boxes are permanently attached or removable. Service brakes shall be provided to properly bring the machine to a stop from normal travel. The adequate

arrangement shall provided to hold the machine stationery during working cycle and also to hold the machine on any gradient which it can negotiate.

Driverôs cabin shall be of steel construction, totally enclosed two men type tropicalised with lockable doors, opening, windows fitted with toughened glass, electric wind screen wiper to front wind screen, electric fan and all other essential accessories.

A load indicator shall be provided in full view of the driver giving the information about the radius at which the crane is derricked and the appropriate load thereof. The crane should be fitted with Electronic automatic safe load indicator confirming to the safety clause of IS:4573-1982. The safe load indicator should give display of actual and maximum safe working load / load moment at radius of operation alongwith audible & visual warning on approach to overload & cut off.

5. **Inspection and Testing :**

All the tests as per the provisions under Clause No.44 of IS:4573-1982 or any other recognized international standard shall be carried out a the place of manufacturer unless otherwise specially agreed upon by the bidder and purchaser at the time of purchase. The bidder shall afford the inspection officer (s) representing the purchaser all reasonable facilities without charges, to satisfy himself that the material is being furnished in accordance with this specification. The purchaser has the right to have the tests carried out at his own cost by an independent agency whenever there is a dispute regarding the quality of supply.

The inspection may be carried out by the purchaser at any stage of manufacture / before dispatch as per relevant standard.

Inspection and acceptance of any material under the specification by the purchaser, shall not relieve the bidder of his obligation of furnishing material in accordance with the specification and shall not prevent subsequent rejection if the material is fund to be defective. The bidder shall keep the purchaser informed in advance, about manufacturing programme so that arrangements can be made for inspection.

The purchaser reserves the right to insist for witnessing the acceptance / routine testings of the bought out items if any.

The bidder shall give 15 days advance intimation to enable the purchaser to depute his representative for witnessing the acceptance and routine tests. The inspection charges would be to the purchaserôs account.

6.0 **Quality Assurance Plan**

6.1 The bidder shall invariably furnish following information alongwith his offer, failing which his offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

i) Statement giving list of important raw materials names of sub-suppliers for the raw materials list of standards according to which the raw materials are tested. List of tests normally carried out on raw materials in presence of tendererôs representative, copies of test certificates.
ii) Information and copies of test certificates as in (i) above in respect of bought out accessories.
iii) List of manufacturing facilities available.
iv) Level of automation achieved and list of areas where manual processing exists.
v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
vi) Special features provided in the equipment to make it maintenance free.
vii) List of testing equipments available with the bidder for final testing of equipment specified and test plant limitation, if any, vis-a-vis the type, special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

6.2 The successful Bidder shall within 30 days of placement of order, submit following information to the purchaser.

i) List of raw materials as well as bought out accessories and the names of sub-suppliers selected from those furnished alongwith offer.
ii) Type test certificates of the raw material and bought out accessories.
iii) Quality Assurance Plan (QAP) with hold points for purchaserôs inspection. The quality assurance plan and purchasers hold points shall be discussed between the purchaser and supplier before the QAP is finalized.

6.3 The successful bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material viz. oil, copper, aluminum, conductors insulating materials, cope material.

**7.0 Documentation :**

7.1 All drawings shall conform to International Standards Organization (ISO) óAô series of drawing sheet / Indian Standards Specification as per relevant ISS. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

7.2 List of drawings and documents

The bidder shall furnish four sets of drawing and a diagram alongiwth his offer giving the position of the centre of gravity under the following conditions.

i) With no load and jib at minimum radius.
ii) With maximum working load at radius specified.
iii) With test load at radius specified and
iv) With jib removed.

The Guaranteed Technical Particulars for the cranes offered shall be supplied with the tender as at Annexure-I.

7.3 The manufacturing of the equipments shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing work in connection with the equipment prior to the approval of the drawing shall be at the supplierôs risk.

7.4 Details of manufacture :

The bids received from the manufacturers shall only be considered. The bidder shall invariably furnish the details of their works and other allied particulars. The offer received without these particulars as per their Performa shall be liable to be ignored.

7.5 The successful bidder shall be required to supply 4 sets of general arrangement drawings as at 7.2 along with other important details for approval of the purchase.

7.6 After the approval of the drawings the bidder shall forward 4 sets of operating and maintenance manual for crane, which would include the printed literature and all necessary instructions for operation, servicing and maintenance of the cranes as well as drawing showing general arrangement with all fitting and accessories, electric / hydraulic control and protection.

## 8.0 Packing and Forwarding

8.1 The packing shall have to be done in accordance with the manufacturerôs standard practice worthy of rail and / or road borne. All packing cases shall be suitably marked for inland transport so that there is no possibility of goods being lost or wrongly dispatched due to faulty marking.

8.2 Consignment shall be accompanied with a details packing list containing the following information :

a) Name of the consignee
b) Details of consignment
c) Destination.

## 9.0 Tools & Spares

i) A set of essential tools required during operation and maintenance of the crane, packed in a tool cabinet shall be supplied alongwith the crane without any extra cost.

ii) The crane shall be supplied with D-Shackles and sling for lifting of loads as below :

| | Percentage Rate of load | Length of sling | No. of "D" Shackles |
|---|---|---|---|
| a) | 100% | 4.0 M | 4 |
| b) | 75% | 4.0 M | 4 |
| c) | 50% | 4.0 M | 4 |
| d) | 25% | 4.0 M | 4 |

The cost of the above shall be included in the total quoted price.

## 10.0 Training :

The bidder shall provide suitable 2Nos. training for the purchaser's maintenance / operation staff for satisfactory operation and maintenance of these cranes.

**ANNEXURE-I**

# SCHEDULE OF GURANTEED TECHNICAL PARTICULARS OF TRUCK MOUNTED SEMI MOBILE CRANES

| S.NO. | DESCRIPTION | DETIALS OF THE CRANE |
|---|---|---|
| 1. | 2. | 3. |
| 1. | Type and make of crane | |
| 2. | Maximum lifting capacity at 85% rating at 2.25 Mtr. Clear out reach. On maximum and minimum radius | |
| | i) Over front, rear & all round (on out ï riggers) | |
| | ii) Over front (FOW) | |
| 3. | Clear out reach available for lifting specified loads | |
| | a) Over front | |
| | b) Rear | |
| 4. | Maximum height of lift (hook) above ground level for lifting specified loads | |
| 5. | Maximum travel speed (Unloaded) | |
| 6. | Can the offered crane move with specified loads | |
| 7. | Turning circle diameter | |
| 8. | Type of out riggers & control | |
| 9. | Diameter of Hoist rope | |
| 10. | Hoisting speed | |
| 11. | Derricking speed | |
| 12. | Slewing speed | |
| 13. | Slewing rotation in degree | |
| 14. | Size of wheels & types | |
| 15. | Approximate weight | |
| 16. | The maximum slope of a smooth hard gradient on which the crane can travel either backward or forward and either up or down whilst remaining completely stable | |
| | a) Loaded (FOW) | |
| | b) Unloaded | |
| 17. | Boom | |
| | a) Number of sections | |
| | b) Retracted length | |
| | c) Fully extended length | |
| | d) Extension mechanism | |
| 18. | Boom Telescoping | |
| | a) Normal (Mtrs./Min.) | |
| | b) Fast Mtrs./Min. | |

| | | |
|---|---|---|
| 19. | Details of electronic safe load indicator, type, make etc. | |
| 20. | Engine | |
| | a) Manufactures name, model number & type | |
| | b) Number of cylinders bore and stroke, displacement | |
| | c) Full load governed speed in Rev. / Min. | |
| | d) Type of starting equipment | |
| | e) Rated horse power that is the net brake horse power at the fly wheel | |
| | i) at sea level or at specified altitude | |
| | ii) at full load governed speed with engine fully equipped with generation fan, air cleaner and other regular equipment | |
| | f) Engine power at high altitude and | |
| | g) Power take off | |
| 21. | Crane Diagram Indicating | |
| | a) Overall length of chassis | |
| | b) Overall width of crane | |
| | c) Overall height of crane with jib in lowest position | |
| | d) Tail radius of the revolving super-structure | |
| | e) Distance from centre line of revolving super-structure to ends and sides of chassis and over outriggers, if provided; and | |
| | f) Distances between two kerbs in which the crane may be completely turned round in one movement on: | |
| | i) Right look | |
| | ii) Left look | |
| | g) Load deck dimensions | |
| 22. | Description of: | |
| | i) Brakes; | |
| | ii) Controls of various motions; | |
| | iii) Operators cabin | |
| | iv) Safety & indicating devices provided | |
| | v) List of tools and accessories | |
| 23. | Any other important particulars not schedule above. | |

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BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-II)**

**TESTING/ MEASURING INSTRUMENTS, TOOLS/ TACKLES**

**Part-23**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

**TESTING/ MEASURING INSTRUMENTS, TOOLS/ TACKLES**
**Vol-II (Part-23)**

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**TECHNICAL SPECIFICATION**
**OF**
**TESTING/ MEASURING INSTRUMENTS, TOOLS/ TACKLES**

## 1. SCOPE OF SUPPLY:

The following testing/ measuring equipments, tools & tackles shall be supplied in the quantities as mentioned in the price schedule. For few instruments/ equipments approved makes for the instruments/ equipments are mentioned elsewhere in the specifications, however all the makes shall be of reputed makes having at least 2 Years in satisfactory operation with the user. The Nigam reserves the right of final selection of make as per the specification requirements and accessing the overall performance of the equipment.

### 1.1 Climatic Conditions

The Current transformers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions:

| | |
|---|---|
| i) Location | In state of Rajasthan |
| ii) Maximum ambient air temperature (deg C) | 50 deg C |
| iii) Minimum ambient air temperature (deg C) | -5 deg C |
| iv) Average daily ambient air temperature (deg C) | 45 deg C |
| v) Max. yearly weighted ambient temperature. | 35 deg C |
| v) Maximum Relative Humidity (%) | 100% |
| vi) Max. altitude above mean sea level (Meters) | Varies from 61 Mts. to 815 Mts. |
| vii) Average annual rainfall(cm) | 15 mm to 100 cm |
| viii)Max. wind pressure (kg/Sq.mt) | 195 |
| ix) Isoceraunic level (days/year) | 4 Months (June to Sept.) |
| x) Seismic level (Horizontal Acceleration) | 0.3 g |

NOTE: Hot and humid tropical climate, conducive to rust and fungus growth.

The climatic conditions are also prone to wide variations in ambient conditions. Smoke is also present in the atmosphere. Heavy Lightning also occurs during June to October.

1.2 **AUXILIARY POWER SUPPLY**

Auxiliary electrical equipment shall be suitable for operation on the following supply system:

| | |
|---|---|
| a) Power Devices (Like drive motors) | 415 V, 3 Phase 4 wire 50 Hz, neutral grounded AC Supply. |
| b) D.C. Alarm, Control and protective device | 220 V DC, 2 Wire. Sub Stationwise exact details shall be furnished to successful Bidder. |

Each of the foregoing supplies shall be made available by the Purchaser at the terminal point for each current transformer for operation of accessories and auxiliary equipment. Bidders scope include supply of interconnecting cables, terminal boxes etc. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over entire range of voltages.

i) AC Supply : Voltage ± 10% frequency ± 5%
ii) DC Supply : -15% to + 10%

## 2. STANDARDS:

Except otherwise specified or implied herein the instruments/ equipments shall comply with the relevant IS/ IEC/ASTM or any other equivalent standards.

It is not the intent to specify completely herein all the details of the design and construction of equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship and shall be capable of performing in continuous commercial operation. The offered equipment shall be complete with all components necessary for their effective and trouble free operation. Such, components shall be deemed to be within the scope of contractor's supply irrespective of whether those are specifically brought out in this specification and / or the commercial order or not.

## 3. TECHNICAL SPECIFICATION OF INSTRUMENTS/ EQUIPMENTS:

### 3.1 50 k- Ohms EARTH TESTER

1. The Earth tester should be battery powered.It is to measure earth resistance, earth continuity and to determine soil resistivity.
2. It should have the following features.

| | |
|---|---|
| Measuring Resistance | 0 - 20 ohms in steps of 0.01 ohms |
| Range to be selected by | |

| | |
|---|---|
| a rotary switch completed with an off position | 0 - 200 ohms in steps of 0.01 ohms<br>0 - 2 K ohms in steps of 1 ohms<br>0 - 20 K ohms |
| Accuracy | 2% of reading or +/- 2 decimals. |
| Test Current | 10 mA A.C. RMS on 20 ohms range<br>1 mA A.C. RMS on 200 ohms range<br>0.1 mA A.C. RMS on 2 K ohms range<br>0.01 mA A.C. RMS on 20 K ohms range |
| i) Ambient temperature influence | Less than 5% of indicated value at the central scale mark for temperature change by 5 deg. C to 50 deg. C. |
| ii) External magnetic field influence | No noticeable change in 400 A/M field influence |
| iii) Insulation resistance | The insulation resistance between the electrical circuit and the body of the instrument shall be more than 50 mega ohms. |

It should have maximum current/voltage spike resistance upto 50 K-ohms on 2 K-ohms range. The tester should have a capability to withstand upto 3 KV for 1 minute.

It should employ 4 terminal measurement method and should be free from all high levels of interfering stray voltages high ground current or high value auxiliary plate resistance. For safety the maximum test volt shall be limited to 50 V.

The display should be LED type, Batteries should be rechargeable type. The battery shall have battery check feature with automatic switch off. A suitable charger shall also be provided. All the necessary leads should be provided. Weight should not exceed 0.5 Kg.

No hold down button shall be provided and accurate readings shall be displayed on digital display. The display shall also indicate.

- If the current test spike resistance is too high.
- If the potential test spike resistance is too high.
- If the battery power is too low.

Each instrument shall be housed in a robust weather proof case complete with test spikes, insulated cables on reels, connectors and suitable carrying case.

## 3.2 5 kV INSULATION TESTER / MEGGER:

### 3.2.1 SERVICE CONDITIONS

(i) Operating Conditions: Temperature: 0 to + 50º C
RH up to 95 %

(ii) Power Supply: 230 VAC± 15%, 50 Hz (± 5%)

(iii) Atmospheric Conditions: Normal

(iv) Installation: Indoor

### 3.2.2 FIELD OF APPLICATION:

The instrument shall be used for the measurement of insulation in transformer, switches, high voltage systems, low and high tension lines etc. with precision in the charged yard of 400 kV environment having electro magnetic field and its interference.

### 3.2.3 STANDARDS:

The instrument shall conform to relevant International/ Indian and Industry Standards and able carry out the testing as per IEEE recommended practices.

### 3.2.4 TECHNICAL PARAMETERS AND OTHER FEATURES

3.2.4.1 Power Supply: 230 V AC ± 15%, 50 Hz (± 5%).
3.2.4.2 Use / Installation: Indoor / Outdoor.
3.2.4.3 Range of Resistance: **0 to 5000 GΩ**
3.2.4.4 Range of voltages: **500V , 1 KV, 2.5KV and 5 KV ..**
3.2.4.5 Other functions to be provided: Hold, auto range, and manual range.
3.2.4.6 Automatic discharge: Auto discharge facility of test circuit after measurement.
3.2.4.7 Programmable Timer shall be provided.
3.2.4.8 The instrument shall have three modes of operation:

1) Manual Mode: It shall be possible to start and stop the measurement at the operatorôs choice.
2) Automatic Mode: It shall be possible for the operator to select the duration of measurement. The measurement shall be started by the operator but it shall stop automatically after the preset time.
3) Polarization Index Measurement: The instrument shall automatically measure the Polarization index (ratio of 600 seconds reading to 60 seconds reading).

3.2.4.9 Display: Digital display with facility to display current and voltage.
3.2.4.10 Isolated **RS 232 output or USB port** to be provided for connection to PC . Suitable software for storage and transfer of data is required without extra cost.
3.2.4.11 Guard Terminal: Guard circuit and terminal shall be provided to bypass unwanted leakage current around the insulation tester and shall eliminate resistance measurement of other conducting paths.
3.2.4.12 Operating ranges:

a) Range: Up to **5000 GΩ**.
b) Accuracy: **± 5% up to 1000 GΩ**
c) Voltage Range: 500V to 5 kV (in steps of 500 V / 1000V)
d) Voltage Accuracy: 5% on load of 10 M Ohm and above load.
e) Nominal Test current : **Minimum 3 mA**.
f) Temperature: 0 to 50 Deg C.

g) Relative humidity: up to 95%.

3.2.4.13 Batteries: Internal rechargeable battery pack having capacity of minimum 5 hours continuously.

3.2.4.14 The instrument shall be supplied in a suitable shock proof carrying case suitable for field transportation.

3.2.4.15 Weight: Light Weight & suitable for transportation, less than 10 Kgs.

3.2.4.16 Operation: **The instrument shall operate directly from 230V AC mains power supply (without internal rechargeable battery into circuit). The instrument shall also operate with internal rechargeable** battery.

### 3.2.5 STANDARD/ASSOCIATED ACCESSORIES:

Following standard accessories shall be supplied along with the equipment.

a) Test Leads of 8 Metres Length.
b) Operation and Maintenance Manuals (in English): 2 Nos.
c) Any other accessories bidder feels necessary for normal operation of instrument and for carrying out requisite testing shall be offered / supplied with the instrument

## 3.3 DIGITAL MULTIMETERS

a). **Features**

Portable Digital Multimeter 3½ digit, LCD displays light in weight having the standard functions like AC, DC voltages, AC, DC currents and resistance shall have following general feature:

1) Auto range and Manual Range selection.
2) Diode test feature.
3) Automatically turning power off.
4) Instrument safety against wrong selection of Menu/Range.
5) Instrument safety against over load conditions in all measuring ranges.
6) Audiable continuity check.
7) Over range indication
8) Data hold.
9) In High voltage switchyard conditions work reliably/accurately as electro-magnetic interference present in such yards.
10) The state of battery shall be displayed if the battery condition deteriorates and it needs replacement.
11) The meter should give automatic (-) negative polarity indication.
12) The instrument should be least affected by stray magnetic field.

b) **TECHNICAL SPECIFICATION**

| S.No. | Particulars | Range | Accuracy |
|---|---|---|---|
| 1 | DC Voltage | 300 mV/3/30/300/600 V or equivalent suitable ranges. | ± 0.8%/ ±2 digit or better. |
| 2 | AC Voltage | 3/30/300/600 V or equivalent suitable ranges. | ± 1.6%/ ±5 digit or better. |
| 3 | Frequency | 45 to 55 Hz or equivalent suitable ranges. | ± 2.5%/±5digit or better. |
| 4 | DC current | 300 µA /3000 µA/300 mA/3 A/10A or equivalent suitable ranges. | ± 2.0%/ ±5 digit or better. |
| 5 | AC current | 300µA / 30 mA /300mA/ 3A/10 A or equivalent suitable ranges. | ± 2.6%/ ±5 digit or better. |
| 6 | Resistance | 300 q /3/30/300 Kq /3M q /30M q or equivalent suitable ranges. | ± 2.5%/ ±5 digit or better. |

c) **Accessories**

It shall accompany with test leads, fuses, battery carrying case and instruction manual.

The set should be as compact as possible. The construction and dimensions should be such that it is convenient for transportation. It should withstand shock and vibration during transportation by road in Jeep.

d) **STANDARDS**

i) Safety of measuring instruments IEC61010 ï i or better
ii) Over Voltage Category CAT III 300 V or better
iii) EMC-conformity

**3.4 PORTABLE PRIMARY CURRENT INJECTION TESTS KIT:**

Air cooled type, easily movable in the switch yard, continuous rated and step less output, trolley mounted :

a) To be used for testing of circuit breakers, CTs and Relays etc.

KVA : 15 KVA
Input : 230V
Output : 0-20V ; 750 A
0-10V ; 1500 A
0- 5V ; 3000 A

b) Two test leads of capacity 2000 A each, with suitable length for reaching CTs in the yard (after erecting the CTs on the structure) i.e. 15-20 meters.

## 3.5 ANALOG MULTIMETERS:

### a) Feature

Portable meter having 5 functions, different ranges and having accuracy of measurement as under:

### b) Technical

| | |
|---|---|
| Current | +/- 1% full scale value over the effective range i.e. above 10% FSD |
| DC voltage upto 1 kV | +/- 1% full scale value over the effective range i.e. above 10% FSD |
| DC voltage over 1 kV | +/- 1.5% full scale value over the effective range i.e. above 10% FSD |
| AC current | +/- 2% full scale value over the effective range i.e. above 25% FSD |
| AC voltage | +/- 2% full scale value over the effective range i.e. above 25% FSD |

The meter shall be having following ranges:

AC/DC Voltage from 0 to 2500 volts in ranges namely:

| | |
|---|---|
| 0 to 2.5 V , 0 to 10 V , 0 to 25 V, 0 to 100 V , 0 to250 V , 0 to 1000 V , 0 to2500 V | For AC voltage |
| 0 to 2.5 V , 0 to 10 V , 0 to 25 V, 0 to 100 V , 0 to250 V , 0-500V, 0 to 1000 V , 0 to2500 V | For DC voltage |

AC current from 0 to 10 Amp. in 4 ranges namely.

0 to 100 mA , 0 to 1 Amps., 0 to 2.5 Amps. , 0 to 10 Amps.

DC current shall have following ranges:

0 to 50 micro Amps. , 0 to 250 micro Amps., 0 to 1 mA, 0.to 10 mA.
0 to 100 mA. 0 to 1 A, 0 to 10 Amp.
Resistance:

0 to 200 M Ohm (2 M Ohm. ,mid-scale)
0 to 20 M Ohm. (200,000 ohms. mid scale)
0 to 2000 ohms. (20 ohms. mid scale)
0 to 2.5 ohms.(1.25 ohms. mid scale)

### c). Other features

i) The range selection with the help of manual switch.
ii) The state of battery shall be displayed if the battery condition deteriorates and it needs replacement.
iii) The over range indication may be provided to facilitate manual switching to higher range. The minimum response for indication shall not be more than 1 second.

iv) The meter shall have 115 MM scale having clear and easy to read markings, an anti-parallax mirror to facilitate accurate readings.

v) A simple press button to reverse the flow of DC current for obtaining + Ve & -Ve measurement of DC voltage without changing lead .

vi) An automatic cut out should be provided with reset knob to protect the meter from sudden and inadvertent over loading.

d). **Accessories**

The equipment shall be complete with long reach probes, a set of plug in type testing leads, interchangeable crocodile clips/batteries and leather carrying case and operating instructions.

e). **Standard**

Meter should confirm to Indian standards.

## 3.6 VACCUM CLEANERS:

i) The instrument shall be heavy duty suitable for cleaning of Control & Relay Panels

ii) shall operate on 230V single phase AC supply

iii) Air flow shall be 36 lit/sec or better

iv) shall have thermal cut off feature

v) shall have suction capacity of 2200mm water column or better

## 3.7 UNIVERSAL COMPUTERIZED RELAY TEST KIT:

The instrument shall be suitable for testing all types of three phase relays (static, numerical and electromagnetic type). It shall be portable and handy for easy transportation to be carried by one person. It should be able to test all protection relays based on impedance, voltage, current, frequency, harmonics, and synchronization. The equipment must be capable of efficiently testing all types of electronic and electromechanical relays with a high degree of accuracy. The testing system shall be able to simulate all the wave forms and transients as recorded on the disturbance recorder. The system should be operable manually, semi-automatic and automatic and should meet the following specifications:-

3.7.1 The testing system must generate at least four independent voltages and three independent currents with the facility to control their amplitudes and phase angles independently. The kit should have df/dt facility (i.e. frequency variation with respect to time).

3.7.2 i). Voltage and current outputs : The test kit shall specify the VA rating of output sources as per the requirement of relay protection scheme. However it can have the following output quantities.

- Four phase voltage outputs : (0-150) V
- Three phase current outputs : (0-30) A without external Amplifier in three phase

mode.

- Three phase output power (for voltage) : 75 VA or better for each phase.
- Three phase output power (for current) : 150 VA or better for each phase.
- Output Distortion : Less than 0.5 %.

ii). All voltage and current amplifier should be protected against overload and short circuit.

3.7.3 Power supply requirements to the instrument shall be as follows : Independent of mains supply fluctuations, variations and distortions available so that its accuracy is not dependent due to inherent mains supply features.

- Nominal input voltage : 230 V +/- 10% , AC single phase
- Frequency : 50 Hz +/- 5%
- Power consumption : 1600 W Max.

3.7.4 Timer selection :

There should be at least 10 inputs (binary) in 2 groups of 5 independent contacts each with voltage more than 220 V DC and AC. The two groups should be galvanically separated.

- Measuring time : 0-1 hour.
- Resolution : 0.1 ms.
- Time measurement accuracy : 0.02 % or less

3.7.5 To ensure extra protection of relay, the relay testing kit must incorporate auxiliary DC voltage with range (25 Vï 210 V) and output power of min.50 W.

3.7.6 Phase angle :

Variation in phase angle shall be possible in each output channel independently with following specifications:

- Phase Angle Range : 0-360 Degree
- Phase Resolution : 0.1 Degree or lower
- Phase Accuracy : 0.05 Degree or lower

3.7.7 Frequency Generator Range :

- Continuous signals : 10- 1000 Hz.
- Transient signals : DC -3000 Hz
- Frequency Accuracy : < 0.01%
- Frequency Resolution : < 1mHz

3.7.8 Weight of the instrument should not be more than 50 kg in not more than two units.

3.7.9 The relay testing kit offered must be computer compatible. It should be capable of being operated with a computer. Manual operation of the

equipment should be possible for variation of all parameters either by key provided on equipment or through the laptop/ computer under the scope of supply. A laptop computer preï loaded with the easy to use relay testing software should be provided for fully automatic operation of the relay testing set.

3.7.10 Software :

The software shall be user friendly and shall have the standard test plans for the majority of the relays under test and shall have flexibility to modify by the user as per specific requirement. The software should be easy to use without the requirement of extensive computer literacy and should be possible to use in manual. semi-automatic and fully automatic mode. It should be possible to automatically create the IEC and IEEE standard waves and /or create other characteristics using the standard circular lens and linear elements. It should be capable to perform dynamic and transient test with band width of 5 to 1200 Hz by fault simulation or pre-recorded event.

The software should also contain an automatic test plan editor to create automatic test plans for new unknown relays easily and without programming knowledge.

The kit should have the capability to accept transient fault data recorded by disturbance recorder from 3.5ò floppy and replay these on the relay under test. It should be able to perform both static and dynamic testing such as fault and prefault generation, simultaneous ramping of quantities and editing wave forms etc. The kit offered must have provision for generating COMTRADE and EMTP files (EMTP PC programmes also) as well as editing the wave forms.

3.7.11 Microprocessor :

The kit should employ minimum 32 bit DSP technology or better.

3.7.12 Calibration :

Apart from self- calibration (software), the system should also be provided with an independent calibration box as an independent external means of verifying the relevant parameters. It should be possible to calibrate the calibration box and, therefore, the kit to relevant international traceable standards.

3.7.13 Analog Inputs :

The kit shall also have analog input for measurement of AC/DC current and voltages (both low and high) as per the following specifications. These analog inputs for measurement shall be galvanically isolated from each other.

DC Current measuring input (low)

- Measuring range: +/-20 mA
- Accuracy: 0.03%

DC Voltage measuring inputs (Low)

- Measuring range: +/- 10V
- Accuracy : 0.03%

AC/DC current measuring inputs (High)

- Measuring Range: +/- 10 A DC, 10A AC rms.
- Accuracy : DC < 0.2%, AC< 0.3%

AC/DC Voltage measuring inputs (High)

- Measuring Range: +/- 220V DC, 150V AC rms.
- Accuracy : DC<0.02% , AC <0.2%
- Frequency measuring range : 0-3000 Hz.

3.7.14 Interface: Communication serial port RS 232 shall be provided to Interface the instrument.

3.7.15 Protection: All current and voltage outputs shall be independent and should have overload and short circuit protection.

3.7.16 The equipment should be designed to operate under the adverse conditions of external influence like electrostatic discharge, magnetic field, Electro-magnetic field induction, RF interference, input wave form distortion and harmonics, input voltage and frequency variation.

3.7.17 Environment :

- Temp. operating range : 0-50° C
- Relative humidity: 95% , Non condensation

3.7.18 Standards :

- Protection: IP20 or equivalent
- Safety: IEC 61010 or EN 6100-3-3 or Equivalent.
- EMC Emissions : EN 50081-2 Industrial or equivalent IEEE.
- Calibration: Traceability to relevant International standard.

3.7.19 Test Certificate: Manufacturerôs test certificate for all the parameters alongwith calibration certificate having traceability to national/ international laboratory/ standard should be furnished with offer.

3.7.20 Accessories: The testing kit shall include all required suitable testing leads, test software, laptop computer, case, instruction manual, tools and spare fuses etc.

3.7.21 The kit shall be supplied with the Lap-Top having following specification:
Make: Reputed Indian /International Manufacturer having ISO 9001 certification (Design & Mfg.)

Intel Core 2 Duo Higher Configuration
a. Processor: Mobile Intel Core 2 DUO Processor, T 7200, 2.4 GHz with 4 MB L2 Cache 667 MHz FSB or higher
b. Motherboard & Chipset: 945 PM or higher Chipset on OEM Motherboard
c. Memory: 1 x 2 GB DDR2 SDRAM expandable up to 4 GB
d. HDD: 160 GB 5400 rpm (minimum)

e. Display: 39.1 cm TFT Active Matrix Display (1280x800 WXGA Resolution)
f. Video controller : Integrated PCI Express Graphics Card with 128 MB dedicated memory
g. Modem: Integrated 56 KBPS Modem (Fax/Data) and 10/1001/000 Gigabit Fast Ethernet
h. Wireless Connectivity : Integrated Wireless 3945 a/b/g, integrated Blue Tooth
i. DVD Writer : Integrated DVD writer 8X and integrated stereo speaker
j. Key Board : Keyboard with Touch Pad
k. Expansion Port : 2 USB, Gigabit Ethernet Card, RGB or S-Video or VGA, PCI MCI slot, Connector for port replicator/ Docking Station and Travel Battery, microphone, stereo head phone and other standard features.
l. Operating system: Microsoft Windows Vista Business and & other software Norton/McAfee/e-trust Antivirus Software latest pre installed version with license, Recovery Solution
m. Power Supply : 230V, 50 Hz AC Supply with Rechargeable Battery Pack Comprising of Li-Ion Batteries suitable for approx. 4 hours operation complete with battery charger/adaptor (voltage and capacity of battery pack to be indicated in the offer)
n. Carry case: To be provided

## 3.8 DEW POINT METER.

The meter shall be capable of measuring the dew point of SF6 gas of the circuit breaker/GIS equipment. It should be portable and adequately protected for outdoor use. The meter shall be provided with dew point hygrometer with digital indication to display the dew point temperature in degree C, degree F or PPM. It should be capable of measuring the corresponding pressure at which dew point is being measured.

The measurement and use of the instrument must be simple, direct without the use of any other material /chemical like dry ice/acetone etc. It should be battery operated with rechargeable batteries.

**TECHNICAL SPECIFICATION:**

1. Measuring Range: Upto-100 º C dew point.
2. Accuracy: ± 2 º C.
3. Display: 4 digit LCD, 0.5 inch high.

## 3.9 MICROPROCESSOR BASED DIELECTRIC STRENGTH ANALYZER:

### 3.9.1 SERVICE CONDITIONS

(v) Operating Conditions: Temperature: 0 to + 45º C
(Normally in Air conditioned environment

between 25ºC to 30 ºC
RH + 25 to 85 %

(vi) Power Supply: 220 V to 240 V AC, 50 Hz.
(vii) Atmospheric Conditions: Normal
(viii) Installation: Indoor

### 3.9.2 FIELD OF APPLICATION:

The equipment shall be used to determine dielectric strength of liquid insulants (transformer oil etc.)

### 3.9.3 STANDARDS:

The equipment shall be able to perform the standard test cycles as per IS-6792, IEC-156/1995-05, BS EN 60156, VDE 0370 Part 5/96, UNE21309/89, ASTM DD 1816/97 etc.

### 3.9.4 TECHNICAL PARAMETERS AND OTHER FEATURES

1) Power Supply: 230 VAC± 15%, 50 Hz (± 5%)
2) Installation: Indoor
3) The equipment shall be fully automatic and microprocessor controlled compact instrument with in built printer. Instrument shall be user friendly and menu guidance. The test shall be visible and illuminated.
4) Test Voltage range of testing insulants: 0- 100 kVrms symmetric (Selectable in steps)
5) Method: The complete sequence of testing Viz. required initial stand time, stir time, rate of rise of applied voltage shall be pre-programmed as per different standards like IEC, BS, ASTM, BIS etc. and instrument shall carryout the sequence of tests without supervision when switched ñONò. Repeatability of test shall be possible. Oil circulation by built in submerged magnetic stirrer.
6) Display: LCD display (backlit)
7) **Test Vessel with stirrer : It shall be of high impact and chemical resistant with non breakable quality material with maximum 400 ml capacity** suitable for easy handling and cleaning by a stirrer . Test Vessel shall be according to IEC 156/1995-05 (latest version).
8) Electrodes: **Provided with full sets of electrodes of brass/ copper for testing as per IEC/BIS. Additional electrodes may also be supplied as per relevant standard of testing.**
9) Electrode Mounting: Horizontal axis, max. gap 5.5 mm. Fully corona free operation of holders to support the test vessel. **After adjusting the gap of the electrode, a precision electrode gap locking system shall also be provided.**
10) Additional features: Fast disconnecting time at the moment of flash over, control circuit to limit breakdown discharge energy to allow

multiple test on samples. Facility for manual operation, recalling of breakdown values and average value of results. Electromagnetic shielding of high voltage compartment, free from radiated interference to enable use of this instrument nearby to computer, gas chromatograph etc. Test voltage results shall not be affected by line voltage variations.

11) Printer: **In built printer must be provided**. For each test cycle, individual breakdown value (Vpeak / ã2), Arithmetic mean breakdown value, standard deviations are to printed along with date and time.
12) Safety interlocking system: HV circuit shall be energized only when the test chamber is closed.
13) Voltage class of high voltage bushing: 100 kV (min.)
**14)** Measuring accuracy: Less than **± 0.1 kV± 1%**
15) Resolution: 0.1 kV
16) Power Supply: 220 V 1 Phase AC, 50 Hz
17) Maximum time for switch off: Less than **5 m. sec**
18) Swith off current : **Less than 4 mAmp. for 5 msec.**
19) Short current limitation : Less than 30 mA for whole measuring range.
20) Rate of Voltage rise: 0.5 to 5 KV ( In suitable selectable ranges)
21) PC Communication: PC communication via **RS-232 interface or USB port.**
22) Additional test cycle: At least 1 free programmable test cycles.
23) **Alphanumeric keypad should be provided to facilitate entry of test ID to be automatically incorporated in the test results.**

3.9.4 **STANDARD/ASSOCIATED ACCESSORIES**

Following standard accessories shall be supplied alongwith the equipment.

1) Test vessel with cover- 2 Nos.
2) Oil collecting tray **or better system to collect spillover oil – 1 No**.
3) Magnetic oil Stirrer- 2 Nos.
4) Drive for Stirrer
5) Lifting stick for stirrer- 2 Nos.
6) Setting Guage- 2 Nos.
7) Mains connection and PC connecting cables
8) Printer paper roll- 10 Nos.
9) Operation and maintenance Manuals ( In English- 2 Nos.)
10) Dust Cover
11) Any other accessories bidder feels necessary for normal operation of equipment and carrying out requisite testing, should be offered / supplied with the instrument.

## 3.10 CONTACT RESISTANCE METER

**General**

The equipment shall measure and display the static contact resistance of circuit breaker, isolator, bus bar joints and earth switches etc: directly in micro-ohms under live switchyard conditions.

**Technical Specification**

Ranges: 1999.9 micro ohm, 1999 micro ohm and 19.99m. ohm.
Resolution: 0.1 micro ohm, 1 ohm, and 10 micro ohm. respectively.
Accuracy: Value: *±1%: ± 2* digits.
Current: 200 ADC,
Display: Two,3½ digit ½ inch LCD, for current and resistance Values.
Power: 220 VAC ± 10% 50 Hz ± 5%, 30VA
Battery: Instrument operation on input rechargeable batter(12 V 7 AH Maintenance free).

## 3.11 TRANSFORMER OIL BREAKDOWN VOLTAGE TEST SET

1. The equipment shall, be suitable for determination of electric strength (breakdown voltage) of insulating oil upto 100KV to IS: 335 when measured in accordance with IS: 6792.
2. The test cell shall be as per IS: 6792 suitable for BDV upto 100KV without external flashover.

3. The unit shall be of automatic type having control unit and high voltage transformer in a common cabinet with necessary partition. HV chamber interlocking and zero start interlocking shall be provided.

4. The unit shall have motorized drive to increase voltage linearly as per the rate specified in IS: 6792. Provision should be available for manual increase of voltage. The unit shall be complete with test cell, stirrer and 'GO" and "NO GO" gauge for adjusting the gal). Automatic power supply cut-off at the BDV shall be provided to record the value.

5. The equipment shall suitable for operation at 240 volts 50Hz.

6. As per IEC-156 : 1995, breakdown voltage test kit shall be provided with circuit breaker operated by current resulting from the breakdown of the sample and shall break the voltage within l0m sec.

## 3.12 OIL SAMPLING BOTTLE:

1. Oil Sampling bottles shall be suitable for collecting oil samples from transformers for Dissolved gas analysis. Bottles shall be robust enough, so that no damage occurs during frequent transportation of samples from site to laboratory.
2. Oil Sampling bottles shall be made of stainless steel having a capacity of one litre.

3. Oil Sampling bottles shall be capable of being scaled gastight and shall be fitted with cocks on both ends.

4. The design of bottle & seal shall be such that loss of hydrogen shall not exceed 5% per week.

5. An impermeable oil-proof, plastic or rubber tube of about 3mm diameter, and of sufficient length shall also be provided with each bottle along with suitable connectors to fit the tube on the oil sampling valve of the equipment and the oil collecting bottles respectively.

## 3.13 TRANSFORMER TURN RATIO TESTER

Supply of **three phase** microprocessor based digital transformer turns ratio meter capable of measuring and testing the transformation ratio of all types of power transformers on site and to be delivered up to our stores.

1 Automatic functions: The instrument shall be fully automatic. No user calibration, range selection, hand cranking or balancing shall be required.

2 The minimum range of ratio measurement of the equipment shall be 1.0000 to 999.99. The instrument shall have auto ranging facility.

3 The accuracy of the instrument shall be atleast ± 0.1% of full scale deflection of the selected range ± 3 digits or better for all transformation ratios.

4 The Resolution shall be as below or similar depending on the ranges offered:

(a) 0.0001 for readings from 1.0000 to 1.9999.
(b)0.001 for readings from 2.000 to 19.999.
(c) 0.01 for readings from 20.00 to 99.999.
(d) 0.1 for readings from 100.0 to 999.99.

5 The instrument shall be user friendly and simple to operate.

6 The instrument shall be capable of making the following measurements:

i) Transformer turns ratio
ii) RMS test / Excitation current
iii) Indication of primary / secondary polarity (phase)
iv) Testing of continuity and any short circuit before measurement.

7 The readings of the equipment shall be minimum 4 ½ digit display. The instrument shall display the following:

i) Transformer ratio
ii) RMS test/excitation current and voltage
iii) Indication of primary/secondary polarity

8 On each measurement the instrument shall automatically perform self checking / calibration and display the following warning messages, if applicable.

i) Incorrect connections
ii) Accidental step up misconnection.

iii) Short circuits
iv) Circuit continuity not available
v) Low battery

9 POWER SUPPLY:

The instrument shall be powered by AC 230V, 50Hz supply (without internal rechargeable battery). The instrument shall also be powered by internal rechargeable battery.

10 TEMPERATURE RANGE**:**

The instrument shall be able to work in the temperature range of 0 to 50 degree C.

11 ACCESSORIES**:**

All the accessories such as measuring leads, etc. of length 15 metres and power cord of length 5 metres shall be supplied alongwith the instrument. Extra battery and 2 copies of the manual shall also be supplied.

12 STANDARD:

The instrument shall confirm to relevant national and international standards. To ensure compliance of the instrument to the above, type tests certificates for tests as prescribed in the following applicable standards are required to be furnished alongwith tender

a) Damp heat test as per IEC 60068-2-3.
b) Vibration test as per IEC 60068-2-6.
c) Shock test as per IEC 60068-2-27
d) Bump test as per IEC 60068-2-29.
e) Electrostatic discharge immunity test as per IEC 61000-4-2
f) Radiated radio frequency, electromagnetic field immunity test as per IEC 61000-4- 3.
g)Power frequency magnetic field immunity test as per IEC 61000-4-8.

13 WEIGHT:

Instrument shall be light in weight and portable.

14 HOUSING:

Instrument shall be housed and packed in a robust, shock proof and weather proof cover so that it is not damaged during transportation.

15 MEMORY CAPACITY:

The instrument shall have the capability to store **test readings. The storage capacity shall be indicated.**

16 PRINTER:

The instrument shall be supplied with necessary WINDOW based software for down loading of data, test results (which can be loaded on to an IBM compatible computer) & shall be supplied along with connecting cable between computer and instrument (USB connector at computer end.) so that print out of test results can be taken. Alternatively built-in printer is also acceptable

17 PROTECTION:

Instrument shall be protected against any wrong connections.

18 GUARANTEE:

Guarantee of minimum two years shall be given from date of supply.

19 CALIBRATION CERTIFICATES:

The equipments shall be supplied with calibration certificates. The instruments used for such calibration shall have traceability to National Physical Laboratories or NABL accredited laboratories.

20 Acceptance Test

Following tests will be conducted in addition to all routine tests as per relevant standards.

- Dielectric test
- I.R. measurement
- Functional Test
- Verification of calibration

## 3.14 SF6 GAS LEAK DETECTOR

a) Microprocessor control, with advanced digital signal processing Tricolor visual LED display and audible signal for progressive leak-size indication

b) The instrument shall have following technical parameters:

| | |
|---|---|
| Power supply: | 3 V = two 1.5 V "C"-cell alkaline batteries |
| Guaranteed sensitivity: | 14 g SF / year (0.5 oz / year) |
| Operating temperature: | 0°C to + 52°C |
| Battery life: | approx. 30 hours |
| Method of operation: | continuous operation withour limitation |
| Response time: | immediately |
| Reset time: | 1 second |
| Warm-up time: | approx. 2 seconds |
| Fixed sensor length: | 355 mm |

c) The detector shall be free from induced voltage effects.
d) The sensing probe shall be such that it can reach all the points on the breaker where leakage is to be sensed.

## 3.15 CIRCUIT BREAKER OPERATIONAL ANALYSER

### 3.15.1 General: Main Equipment

(i) The Computer Aided CB Analyzer system comprising of CB operation unit, programme unit, travel analyzer unit & analysis software should be capable to perform close, open, close-open, open-close, open-close, open operation on CB under test, with a facility to introduce time delays between composite operation.

(ii) The CB Analyzer should be capable to measure, record and analyze the CB operation timing.

(iii) The CB Analyzer should be able to measure and record current rise and fall of tripping coils as well as of closing coils of all three poles of CB simultaneously.

(iv) The CB Analyzer should be capable to measure and record travel and speed of movement of operating mechanism of CB.

(v) The CB Analyzer should be capable to measure and record dynamic contact resistance of main and arcing contacts of CB with injection of minimum 100 Amp. DC current.

(vi) The CB Analyzer should be capable to measure pole discrepancy timing.

(vii) The CB Analyzer should be capable of measuring contact closing & opening timing up to four (04) main and four(04) no. PIR contact.

(viii) The CB Analyzer should be capable to calculate and print all contact closing & opening tuning in tabular form also.

(ix) Suitable mounting kits for transducers and sensors, alongwith sensor cable of suitable length should be supplied with CB analyzer system.

(x) Test leads with suitable clamp and connectors and having length suitable for leads with suitable clamp and connectors and having length suitable for connection to EHV CBs should be supplied with CB Analyzer system for

(xi) Necessary custom built travel transformer cum fixtures suitable for mounting on BHEL/ABB/CGL/Siemens/ALSTOM (132 KV and above) makes of CBs, to monitor travel related parameters like contact gap. Contact insertion, over travel etc. should be supplied with CB Analyzer.

**3.15.2 System Operation hardware/software, peripherals and analysis software.**

(i) The test report for recording motion should provide test results both in form of curve and tables. The tables should consist of calculated CB parameters such as closing/opening speed etc.

(ii) The entry of various data/parameters (pertaining to CB) be possible sing built in display of menu.

(iii) The battery backup and real time clock should be provided for automatic date and time functions.

(iv) a) The computer aided analysis software should have sampling frequency upto 40 KHz or more.

b) The analyzer should be capable to record transient phenomenon for duration at least 500 ms.

(v) The binary channel accuracy and analogue channel accuracy should be suitable meet all desired functions (stated above).

(vi) The CB analyzer should be provided with facility of down loading data to a IBM compatible PC.

(vii) The printer provided with CB analyzer should be preferably a plain paper printer.

(viii) The computer aided CB analysis software should be supported with suitable report generation.

(ix) It should be possible to change scale factor of time axis to enable enlarged view of part of diagram.

(x) It should be possible to change amplitude scale to make best use of available space.

(xi) It should be possible to study on speed curve, the damping and speed variations at CB opening and closing time.

(xii) The CB analyzer should be supplied with portable memory bank to store test result taken by test kit to enable further down loading to centrally located PC.

(xiii) Window based PC down loading software should be provided with CB analyzer to facilities downloading test result from memory bank to PC where it can be analyzed and stored in proper directory/file.

(xiv) It should be possible to compare present results with previous one. The feature of zooming the graph and moving the cursors on graph, thereby indicating instantaneous values of test parameters should also be provided.

(xv) The latest version of CB analyzer system (hardwares and softwares) to be supplied and time to time updating of software should be offered.

(xvi) As and when required, technical support for analysis of critical test result to be offered, on regular basis.

**3.15.3 Other Essential Requirements**.

(i) The CB analyzer should operate on power supply of 220 volts (± 10%) at 50 Hz(± 5%) frequency .

(ii) The CB analyzer should be capable of working in high electro-magnetic and electrostatic conditions.

(iii) The CB analyzer should be capable of functioning accurately in environmental condition of temperature 0° to 50° C and humidity (RH) up to 95 %( non-condensing).

(iv) The CB analyzer should be portable so as to facilitate moment from one site to other and supplied with suitable transportation case.

(v) The supplier should have adequate after sale service facility.

(vi) As per ISO:9001 requirement, celebration certificates for each instrument should be supplied.

(vii) Installation:

a) Indoor/outdoor

b) The equipment should be portable easy to handle robust and sturdy, for field applications.

**Annexure- 1**

## GUARANTEED AND OTHER TECHNICAL PARTICULARS OF TESTING INSTRUMENT/ EQUIPMENTS

| S. No. | Item/ Description | Particular |
|---|---|---|
| **A** | **50 k ohm Earth Tester** | |
| 1 | Make | |
| 2 | Model | |
| 3 | Standard Conformity | |
| 4 | Measuring Resistance Range | |
| 5 | Display Type | |
| 6 | Test Current Ranges | |
| 7 | Accuracy | |
| 8 | Whether Leaflet of the Instrument Enclosed (Yes/ No) | |
| **B** | **5 kV Megger** | |
| 1 | Make | |
| 2 | Model | |
| 3 | Standard Conformity | |
| 4 | Motor Details | |
| 5 | Voltage Ranges | |
| 6 | Insulation Range | |
| 7 | Accuracy | |
| 8 | Whether Leaflet of the Instrument Enclosed (Yes/ No) | |
| **C** | **Portable Primary Injection Test Kit** | |
| 1 | Make | |
| 2 | Model | |
| 3 | Standard Conformity | |
| 4 | kVA | |
| 5 | Input | |
| 6 | Output | |
| 7 | Whether Leaflet of the Instrument Enclosed (Yes/ No) | |
| **D** | **Relay Test Kit** | |
| 1 | Make | |
| 2 | Model | |
| 3 | Standard Conformity | |
| 4 | Voltage Outputs | |
| 5 | Current Outputs | |
| 6 | Frequency Ranges | |
| 7 | Accuracy | |

| | | |
|---|---|---|
| 8 | Output power (VA) | |
| 9 | Whether Leaflet of the Instrument Enclosed (Yes/ No) | |
| **E** | **Transformer Turn Ratio Meter** | |
| 1 | Make | |
| 2 | Model | |
| 3 | Standard Conformity | |
| 4 | Operating Voltage | |
| 5 | Test Voltage | |
| 6 | Measuring Range | |
| 7 | Accuracy | |
| 8 | Whether Leaflet of the Instrument Enclosed (Yes/ No) | |
| **F** | **SF6 Leakage Detector** | |
| 1 | Make | |
| 2 | Model | |
| 3 | Standard Conformity | |
| 4 | Power Supply | |
| 5 | Sensor Length | |
| 6 | Battery Life | |
| 7 | Response Time | |
| 8 | Reset Time | |
| 9 | Warm Up time | |
| 10 | Whether Leaflet of the Instrument Enclosed (Yes/ No) | |
| **G** | **Microprocessor Based Dielectric Strength Analyzer** | |
| 1 | Make | |
| 2 | Model | |
| 3 | Standard Conformity | |
| 4 | Resolution | |
| 5 | Display Type | |
| 6 | Voltage Range | |
| 7 | Measuring Accuracy | |
| 8 | Whether Leaflet of the Instrument Enclosed (Yes/ No) | |
| **H** | **Circuit Breaker Analyzer** | |
| 1 | Make | |
| 2 | Model | |
| 3 | Standard Conformity | |
| 4 | Injection Current | |
| 5 | Display Type | |
| 6 | No. of Open Close CB Contacts to | |

| | | |
|---|---|---|
| | monitor | |
| 7 | Accuracy | |
| 8 | Whether Leaflet of the Instrument Enclosed (Yes/ No) | |
| **I** | **Transformer Oil Breakdown Test Kit** | |
| 1 | Make | |
| 2 | Model | |
| 3 | Standard Conformity | |
| 4 | BD Voltage Range | |
| 5 | Display Type | |
| 6 | Accuracy | |
| 7 | Whether Leaflet of the Instrument Enclosed (Yes/ No) | |

**RAJASTHNAN RAJYA VIDYUT PRASARAN NIGAM LTD**
**(PROJECT & PLANNING CIRCLE)**

# TURNKEY PROJECT
# FOR
# CONSTRUCTION OF 400/220kV GSS AT JAISALMER-2
# AND
# 400kV BAY WORK AT EXISTING 400/220 KV GSS BARMER AND AKAL-1 (JAISALMER)

## BID ENQUIRY NO. **RVPN /KfW/ICB-1**

**TECHNICAL SPECIFICATION**
**(VOLUME-III)**

CIVIL WORKS
**Volume-III**

**Superintending Engineer (P&P)**
**Rajasthan Rajya Vidyut Prasaran Nigam Ltd.**
**Vidyut Bhawan, Janpath, Jyoti Nagar**
**Jaipur- 302 005.**

## SECTION - CIVIL


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## SECTION : CIVIL

### 1.0 GENERAL

The intent of specification covers the following:

Design , engineering and construction of all civil works at sub-station. All civil works shall also satisfy the general technical requirements specified in other sections of this 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 National/ International Standards.

All civil works shall be carried out as per applicable Indian Laws, Standards and Codes. All materials shall be of best quality conforming to relevant Indian Standards and Codes.

The Bidder shall furnish all design, drawings, **(Unless otherwise specified)** 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 Owner.

The work shall be carried out according to the design/ drawings to be developed by the Bidder and approved by the Owner based on Tender Drawings supplied to the Bidder by the Owner. For all buildings, structures, foundations etc. necessary layout and details shall be developed by the Bidder keeping in view the functional requirement of the substation facilities and providing enough space and access for operation, use and maintenance based on the input provided by the Owner. **Certain minimum requirements are indicated in this specification for guidance purposes only**. However, the Bidder shall quote according to the complete requirements.

### 2.0 GEO-TECHNICAL INVESTIGATION

2.1 The Bidder shall perform a detailed soil investigation and Contouring to arrive at sufficiently accurate, general as well as specific information about the soil profile, levels 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 report to the effect will be submitted by the Bidder for Owner's specific approval giving details regarding data proposed to be utilized for civil structures design.

2.2 The Bidder 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 & condition of the Contract. Tests must be conducted

under all the critical locations i.e. Control Room Building, Lightning Mast. Tower locations, Auto 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 allow able safe bearing capacity for different sizes of foundations at different founding strata for the various structures of the substation. The Bidder 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 bench mark indicated by the Owner.

All the work shall be carried out as per latest edition of the corresponding Indian Standard Codes.

### 2.3.1 Bore Holes

Drilling of bore holes of 150 mm dia in accordance with the provisions of IS: 1892 at the rate of minimum two number of bore holes per bay to 6 m depth or to refusal whichever occur earlier. (By refusal it shall mean that a standard penetration blow count (N) of 100 is recorded for 30 cm penetration). In cases where rock is encountered, coring in one bore hole per bay shall be carried out to 3 M in bed rock and continuous core recovery is achieved.

Performing Standard Penetration Tests at approximately 1.5 m interval in the bore hole 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.

Collecting undisturbed samples of 100 / 75 mm diameter 450 mm long from the bore holes at intervals of 2.5 m and every change of stratum starting from 1.0 m below ground level onwards in clayey strata.

The depth of Water Table shall be recorded in each bore hole.

All samples, both disturbed and undisturbed, shall be identified properly with the bore hole 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 Bidder's laboratory without any damage or loss.

The logging of the boreholes shall be complied immediately after the boring is completed and a copy of the bore log shall be handed over to the Engineer-in-charge.

### 2.3.2 Dynamic Cone Penetration Test

Dynamic cone penetration tests of two numbers shall be carried out with the circulation of bentonic slurry at specified locations and a continuous record of penetration resistance (NG) up to 15.00 meter from natural ground level or the refusal shall be maintained by the Bidder IS: 4968 (Part-2) shall be followed for carrying out the test and reporting results.

The location for tests shall be as directed by the Owner. On completion of the test, the results shall be presented as a continuous record as the numbers of blows required for every 300 mm penetration of the cone into the soil.

### 2.3.3 Trial Pits

Trial pits shall be carried at specified one locations of per bay as directed by the Owner. The trial pits shall be 2 m x 2 m in size extending to 4 m depths, or as specified by the Owner. Undisturbed samples shall be taken from the trial pits as per the direction of the Owner.

### 2.3.4 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 IS: 3043. The test shall be conducted using Wagner's four electrode method as specified in IS: 1892, Appendix-B2. 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 0.5 m up to a distance of 10.0 m.

### 2.3.5 Water

The Bidder shall make the arrangement of water for constructional activities at his own cost. The sample of water shall be got tested for its chemical analysis and it should be suitable for construction of civil works as per norms of relevant IS codes/ specifications.

### 2.3.6 Back Filling of Bore Holes

On completion of each hole, the Bidder shall backfill all bore holes as directed by the Owner. The backfill material can be the excavated material.

2.3.7 **Laboratory Test**

1. The laboratory tests shall be carried our progressively during the field work after sufficient number of samples have 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 I.S. codes.

The following laboratory tests shall be carried out

a) Visual and Engineering Classification

b) Liquid limit, plastic limit and shrinkage limit for C-0 soils.

c) Natural moisture content, bulk density and specific gravity.

d) Grain size distribution.

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) Rock quality designation (RQD), RMR in case of rock is encountered.

2.3.8 **The Results and Reports**

2.3.8.1 The Bidder shall submit the detailed report in two (2) copies wherein information regarding the geological detail of the site, summarized observations and test data, bore logs, and conclusions and recommendations on the type of foundations with supporting calculations for the recommendations. Initially the report shall be submitted by the Bidder in draft form and after the draft report is approved, the final report in four (4) copies shall be submitted. The test data shall bear the signatures of the Investigation Agency, Vendor and also site representative of RVPN.

2.3.8.2 The report shall include, but not limited to the following:-

a) A plan showing the locations of the exploration work i.e. bore holes, dynamic cone penetration tests, trial pits. Plate load test 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 summarized 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, shall be enclosed.

Recommendations: The report should contain specific recommendations for the type of foundation for the various structures envisaged at site. The Bidder shall acquaint himself about the type of structures and their functions from the Owner. 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.

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 shall be provided.

d) Recommendations regarding slop of excavation 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. 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.

## 3.0 SITE PREPARATION:

**Site will be handed over as "AS IS WHERE IS" condition**. The layout and levels of all structure etc shall be made by the successful Bidder at his own cost from the general grids of the plot and benchmarks set by the Bidder and approved by the Owner. The Bidder shall give all help in instruments, materials and personnel to the Owner for checking the detailed layout and shall be solely responsible for the correctness of the layout and levels.

**Site shall be graded to the levels as per the existing FGL (finished grade level) which includes clearing the site area free of bushes, trees including removal of roots, any unsuitable materials, demolition of any temporary/ permanent building / structures / foundations and removal of debris / unsuitable material and disposing of un suitable / unserviceable material outside the premises with the permission of Engineer-in-charge**.

## 3.1 SCOPE

This clause covers the design and execution of the work for site preparation, such as clearing of the site, the supply and compaction of fill material, excavation and compaction of backfill for foundation, road construction, drainage, trenches and final topping by stone (broken hard stone).

## 3.2 GENERAL

1) The Bidder 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 standard specifications.

2) If fill material is required, the fill material shall be suitable for the above requirement. The fill shall be such a material and the site so designed as to prevent the erosion by wind and water of material 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, approved by the Owner.

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 Owner.

## 3.3 EXCAVATION AND BACKFILL

1. Excavation and backfill for foundations shall be in accordance with the relevant code.

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 Owner. 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.

## 3.4 COMPACTION

1. The density to which fill materials shall be compacted shall be as per relevant IS and as per direction of Owner. 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 OMC. Cohesionless 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 center 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.

## 3.5 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 Owner.

## 4.0 ANTIWEED TREATMENT & STONE SPREADING

### 4.1 Scope of Work

4.2 The Bidder shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the drawings, specification and direction of the Owner. Stone spreading along with Crusher dust (residue of coarse aggregate) / Quarry Rubbish / Murram / any locally available Non cohesive material having anti weeding property shall be done in the areas of the switchyard under present scope of work. However the stone spreading along with Crusher dust (residue of coarse aggregate) / Quarry Rubbish / Murram / any locally available Non cohesive material having anti weeding property in future areas within fenced area shall also be provided in case step potential without stone layer is not well within safe limits.

4.3 This work is to be taken up after the site is cleared off all vegetation and prepared to the levels and grades as per the approved drawing.

4.4 Engineer-in-charge 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.

4.5 After antiweed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by Engineer-incharge. 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.

4.6 In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipments is not possible, the material shall be compacted by hand. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling compaction.

4.7 Over the prepared sub grade, 150mm thick Crusher dust (residue of coarse aggregate) / Quarry Rubbish / Murram / any locally available Non cohesive material having anti weeding property shall be laid evenly, rolling and compaction

4.8 A final layer of 100mm thickness of uncrushed/crushed/broken stone of 20mm nominal size (ungraded size) shall be spread uniformly over CNS layer.

4.9 **Stone spreading for the areas of Future scope of work**

4.10 After the soil sterilization material is applied and surface prepared / compacted to the required slope / grade **a base layer of 150mm** Crusher dust (residue of coarse aggregate) / Quarry Rubbish / Murram / any locally available Non cohesive material having anti weeding property. Over the brick edging, 100mm thick layer of granite/basalt/trap jelly of 20mm size shall be spread over the entire switchyard area as per drawing and directions of engineer incharge of the work

4.11 The 20mm nominal size shall pass 100% through IS. Sieve designation 40 mm and nothing through 16.00 mm IS Sieve. The whole switchyard area (excluding buildings pathway road, drainages, cable trenches, equipments/ structures plinths etcé ) shall be covered with jelly spreading.

4.12 **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 Owner.

The material to be used for stone filling/ site surfacing shall be uncrushed/ crushed/ broken stone of 20mm nominal size (ungraded single size) conforming to table 2 of IS : 383 - 1970. Hardness, Flakiness shall be as required for wearing courses are given below:

| | | |
|---|---|---|
| (a) | Sieve Analysis limits (Gradation) | |
| | (IS: 383 - Table - 2) | |
| | Sieve Size | % passing by weight |
| | 40 mm | 100 |
| | 20 mm | 85-100 |
| | 10 mm | 0-20 |
| | 4.75 mm | 0-5 |

| | | |
|---|---|---|
| | 'One Test' shall be conducted for every 500 cu.m. | |
| (b) | Hardness | |
| | Abrasion value (IS:2386 Part-IV) | Not more than 40% |
| | Impact value (IS: 2386 Part-IV) | Not more than 30% and frequency shall be one test per 500 cum with a minimum of one test per source. |
| (c ) | **Flakiness Index**: One test shall be conducted per 500 cum of aggregate as per IS: 2386 Part-1 and maximum value is 25%. | |

4.13 After all the structures/equipments are erected, antiweed treatment shall be applied in the switchyard where ever stone spreading 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 antiweed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturerôs recommendation. Nevertheless the effectiveness of the chemical shall be demonstrated by the contractor in a test area of 10MX10M (appx) and shall be sprinkled with water at least once in the afternoon everyday 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 Engineer ï in- charge. The final approval shall be given by Engineer ï in ï charge based on the results.

4.14 The dosage and application of chemical shall be strictly followed as per manufacturerôs recommendation. The Bidder shall be required to maintain the area free of weeds for a period of 1 year from the date of application of 1st dose of anti-weed chemicals

4.15 **Cement Concrete Block Masonry barricades**:

4.16 Barricades in solid concrete block masonry in cement mortar 1:6 with concrete blocks of proportion (1:5:3), crushing strength not less than 50 kgs per sq. cm, 40x20x40cm size(L.B.H) conforming to ISS : 2185 ï 1987 to confine stone spreading and along road side curb stone shall be provided. The masonry shall be 225 mm above FGL, plastered in cement mortar 1:6 and shall be given two coats of weather proof painting over primer to the exposed faces.

## 5.0 SITE DRAINAGE

1. Adequate site drainage system shall be provided by the Bidder. The Bidder shall obtain rainfall data and design the storm water drainage system, (culverts, ditches, drains etc.) to accommodate run off due to the most intense rainfall that is likely to occur over

the catchment area in one hour period on an average of once in ten years. The surface of the site shall be sloped to prevent the ponding of water.

2. The maximum velocity for pipe drains and open drains shall be limited to 2.4 m/sec and 1.8m/sec respectively. However, minimum non silting velocity of 0.6m/sec shall be ensured. Longitudinal bed slope not milder than 1 in 1000 shall be provided.

3. For design of RCC pipes for drains and culverts, IS: 456 and IS: 783 shall be followed.

4. The Bidder shall ensure that water drains are away from the site area and shall prevent damage to adjacent property by this water. Adequate protection shall be given to site surfaces, roads, ditches, culverts etc. to prevent erosion of material by water.

5. The drainage system shall be adequate without the use of cable/ pipe trenches. (Pipe drains shall be provided in areas of switchyard where movement of crane will be necessary in operating phase of the substation).

6. 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, pipes conforming to railway loading standards or at least NP4 class shall be provided. Manholes shall be provided at every 30m interval, at connection points and at every change of alignment.

7. Surface drains with suitable size removable light duty covers shall be provided using Stone/Brick masonry with minimum thickness of 300/230 mm or more as per design condition.

8. Pipe drains shall be connected through manholes at an interval of max. 30m. Effluents shall be suitably treated by the Bidder to meet all the prevalent statutory requirements and local pollution control norms and treated effluents shall be conveyed to the storm water drainage system at a suitable location for its final disposal.

9. Invert of the drainage system shall be decided in such a way that the water can easily be discharged above in High Flood Level (HFL) outside substation boundary at suitable location upto a maximum 50M beyond boundary wall of substation or actual whichever occurs earlier and approved by Owner. Pumps for drainage of water (if required) shall be provided by Bidder.

10. All internal site drainage system, including the final connection/ disposal to **Owner's** acceptance points shall be part of **Bidder's** scope including all required civil work, mechanical & electrical

systems. The Bidder shall connect his drain(s) at one or more points to outfall points as feasible at site.

11. The drainage scheme and associated drawings shall be got approved.

## 6.0 ROADS AND CULVERTS

1. The approach road and road within substation shall be provided for access to equipment and building are in the scope of bidder. Layout of the roads shall be based on General detail & Arrangement drawing for the substation. Parking areas shall be provided for Site personnel and visitors at convenient locations. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Road to the Autotransformer/ Reactor shall be as short and straight as possible.

2. All substation roads be constructed so as to permit transportation of all heavy equipment. The double lane road shall have minimum **7.5** m black topping with 1.6 m wide moorum shoulder on either side of the road. Other roads shall be with 3.75 m black topping and 1.3 m wide moorum shoulder on either side of the road.

3. Road construction shall be as per IRC standards.

4. Adequate provision shall be made for road drainage.

5. All the culverts and its allied structure (required for road/ rail, drain trench crossing etc.) shall be designed for class AA loading as per IRC standard/ IS code and should be checked for Auto transformer/ Reactor loading.

6. All roads shall be designed for class of traffic as per IRC-37-1984 Guide lines for the design of flexible pavements.

## 7.0 FOUNDATION/RCC CONSTRUCTION

### 7.1 GENERAL

1. Work covered under this clause of the specification comprises the design and construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, control cubicles, bus supports, Auto transformer/ Reactors, marshalling kiosks, auxiliary equipments & systems buildings, tanks 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 IS: 456-2000 and all the tests shall be conducted as per relevant Indian Standard Codes as mentioned in Standard field quality plan appended with the specification

   A minimum grade of M20 concrete shall be used for all structural/ load bearing members as pr latest IS 456-2000.

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 foundationôs plinths and building plinths shall be **minimum** 300 mm and 550 mm above finished ground level respectively.

5. Minimum 75 mm 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 approval soil data and sub-soil conditions as well as for all possible critical loads and the combinations thereof.

## 7.2 DESIGN

1. All foundation shall be of reinforced cement concrete. The design and construction of RCC structures shall be carried out as per IS: 456 and minimum grade of concrete shall be M-20.

2. Limit state method of design shall be adopted unless specified otherwise in the specification.

3. For detailing of reinforcement IS: 2502 and SP:34 shall be followed. Cold twisted deformed bars (Fe = 415/500 N/mm2) conforming to IS:1786 shall be used as reinforcement. 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 towards the earth face shall be minimum 40 mm.

4. RCC water retaining structures like storage tanks etc. shall be designed as un-cracked section in accordance with IS: 3370 (Part I to IV) by working stress method. However, water channels shall be designed as cracked section with limited steel stresses as per IS: 3370 (Part I to IV) by working stress method.

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 IS Codes of foundation design.

6. Design shall consider any sub-soil water pressure that may be encountered following relevant standard strictly.

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.

8. RCC columns shall be provided with rigid connection at the base.

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 IS Codes 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.

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. 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.

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.

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.

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.

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.

16. The foundations of transformer/ reactor and circuit breaker shall be of block type foundation. Minimum reinforcement shall be governed by IS: 2974 and IS: 456.

17. The tower and equipment foundations shall be checked for a factor of safety of 2.2 for normal condition and 1.65 for 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.

## 7.3 ADMIXTURES & ADDITIVES

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 labeled containers to enable identification.

2. Admixtures in concrete shall conform to IS: 9103. The water proofing cement additives shall conform to IS: 2645. Concrete Admixtures/ Additives shall be approved by Owner.

3. The Bidder may propose and the Owner 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.

4. The water-reducing set-retarding admixture shall be an approved brand of Ligno-sulphonate type admixture.

5. The water proofing cement additives shall be used as required/ advised by the Owner.

## 8.0 AUTO TRANSFORMER FOUNDATION, RAIL TRACK/ ROAD CUM RAIL TRACK.

The Bidder shall provide a RCC Rail cum road system integrated with the Autotransformer/ Reactor foundation to enable installation and the replacement of any failed unit by the spare unit located at the site. The transfer track system shall be suitable to permit the movement of any failed unit fully assembled (including OLTC, bushings) with integral radiators and oil, without the deenergization of any other equipment in the station. 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 I.R.C. code/ relevant IS.

The rail shall be of commercial quality flat bottom.

A pylon support system shall be provided for supporting the fire fighting system by the Bidder.

## 8.1 DESCRIPTION OF OIL RECOVERY SYSTEM

The oil recovery system shall be provided for all Auto transformer/ Reactors (containing insulating oil or any inflammable or polluting liquid) in order to avoid spread of fire by the oil, and for environmental protection.

Each Auto 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 from the Auto transformer/ Reactor shall be 20% of the Auto transformer/ Reactor height or 0.8 m whichever is more. The oil collection pit thus formed shall have a void volume equal to 200% volume of total oil in the Auto transformer/ Reactor. The MS grating placed at the formation level shall be covered with 100 mm thick layer of broken/ crushed/ non crushed stone 40 mm nominal size which acts as an extinguisher for flaming oil.

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 & clean.

## 8.2 MATERIALS

The retaining walls which make up the oil collection pit shall be made of fire resistant material such as reinforced cement concrete, fire brick etc., and shall be impervious to oil.

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 bottom of the pit shall have a uniform slope towards the sump pit.

## 8.3 DRAINAGE

A device showing level of sump pit shall be provided by Bidder fitted along with the automatic pumping system which shall have sufficient capacity to evacuate the fire fighting& rain water from the sump pit. The Bidder may propose other better scheme, if agreed by Owner.

If the height of the retaining walls which form the oil collection pit exeed 60 cm, steps shall be provided to facilitate access to the oil collection pit.

When designing the oil collection pit, the movement of the auto transformer must be taken into account.

## 9.0 CABLE & PIPE TRENCHES

1. The cable trenches and precast removable RCC cover (with lifting arrangement) shall be constructed using RCC of M20 grade.

2. 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 end.
   (ii) Triangular earth pressure + uniform surcharge ;pressure of 2T/m2.

3. Cable trench covers shall be designed for self weight of top slab + UDL of 2000 Kg/$m^2$ + concentrated load of 200 kg at centre of span on each panel.

4. Cable trench crossing the road/ rails shall be designed for class AA. Loading of IRC/ relevant IS code and should be checked for transformer/ reactor loading.

5. Trenches shall be drained. Necessary sumps be constructed and sump pumps if necessary shall be supplied. Cable trenches shall not be used as storm water drains.

6. 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 rain water do not enter the trench.

7. All metal parts inside the trench shall be connected to the earthing system.

8. Cables from trench to equipments shall run in hard conduit pipes.

9. Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.

10. The trench bed shall have slope of 1/500 along the run & 1/250 perpendicular to the run.

11. All the construction joints of cable trenches i.e. between base slab to base slab and the junction of vertical wall to base slab as well as from vertical wall to wall and all the expansion joints shall be provided with approved quality PVC water stops of approx. 230 x 5 mm size for those sections where the ground water table is expected to rise above the junction of base slab and vertical wall of cable trenches.

12. Cable trenches shall be blocked at the ends if required with brick masonry in cement sand mortar 1:6 and plaster with 12 mm thick 1:6 cement sand mortar.

13 cable trays be provided in required teirs to lay the control cables in cable trenches supported with the design data and approved by the RVPN.

## 10.0 SECURITY OFFICE

A security office shall be provided at the entrance of switch yard. The minimum dimension of the room and associated dormitory, toilet and pantry etc. is given on the drawing.

## 11.0 BUILDINGS - GENERAL REQUIREMENTS

### 11.1 GENERAL

The scope include the design, engineering and construction including anti-termite treatment, plinth protection DPC of Building including sanitary, water supply, electrification false ceiling etc. of control room building, AC Kiosk building, fire fighting building. All buildings shall be of RCC framed structure of concrete of M20 grade minimum.

### 11.2 CONTROL ROOM BUILDING

Minimum floor area requirements have been given in tender drawings which may be increased at the time of detailed engineering to suit project requirements.

An open space of 1 m minimum shall be provided on the periphery of the rows of panel and equipment generally in order to allow easy operator movement and access as well as maintenance.

Any future possibility of annex building shall be taken care of while finalizing the layout of the control room building.

11.2.1 **DESIGN**

a) The buildings shall be designed:

1. To the requirements of the National Building Code of India, and the standards quoted therein..

2. For the specified climatic & loading conditions.

3. To adequately suit the requirements of the equipment 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. For a life expectancy of structure, systems and components not less than that of the equipment which is contained in the building provided regular maintenance is carried out.

6. To be aesthetically pleasing. Different buildings shall show a uniformity and consistency in architectural design.

7. To allow for easy access to equipment and maintenance of the equipment.

8. With, wherever required, fire retarding materials for walls, ceilings and doors, which would prevent supporting or spreading of fire.

9. With materials preventing dust accumulation.

b) Suitable expansion joints shall be provided in the longitudinal direction wherever necessary with provision of twin columns.

c) Individual members of the buildings frame shall be designed for the worst combination of forces such as bending moment, axial force, shear force torsion etc.

d) Permissible stresses for different load combinations shall be taken as per relevant IS Codes.

e) All cable vaults shall be located above ground levels i.e. cable vaults shall not be provided as basements in the buildings.

f) The building lighting shall be designed in accordance with the requirements of relevant section. **All conduit system, air conditioning tubing etc shall be properly cared prior to concreting / finishing work. Complete wiring for lighting, air conditioning, intercom, broadband etc. shall be in GI concealed conduit during concreting or plaster what so ever be case.**

g) The building auxiliary services like air conditioning and ventilation systems, fire protection and detection systems and all other miscellaneous services shall be designed in accordance with the requirements specified in relevant section or elsewhere in this specification.

h) Two nos. emergency exists shall be provided in control room in control room building.

i) Providing plinth protection of 1200 mm wide, along the periphery of control room

11.2.2 **DESIGN LOADS**

Building structures shall be designed for the most critical combinations of dead loads, super-imposed loads, equipment loads, wind loads, scismic loads and temperature loads.

Dead loads shall include the weight of structures complete with finishes, fixtures and partitions and should be taken as per IS : 1911.

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. Equipment loads shall constitute, if applicable, all load of equipments to be supported on the building frame.

The wind loads shall be computed as per IS 875, Seismic Coefficient method shall be used for the seismic analysis as per IS 1893 with importance factor 1.5.

For temperature loading, the total temperature variation shall be considered as 2/3 of the average maximum annual variation in temperature. The average maximum annual variation in temperature for the purpose shall be taken as the difference between the mean of daily maximum temperature during the coldest month of the year and mean of daily maximum temperature during hottest month of the year. The structure shall be designed to withstand stresses due to 50% of the total temperature variation.

Wind and Seismic forces shall not be considered to act simultaneously.

Floors/ slabs shall be designed to carry loads imposed by equipment, cables piping travel of maintenance trucks and equipment and other loads associated with building. Floors shall be designed for live loads as per relevant IS. Cable and piping loads, shall also be considered additionally for floors where these loads are expected.

In addition, beams shall be designed for any incidental point loads to be applied at any point along the beams. The floor loads shall be subject to Owner's approval.

For consideration of loads on structures, IS: 875, the following minimum superimposed live loads shall, however, be considered for the design.

| | | | | |
|---|---|---|---|---|
| a. | Roof | | 1.5 KN/$M^2$ | For accessible roofs |
| | | | 0.75 KN/$M^2$ | For in-accessible roofs |
| b. | RCC-Floor | (i) | 5KN/$M^2$ | For offices |
| | | (ii) | 10KN/$M^2$ (minimum.) | For equipment floors or actual requirement. If higher than 10 KN/$M^2$ based on equipment component weight and layout plans. |
| c. | Toilet Rooms | | 2 KN/$M^2$ | |
| d. | Chequered plate floor | | 4KN/$M^2$ | |
| e. | Walkways | | 3 KN/$M^2$ | |

Any additional load coming in the structure shall be calculated as per IS: 875

### 11.2.3 **SUBMISSION**

The following information shall be submitted for review and approval to the Owner:

1. Design criteria shall comprise the codes and standards used, applicable climatic data including wind loads, earthquake factors maximum and minimum temperatures applicable to the building locations, assumptions of dead and live loads, including equipment loads, impact factors, safety factors and other relevant information.

2. Structural design calculations and drawing (including construction/ fabrication) for all reinforced concrete and structural steel structures.

3. Fully, dimensioned concept plan including floor plans, cross sections, longitudinal sections, elevations and perspective view of each building. These drawings shall be drawn at a scale not smaller than 1:50 and shall identify the major building components.

4. Fully dimensioned drawings showing details and sections drawn to scales of sufficient size to clearly show sizes and configuration of the building components and the relationship between them.

5. Product information of building components and materials, including walls partitions flooring ceiling, roofing, door and windows and building finishes.

6. A detailed schedule of building finishes including colour schemes.

7. A door & window schedule showing door types and locations, door lock sets and latch sets and other door hardware.

**Approval of the above information shall be obtained before ordering materials or starting fabrication or construction as applicable**

### 11.2.4 FINISH SCHEDULE

The finishing schedule is given in subsequent clauses.

### 11.2.5 FLOORING

Flooring in various rooms of control room building shall be as for detailed schedules given in Table-1.

### 11.2.6 WALLS

Control room buildings shall be of framed superstructure. All walls shall be non-load bearing walls. Min. thickness of external walls shall be 300 mm R.R. stone masonry/ 230 mm Brick masonry in 1:6 cement sand mortar.

### 11.2.7 Plastering

All internal & external walls shall have minimum 20 mm thick 1:6 cement sand plaster. The ceiling shall have 6 mm thick 1:4 cement sand plaster.

**Internal finish schedule is given Table - 1:**

| S. No. | Location | Flooring & skirting 150 mm high | Wall Internal | Ceiling | Doors windows ventilators |
|---|---|---|---|---|---|
| 1. | Control room | Vitrified tiles 600x600 10mm thick Homogeneus | All walls shall be prepared with POP/Cement putty & Plastic Emulsion of approved quality. | Aluminium False Ceiling TRAC-84 or Equivalent | Anodised Aluminium indal/Jindal or equivalent extruded sections as per IS 733 & 1285 glazing with 5.5mm toughened glass Hermitically sealed with 12 mm gap |
| 2. | Sub-station incharge officers conference library/ record, corridor, staff rooms | Same as 1 | Same as 1 | Aluminium False Ceiling TRAC-84 or Equivalent | Teak wood frame & flush door shutter, windows & ventilators Aluminium indal/Jindal or equivalent extruded sections as per IS 733 & 1285 glazing with 5.5mm Float glass |
| 3. | Reception/ Lobby | Vitrified Tile/ combination of Green Kesaria marble/ Jaisalmer stone/ Wonder marble | Same as 1 | Aluminium False Ceiling TRAC-84 or Equivalent | Anodised Alum. Extruded sections as at 1 for entrance with glazing |
| 4. | Battery Room | Porcelain Tiles | DADO acid resistant title 2.1 M high. Glazed tiles | Aluminium False Ceiling TRAC-84 or Equivalent | Aluminium door with 12mm thick pre laminated panels. |
| 5. | DCDB, MCC FF pump house hosting platform | Ironite flooring | Acrylic Distemper | Acrylic Distemper | Aluminium door with 12mm thick pre laminated panels. |
| 6. | Toilet | Ceramic floor tiles of approved make & quality | DADO glazed tile 2.1 M high for toilet for pantry above working platform upto 750 mm | Plastic Emulsion | Teak wood frame flush door shutter with Anodised Aluminium fixtures best quality & windows, ventilators aluminium as at 1 |
| 7. | Stair & Pantry | Vitrified Tile/ combination of Green Kesaria marble/ Jaisalmer stone/ Wonder marble | - | Plastic Emulsion | Stainless steel Railing of approved design |
| 9. | Other areas not specified | Vitrified Tile/ combination of Green Kesaria marble/ Jaisalmer stone/ Wonder marble | Plastic Emulsion | Plastic Emulsion | Stainless steel Railing for cut outs etc. |
| 11 | Exterior finish | Textured Paint after application of cement putty and primer over the areas of plastered surface. | | | |

11.2.8 **ROOF**

Roof of the C.R. Building shall consist of Cast-in-situ RCC slab treated with a water proofing system which shall be an integral cement based treatment confirming to PWD specification (item No. 25.8 of DSR 1997). 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 IS; 2645 over the RCC slab including cleaning the surface before treatment.

(b) Over RCC roof grading shall be done by using M-10 grade mix 1:3:6 (1 cement : 3 course sand: 6 graded stone aggregate) in proper slop with average thickness of 80 mm and minimum thickness at Khurra 40 mm.

(c) 20 mm thick Terrazo to tiles be provided in cm 1:4 over graded roof.

(d) 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.

12.0 **FIRE PROTECTION WALLS:**

12.1 **General:**

Fire protection walls shall be provided in accordance with Tariff Advisory Committee (TAC) recommendations.

12.2 **Application Criteria:**

A firewall shall be erected between the transformers / reactors, if the free distance between the various pieces of equipment is less than 10m to protect each one from the effects of fire on another.

12.3 **Fire resistance**:

The firewall shall have a minimum fire resistance of 3 hours. The partitions which are made to reduce the noise level of the transformer / reactor shall have the same fire resistance where the partitions are also used as firewalls. 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 in order to protect against the effect of radiant heat and flying debris from an adjacent fire.

12.4 **Mechanical resistance**:

The firewall shall have the mechanical resistance to withstand local atmospheric conditions. If this wall shall serve as a support for the equipment such as insulators etc., its mechanical rigidity must be increased.
Connecting the walls by steel or other structures which may produce a reversing torque, if overheated shall be avoided.

12.5 **Dimensions**:

The firewall shall extend at least 2 m on each side of the power transformers / reactors and at least 1 m above the conservator tank or safety vent.
These dimensions might be reduced in special cases, and if TAC permits so, where there is lack of space. A minimum of 2 m clearance shall be provided between the equipments. i.e., transformers / reactors and firewalls.

The building walls which act as firewalls shall extend at least 1 m above the roof in order to protect it.

12.6 **Materials** :

The firewall may be made of reinforced concrete (M20 grade), fire brick, concrete blocks or corrugated iron on a steel structure as per the system requirements. Materials used must conform to the standards of the National Fire Prevention Association & TAC norms.

## 13.0 CHAIN LINK FENCES AND GATE

13.1 General:

Fencing shall be provided as per the drawings/ details furnished by the owner.

13.2 Areas Requiring Fencing:

Fencing shall be provided all along the boundary covering the entire switch yard in main and wicket gate as per drawing.

Drawing shall be developed as per the typical sketch furnished.

13.3 **a) Product Materials:**

The minimum requirements are as follows:

1. Chain Link fence fabric in accordance to IS: 2721

| | |
|---|---|
| 2. Size of mesh | 50 mm |
| 3. Size of coated wire | 4 mm diameter (8 gauge) |
| 4. Width of chain link | 2500 mm |

5. Class of zinc coating medium

b) **Posts**

| | Angle section | Spacing |
|---|---|---|
| 1. Intermediate | 65x 65 x 6mm | 2500 mm |
| 2. Straining posts/ Corner posts | 65 x 65 x 6mm | 25000 mm |
| 3. Stay post | 50 x 50 x 6mm | 25000 mm |

All structural steel shall conform to IS:2062 and shall be painted with a coat of approved steel primer and two coats of synthetic enamel paint.

Chain link mesh shall be connected/fixed to the posts by providing ISA 45 x 45 x 6 mm horizontally at the top and center (middle) throughout the length of fencing and MS Flat 65 x 6 mm vertically at every posts. Connection of Angle and MS flat & chain link mesh with the posts shall be with suitable bolts and nuts or Welding as per the direction of the Owner/ Engineer-in-charge of work.

The bottom of chain link mesh shall be embedded in CC 1:3:6 to a depth not less than 100 mm.

4. Above chain link, 3 rows (6 Nos.) of galvanized barbed wire, conforming to IS:278 shall be provided in each arm of the 'Y' shaped barbed arm at top. The barbed wire shall consist of two splices per reel. The barbed wire shall be formed by twisting two line wires, one containing the barbs. The barbed wire shall be of 12 SWG galvanized steel with its weight 155-136gm/m length of the wire. Distance between two barbs shall be 75 mm. The barbs shall carry four points and shall be formed by twisting two point wires, each two turn tightly round one line wire, making altogether 4 complete turn. The barbs shall be finished in such a way that the four points are set and locked at right angles to each other. The barbs shall have a length of not less than 13 mm and not more than 18 mm. The points shall be sharp and well pointed.

5. With barbed wire above the chain link fence, the total fence height shall be minimum 3200 mm above finished ground level or 3000 mm above the protection work as the case may be.

6. Barbed wire arms same as intermediate and straining post.

7. Fittings and hardware : cast aluminium alloy or galvanised steel, malleable or ductile cast iron turnbuckles to be drop forged.

8. For every 50 reels or part thereof samples of the barbed wire and the individual line wires shall be put to tensile test and in case of failure to

conform to the tensile properties given below, two additional tests of each kind shall be made on the samples cut from other reels.

**TENSILE PROPERTIES**

Minimum breaking load of complete barbed wire: 444 Kg.

On the results of these additional tests, the whole or portion of the barbed wire shall be accepted or discarded by the Owner, as the case may be.

13.4 **Installation:**

1. Fence shall be installed along lines shown on approved drawings.

2. Post holes shall be excavated by approved methods.

3. Intermediate posts shall be spaced 2.5 m apart measured parallel to ground surface.

4. Straining posts shall be installed at equal interval not exceeding 25.0m

5. Straining posts shall be installed at sharp changes grade, at corners, at change of direction and where directed.

6. All corner post and every 10th post will have two stay post.

7. Posts shall be set in concrete. Concrete work shall conform to relevant clause. Posts shall be braced and held in plumb position and true alignment and elevation until concrete has set.

8. Fence fabric shall not be installed until concrete has cured a minimum of 10 days.

9. Top and center (middle) of the fence fabric shall be fixed with ISA 45 x45 x 6 mm.

10. Fence fabric shall be laid out with barbed edge on top, stretched tightly and shall be fastened to intermediate, gate and straining post with 65 x 6 mm M.S flats(vertical at every post) and horizontal angle 45 x 45 x 6 mm throughout the fence at top and middle.

11. Fabric shall be fixed to the angle and MS flat by welding or suitable G.I bolts, nuts and washers and at bottom the fabric shall be embedded in concrete.

13. Barbed wire shall be stretched to have uniform tension.

14. Barbed wire shall be attached to barbed wire arms with approved metal clips.

15. Gates shall be installed in locations shown on drawings. Next to the main gate, a men gate (1.25 m wide, single leaf) shall also be provided.

16. Bottom of gates shall be set approximately 40 mm above ground surface and necessary guiding mechanism shall be fitted,

17. Drawing for the gate shall be as per the typical sketch furnished.

18. All structural steel shall be painted with two coats of approved synthetic enamel paint over one coat of steel primer.

19 a) **For providing fencing over ground**:

A 300 mm thick size stone masonry toe wall shall be provided below fencing. Toe wall shall be minimum 450 mm, above and 600 mm below finished ground level with 75 mm thick PCC 1:4:8 bed concrete and 100 mm thick PCC 1:3:6 coping for embedding chain link fence. All exposed faces of masonry shall be pointed in cement mortar 1:3.

b**) For providing fencing over retaining wall / protection wall:**

The excess quantities of different items of work of construction of retaining wall over and above the quantities applicable for construction of toe wall of security fencing as per drawing will be measured and paid under construction of retaining wall/ protection wall.

20) In case of B.C./Expansive soil and filled up soils, masonry wall shall be strengthened to overcome the effects of soil on foundation and to avoid settlements.

21) for expansive / BC soil , back filling shall be with new earth / murrum.

14.0 **Gates:**

1. The Gate frame shall be made of medium duty MS pipe conforming to relevant IS with welded joints.

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. Gates shall be fitted with approved quality iron hinges, latch and latch catch. Latch and latch catch shall be suitable for attachment and operation of pad lock from either side of gates. Hinges shall permit gates to swing through 180 degree back against fence.

4. Gates shall be fitted with galvanised chain hook or gate hold back to hold gates open. Double gates shall be fitted with centre rest and drop bolt to secure gates in closed position.

5. Drawings shall be developed as per the typical sketch furnished and got it approved.

## 15.0 GLAZING

Minimum thickness of glazing shall be 5.5 mm as per IS: 2835. Sun film shall be provided for all windows/ doors for AC rooms.

## 15.1 DOORS AND WINDOWS

The details of doors and windows of the control room building shall be as per finish schedule Table-1 and tender drawing with the relevant IS, code, Rolling steel shutters and rolling steel grills shall be provided as per layout and requirement of buildings. Paints used in the work shall be of best quality specified in PWD/RVPN, specification.

## 15.2 PARTITION

Partition made of anodized aluminum frame provided with 5.5 mm thick clear glass shall be supplied and installed at locations shown in tender drawings.

## 15.3 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 Bidder 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 3 Nos. 1000 litres capacity shall be provided.

(iii) Galvanized MS pipe of medium class conforming to IS: 1279 shall be used for internal & external piping work for potable water supply.

(iv) SWR pipes with rubber rings and solvent cement joints conforming to IS: 13592 shall be used for sanitary works .

(v) Each toilet shall have the following minimum fittings.

(a) WC (Western type wall hung) 390 mm high with toilet paper roll holder and all fittings.

(b) Wash basin (550x400 mm) with all fittings.

(c) Bathroom mirror (600 x 450 x 6 mm thick) hard board backing

(d) CP brass towel rail (600 x 20mm) with C.P. brass brackets

(e) Soap holder and liquid soap dispenser.

(vi) Water cooler for drinking water with 200 ltrs PVC loft tank shall be provided and located near control room instead of near toilet block.

(vii) 1 No. stainless steel kitchen sink with Drain board (510 x 1040 x 178 mm bowl depth) for pantry shall be provided.

(vii) All fittings, fastener, grating shall be chromium plated.

(ix) 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.

(x) Soil, waste and drain pipes, for underground works shall be stone ware for areas not subject to traffic load.

16.0 **OTHER BUILDINGS**:

**(A) Fire Fighting Pump House**

16.1 The minimum dimensions and details of the building are indicated in the tender drawings which may be increased at the time of detailed engineering to suit project requirements.

16.2 All equipment foundations and structural members shall be designed as per the relevant clauses of this specification and IS codes.

16.3 All the external features of the FF building shall be similar to CR building.

16.4 Doors and windows shall be provided as indicated in drawings.

(B) **Parking**

16.5 An architecturally pleasing Parking shed of RCC pavement and roof slab to accommodate 20 Cars and filter machine including proper illumination shall be provided as per tender drawing / approved drawing.

**(C) AC Kiosk Building**

The minimum dimensions and details of the building are indicated in the tender drawings which may be increased at the time of detailed engineering to suit the requirements.

17.0 **BUILDING STORM WATER DRAINAGE FOR ALL BUILDINGS**.

The building drain shall be provided for the collection of storm water from the roofs. This water shall be collected in junction boxes and these boxes shall drain to the main drainage system of the station.

Cast Iron rain water down comers conforming to IS: 1230 with water tight lead joints shall be provided to drain off the rain water from the roof. These shall be suitably concealed with masonry work of cement concrete or cladding material. The number and size of down comers shall be governed by IS: 1742 and IS: 2527.

For all buildings, suitable arrangement for draining out water collected from equipment blow down, leakages, floor washings fire fighting etc. shall be provided for each floor.

**Water harvesting by rain water through control room building and other building shall be provided as per approved design and drawing.**

18.0 **MISCELLANEOUS GENERAL REQUIREMENTS**

18.1 Dense concrete with controlled water cement ratio as per IS-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.

18.2 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 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.

18.3 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 IS: 2629 and IS: 2633. Galvanizing shall be checked and tested in accordance with IS:

2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS: 3416.

18.4 A screed concrete layer not less than 100 mm thick and of grade not weaker than M10 conforming to IS: 456-1978 shall be provide 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.

18.5 Bricks having minimum 75 kg/cm$^2$ compressive strength can only be used for mansonry work. Bidder shall ascertain himself at site regarding the availability of bricks of minimum 75 kg/cm2 compressive strength before submitting his offer.

18.6 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.

18.7 Anti termite chemical treatment shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS: 6313 and other relevant Indian Standards.

18.8 For all civil works covered under this specification, design mix by batching as per IS specification is intended. However for small quantities of concreting, Nominal mix shall be allowed at the discretion of Engineer-in-charge with relationship of grade of concrete and ratio of ingredients as below:

| S. No. | Mix | Cement | Sand | Coarse aggregate of 20 mm down grade as per IS 383 |
|---|---|---|---|---|
| 1. | M 10 | 1 | 3 | 6 |
| 2. | M 15 | 1 | 2 | 4 |
| 3. | M 20 | 1 | 1.5 | 3 |

The material specification, workmanship and acceptance criteria shall be as per relevant clauses of PWD specification and approved standard Field Quality Plan.

18.9 The details given in tender drawings shall be considered along with details available in this section of the specification while deciding various components of the building.

18.10 Items/ components of buildings not explicitly covered in the specification but required for completion of the project shall be deemed to be included in the scope.

## 19.0 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 / embedments, provision of cutouts etc. shall be the sole responsibility of the Bidder. 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.

## 20.0 WATER SUPPLY

(i) Water shall be made available by Owner at any feasible point near scope boundary at single point to the Bidder. Bidder shall state the total water requirement both in terms of quantity and head to the Owner.

(ii) The Bidder shall carry out all the plumbing/ erection works required for supply of water in control room building beyond the single point as at (i).

(iii) The Bidder shall carry out all the plumbing / erection works required for supply of water to FF pump house beyond the single point as at (i).

(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 Bidder indicating the layout and details of water supply which shall be got approved by the Owner 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.

(vi) Bore wells and pumps for water supply is not in the scope of Bidder.

## 21.0 SEWERAGE SYSTEM

(i) Sewerage system shall be provided for control room building.

(ii) The Bidder shall construct septic tank and soak pit suitable for 50 users.

(iii) The system shall be designed as per relevant IS Codes.

## 22.0 STATUTORY RULES

22.1 Bidder shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State). Fire Safety Rules of Tariff Advisory Committee. Water Act for pollution control etc.

22.2 Provisions for fire proof doors, no. of staircases, fire separation wall, plastering on structural members (in fire prone areas) etc. shall be made according to the recommendations of Tariff Advisory Committee.

22.3 Statutory clearance and norms of State Pollution Control Board shall be followed as per Water Act for effluent quality from plant.

22.4 Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation to be carried out by the Bidder.

22.5 Foundation system adopted by Bidder shall ensure that relative settlement and other criteria shall be as per provision in IS: 1904 and other Indian Standards.

22.6 All water retaining structures designed as un cracked section shall also be tested for water tightness at full water level in accordance with clause no. 10 of IS: 3370 (Part-1).

22.7 Construction joints shall be as per IS: 456-2000

22.8 All underground concrete structures like basements, pumps houses, water retaining structures etc. shall have plasticizer cum water proofing cement additive conforming to IS: 9103. In addition, limit on permeability as given in IS: 2645 shall also be met with. 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, Injection Method shall be applied for repairing the leakage.

22.9 All building/ construction materials shall conform to the best quality specified in PWD specifications if not otherwise mentioned in this specification.

22.10 All tests as required in the standard field quality plans have to be carried out.

(**Quality Assurance & Inspection Deptt.)**
**STANDARD FIELD QUALITY PLAN**
**FOR SWITCHYARD CIVIL WORKS**

Section : FOUNDATION MATERIALS

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| 1. | CHECKING OF FOUNDATION MATERIALS | | | | | |
| A | CEMENT | | | | | |
| i)<br><br>ii)<br><br>iii)<br><br>iv)<br><br>v) | Fineness<br><br>Compressive Strength<br><br>Initial & final setting time<br><br>Soundness<br><br>Heat of Hydration for low heat cement (Not applicable for OPC & PPC) | One sample per lot of 100 MT or part thereof from each source for MTCs and one sample per lot of 200 MT or part thereof from each source for site testing | IS:456, IS:269, IS: 8112, IS: 12269, IS: 1489 & RVPN specification | Manufacturer/ RVPN approved lab | Review of manufactures test certificates (MTCs) and laboratory test results by RVPN | B |
| vi) | Chemical Composition of Cement | One sample per lot of 100 MT or part thereof from each source for MTCs | IS: 456, IS: 269, IS: 8112, IS: 12269, IS: 1489 & RVPN specification | Manufacturer | Review of manufacturers test certificates by RVPN | B |
| B) | COARSE AGGREGATES | | | | | |
| i)<br>ii)<br>iii)<br>iv)<br>v)<br>vi)<br>vii)<br>viii)<br>ix) | Determination of Particle size (Sieve Analysis)<br>Flakines index<br>Crushing Value<br>Specific Gravity*<br>Bulk Density*<br>Absorption Value*<br>Moisture Content*<br>Soundness of Aggregate**<br>Presence of deleterious materials | One sample per lot of 100 cubic meter or part thereof from each source for each size | IS: 383, IS: 2386 & RVPN specification | RVPN approved lab. However, Moisture content test for design mix concrete shall be done on all days of concreting at site | Each source to be approved by RVPN Review and acceptance of test result by RVPN | B |

*Applicable Design concretes only
** Applicable to concrete work subject to frost action

Section : FOUNDATION MATERIALS

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| C) | FINE AGGREGATE | | | | | |
| i) | Gradation/ Determination of Particle size (Sieve Analysis) | One sample per lot of 100 cubic meter or part thereof from each source | IS: 383, IS: 2386, IS: 456 and RVPN specification | RVPN approved lab. However Moisture content test for design mix concrete shall be done on all days of concreting at site | Each source to by approved by RVPN Review and acceptance of test result by RVPN | B |
| ii) | Specific Gravity and density * | | | | | |
| iii) | Moisture content* | | | | | |
| iv) | Absorpotion Value* | | | | | |
| v) | Bulking | | | | | |
| vi) | Silt Content Test | | | | | |
| vii) | Presence of deleterious materials | | | | | |
| D) | BRICKS | | | | | |
| i) | Diemenssional tolerance | As per enclosed Annexure-II | PWD & RVPN specification | RVPN Approved Lab. | Approved by RVPN | B |
| ii) | Compressible Strength | | | | | |
| iii) | Water Absorption | | | | | |
| iv) | Efflorescene | | | | | |
| E) | WATER | | | | | |
| i) | Cleanliness (Visual Check) | Random | IS: 456, IS: 3025 and RVPN specification. The water used for mixing concrete shall be fresh, clean and free from oil, acids and alkalies, organic materials, or other deleterious materials | Bidder | Each source to be approved by RVPN | B |
| ii) | Chemical and physical properties of water for checking its suitability for construction purposes | One sample per source | IS: 456, IS: 3025 and RVPN specification | Bidder/ RVPN Approved Lab | Approved by RVPN | B |
| * Applicable to design mix concretes only. | | | | | | |

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| 1. | REINFORCEMENT STEEL | | | | | |
| i) | Identification & size | Random | IS: 432, IS: 1139, IS: 1786 & RVPN specification | Bidder | Approval by RVPN | B |
| ii) | Chemical Analysis test | One sample per heat | IS: 432, IS: 1139, IS: 1786 RVPN specification | Manufacturer | Review of manufacturers test certificates by RVPN | B |
| iii)<br><br>iv)<br><br>v) | Tensile Test<br><br>Yield stress/ proof stress<br><br>Percentage Elongation | One sample per lot of 40 MT or part thereof for each size of steel conforming to IS: 1139 and 5 MT or part thereof for HDS wire for each size of steel as per IS: 432. For steel as per IS: 1786 under 10 mm 1 sample for each 25 MT or part thereof. 20 mm 16 mm 1 sample for each 35 MT or part thereof. Over 16 mm. 1 sample for each 45 MT or part thereof. | IS: 432, IS: 1139, IS: 1786 RVPN specification | Manufacturers/ RVPN approved lab | Review of manufacturers test certificates as well as lab test result by RVPN | B |

Section : FOUNDATION MATERIALS

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| vi) | Bend/ Rebend Test | One sample per lot of 20 MT or part thereof for each size of steel as per IS: 432, IS: 1139. For steel as per IS: 1786 under 10 mm- 16mm 1 sample for each 25 MT or part thereof 10 mm-16mm 1 sample for each 45 MT or part thereof | IS: 432, IS:1139, IS:1786 RVPN specification | Manufacturers/ RVPN | Review of manufacturers test certificates as well as lab test results by RVPN | B |
| vii) | Reverse Bend Test for HDS wire | One sample per lot of 5 MT or part thereof for each size | IS: 432 RVPN specification | Manufacturer/ RVPN approved lab | Review of manufacturers test certificates as well as lab test result by RVPN | B |

Section : FOUNDATION

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| C | STRUCTURAL STEEL USED IN CABLE TRENCHES & FOUNDATIONS | | | | | |
| i) | Dimensional Check | Random | RVPN specification & approved drawing | Bidder | Checklist to be prepared and signed jointly | B |
| ii) | Visual Check for damages, rusting, pitting etc. | 100% | RVPN specification & approved drawing | Bidder | Checklist to be prepared and signed jointly | C |
| iii) | Visual check for welding, defects, primer coating and painting/ galvanising as applicable | Random | RVPN specification & approved drawing | Bidder | Checklist to be prepared and signed jointly | C |
| iv) | Physical properties of structural steel | 1 sample per lot of 40 MT or part thereof for tensile tests and 1 sample per lot of 20 MT or part thereof for bend test for each size | IS: 2062 RVPN specification & approved drawings | Manufacturer/ RVPN approved lab | Review of Mfgs test certificates as well as lab test results by RVPN | B |

Section : FOUNDATION

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| 2. | GANTRY/ EQUIPMENT FOUNDATION/ CABLE TRENCH | | | | | |
| a. | BEFORE EXCAVATION | | | | | |
| i) | Checking of pegs condition as per line and alignment | 100% on each location | IS: 4091, IS: 3764 & RVPN approved drawings/ specification | Bidder | Approval by RVPN | C |
| ii) | Checking of pit making as per drawing & RL | 100% on each location | IS: 4091, IS: 3764 & RVPN approved drawings/ specification | Bidder | Approval by RVPN | C |
| B) | EXCAVATION | | | | | |
| i) | Dimensional conformity | Each location | IS: 4091, IS: 3764 & RVPN approved drawings/ specifications | Bidder | Approval by RVPN (JMC/MB) | B |
| ii) | Vertically/ slopes & squareness of each pit | Each location | IS: 4091, IS: 3764 & RVPN approved drawings/ specifications | Bidder | Checklist to be prepared and signed jointly | B |
| iii) | Vertification of classification of foundation wherever applicable | Each location | IS: 4091, IS: 3764 & RVPN approved drawings/ specifications | Joint inspection by RVPN and Bidder | Approval by RVPN | B |
| C. | FOUNDATION BOLTS/ MATALLIC INSERTS | | | | | |
| i) | Check for proper identification foundation bolts w.r.t. type of foundation | 100% | RVPN specification & approved drawings | Bidder | Checklist to be prepared & signed jointly | C |
| ii) | Visual check for mechanical damage and galvanising painting if applicable for metallic insert | 100% | RVPN specifications & approved drawings | Bidder | Checklist to be prepared & signed jointly | C |
| iii) | Alignment & Level | 100% | RVPN specification & approved drawings | Bidder | Checklist to be prepared & signed jointly | B |

Section : FOUNDATION

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| iv) | Grouting/ Underpinning of foundation base plate | 100% | RVPN specification & approved drawings | Bidder | Checklist to be prepared & signed jointly | C |
| D) | P.C.C. Padding | For all locations | IS: 456 and RVPN approved foundation drawings & specification | Joint Inspection by RVPN and Bidder | Approval by RVPN | B |
| E. | SHUTTERING (Formwork) | | | | | |
| i) | Check for materials breakage or damage | 100% | IS: 456, RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | C |
| ii) | Check for plumb, alignment parallelism, squareness and equidistance from stub | 100% casting | IS: 456, RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval byRVPN | B |
| iii) | Dimensional check | 100% before casting | IS: 456, RVPN specification/ approved drawings | Joint RVPN inspection by RVPN and Bidder | Approval by RVPN | B |
| iv) | Check for level & height | 100% before casting | RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | B |
| v) | Check for rigidity of frame/ tightness | 100% | RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | B |
| vi) | Cleaning and oiling | 100% | RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | B |

Section : FOUNDATION

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| vii) | Diagonal bracing if required as per drawings/ site conditions | 100% | RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | C |
| viii) | Checking of joints to avoid undue loss of cement slurry | 100% | RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | C |
| E. | PLACEMENT OF REINFORCEMENT STEEL | | | | | |
| i) | Check the steel bars for rust, cracks, surface flaws, laminate etc. (Visual check) | 100% | IS: 456 and RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | C |
| ii) | Check as per the bar bending schedule before placement of concrete | For all locations | IS: 456, IS: 2502 and RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN (Pour Card) | B |
| iii) | Check cutting tolerance for bars as per check list/ drawings.<br>Check whetehr all the bent bars and lap lengths are as per approved bar bending schedule | For all locations | IS: 456, IS: 2502 and RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN (Pour Card) | B |
| iv) | Check whether all joints & crossing of bars are tied properly with right guage & annealed wire as per specification | 100% | IS: 456 and RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | C |
| v) | Check for proper cover distance spacing of bars, spacers & chairs after the reinforcement cage has been put inside the form work | 100% | IS: 456 and RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | C |
| vi) | Check whether lapping of bars are tied properly by with right gauge and annealed wire as per specification | 100% | IS: 456 and RVPN specification/ approved drawings | Joint inspection by RVPN and Bidder | Approval by RVPN | B |

Section : FOUNDATION

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| 3. | CONCRETING | | | | | |
| A) | APPROVAL OF MIX DESIGN | Each Mix. | IS: 456 & RVPN approved drawings and specifications | RVPN approved by lab | Approval by RVPN | A |
| B) | BATCHING, MIXING & PLACING OF CONCRETE AND COMPACTING | 100% | IS: 456 & RVPN approved drawings and specifications | Joint inspection by RVPN and Bidder | Approval by RVPN | B |
| C) | FIXING OF CHIMNEY COLUMN<br>Check for width length squareness, parallelism & equidistance from stub | 100% | IS: 456 & RVPN approved drawings and specifications | Joint inspection by RVPN and Bidder | Approval by RVPN | C |
| D) | PLACING CONCRETE AND COMPACTING | 100% | IS: 456 & RVPN approved drawings and specifications | Joint inspection bY RVPN and Bidder | Min gap between boxes and reinforcement bars should be maintained approval by RVPN | B |

Section : FOUNDATION

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| E) | CONCRETE TESTING | | | | | |
| i) | Slump Test | One sample per foundation | IS: 456, IS: 516, IS: 1199 and RVPN specification | Bidder | Approval by RVPN | B |
| ii) | Check for quantities for cement, fine aggregate, coarse aggregate and water while batching | 100% on all locations | IS: 456, IS: 516, IS: 1199 and RVPN specification | Bidder | Checklist to be prepared and signed jointly | B |
| F) | CONCRETE CUBE TESTING | | | | | |
| i) | Compressive Strength | One sample for every 20 cum of concreting or part thereof for each days concreting (one sample consists of min. 3 test cubes for 28 days strength). | IS: 1199, IS: 456, IS: 516 and RVPN specification | RVPN approved lab | Approval by RVPN cubes must be tested within a week after 28 days curing period and test results should be approved | A |
| G) | CHECK FINISING, DIMENSIONAL CONFORMITY AND WORKMANSHIP BEFORE & AFTER BOX REMOVAL | 100% | IS: 456, IS: 516, IS:1199 and RVPN specification | Bidder | Approval bY RVPN | B |
| 4. | BACKFILLING | | | | | |
| i) | Check for thickness of layer & watering | 100% | RVPN specification and approved drawings | Bidder | Approval by RVPN | C |
| ii) | Visual check for correction/ ramming | 100% | RVPN specification and approved drawings | Bidder | Approval by RVPN | C |

Section : FOUNDATION

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| iii) | Compaction test (percentage of max. dry density) | Gantry foundation 2 samples for each pit. Equipment & other foundation 20% at random | RVPN specification | RVPN approved lab | Review of lab test results by RVPN. Elevation for testing to be decided by RVPN | B |
| 5. | R.R. STONE/ BRICK WORK | | | | | |
| i) | Mortar mix/ proportion | Random | IS:2250, RVPN specification & PWD specification | Bidder | Approval by RVPN | B |
| ii) | Plumb & Alignment | Random | RVPN specification & PWD specification | Bidder | Approval by RVPN | B |
| iii) | Joints | Random | RVPN specification PWD specification | Biddere | Approval by RVPN | B |
| 6. | PLASTERING | | | | | |
| i) | Plastering thickness and evenness | Random | RVPN specification & PWD specification | Bidder | Approval by RVPN | B |
| ii) | Mortar mix/ proportion | Random | RVPN specification & PWD specification | Bidder | Approval by RVPN | B |
| 7. | CURING FOR CONCRETE, MASONRY, PLASTERING ETC. | 100% on all location | IS: 5613 & RVPN specification | Bidder | Approval bY RVPN | C |

Section : FOUNDATION

| S. No. | Component/ operation & Description of Test | Sampling Plan with basis | Ref. Document & acceptance norm | Testing Agency | Remarks | Check |
|---|---|---|---|---|---|---|
| 8. | SITE SURFACING | | | | | |
| i) | Levelling | 100% | RVPN specification and approved drawings | Bidder | Checklist to be prepared and signed jointly | C |
| ii)<br>a) | Soil Sterlisation<br>sraying of chemicals | 100% | RVPN specification and manufacturers recommendations | Bidder | Checklist to be prepared and signed jointly | B |
| iii) | Grading of 20/40 mm stone | 1 sample per lot of 500 cubic metre or part thereof from each source for each size. | IS:383, IS: 2386 and RVPN specification. The grading shall be as per single sized nominal size. | Bidder/ RVPN approved lab | Each source to be approved by RVPN. Review and acceptance of test results by RVPN | B |
| iv) | Compacted thickness of 20/40 mm stone layers as applicable | Random | RVPN specification and approved drawings | Bidder | Checklist to be prepared and signed jointly | B |

RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED
(QUALITY ASSURANCE & INSPECTION DEPTT.)

# STANDARD FIELD QUALITY PLAN FOR SWITCHYARD CIVIL WORKS

## Section : GENERAL GUIDELINES FOR IMPLEMENTATION

1. Details of categories of check codes A,B & C including accepting and deviation dispositioning authorities are indicated at Annexure-1

2. RVPN specification shall mean RVPN technical specification, approved drawings/ data sheets and LOA provisions applicable for the specific contract.

3. Acceptance criteria and permissible limits for certain tests are indicated at Annexure--II. For balance tests, site to verify the same with respect to RVPN specification, relevant Indian Standards and/ or prevalent code of practice.

4. It is clarified that the tests indicated at column 2 of the FQP i.e. against column "Component operation & Description of Test", are only generally required to be conducted. However, RVPN reserves the right to carry-out any additional tests at any stage if the situation so warrants.

5. RVPN site representative shall witness all the tests conducted by the Bidder as mentioned in this FQP. However, in case of tests conducted in the RVPN approved lab, it is preferred to witness the tests in the lab itself, if possible.

6. Head of GHO shall approve testing laboratory before accepting the test results from the lab.

7. Head of GHO shall approve the sources for cement, coarse aggregate, fine aggregate & water before actual utilisation.

8. All the testing & measuring equipments used by the Bidder for testing are required to be calibrated. A copy of valid calibration report shall be retained by RVPN as records.

9. Classification of foundations shall be approved by RVPN based on the joint inspection Report & soil investigation reports.

10. Curing of concrete work should be continued for a minimum period of 10 days.

11. ZONE-IV FINE AGGREGATE

11.1 Zone-IV fine aggregate shall be used for nominal mix reinforced cement concreting work.

11.2 Zone-IV fine aggregate shall be avoided for design mix reinforced cement concreting work unless tests have been done to ascertain the suitability of proposed mix proportion with the prior approval RVPN site.

12. Bricks should be free from cracks, flaws and modules of free lime. They should have smooth rectangular faces with sharp corners and should be uniform in colour.

13. CEMENT

13.1 in case supply of cement is in the scope of the Bidder, the same shall be procured from sources approved by RVPN site and got tested at site on sample basis for specified acceptance tests as specified in the FQP at a reputed Third Party Lab approved by RVPN site.

13.2 The samples of cement for site testing shall be taken within three weeks of the delivery and all the tests shall be commenced within one week of sampling. If the cement remains in store for a period of more than six month. All the site tests are required to be repeated before usage.

14. REINFORCEMENT STEEL & STRUCTURAL STEEL USED IN CABLE TRENCHES & FOUNDATIONS

14.1 In case supply of steel is in the scope of the Bidder, the same shall be procured from the main producers i.e. SAIL, TISCO, IISCO OR Rsashtriya ispat Nigam or the rerollers approved by main producers. The steel shall be got tested at site on sample basis for specified acceptance tests, as specified in this FQP at a reputed Third Party Lab approved by RVPN site.

14.2 The results of the testing of cement and reinforcement steel referred to in 13.1 and 14.1 above shall be got approved from RVPN site before cement and reinforcement steel are put to use. However, in exceptional cases due to exigencies of work. RVPN site may authorise the Bidder to use cement and Reinforcement steel even before the test results are received. However, in all such cases, if the test results subsequently received are found to be not complying with the specified acceptance criteria, the Bidder shall have to dismantle and recast all such foundations cast with such non-conforming materials at his own cost. Confirmation to this effect shall be obtained from the Bidder by the Project authorities before hand in all such cases.

15. The Bidder shall submit welding procedure specification (WPS) including the type of electrode used for approval of RVPN site before starting the welding work.

16. Approval/ acceptance of individual test results by RVPN in the course of execution of contract, will not relieve the Bidder of his contractual obligations and responsibilities, nor does it limit the Owner's right under the contract.

17. In case, requirement of special items like Super Sulphated Cement, Corrosive Resistant Reinforcement Steel (CRRS) etc. araise due to site conditions, the specific approval of RVPN may be obtained before using the same and all the tests as per relevant standards shall be carried out.

18. All the materials shall be stored by the Bidder in a manner affording convenient access for identificates and inspection at all times. Storage of material shall be in accordance with IS: 4032 (Latest Edition).

ACCEPTING AND DEVIATION DISPOSITIONING AUTHORITIES
FOR DIFFERENT CATEGORIES OF CHECKS AS ENVISAGED
IN FIELD QUALITY PLAN AS WELL AS DEVIATION IN QUANTITY.

| Category | Type Of Check | 100% Checking / Witnessing By | Counter Check / Surveillance Check By | Accepting Authority, If Test Results Are Within Permissible Limits | Deviation Dispositioning Authority |
|---|---|---|---|---|---|
| óAô | Critical | Executive Engineer (Civil) | Superintending Engineer (Civil) | Executive Engineer (Civil) | Chief Engineer (Civil) |
| óBô | Major | Assistant Engineer (Civil) | Executive Engineer (Civil) | | |
| óCô | Minor | Assistant Engineer (Civil) | Executive Engineer (Civil) | | |

ACCEPT ANCE CRITERIA AND PERMISSIBLE LIMITS FOR FOUNDAION MATERIALS & CONCRETE.

A) **CEMENT:**

| S.No. | Description of the tests | 33 grade OPC as per IS:269 | 43 grade cement as per IS: 8112 | PPC as per IS: 1489 | Low heat cement |
|---|---|---|---|---|---|
| i) | Fineness (Min.) | 225$m^2$/kg | 225 $m^2$/kg | 300 $m^2$/kg | 225 $m^2$/kg |
| ii) | Compressive Strength (Min.) | | | | |
| | 72 ± 1 hours | 160 kgf/$cm^2$ | 23 MPa | 16 MPa | 100 kgf/ $CM^2$ |
| | 168 ± 2 hours | 220 kgf/$cm^2$ | 33 MPa | 22 MPa | 160 kgf/$cm^2$ |
| | 672 ± 4 hours | - | 43 MPa | 33 MPa | 350 kgf/$cm^2$ |
| iii) | Initial Setting Time (Minimum) | 30 Minutes | 30 Minutes | 30 Minutes | 30 Minutes |
| iv) | Final Setting Time (maximum) | 600 Minutes | 600 Minutes | 600 Minutes | 600 Minutes |
| v) | Soundness (Le chatelier Method) | Maximum 10mm expansion | Maximum 10mm expansion | Maximum 10mm expansion | Maximum 10 mm expansion |
| vi) | Heat of hydration (Max.) | - | - | - | Max. 65 cal/ gm for 7 days & max. 75 cal/ gm for 28 days |
| vii) | Chemical Composition | As per IS | As per IS | As per IS | As per IS |

B) COARSE AGGREGATE:

(i) Sieve Analysis

| IS SIEVE DESIGNATION | PERCENTAGE PASSING FOR GRADED AGGREGATE OF NOMINAL SIZE | | PERCENTAGE PASSING FOR SINGLE SIZED AGGREGATE OF NOMINAL SIZE | |
|---|---|---|---|---|
| | 40mm | 20mm | 40mm | 20mm |
| 63 mm | - | - | 100 | - |
| 40 mm | 95 to 100 | 100 | 85-100 | 100 |
| 20 mm | 30 to 70 | 95 to 100 | 0-20 | 85-100 |
| 10 mm | 10 to 35 | 25 to 55 | 0-5 | 0-20 |
| 4.75 mm | 0 to 5 | 0 to 10 | - | 0-5 |

| | | |
|---|---|---|
| (ii) | Flakiness Index | Not to exceed 25% |
| (iii) | Crushing Value | Not to exceed 45% |
| (iv) | Soundness of aggregate applicable for concrete works subject to froast action | Loss of weight after 5 cycle not to exceed 12% when tested with Sodium sulphate and 18% when tested with magnesium sulphate. |
| (v) | Deleterious material | Not to exceed 5% of the weight of aggregate when tested as per IS: 2386 Part-II (1963) |

(C) FINE AGGREGATE

(i) Sieve Analysis — Shall confirm to Zone 1, Zone II or Zone III.

| IS Sieve Designation | Percentage Passing for | | | |
|---|---|---|---|---|
| | Grading Zone-I | Grading Zone-II | Grading Zone-III | Grading Zone-IV |
| 10 mm | 100 | 100 | 100 | 100 |
| 4.75 mm | 90-100 | 90-100 | 90-100 | 95-100 |
| 2.36 mm | 60-95 | 75-100 | 85-100 | 95-100 |
| 1.18 m | 30-70 | 55-90 | 75-100 | 90-100 |
| 600 Micron | 15-34 | 35-59 | 60-79 | 80-100 |
| 300 Micron | 15-20 | 8-30 | 12-40 | 15-50 |
| 150 Micron | 0-10 | 0-10 | 0-10 | 0-15 |

(iii) For guidance of adjusting sound in mix of concrete, the following table may be used.

| Moisture Content % | Building % by volume |
|---|---|
| 2 | 15 |
| 3 | 20 |
| 4 | 25 |
| 5 | 30 |

(iii) Silt Content Test : shall not exceed 8% by volume when tested as per test procedure specified in appendix-D of chapter 3 of 1991-92 CPWD specification

(iv) Deleterious Materials : Total deleterious material shall not be more than 5% by weight.

(D) REINFORCEMENT STEEL : As per relevant Indian Standards.

(E) CONCRETE CUBE TEST

For nominal (volumetric) concrete mixes, compressive strength for 1:1 ½. :3 (cement : Sand: Coarse aggregate) concrete shall be 265 kg/cm$^2$ for 28 days and for 1:2:4 nominal mix. It shall be 210 mg/cm$^2$.

(F) ACCEPTANCE CRITERIA BASED ON 28 DAYS COMPRESSIVE STRENGTH FOR NOMINAL MIX CONCRETE

(a) The average of the strength of three specimen be accepted as the compressive strength of the concrete, provided the strength of any individual cube shall neither be less than 70% nor higher than 130% of the specified strength.

(b) If the actual average strength of accepted sample exceeds specified strength by more than 30% the Engineer-in-charge, if he so desires, may further investigate the matter. However, if the strength of any individual cube exceeds more than 30% of specified strength, it will be restricted to 30% only for computation of strength.

(c ) If the actual average strength of accepted sample is equal to or higher than specified strength upto 30% than strength of the concrete shall be considered in order and the concrete shall be accepted at full rates.

(d) If the actual average strength of accepted sample is less than specified strength but not less than 70% of the specified strength, the concrete may be accepted at reduced rate at the discretion of Engineer-in-charge.

(e) If the actual average strength of accepted sample is less than 70% of specified strength, the Engineer-in-charge shall reject the defective portion of work represented by sample and nothing shall be paid for the rejected work. Remedial measures necessary to retain the structure shall be taken at the risk and cost of Bidder. If, however, the Engineer-in-Charge so desires, he may order additional tests to be carried out to ascertain if the structure can be retained. All the charges in connection with these additional tests shall be borne by the Bidder.

(G) ACCEPTANCE CRITERIA FOR DESIGN MIX CONCRETE SHALL BE AS PER IS: 456-2000

(H) SAMPLING PLAN FOR BRICK - WORK

Scale of sampling and permissible number of defectives for visual and dimensional characteristics.

| No. of bricks in the lot | For characteristics specified for individual bricks | | For dimensional characteristics for group of 20 bricks No. of bricks to be selected |
|---|---|---|---|
| | No. of bricks to be selected | Permissible no. of defective in the sample | |
| (1) | (2) | (3) | (4) |
| 2001-10000 | 20 | 1 | 40 |
| 10001-35000 | 32 | 2 | 60 |
| 35001-50000 | 50 | 3 | 80 |

Note: In case the lot contains 2000 or less bricks the sampling shall be as per decision of the Engineer-in-Charge.

ii) Scale of sampling for physical characteristics

| Lote size | Sampling size for compressive strength water absorption and efflorescence | Permissible No. of defectives for effloresence |
|---|---|---|
| (1) | (2) | (3) |
| 2001-10000 | 5 | 0 |
| 10001-35000 | 10 | 0 |
| 35001-50000 | 15 | 1 |

Note: In case the lot contains 2000 or less bricks, the sampling shall be as per decision of Engineer-in-Charge.

(1) ACCEPTANCE CRITERIA FOR BRICK-WORK

(i) Dimensional tolerances: The dimensions of modular bricks when tested shall be within the following limits per 20 bricks.

Length 372 to 388 cm (380 ± 8 cm)

Width 176 to 184 cm (180 ± cm)

Height 176 to 184 cm ( 180 ± 4 cm) for 90 mm high bricks

(ii) In case of non-modular bricks, % age tolerance will be ± 2% for group of 20 number of class-10 bricks, and ± 4% for other class of bricks

(iii) Compressive strength : The bricks, shall have a minimum average compressive strength as specified in RVPN specification. The compressive strength of any individual brick tested shall not fall below the min. average compressive strength specified for the corresponding class of brick by more than 20%. In case compressive strength of any individual brick tested exceeds the upper limit specified for the corresponding class of bricks, the same shall be limited to upper limit of the class as specified for the purpose of calculating the average compressive strength.

(iv) Water absorption : The average water absorption of bricks shall not be more than 20% by weight.

(v) Efflorescence : The rating of efflorescence of bricks shall not be more than moderate.

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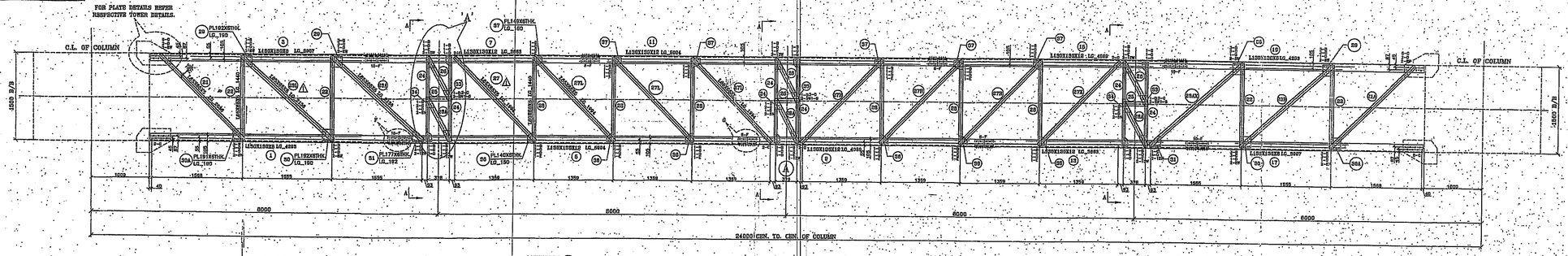
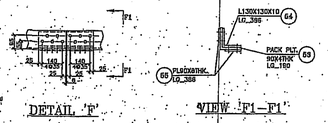
FOR PLATE DETAILS REFER RESPECTIVE TOWER DETAILS.




FRONT ELEVATION (VIEW '1-1')



DETAIL 'F'

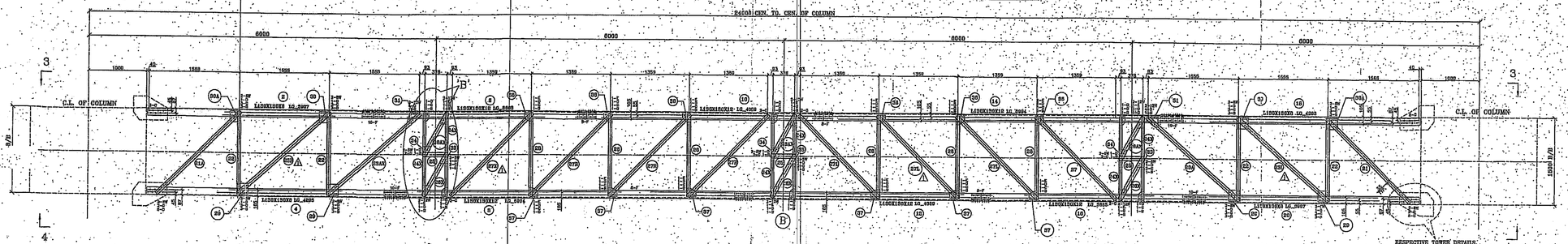


VIEW 'F1-F1'

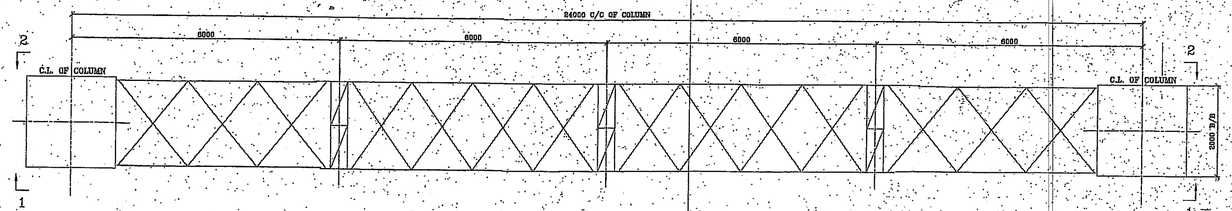
DETAIL 'G'



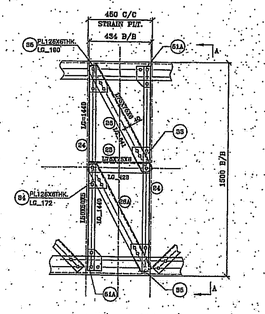
VIEW 'G1-G1'



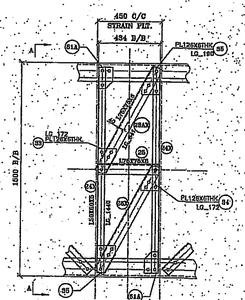

REAR ELEVATION (VIEW '2-2')



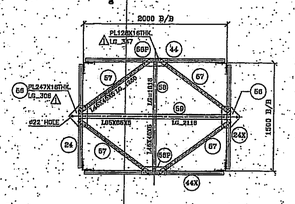

KEY PLAN



DETAIL 'A'



DETAIL 'B'



SECTION 'A-A'

| LIST OF ø16 ø BOLTS, NUTS & WASHERS | | |
|---|---|---|
| | SIZE (Length in mm) | TOTAL QTY. |
| A | M16 X 35 mm | — |
| B | M16 X 40 mm | 184 |
| C | M16 X 45 mm | 374 |
| D | M16 X 50 mm | 282 |
| E | M16 X 55 mm | 144 |
| F | M16 X 60 mm | 300 |
| G | M16 X 65 mm | — |
| SPRING WASHER | 3.5 X 16 ø | 1284 |
| STEP BOLTS | ø16x150 LG. | — |
| PACK WASHER | 5 mm | 36 96 |
| PACK WASHER | 6 mm | 44 |
| PACK WASHER | 8 mm | 102 136 |
| PACK WASHER | 10 mm | 29 56 |
| PACK WASHER | 12 mm | 122 Nos |

Generally Approved
S.E. XEN KRV, RVPNNL JAIPUR AEN

Note: Quantity of Nuts & Bolts shall be as per approved BOM

PROTO CORRECTED

MARK NOS :- 1 TO 60, DELETED MARK NO: 32,38

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL HOLES SHALL BE 17.5ø FOR 16ø BOLTS UNLESS OTHERWISE SPECIFIED.
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH :c1-1,2,3 etc.
4. MINIMUM EDGE SECURITY FOR 16MM BOLTS SHALL BE 25 MM FROM CUT EDGE & 20 MM FROM ROLLED EDGE.
5. L45x45x3 & L45x45x4, WITH 23 MM BACK MARK
6. EDGE PREPARATION OF WELDING SHALL BE DONE AS PER IS:823 (LATEST)
7. ALL STEEL SECTIONS & PACK WASHERS SHALL BE HOT DIP GALVANIZED MINIMUM WEIGHT OF ZINC COATING SHALL BE 610gm/sq.m.
8. ALL BOLTS NUTS SHALL CONFORM TO IS:1367 (LATEST) CLASS 5.6 FOR BOLTS & 5 FOR NUTS. ALL BOLTS & NUTS SHALL HOT DIP GALVANIZED AS PER IS:1367 (PART-13)

GENERAL NOTES

9. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062-1999 GRADE-A
10. FABRICATION SHALL BE CARRIED OUT AS PER PROVISIONS OF IS:802 PART-II (1972)
11. ALL UNNOTTED MEMBERS ARE L45x45x4,
12. ALL UNNOTTED GUSSET PLATE ARE 6 MM THICK UNLESS OTHERWISE SPECIFIED.
13. SPRING WASHER CONFORMING TO IS:3063-1972 SHALL BE USED UNDER EACH NUT.

| REFR. DRG. NO. | DESCRIPTION |
|---|---|

| REV. | DESCRIPTION |
|---|---|
| R1 | REVISED AS PER PROTO CORRECTION AS MKD |
| R0 | FIRST ISSUE |

| Project Doc. No. | | | | CUSTMER: | |
|---|---|---|---|---|---|
| Scale 1 : 800 | | | | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | | | SEIMENS LIMITED, GURGAON | |
| | | | Date | 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| | | | Drawn | GB/HK | |
| | | | Appr. | RK | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV BEAM TYPE G1 |
| | | | Norm | KTV | |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | 5427PN066-BHA-C-SYD-SYS-7551-SM — Rev. 0 |
| Rev. | Remarks | Date | Name | LOA No. | RVPN/SE(P&P)/XEN/KRV/CB-1D 1771 dated 16.10.2015 — Sheet 1 of 2 |

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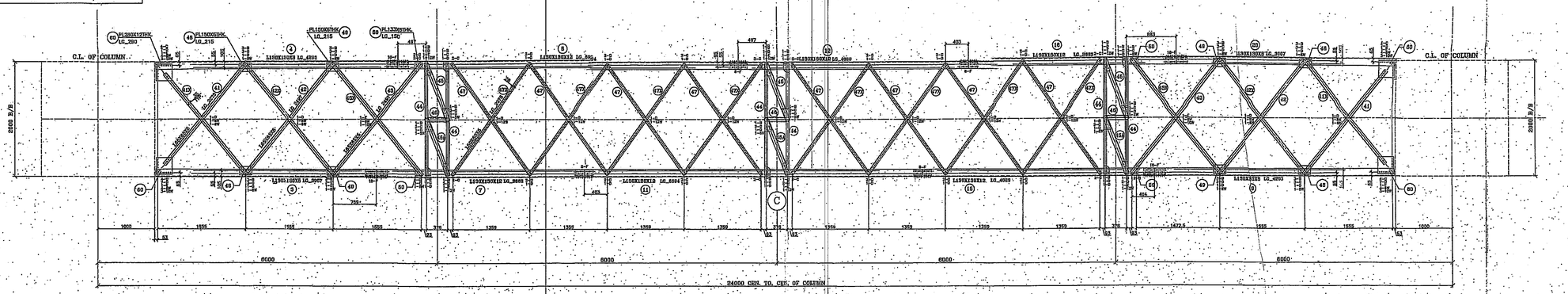
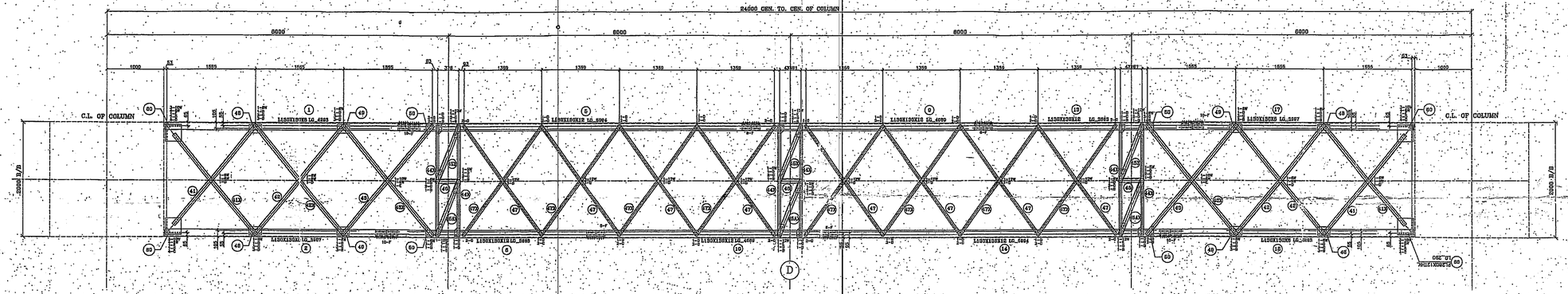
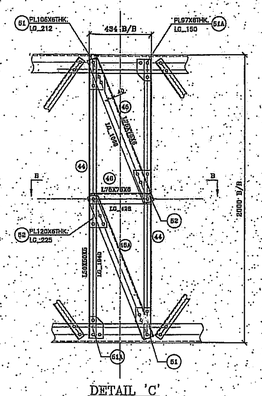


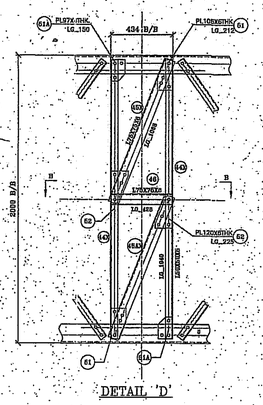

TOP PLAN (VIEW '4-4')



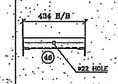

BOTTOM PLAN (VIEW '3-3')




DETAIL 'C'




DETAIL 'D'




VIEW 'B-B'

Generally Approved
S.E. XEN KFW Projects RRVPNL JAIPUR XEN

Note: Quantity of Nuts & Bolts shall be as per Approved BOM.

PROTO. CORRECTED

DELETED MARK No. 32 & 38
MARK NOS :- 1 TO 60

| REFR. DRG. NO. | DESCRIPTION |
|---|---|

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL HOLES SHALL BE 17.5ø FOR 16ø BOLTS UNLESS OTHERWISE SPECIFIED.
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH :31-1,2,3 etc.
4. MINIMUM EDGE SECURITY FOR 16MM BOLTS SHALL BE 25 MM FROM CUT EDGE & 20 MM FROM ROLLED EDGE.
5. L45x45x5 & L45x45x4, WITH 23 MM BACK MARK
6. EDGE PREPARATION OF WELDING SHALL BE DONE AS PER IS:823 (LATEST)
7. ALL STEEL SECTIONS & PACK WASHERS SHALL BE HOT DIP GALVANIZED MINIMUM WEIGHT OF ZINC COATING SHALL BE 610gm/sq.m.
8. ALL BOLTS NUTS SHALL CONFORM TO IS:1367 (LATEST) CLASS 5.6 FOR BOLTS & 5 FOR NUTS. ALL BOLTS & NUTS SHALL HOT DIP GALVANIZED AS PER IS:1367 (PART-13)

GENERAL NOTES

9. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062-1999 GRADE-A
10. FABRICATION SHALL BE CARRIED OUT AS PER PROVISIONS OF IS:802 PART-II (1972)
11. ALL UNNOTED MEMBERS ARE L45x45x4.
12. ALL UNNOTED GUSSET PLATE ARE 6 MM THICK UNLESS OTHERWISE SPECIFIED.
13. SPRING WASHER CONFORMING TO IS:3063-1972 SHALL BE USED UNDER EACH NUT.

| REV. | DESCRIPTION |
|---|---|
| R1 | REVISED AS PER PROTO CORRECTION AS MKD. |
| R0 | FIRST ISSUE |

| Project Doc. No. | CUSTMER: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
|---|---|---|
| Scale 1 : 600 | PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | SEIMENS LIMITED, GURGAON |
| | Date 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| | Drawn GB/RK | |
| | Appr. RK | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV BEAM TYPE G1 |
| | Norm KTV | |

| Rev. | Remarks | Date | Name | LOA No. | RVPN/SE(P&P)/XEN/KFW/ICB-1D 1771 dated 16.10.2015 | Sheet 2 of 2 |
|---|---|---|---|---|---|---|
| 0 | First Issue | 21.03.16 | GB | DRG. No. | 5427PN066-BHA-C-SYD-SYS-7551-SM | Rev. 0 |

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FRONT ELEVATION (VIEW '1-1')

DETAIL 'A'

DETAIL 'B'

REAR ELEVATION (VIEW '2-2')

KEY PLAN

SECTION 'A-A'

DETAIL 'E'

DETAIL 'F'

| LIST OF ø16 ø BOLTS (4.6 GRADE), NUTS & WASHERS | | |
|---|---|---|
| | SIZE (Length in mm) | TOTAL QTY. |
| A | M16 X 35 mm | — |
| B | M16 X 40 mm | 260 |
| C | M16 X 45 mm | 334 |
| D | M16 X 50 mm | 218 |
| E | M16 X 55 mm | 224 |
| F | M16 X 60 mm | 12 |
| G | M16 X 65 mm | — |
| SPRING WASHER | 3.5 X 16 ø | 1048 |
| STEP BOLTS | ø16x150 LG. | — |
| PACK WASHER | 5 mm | 36 |
| PACK WASHER | 6 mm | 44 |
| PACK WASHER | 8 mm | 78 |
| PACK WASHER | 10 mm | 116 |
| PACK WASHER | 12 mm | — |

Note: Quantity of Nuts and Bolts shall be as per approved BOM.

Generally Approved
S.E. XEN KRW/Projects RVPNL JAIPUR XEN

PROTO CORRECTED

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL HOLES SHALL BE 17.5ø FOR 16ø BOLTS UNLESS OTHERWISE SPECIFIED.
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH :G2-1,2,3' etc.
4. MINIMUM EDGE SECURITY FOR 16MM BOLTS SHALL BE 25 MM FROM CUT EDGE & 20 MM FROM ROLLED EDGE.
5. L45x45x5. & L45x45x4. WITH 23 MM BACK MARK.
6. EDGE PREPARATION OF WELDING SHALL BE DONE AS PER IS:823 (LATEST)
7. ALL STEEL SECTIONS & PACK WASHERS SHALL BE HOT DIP GALVANIZED MINIMUM WEIGHT OF ZINC COATING SHALL BE 610gm/sq.m.
8. ALL BOLTS NUTS SHALL CONFORM TO IS:1367 (LATEST) CLASS 5.6 FOR BOLTS & 'S FOR NUTS. ALL BOLTS & NUTS SHALL HOT DIP GALVANIZED AS PER IS:1367 (PART-13)
9. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062-1999 GRADE-A
10. FABRICATION SHALL BE CARRIED OUT AS PER PROVISIONS OF IS:802 PART-II (1972)
11. ALL UNNOTTED MEMBERS ARE L45x45x4.
12. ALL UNNOTTED GUSSET PLATE ARE 8 MM THICK UNLESS OTHERWISE SPECIFIED.
13. SPRING WASHER CONFORMING TO IS:3063-1972 SHALL BE USED UNDER EACH NUT.

GENERAL NOTES

GENERAL NOTES

| REFR. DRG. NO. | DESCRIPTION |
|---|---|

| REV. | DESCRIPTION |
|---|---|
| R1 | REVISED AS PER PROTO CORRECTION AS MKD. |
| R0 | FIRST ISSUE |

| Project Doc. No. | CUSTMER: |
|---|---|
| Scale 1 : 600 | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | SEIMENS LIMITED, GURGAON |
| Date 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| Drawn GB/RK | |
| Appr. RK | |
| Norm KIV | |
| DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV BEAM TYPE G2 | |
| 0 First Issue 21.03.16 GB DRG. No. 5427PN066-BHA-C-SYD-SYS-7552-SM | Rev. 0 |
| Rev. Remarks Date Name LOA No. RVPN/SE(P&P)/XEN/KRW/ICB-1D 1771 dated 16.10.2015 | Sheet 1 of 2 |

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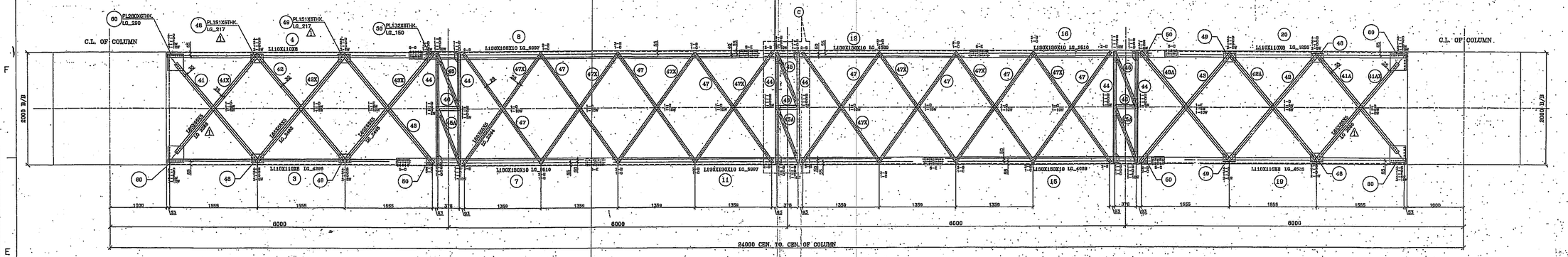
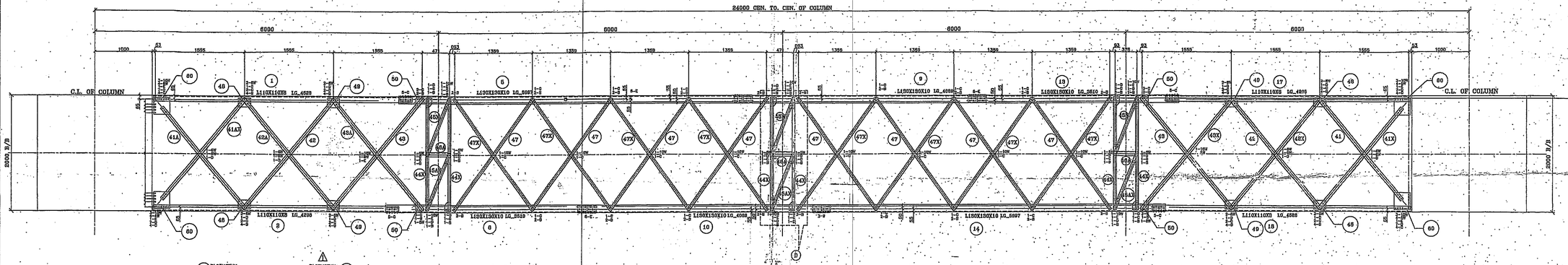
DRAWING NO. 5427PN066-BHA-C-STD-SYS-7552-SM

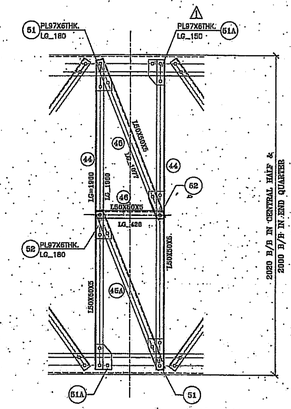
DF009



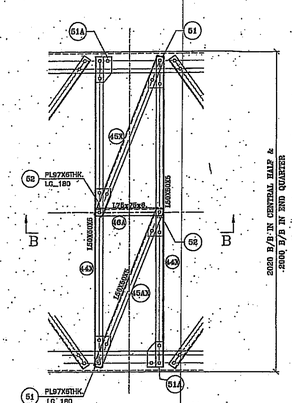

TOP PLAN (VIEW '4-4')




BOTTOM PLAN (VIEW '3-3')




DETAIL 'C'

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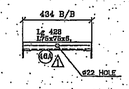



VIEW 'B-B'

Note: Quantity of Nuts and Bolts shall be as approved BOM.

Generally Approved
XEN
KPW Projects
RRVPNL JAIPUR

SIEMENS LTD.

PROTO CORRECTED

( DELETED MARK No. 33, 38, 53 To 55 )
MARK No. 1 To 60

| REFR. DRG. NO. | DESCRIPTION |
|---|---|

GENERAL NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL HOLES SHALL BE 17.5ø FOR 16ø BOLTS UNLESS OTHERWISE SPECIFIED.
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH :G2-1,2,3 etc.
4. MINIMUM EDGE SECURITY FOR 16MM BOLTS SHALL BE 25 MM FROM CUT EDGE & 20 MM FROM ROLLED EDGE.
5. L45x45x5 & L45x45x4, WITH 23 MM BACK MARK
6. EDGE PREPARATION OF WELDING SHALL BE DONE AS PER IS:823 (LATEST)
7. ALL STEEL SECTIONS & PACK WASHERS SHALL BE HOT DIP GALVANIZED MINIMUM WEIGHT OF ZINC COATING SHALL BE 610gm/sq.m.
8. ALL BOLTS NUTS SHALL CONFORM TO IS:1367 (LATEST) CLASS 5.6 FOR BOLTS & 5 FOR NUTS. ALL BOLTS & NUTS SHALL HOT DIP GALVANIZED AS PER IS:1367 (PART-13)

GENERAL NOTES

9. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062-1999 GRADE-A
10. FABRICATION SHALL BE CARRIED OUT AS PER PROVISIONS OF IS:802 PART-II (1972)
11. ALL UNNOTTED MEMBERS ARE L45x45x4,
12. ALL UNNOTTED GUSSET PLATE ARE 6 MM THICK UNLESS OTHERWISE SPECIFIED.
13. SPRING WASHER CONFORMING TO IS:3063-1972 SHALL BE USED UNDER EACH NUT.

| REV. | DESCRIPTION |
|---|---|
| R1 | REVISED AS PER PROTO CORRECTION AS MKD |
| R0 | FIRST ISSUE |

| Project Doc. No. | CUSTMER: |
|---|---|
| Scale 1 : 600 | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | SEIMENS LIMITED, GURGAON |

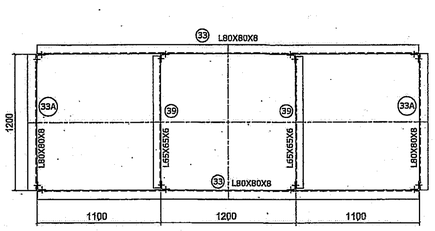
| | | | | | |
|---|---|---|---|---|---|
| | | | | Date | 21.03.2016 |
| | | | | Drawn | GB/RK |
| | | | | Appr. | RK |
| | | | | Norm | KTV |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | 5427PN066-BHA-C-SYD-SYS-7552-SM |
| Rev. | Remarks | Date | Name | LOA No. | RVPN/SE(P&P)/XEN/KRW/ICB-1D 1771 dated 18.10.2015 |

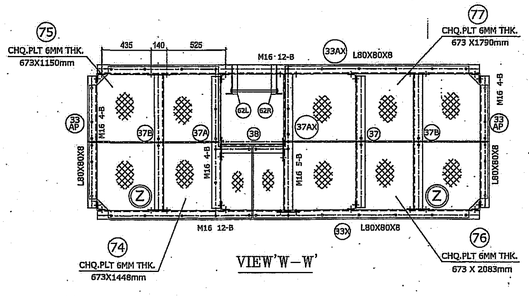
Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA

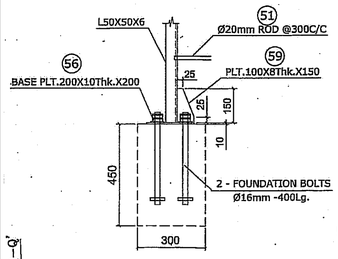
DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV BEAM TYPE G2

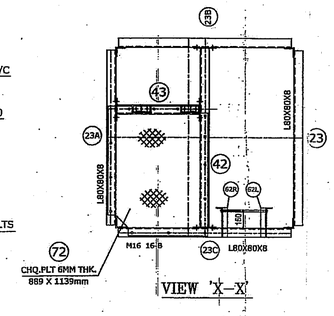
Rev. 0
Sheet 2 of 2

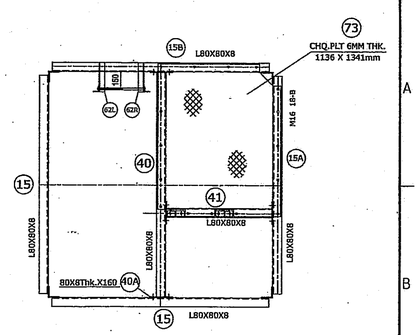
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

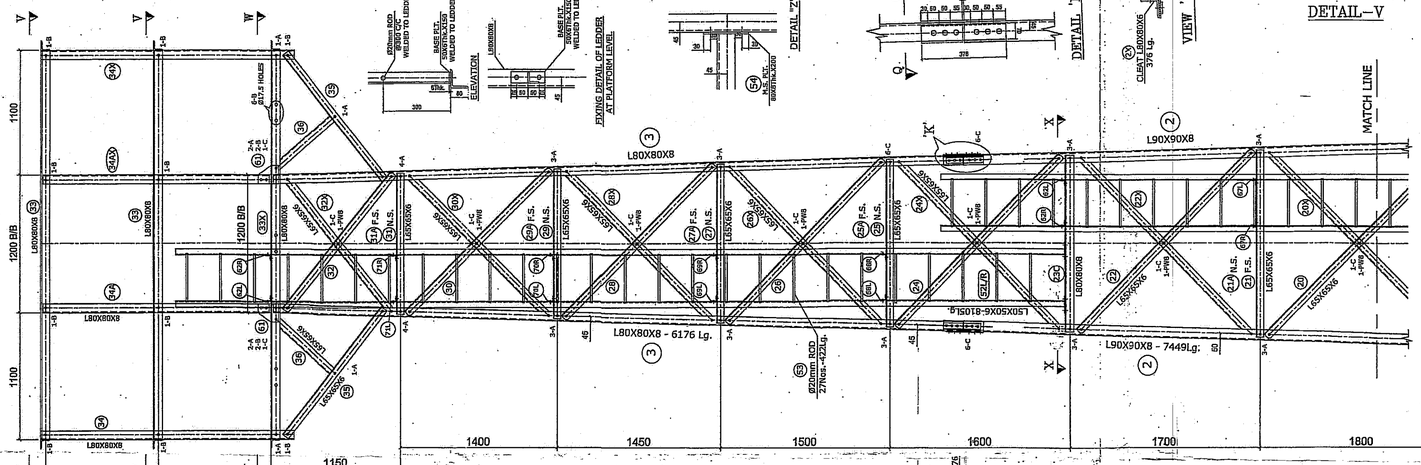


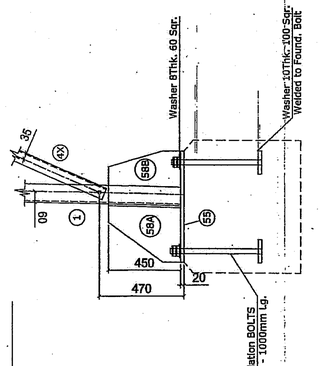



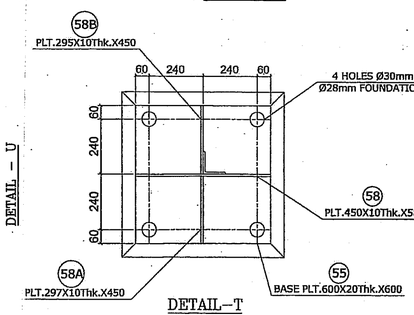



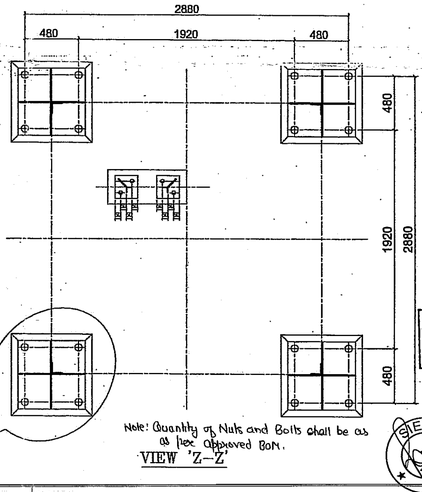



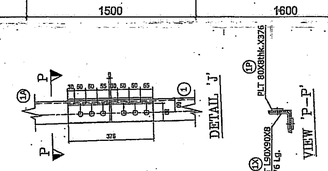



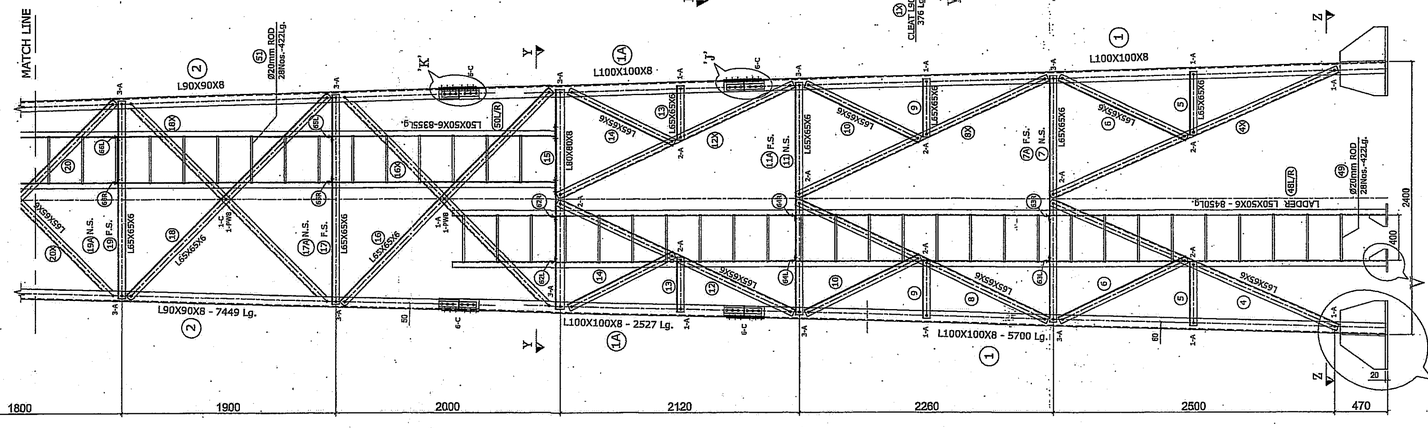



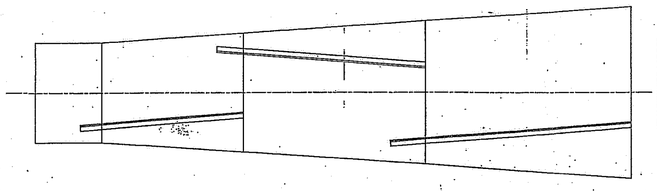




1. 16 x 35 mm = 324 Nos.
2. 16 x 40 mm = 120 Nos.
3. 20 x 40 mm = 396 Nos.
4. 20 x 45 mm = 40 Nos.
5. 20 x 50 mm = 180 Nos.
6. Spring Washer 16ϕ = 144 Nos.
7. Spring Washer 20ϕ = 616 Nos.
8. Pack Washer 30 mm 8 thk = 36 Nos.




NOTES :-

1. ALL DIMENSIONS ARE IN mm.
2. ALL BOLTS ARE 20mm DIA WITH 21.5mm HOLES, UNLESS OTHERWISE STATED.
3. MINIMUM EDGE SECURITY 30mm. FROM CUT EDGE & 25mm. FROM ROLLED EDGE, UNLESS OTHERWISE SPECIFIED.
4. ALL MEMBERS TO BE HOT DIP GALVANISED AS PER IS:2629-1925.
5. SPRING WASHER TO BE USED UNDER EACH NUT.
6. ALL ERECTION MARKS TO BE PREFIXED WITH 'STC/LM'.
7. ALL GUSSETS ARE 6mm THICK, UNLESS OTHERWISE SPECIFIED.
8. MINIMUM GALVANISATION THICKNESS IN STEEL SECTION SHALL BE 610 GSM/SQM..
9. ALL BOLTS & NUTS SHALL CONFIRM TO GRADE 5.6.
10. 16mm DIA BOLTS ARE USED FOR LADDERS & PLATFORMS.

| REV. | DESCRIPTION | PREP. | CHKD. | APPD. | DATE |
|---|---|---|---|---|---|
| | | SIGN. | | | |

Generally Approved
S.E. SEN KFC Projects RRVPNL JAIPUR SEN

| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. | CUSTMER: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | | | | |
| Scale 1:600 | | | | | |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | SEIMENS LIMITED, GURGAON | | | |
| | | Date | 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA | |
| | | Drawn | GB/RK | | |
| | | Appr. | RK | | |
| | | Norm | KTV | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD LIGHTENING MAST MKD-LM | |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | 05516/RRVPNL/C/TOW/LM | Rev. 0 |
| Rev. | Remarks | Date | Name | LOA No. | RVPN/SE(P&P)/XEN/KFW/ICB-1D 1771 dated 16.10.2015 | Sheet. 1 of 1 |

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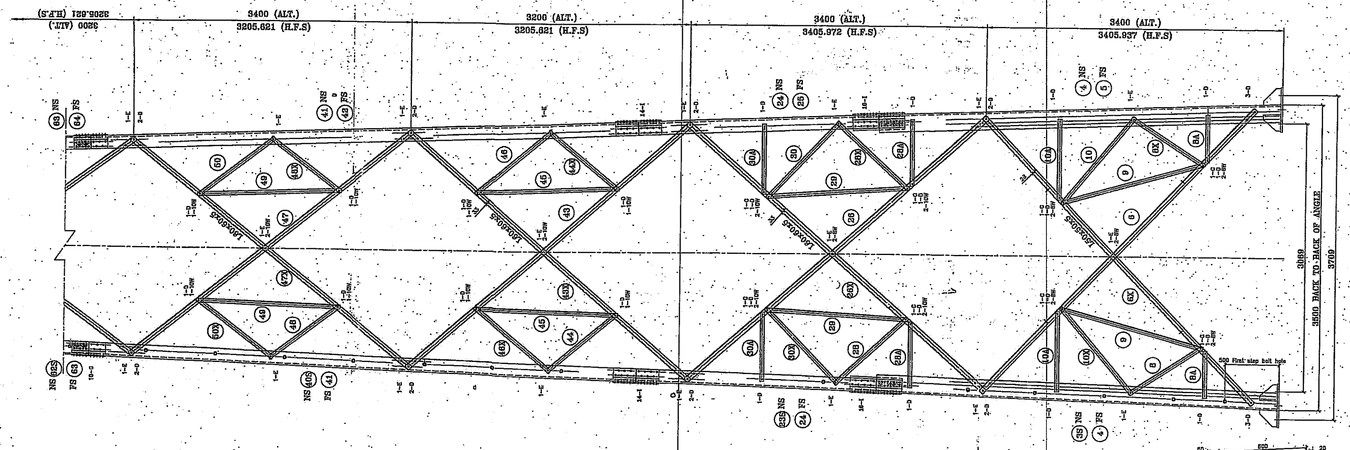
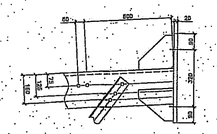
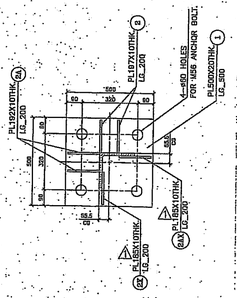
DF009

DRAWING NO. 5427PN066-BHA-C-SYD-SYS-7557-SM

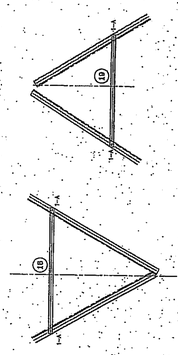


DETAIL AT 'A'

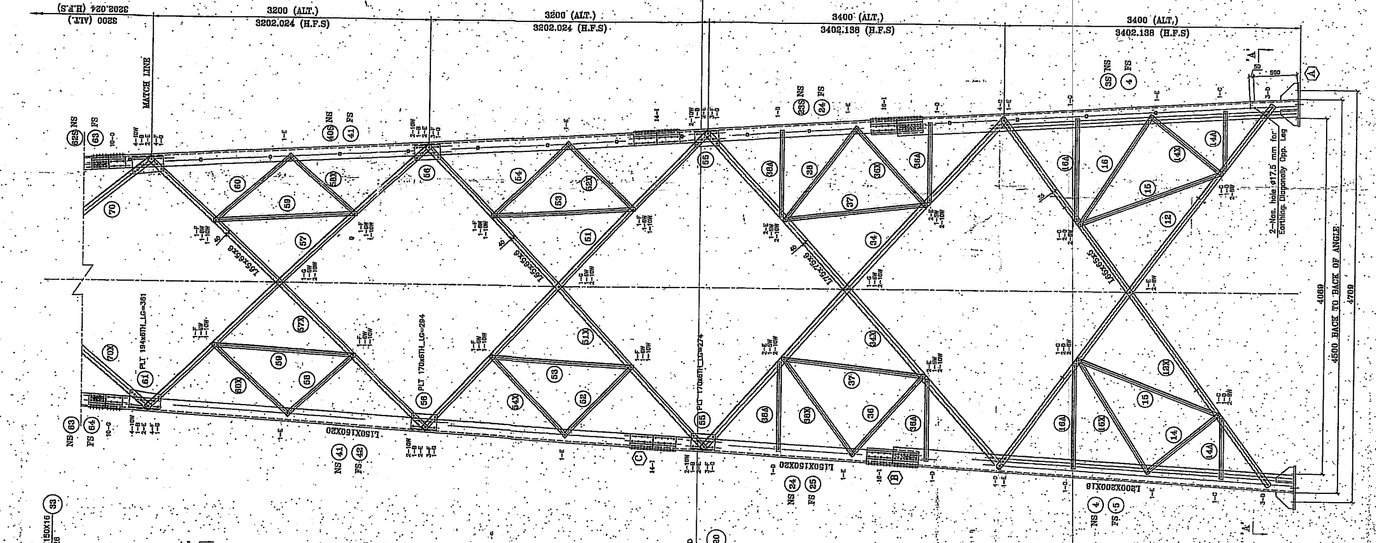


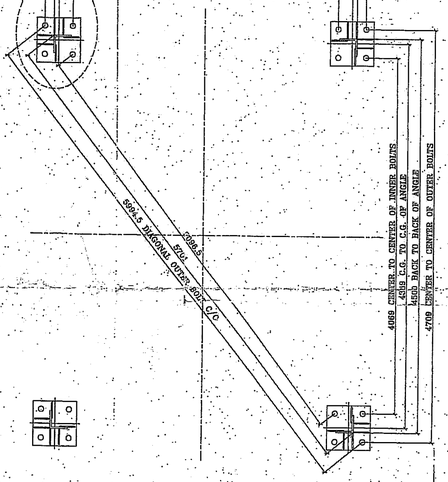

ENLG. DETAIL AT 'R'



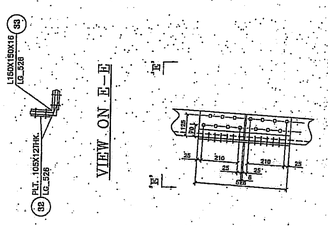
SECTION C–C

SECTION B–B



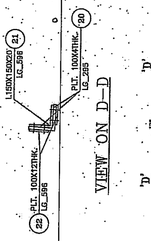

SECTION A–A
(PLAN AT BASE PLATE LEVEL)



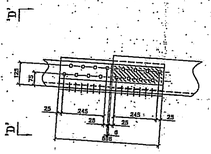

VIEW ON E–E



DETAIL AT 'C'




VIEW ON D–D



DETAIL AT 'B'

| List of ø16mm H.R.H. Bolts, Nuts & Washers. | | |
|---|---|---|
| | SIZE (Length in mm) | TOTAL QTY. |
| A | 35 mm | 018 |
| B | 40 mm | 074 |
| C | 45 mm | 316 |
| D | 50 mm | 292 |
| E | 55 mm | 136 |
| F | 60 mm | 202 |
| G | 65 mm | 100 |
| H | 70 mm | — |
| I | 75 mm | 240 |
| SPRING WASHER | 3.5 THK x ø16 | 1378 |
| STEP BOLTS | ø16x175 LG. | 060 |
| PACK WASHER | 5 mm | 044 |
| PACK WASHER | 6 mm | 030 |
| PACK WASHER | 8 mm | 040 |
| PACK WASHER | 10 mm | 146 |
| PACK WASHER | 12 mm | 040 |

Note: Quantity of Nuts & Bolts shall be as per approved BOM

Generally Approved
S.E. XEN KFW Projects RRVPNL JAIPUR

PROTO CORRECTED

| REFR. DRG. NO. | DESCRIPTION |
|---|---|

GENRAL NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL HOLES SHALL BE 17.5ø FOR 16ø BOLTS UNLESS OTHERWISE SPECIFIED.
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH :TJ-1,2,3 etc.
4. MINIMUM EDGE SECURITY FOR 16MM BOLTS SHALL BE 25 MM. FROM CUT EDGE & 20 MM FROM ROLLED EDGE.
5. L45x45x5 WITH 23 MM BACK MARK
6. EDGE PREPARATION OF WELDING SHALL BE DONE AS PER IS:823 (LATEST)
7. ALL STEEL SECTIONS & PACK WASHERS SHALL BE HOT DIP GALVANIZED MINIMUM WEIGHT OF ZINC COATING SHALL BE 610gm/sq.m.
8. ALL BOLTS NUTS SHALL CONFORM TO IS:1367 (LATEST) CLASS 5.6 FOR BOLTS & 5 FOR NUTS. ALL BOLTS & NUTS SHALL HOT DIP GALVANIZED AS PER IS:1367 (PART-13)

GENRAL NOTES

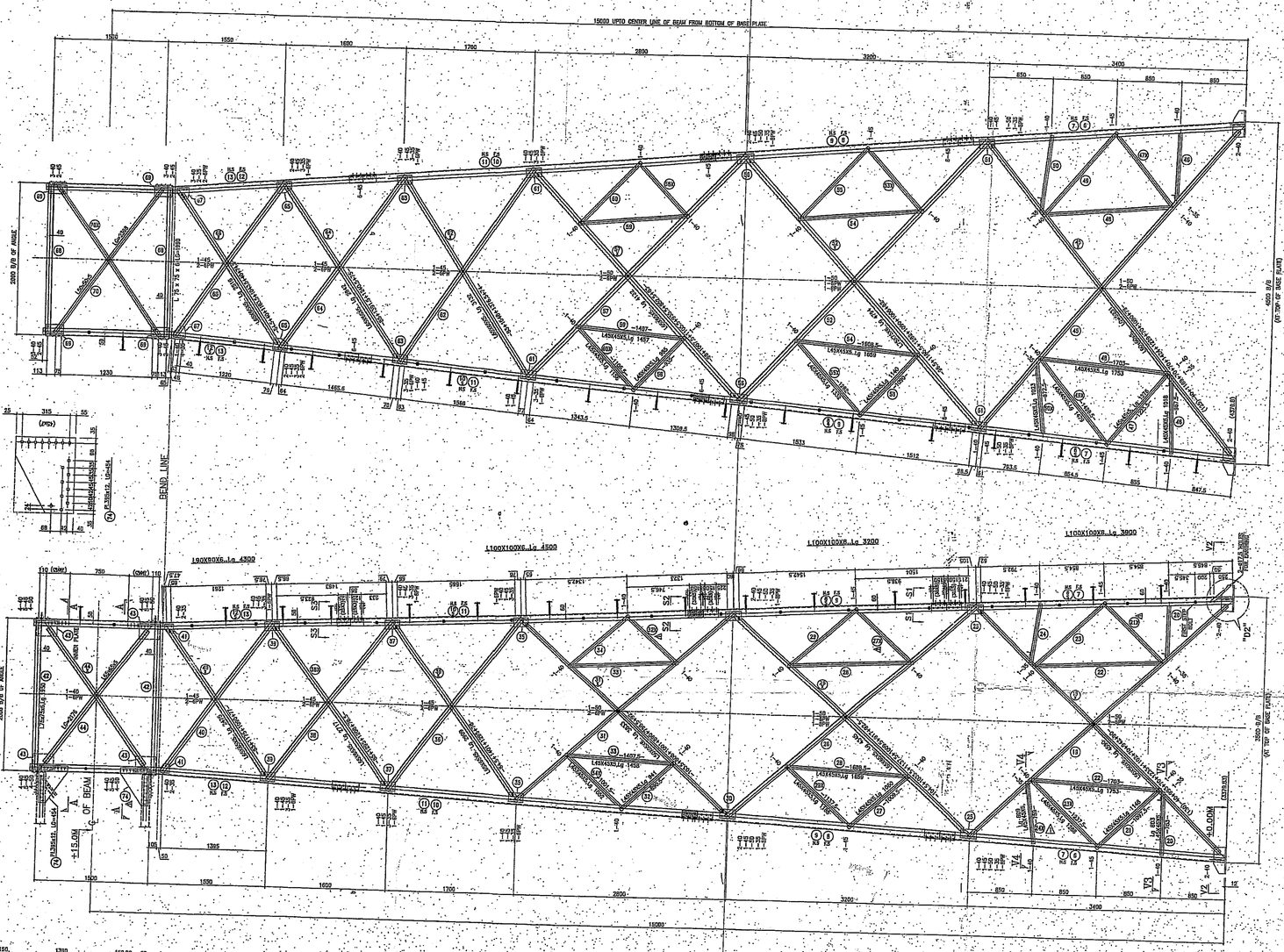
9. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062-1999 GRADE-A.
10. FABRICATION SHALL BE CARRIED OUT AS PER PROVISIONS OF IS:802 PART-II (1972).
11. ALL UNNOTTED MEMBERS ARE L45x45x5.
12. ALL UNNOTTED GUSSET PLATE ARE 6 MM THICK UNLESS OTHERWISE SPECIFIED.
13. MAXIMUM SPACING BETWEEN STEP BOLTS SHALL BE 450 MM.
14. SPRING WASHER CONFORMING TO IS:3063-1972 SHALL BE USED UNDER EACH NUT.
15. ALL WELD ARE 6MM FILLET CONTINOUS WELD UNLESS , OTHERWISE SPECIFIED.

| REV. | DESCRIPTION |
|---|---|
| R1 | REVISED AS PER PROTO CORRECTION AS MKD |
| R0 | FIRST ISSUE |

| Project Doc. No. | | | | CUSTMER: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
|---|---|---|---|---|---|
| Scale 1 : 600 | | | | PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | SEIMENS LIMITED, GURGAON |
| | | | | Date 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| | | | | Drawn GB/RK | |
| | | | | Appr. RK | |
| | | | | Norm KTV | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TJ |
| 0 | First Issue | 21.03.16 | GB | DRG. No. 5427PN066-BHA-C-SYD-SYS-7557-SM | Rev. 0 |
| Rev. | Remarks | Date | Name | LOA No. RVPN/Sh(P&P)/XEN/KfW/CB-10 1771 dated 16.10.2015 | Sheet 1 of 2 |

DF009

DRAWING NO. 5427PN066-BHA-C-SYD-SYS-7553-SM



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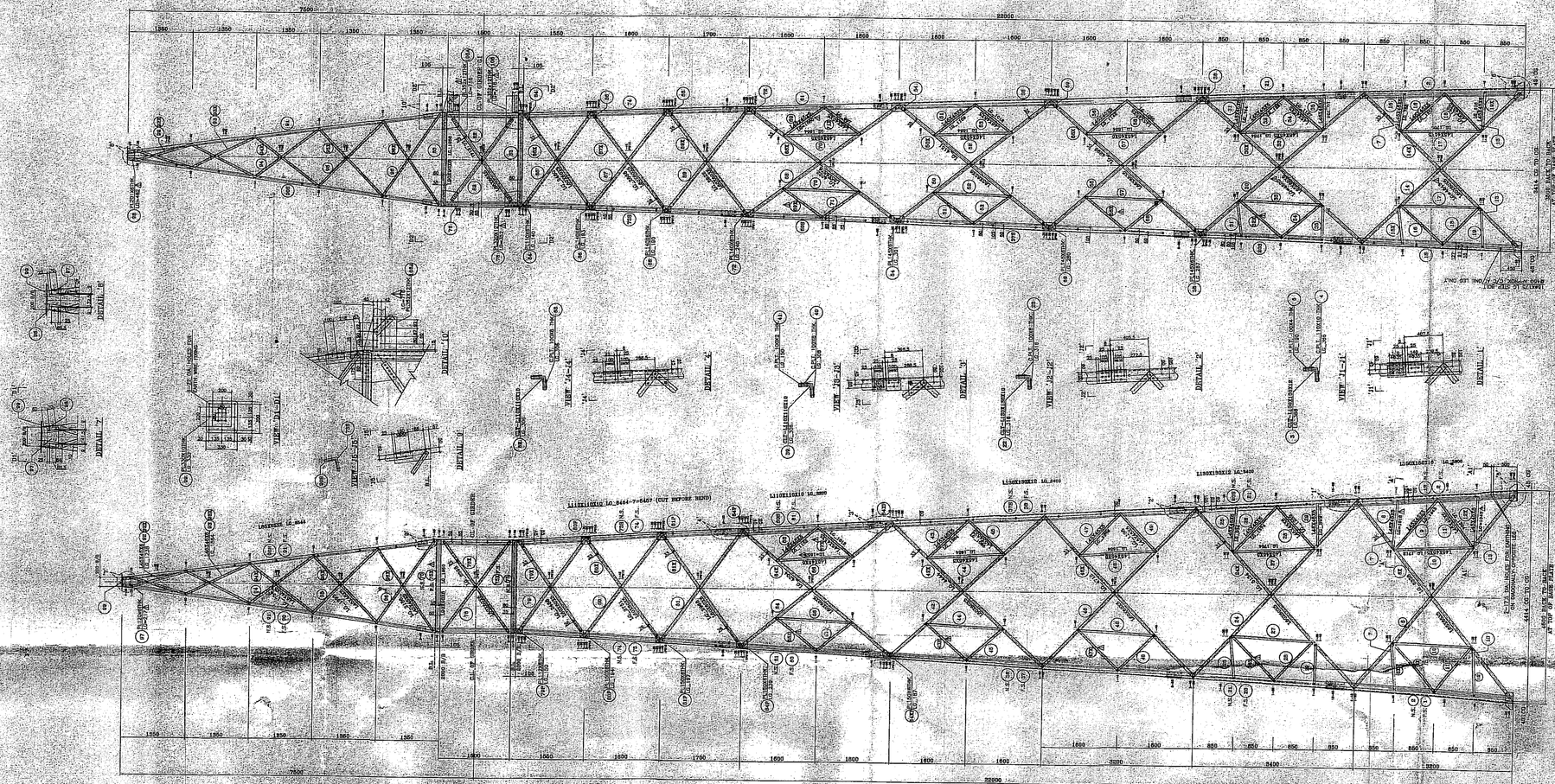


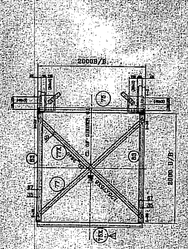


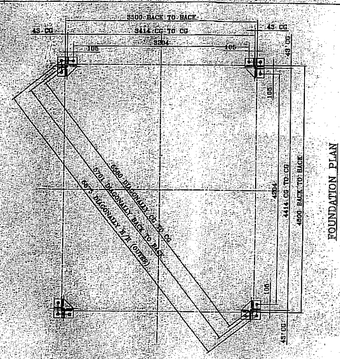


| BOLTS/NUTS STATEMENT WITH 2% EXTRA | |
|---|---|
| SIZE (Length in mm) | TOTAL QTY. |
| M16 X 35 mm | 184 |
| M16 X 40 mm | 314 |
| M16 X 45 mm | 240 |
| M16 X 50 mm | 116 |
| M16 X 55 mm | 140 |
| M16 X 60 mm | — |
| M16 X 65 mm | 84 |
| SPRING WASHER 16 ø | 1058 |
| STEP BOLTS ø16x175 LG. | 63 |
| PACK WASHER 5 mm | 58 |
| PACK WASHER 6 mm | 20 |
| PACK WASHER 8 mm | 4 |
| PACK WASHER 10 mm | 70 |
| PACK WASHER 12 mm | 10 |

| REFR. DRG. NO. | DESCRIPTION |
|---|---|

GENRAL NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL HOLES SHALL BE 17.5ø FOR 16ø BOLTS UNLESS OTHERWISE SPECIFIED.
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH 'TG-1,23..ETC.
4. MINIMUM EDGE DISTANCE FOR 16MM BOLTS SHALL BE 25 MM FROM CUT EDGE & 20 MM FROM ROLLED EDGE.
5. L45x45x5 WITH 21 MM BACK MARK
6. EDGE PREPARATION OF WELDING SHALL BE DONE AS PER IS:823 (LATEST)
7. ALL STEEL SECTIONS & PACK WASHERS SHALL BE HOT DIP GALVANIZED MINIMUM WEIGHT OF ZINC COATING SHALL BE 610gm/sq.m.
8. ALL BOLTS NUTS SHALL CONFORM TO IS:1367 (LATEST) CLASS 5.6 FOR BOLTS & 5 FOR NUTS. ALL BOLTS & NUTS SHALL HOT DIP GALVANIZED AS PER IS:1367 (PART-13)

GENRAL NOTES

9. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062-1999 GRADE-A
10. FABRICATION SHALL BE CARRIED OUT AS PER PROVISIONS OF IS:802 PART-1 (1972)
11. ALL UNNOTTED MEMBERS ARE L45x45x5.
12. ALL UNNOTTED GUSSET PLATE ARE 6 MM THICK UNLESS OTHERWISE SPECIFIED.
13. MAXIMUM SPACING BETWEEN STEP BOLTS SHALL BE 450 MM.
14. SPRING WASHER CONFORMING TO IS:3063-1972 SHALL BE USED UNDER EACH NUT.
15. ALL WELD ARE 6MM FILLET CONTINOUS WELD UNLESS , OTHERWISE SPECIFIED.

MARK NOS. :- 1 TO 105

Quantity of Nuts Bolts and washers should be as per approved BOM.

Generally Approved
S.E | XEN | SDE
KFW Projects
RAJVPNL, JAIPUR

SIEMENS LTD.

| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. | | CUSTMER: | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | | |
| Scale | 1 : 600 | | | | |
| PROJECT: | 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | SEIMENS LIMITED, GURGAON | | |
| | | Date | 21.03.2016 | Tower Mfg: | M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| | | Drawn | GB/RK | | |
| | | Appr. | RK | | |
| | | Nom | KTV | DRG. TITLE: | DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TG |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | 5427PN065-BHA-C-SYD-SYS-7554-SM |
| Rev. | Remarks | Date | Name | LOA No. | RVPNSE(P&P)XEN(KW)WCB-1D 1771 dated 16.10.2015 |

Rev. 0
Sheet 1 OF 1

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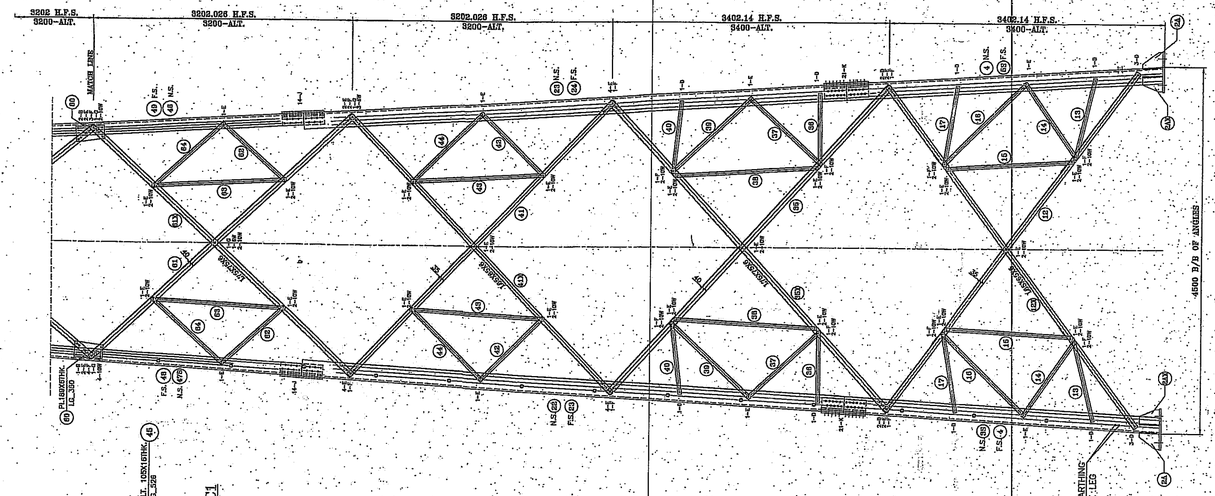
DF009

DRAWING NO. 5427PN066-BHA-C-SYD-SYS-7555-SM

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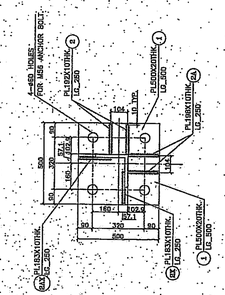


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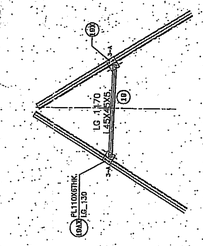
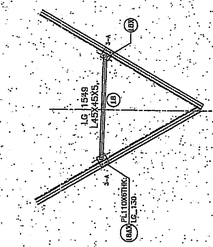



SECTION C-C

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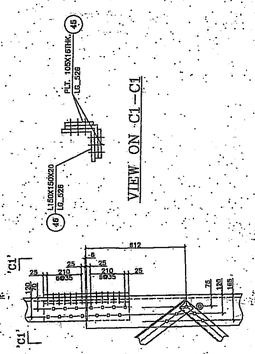
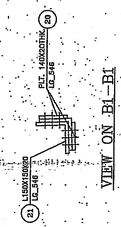
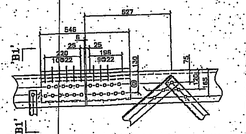



VIEW ON C1-C1

DETAIL 'C'




VIEW ON B1-B1

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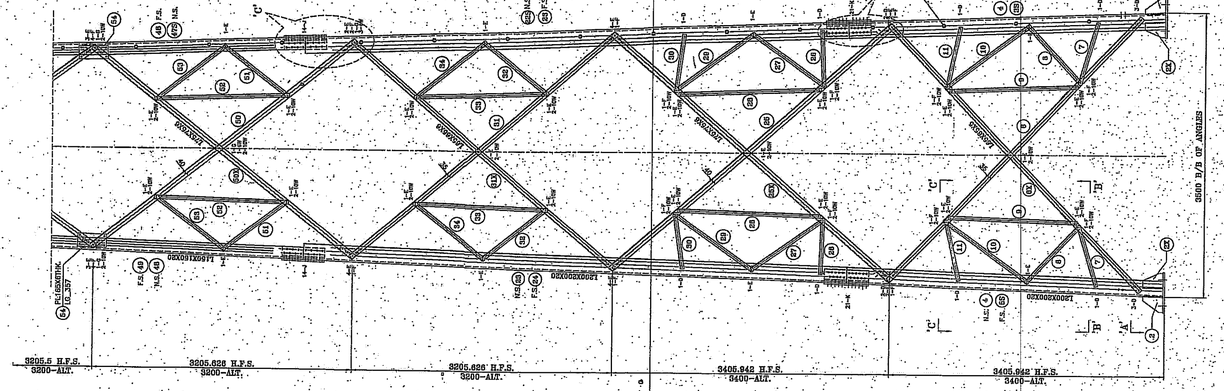
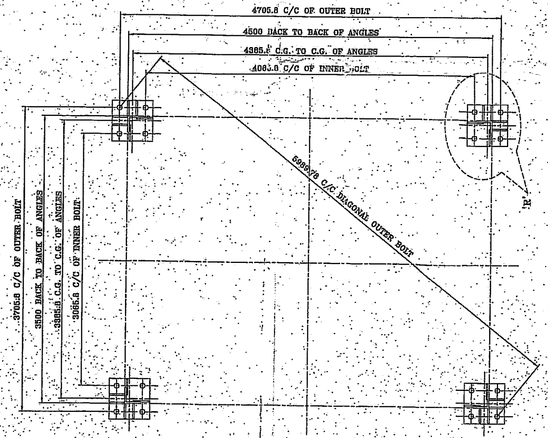



TRANSVERSE FACE




SECTION A-A

Note: Quantity of Nuts and Bolts shall be as per approved BOM.

SIEMENS LTD. Singhal

PROTO CORRECTED

MARK NOS :- 1 TO 106

GENRAL NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL HOLES SHALL BE 17.5ø FOR 16ø BOLTS UNLESS OTHERWISE SPECIFIED.
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH 'TH'-1,2,3 etc.
4. MINIMUM EDGE SECURITY FOR 16MM BOLTS SHALL BE 25 MM FROM CUT EDGE & 20 MM FROM ROLLED EDGE.
5. L45x45x5 WITH 23 MM BACK MARK
6. EDGE PREPARATION OF WELDING SHALL BE DONE AS PER IS:823 (LATEST)
7. ALL STEEL SECTIONS & PACK WASHERS SHALL BE HOT DIP GALVANIZED MINIMUM WEIGHT OF ZINC COATING SHALL BE 610gm/sq.m.
8. ALL BOLTS NUTS SHALL CONFORM TO IS:1367 (LATEST) CLASS 5.6 FOR BOLTS & 5 FOR NUTS. ALL BOLTS & NUTS SHALL HOT DIP GALVANIZED AS PER IS:1367 (PART-13)

GENRAL NOTES

9. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062-1999 GRADE-A.
10. FABRICATION SHALL BE CARRIED OUT AS PER PROVISIONS OF IS:802 PART-II (1972)
11. ALL UNNOTED MEMBERS ARE L45x45x5.
12. ALL UNNOTED GUSSET PLATE ARE 6 MM THICK UNLESS OTHERWISE SPECIFIED.
13. MAXIMUM SPACING BETWEEN STEP BOLTS SHALL BE 450 MM.
14. SPRING WASHER CONFORMING TO IS:3063-1972 SHALL BE USED UNDER EACH NUT.
15. ALL WELD ARE 6MM FILLET CONTINOUS WELD UNLESS , OTHERWISE SPECIFIED.

| REFR. DRG. NO. | DESCRIPTION |
|---|---|

| REV. | DESCRIPTION |
|---|---|
| R1 | REVISED AS PER PROTO CORRECTION AS MKD |
| R0 | FIRST ISSUE |

| Project Doc. No. | | | | CUSTMER: | |
|---|---|---|---|---|---|
| Scale 1 : 600 | | | | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | | | | SEIMENS LIMITED, GURGAON |
| | | | | Date 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| | | | | Drawn GB/RK | |
| | | | | Appr. RK | |
| | | | | Norm KTV | |
| | | | | | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TH |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | 5427PN066-BHA-C-SYD-SYS-7555-SM Rev. 0 |
| Rev. | Remarks | Date | Name | LOA No. | RVPN/SE(P&P)XEN/KTW/CS-1D 1771 dated 16.10.2015 Sheet. 1 of 1 |

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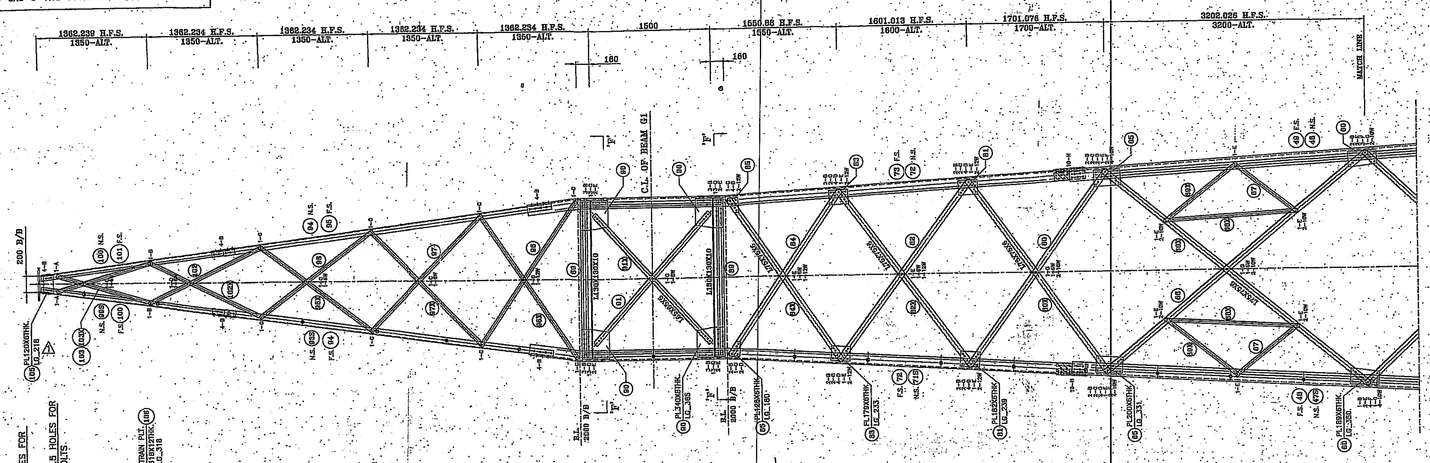
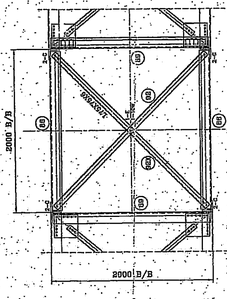
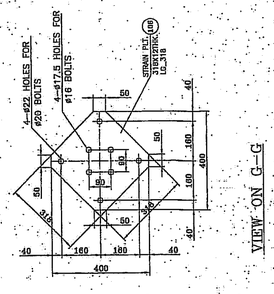
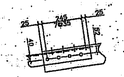
DRAWING NO. 5427PN066-BHA-C-SYD-SYS-7555-SM

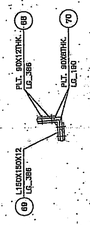


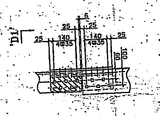



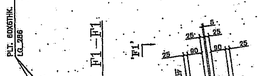

| BOLTS & NUTS STATEMENTS | | |
|---|---|---|
| | SIZE (Length in mm) | TOTAL QTY. |
| A | 35 mm | 26 |
| B | 40 mm | 114 |
| C | 45 mm | 314 |
| D | 50 mm | 162 |
| E | 55 mm | 306 |
| F | 60 mm | 194 |
| G | 65 mm | 28 |
| H | 70 mm | 80 |
| I | 75 mm | – |
| J | 80 mm | 112 |
| K | 85 mm | 188 |
| SPRING WASHER | 3.5 Thk. – 16 ø | 1504 |
| PACK WASHER | 5 mm | 16 |
| PACK WASHER | 6 mm | 246 |
| PACK WASHER | 8 mm | 24 |
| PACK WASHER | 10 mm | 314 |
| PACK WASHER | 12 mm | – |
| STEP BOLTS | M16 X 175 LG. | 66 |

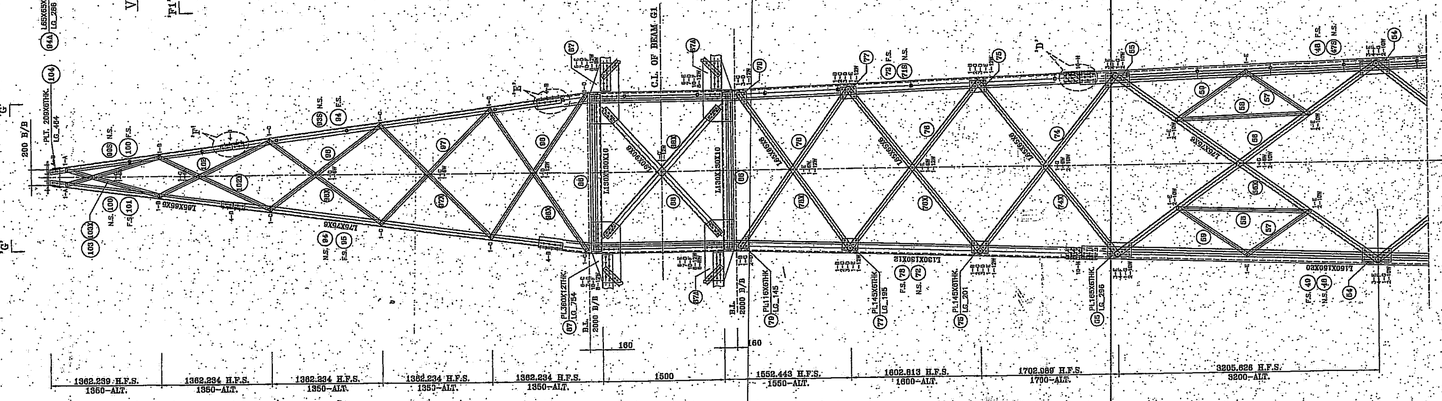



Generally Approved
XEN Proto RRVPNL JAIPUR
SE XEN

Note: Quantity of Nuts and Bolts shall be as per approved Part.

PROTO CORRECTED

MARK NOS :- 1 TO 106

SIEMENS LIMITED

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
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GENRAL NOTES

| REV. | DESCRIPTION |
|---|---|
| R1 | REVISED AS PER PROTO CORRECTION AS MKD. |
| R0 | FIRST ISSUE |

| REFR. DRG. NO. | DESCRIPTION |
|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. | CUSTMER: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | | | | |
| Scale 1 : 600 | | | | | |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | | | SEIMENS LIMITED, GURGAON | |
| | | | Date | 21.03.2016 | |
| | | | Drawn | GB/RK | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| | | | Appr. | RK | |
| | | | Norm | KTV | |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | 5427PN066-BHA-C-SYD-SYS-7555-SM — Rev. 0 |
| Rev. | Remarks | Date | Name | LOA No. | RVPN/SE(P&P)/XEN/KTW/ICB-1D 1771 dated 16.10.2015 — Sheet 2 of 2 |

DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TH

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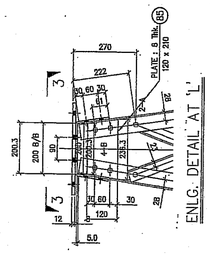


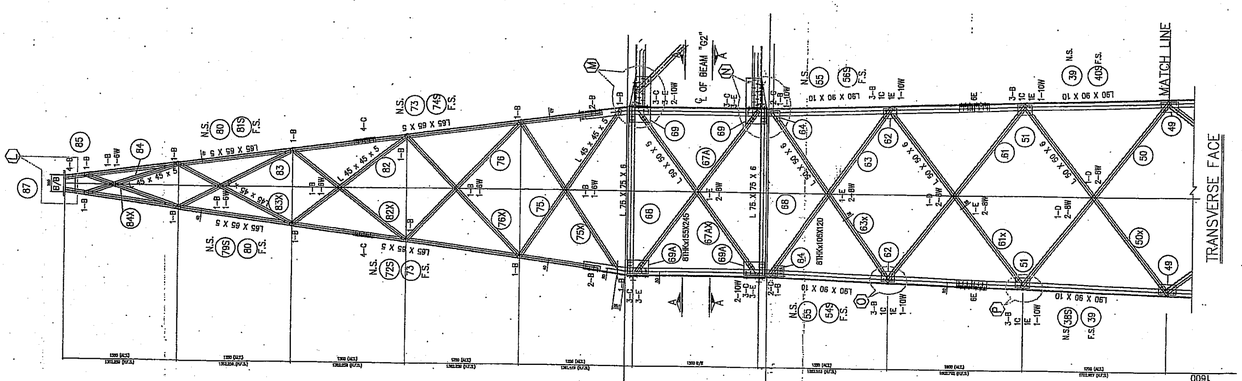


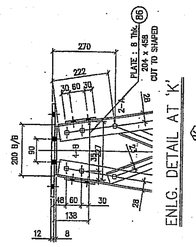


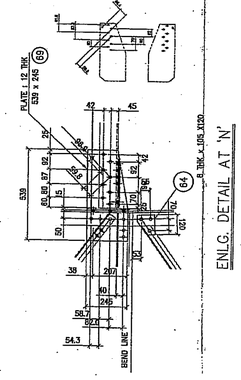


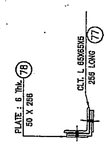


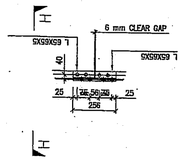


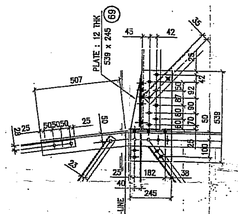

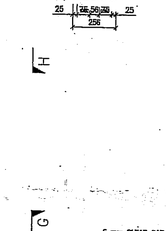


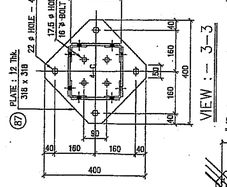


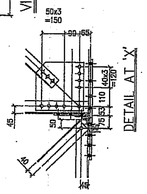


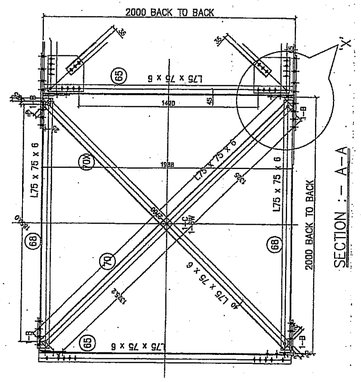


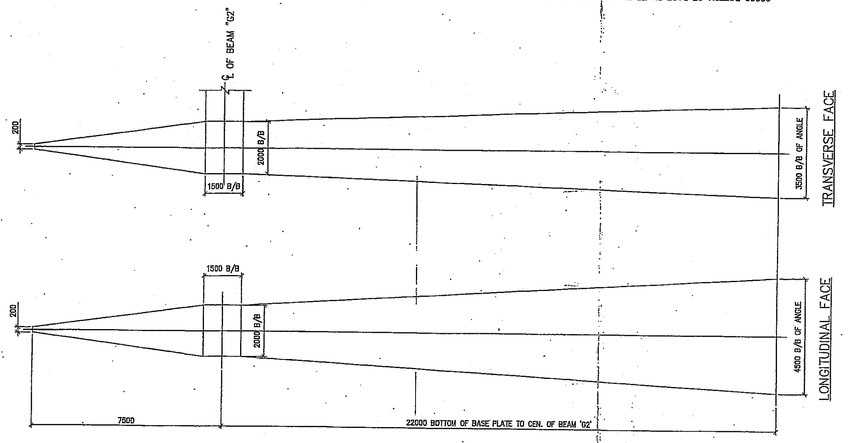


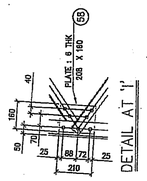


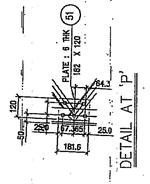


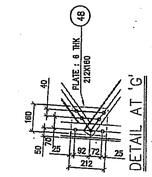


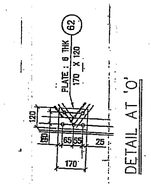


Quantity of Nuts/Bolts and Washers should be as per approved BOM.

Generally Approved
S.E. XEN KfW Projects RRVPNL JAIPUR DEN

SIEMENS LTD.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Doc. No. | | | | | | CUSTMER: | |
| Scale 1 : 600 | | | | | | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | | | | | SEIMENS LIMITED, GURGAON | |
| | | | | | Date: 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA. | |
| | | | | | Drawn: GB/RK | | |
| | | | | | Appr: RK | | |
| | | | | | Norm: KTV | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TI | |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | | 05516/RRVPNL/C/STR/400/TOWER-TI | Rev. 0 |
| Rev. | Remarks | Date | Name | LOA No. | | RVPN/SE(P&P)/XEN/KfW/CB-10 1771 dated 18.10.2015 | Sheet 1 OF 2 |

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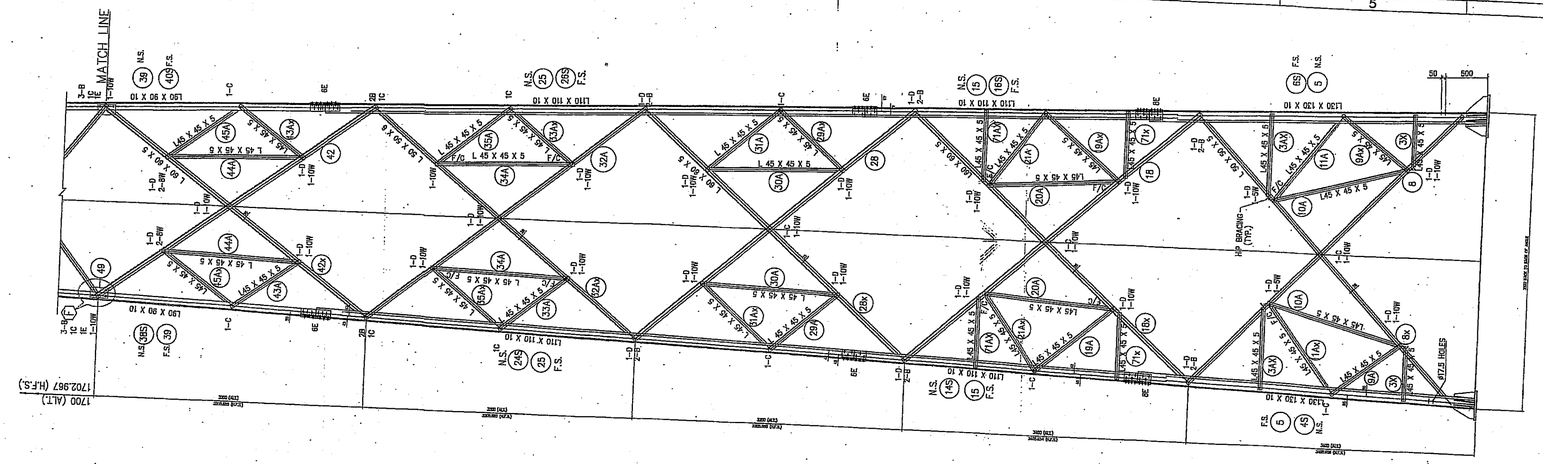


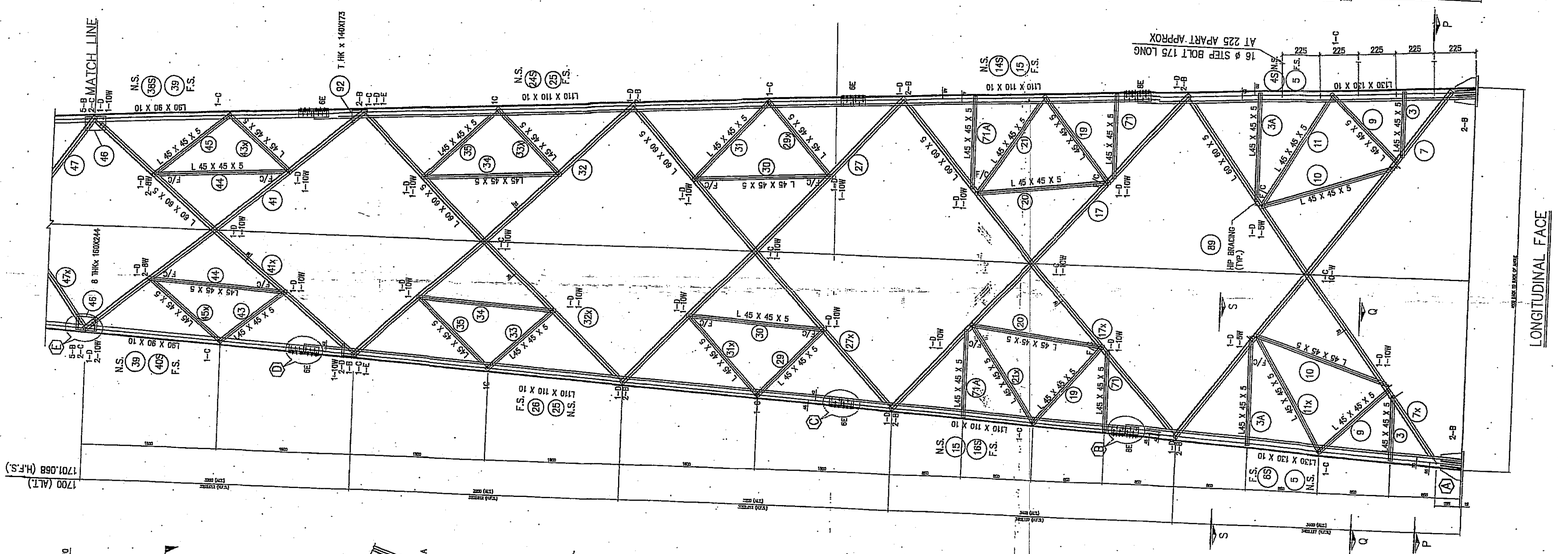


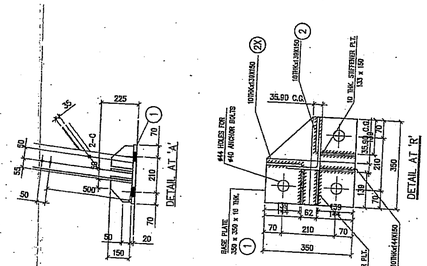


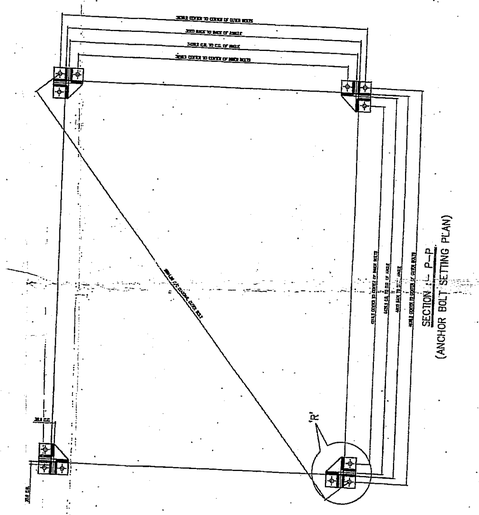


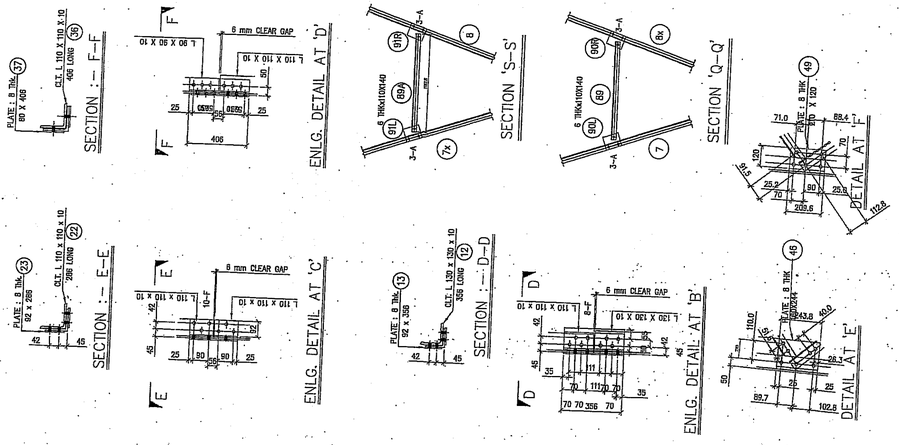


TOWER-TI

List of 16mm ø Bolts (4.6 Grade), Nuts & Washers.

| | SIZE (Length in mm) | TOTAL QTY. | |
|---|---|---|---|
| A | 35 mm | 14 | |
| B | 40 mm | 266 | 3044 |
| C | 45 mm | 124 | |
| D | 50 mm | 110 | |
| E | 55 mm | 28 | 1248 |
| SPRING WASHER | 3.5 Thk. – 16 ø | 154 | |
| PACK WASHER | 5 mm | 6 | |
| PACK WASHER | 6 mm | 28 | 1144 |
| PACK WASHER | 8 mm | 10 | 112 |
| PACK WASHER | 10 mm | 2 | 160 |
| STEP BOLT M16x175 LG. WITH 2 NUT + SP. WASHER | | 8 | 166 |

60 MT = 182
65 MT = 240

NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETRES & ELEVATIONS ARE IN METRE.
2. ALL BRACING MEMBERS ARE L 45 x 45 x 5 UNLESS SPECIFIED OTHERWISE
3. UNLESS OTHERWISE SPECIFIED FOR CONNECTION OF BRACING MEMBERS ALL HOLES ARE 17.5 ø FOR M16 BOLTS
4. ALL WELDS SHALL BE 5 mm FILLET WELD UNLESS SPECIFIED OTHERWISE.
5. HOLES IN BRACING MEMBERS ( L 45 x 45 x 5) SHALL BE AT 25 mm BACKMARK UNLESS OTHER SPECIFIED.
6. a) F.O.- DENOTES FLANGE CUT
   b) CH - DENOTES CHAMFER
7. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062 GRADE-A.
8. 2-17.5 ø HOLES FOR EARTHING CLAMPS SHALL BE PROVIDED ON ALL LEGS OF STRUCTURE.
9. UNLESS NOTED OTHERWISE ALL GUSSET PLATES SHALL BE 8 mm Thk.
10. ALL ITEM NOS. TO BE PREFIXED WITH 'TI'.
11. 16 ø x 175 STEP BOLT AT 450 mm ON DIAGONALLY OPP LEG.

Quantity of Nuts/Bolts and Washers should be as per Approved BOM.

Generally Approved
S/E. XEN KFW Projects RRVPNL JAIPUR SEN

SIEMENS LTD.

| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. | | | | CUSTMER: | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. |
| Scale: 1 : 800 | | | | | |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | | | | SEIMENS LIMITED, GURGAON |
| | | | | Date: 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD., LUDHIANA |
| | | | | Drawn: GB/RK | |
| | | | | Appr.: RK | |
| | | | | Norm: KTV | |
| | | | | | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TI |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | 05618/RRVPNL/C/STR400/TOWER-TI — Rev. 0 |
| Rev. | Remarks | Date | Name | LOA No: | RVPN/SE(P&P)/XEN(KfW/CS-1D 1771 dated 16.10.2015 — Sheet 2 OF 2 |

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DRAWING NO. 5427PN066-BHA-C-STD-SYS-7557-SM

DF009

22000 BEAM CENTER LINE TO BOTTOM OF BASE PLATE

7500

1362.494 H.F.S. 1350-ALT. | 1362.494 H.F.S. 1350-ALT. | 1362.494 H.F.S. 1350-ALT. | 1362.494 H.F.S. 1350-ALT. | 1361.106 H.F.S. 1350-ALT. | 1500 | 1552.556 H.F.S. 1550-ALT. | 1602.7 H.F.S. 1600-ALT. | 1703 H.F.S. 1700-ALT. | 3205.621 H.F.S. 3200-ALT. | 3205.621 (H.F.S) 3200 (ALT.)

150 | 150

C.L. OF BEAM G2

2000 B/B

PLT. 217X8THK. LG.469

PLT. 270X8THK. LG.305

PLT. 115X8THK. LG.226

PLT. 50X8THK. LG.316

PLT. 105X10THK. LG.190

PLT. 135X10THK. LG.386

PLT. 80X8THK. LG.316

L65X65X6 LG.316

L150X130X12 LG.316

L150X150X12 LG.386

L150X130X12 LG.189

L150X130X12 LG.247

L150X130X12 LG.332

L150X150X12 LG.347

STRAIN PLT. 50X8THK. LG.347

9X65X65X6

9X75X65X6

9X90X65X6

9X100X65X6

9X150X65X6

21X90X10PLT

21X100X10PLT

21X150X10PLT

PLT. 131X8THK. LG=189

PLT. 189X8THK. LG=247

PLT. 189X8THK. LG=332

PLT. 201X8THK. LG=332

DETAIL AT 'M'

DETAIL AT 'K'

DETAIL AT 'I'

VIEW ON G1–G1

DETAIL AT 'G'

VIEW ON F–F

DETAIL AT 'E'

SECTION H–H

VIEW ON J–J

TRANSVERSE FACE

LONGITUDINAL FACE

4–ø22 HOLES FOR ø20 BOLTS

4–ø17.5 HOLES FOR ø16 BOLTS

Generally Approved

S.E. | DGM | KSW Projects | JAIPUR

Note: Quantity of Nuts & Bolts shall be as per approved BBN

PROTO CORRECTED

(DELETED MARK No. 13,27,31 & 39)
MARK NOS :-1 TO 107

SIEMENS LIMITED

## GENRAL NOTES

1. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
2. ALL HOLES SHALL BE 17.5ø FOR 16ø BOLTS UNLESS OTHERWISE SPECIFIED.
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH 'S/-1,2,3 etc. .
4. MINIMUM EDGE SECURITY FOR 16MM BOLTS SHALL BE 25 MM FROM CUT EDGE & 20 MM FROM ROLLED EDGE.
5. L45x45x5 WITH 23 MM BACK MARK
6. EDGE PREPARATION OF WELDING SHALL BE DONE AS PER IS:823 (LATEST)
7. ALL STEEL SECTIONS & PACK WASHERS SHALL BE HOT DIP GALVANIZED MINIMUM WEIGHT OF ZINC COATING SHALL BE 610gm/sq.m.
8. ALL BOLTS NUTS SHALL CONFORM TO IS:1367 (LATEST) CLASS 5.6 FOR BOLTS & 5 FOR NUTS. ALL BOLTS & NUTS SHALL HOT DIP GALVANIZED AS PER IS:1367 (PART-13)
9. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062-1999 GRADE-A
10. FABRICATION SHALL BE CARRIED OUT AS PER PROVISIONS OF IS:802 PART-II (1972)
11. ALL UNNOTTED MEMBERS ARE L45x45x5,
12. ALL UNNOTTED GUSSET PLATE ARE 6 MM THICK UNLESS OTHERWISE SPECIFIED.
13. MAXIMUM SPACING BETWEEN STEP BOLTS SHALL BE 450 MM.
14. SPRING WASHER CONFORMING TO IS:3063-1972 SHALL BE USED UNDER EACH NUT.
15. ALL WELD ARE 6MM FILLET CONTINOUS WELD UNLESS , OTHERWISE SPECIFIED.

| REFR. DRG. NO. | DESCRIPTION |
|---|---|

| REV. | DESCRIPTION |
|---|---|
| R1 | REVISED AS PER PROTO CORRECTION AS MKD. |
| R0 | FIRST ISSUE |

| Project Doc. No. | CUSTMER: |
|---|---|
| Scale 1 : 600 | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | SEIMENS LIMITED, GURGAON |
| Date 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| Drawn GB/RK | |
| Appr RK | |
| Norm KTV | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TJ . |
| .0 First Issue 21.03.10 GB | DRG. No. 5427PN066-BHA-C-SYD-SYS-7557-SM Rev. 0 |
| Rev. Remarks Date Name | LOA No. RVPN/SE(P&P)/XCN/KfW/ICB-1D 1771 dated 16.10.2015 Sheet 2 of 2 |

FIRST ANGLE PROJECTION ALL DIMENSIONS ARE IN MM UNLESS

TYP. B/M FOR L-45x45x5

L65x65x5... LG 2363

L65x65x6... LG 4350

L100x100x10... LG 4271

L130x130x10... LG 2700

L130x130x10... LG 6463

L150x150x12... LG 6000

L150x150x12... LG 3900

LONGITUDINAL FACE

TRANSVERSE FACE

DETAIL — 1

DETAIL — 2

DETAIL — 3

DETAIL — 4

DETAIL — 5

DETAIL — 6

DETAIL — 7

DETAIL — 8

DETAIL — 9

DETAIL — 10

VIEW — "A1 — A1"

VIEW — "B1 — B1"

VIEW — "C1 — C1"

VIEW — "D1 — D1"

VIEW — "E1 — E1"

VIEW — "F1 — F1"

VIEW — "G1 — G1"

VIEW — "H1 — H1"

VIEW — "J1 — J1"

VIEW — "K1 — K1"

VIEW — "L1 — L1"

VIEW — "M1 — M1"

FOUNDATION PLAN

4620.8 BOLT/BOLT

4620 BACK TO BACK

4418.8 CG/CG

4200.8 BOLT/BOLT

BOLTS/NUT STATEMENT WITH 2% EXTRA

| TYPE | SIZE | QTY. | REMARK |
|---|---|---|---|
| 14 | 20 ODX14 THK PACK. WASHER | 1158 | |
| 15 | 20 ODX16 THK PACK. WASHER | – | |
| 10 | 20 ODX20 THK PACK. WASHER | 108 | |
| 8 | 20 ODX8 THK PACK. WASHER | 4 | |
| 9 | 20 ODX9 THK PACK. WASHER | 28 | |
| 6 | 20 ODX6 THK PACK. WASHER | 24 | |
| | STEP BOLT M16x170 | 60 | |
| H | M4-16X65 Lg. | – | |
| G | M4 16X50 Lg. | 128 | |
| F | M4 16X55 Lg. | 74 | |
| E | M4 16X60 Lg. | 348 | |
| D | M4 16X45 Lg. | 224 | |
| C | M4 16X40 Lg. | 328 | |
| B | M4 16X35 Lg. | 116 | |

NOTES:–

1. ALL DIMENSIONS ARE IN MM.
2. BOLT SYMBOLS 16# M = 17.54 HOLES
3. ALL ERECTION MARKS ARE TO BE PREFIXED WITH – "TK"
4. ONE SPRING WASHER 3.5mm THK. TO BE PLACED UNDER EACH NUT, NUTS AS PER I:3063-1972
5. ERECTION MARKS TO BE PAINTED BLACK AT CENTRE APART FROM THE ERECTION MARKS.
6. ALL STRUCTURAL STEEL ARE OF MILD STEEL AND SHALL CONFORM TO IS:2062-1992 (GRADE 'A'-STANDARD QUALITY) AND FABRICATION SHALL CONFORM TO IS:802(PART-I)-1978.
7. ALL BOLTS AND NUTS ARE OF HEXAGONAL TYPE AND SHALL CONFORM TO IS:6639-1972 IS:1367(PART-III)-1979,IS:1367(PART-II)-1991 AND IS:1367(PART-I)-1994 (PROPERLY CLASS 5.6)
8. ALL EXPOSED STRUCTURAL STEEL SHALL BE HOT DIP GALVANIZED AS PER IS:4759-1984 WITH A MINIMUM COATING THICKNESS OF 610g/m2
9. FABRICATION SHALL CONFORM TO IS:802(PART-2)

LEGEND:

1. NS – NEAR SIDE
2. FS – FAR SIDE
3. ① ② ERECTION MARKS
4. TYP – TYPICAL
5. THE QTY. & LENGTH OF BOLTS ARE SHOWN AS 1–35, 1–40 ETC.,
6. THE QTY. & THICKNESS OF PACK WASHER ARE SHOWN AS 1–6W, 1–8W ETC.,
7. BL – BEND LINE

MK. NO. 25 OMMITED

KEY PLAN

MK. NO. 1 TO 102

BEAM "G1"

Note: Quantity of Nuts and Bolts shall be as per approved BoM

Generally Approved
S.E.
XEN
NFW Projects
RRVPNL JAIPUR

SIEMENS LTD.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | Date | 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| | | | | | Dsgn. | GB/RK | |
| | | | | | Appr. | RK | |
| | | | | | Norm | KTV | |
| PREP. | CHKD. | APPD. | | | | | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV "OWER TYPE -TK |
| SIGN. | | | DATE | Rev. | Remarks | Date | Name |
| | | | | 0 | First Issue | 21.03.16 | GB |

Project Doc. No.: CUSTMER: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED.

Scale: 1:800

PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AIKAL-1 S/S.

SEIMENS LIMITED, GURGAON

DRG. No. 05616/RRVPNL/C/STR/400" CNER-TK

Rev. 0

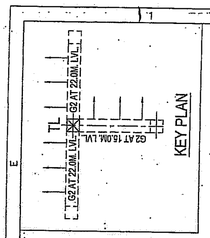
LOA No. RVPN/NSE/P&P/XEN/NFW/CS-1D 1771 dated 18.10.2015

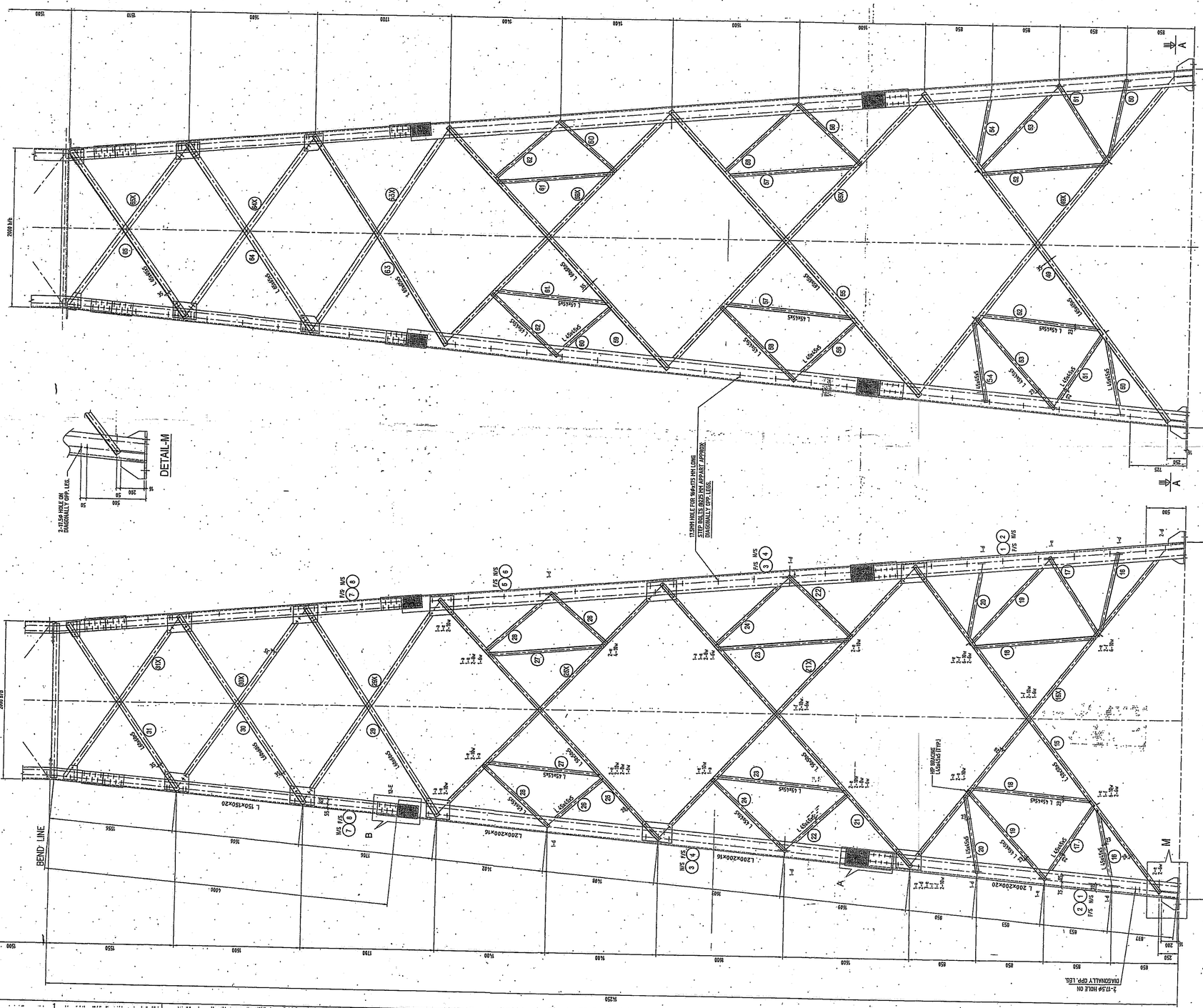
Sheet 1 of 1

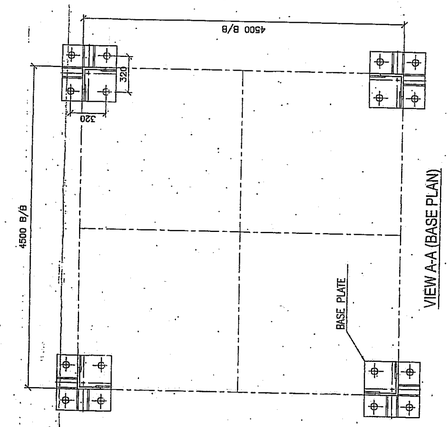
INVENTORY No. | SIGN. & DATE | REF. DRG. No. | COMPUTER DRG. PATH NAME :

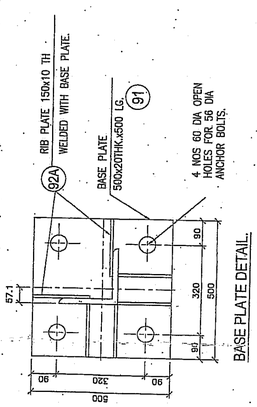
PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT

KEY PLAN




NOTES:

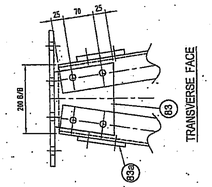
1. ALL DIMENSIONS ARE IN M.M. UNLESS OTHERWISE SPECIFIED.
2. ALL BOLTS 16DIA WITH 17.5 MM HOLES UNLESS OTHERWISE SPECIFIED.
3. 3.5 MM THICK SPRING WASHER TO BE USED WITH EACH BOLT.
4. ALL STEEL TO BE TESTED QUALITY CONFORMING TO IS:-2062(1999)GRADE-A
5. ALL MEMBERS TO BE HOT DIP GALVANISED AFTER FABRICATION.
6. ALL ERECTION MARKS ARE PREFIXED WITH TL-1,2 &3 ETC.
7. ALL BOLTS NUTS & WASHERS TO BE HOT DIP GALVANISED & SPRING WASHERS ELECTRO-GALVANISED.
8. ALL GUSSETS'6 MM THICK UNLESS OTHERWISE SPECIFIED.
9. EDGE SECURITY 25MM FROM CUT EDGE UNLESS OTHERWISE SPECIFIED.
10. FABRICATION SHALL CONFORM TO IS-802 PART-II(1972).
11. ⊕ INDICATES HOLE SHOWN AS A STEP BOLT.
12. MINIMUM GALVANISATION THICKNESS IN STEEL SECTION SHALL BE 610 GMS/SQM.
13. ALL BOLTS& NUTS SHALL CONFIRM TO IS:6639/1967(Latest) OF GRADE 4.6

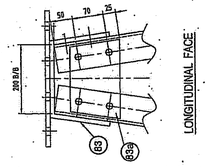
Generally Approved
S.E. XEN KFW Projects RRVPNL JAIPUR XEN

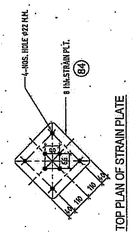
Note: Quantity of Nuts and Bolts shall be as per approved BOM.

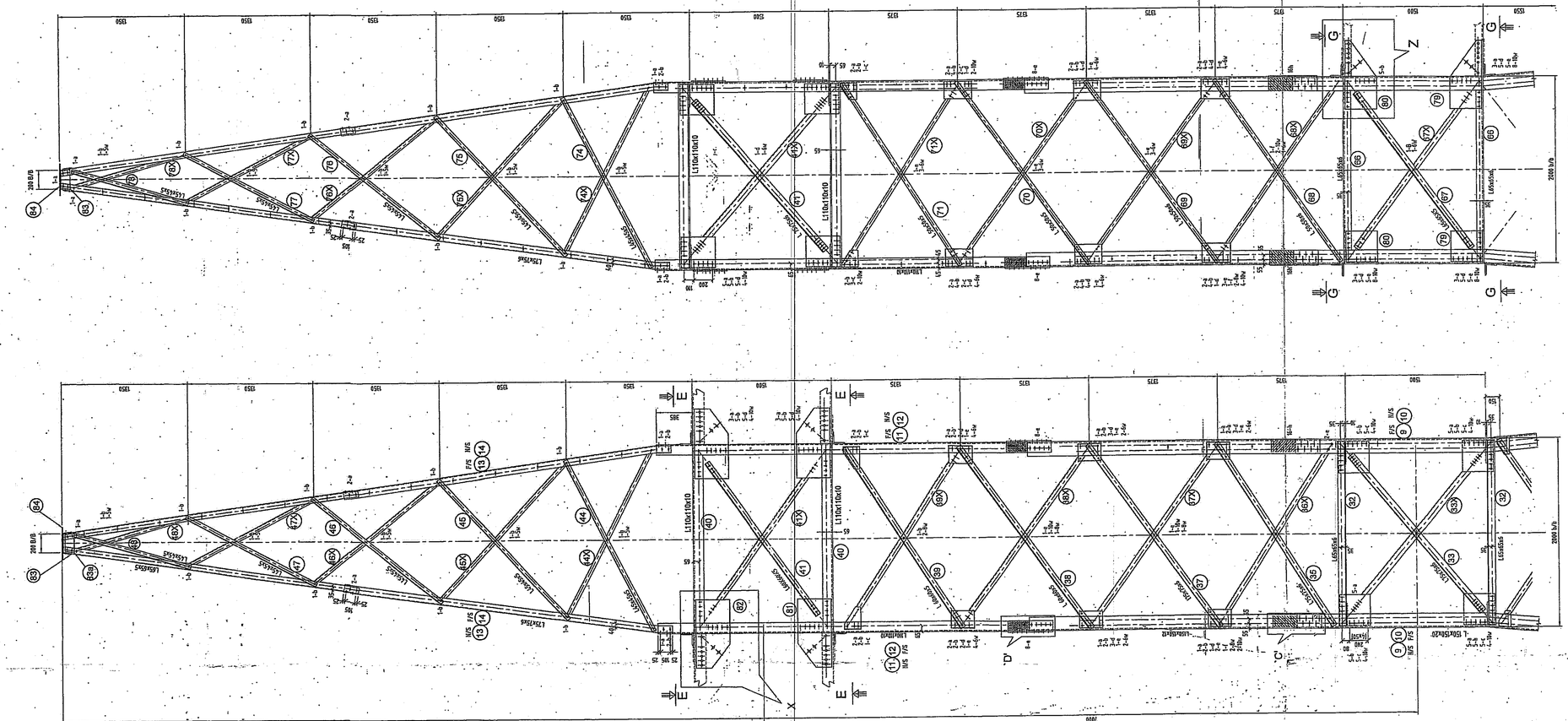
SIEMENS LTD.

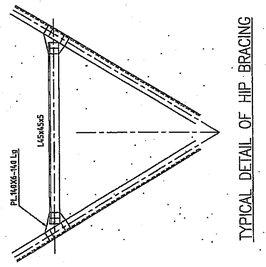
| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. | | | | CUSTMER: | |
| Scale: 1: 600 | | | | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | | | SEIMENS LIMITED, GURGAON | |
| | | | Date | 21.03.2016 | Tower Mfg: M/S NAMOHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| | | | Drawn | GB/RK | |
| | | | Appr. | RK | |
| | | | Norm | KTV | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TL |
| 0 | First Issue | 21.03.18 | GB | DRG. No. | 0516/RRVPNL/CSTR/400TOWER-TL — Rev. 0 |
| Rev. | Remarks | Date | Name | LOA No. | RVPN/SE(P&P)/XEN/KIW/CB-1D 1771 dated 19.10.2015 — Sheet 1 of 2 |

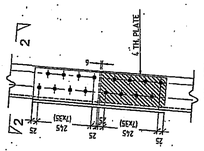


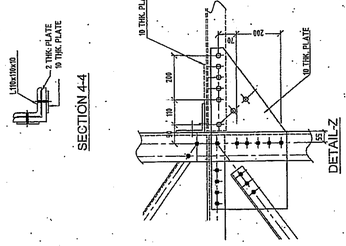



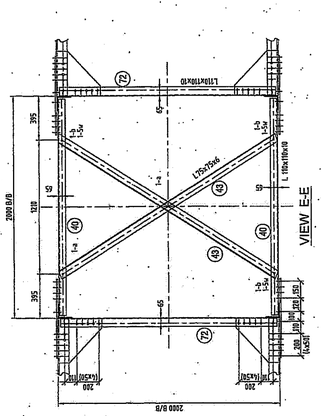



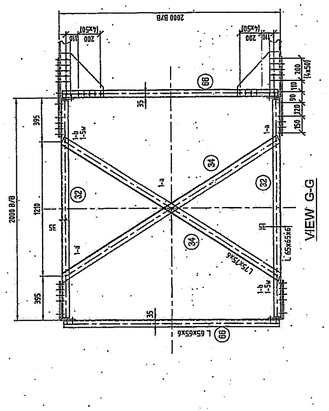



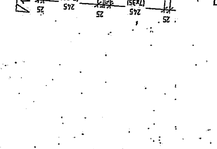



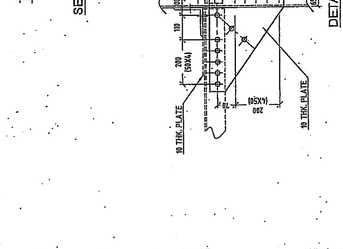




Note: Quantity of Nuts and Bolts shall be as per approved BOM.

NOTES:

1. ALL DIMENSIONS ARE IN M.M. UNLESS OTHERWISE SPECIFIED.
2. ALL BOLTS 16DIA WITH 17.5 MM HOLES UNLESS OTHERWISE SPECIFIED.
3. 3.5 MM THICK SPRING WASHER TO BE USED WITH EACH BOLT.
4. ALL STEEL TO BE TESTED QUALITY CONFORMING TO IS-2062(1999)GRADE-A
5. ALL MEMBERS TO BE HOT DIP GALVANISED AFTER FABRICATION.
6. ALL ERECTION MARKS ARE PREFIXED WITH TL-1,2 &3 ETC.
7. ALL BOLTS NUTS & WASHERS TO BE HOT DIP GALVANISED & SPRING WASHERS ELECTRO-GALVANISED.
8. ALL GUSSETS 6 MM THICK UNLESS OTERWISE SPECIFIED.
9. EDGE SECURITY 25MM FROM CUT EDGE UNLESS OTHERWISE SPECIFIED.
10. FABRICATION SHALL CONFORM TO IS-802 PART-II(1972).
11. ◈ INDICATES HOLE SHOWN AS A STEP BOLT.
12. MINIMUM GALVANISATION THICKNESS IN STEEL SECTION SHALL BE 610 GMS/SQM.
13. ALL BOLTS& NUTS SHALL CONFIRM TO IS:6639/1367(Latest) OF GRADE 4.6

SIEMENS LTD. GURGAON

Generally Approved
KFW Projects
RRVPNL JAIPUR

TL

BOLTS & NUTS STATEMENTS

| TYPE | SIZE IN MM. | QTY. | | QTY. |
|---|---|---|---|---|
| a | ◈ 16MM X140MM | 348 | Packing Washers (40x40) | |
| b | ◈ 16MM X45MM | 164 | 3mm Thick | 12 |
| c | ◈ 16MM X50MM | 534 | 6mm Thick | 98 |
| d | ◈ 16MM X55MM | 236 | 8mm Thick | 12 |
| e | ◈ 16MM X60MM | 42 | 10mm Thick | 168 |
| f | ◈ 16MM X65MM | - | 12mm Thick | |
| g | ◈ 16MM X70MM | | Sch Bolt | 59 |
| h | ◈ 16MM X75MM | | 16X 35 mm | 96 |
| i | ◈ 16MM X80MM | | Spring Washer 16 | 196 |
| j | ◈ 16MM X85MM | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | Date | 21.03.2016 | |
| | | | | Drawn | GB/RK | |
| | | | | Appr. | RK | |
| | | | | Norm | KTV | |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | 0561RRVPNL/DSTR400TOWER-TL | |
| Rev. | Remarks | Date | Name | LOA No. | RVPN/SE(P&P)/XEN(R)/ADC/B-10 1771 dated 18.10.2015 | |

Project Doc. No. CUSTMER:

RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED.

Scale 1 : 600

PROJECT: 400/220KV JAISALMEIR-2 A/S S/S & 400KV BAY AT BARMER & AKAL-1 S/S.

SEIMENS LIMITED, GURGAON

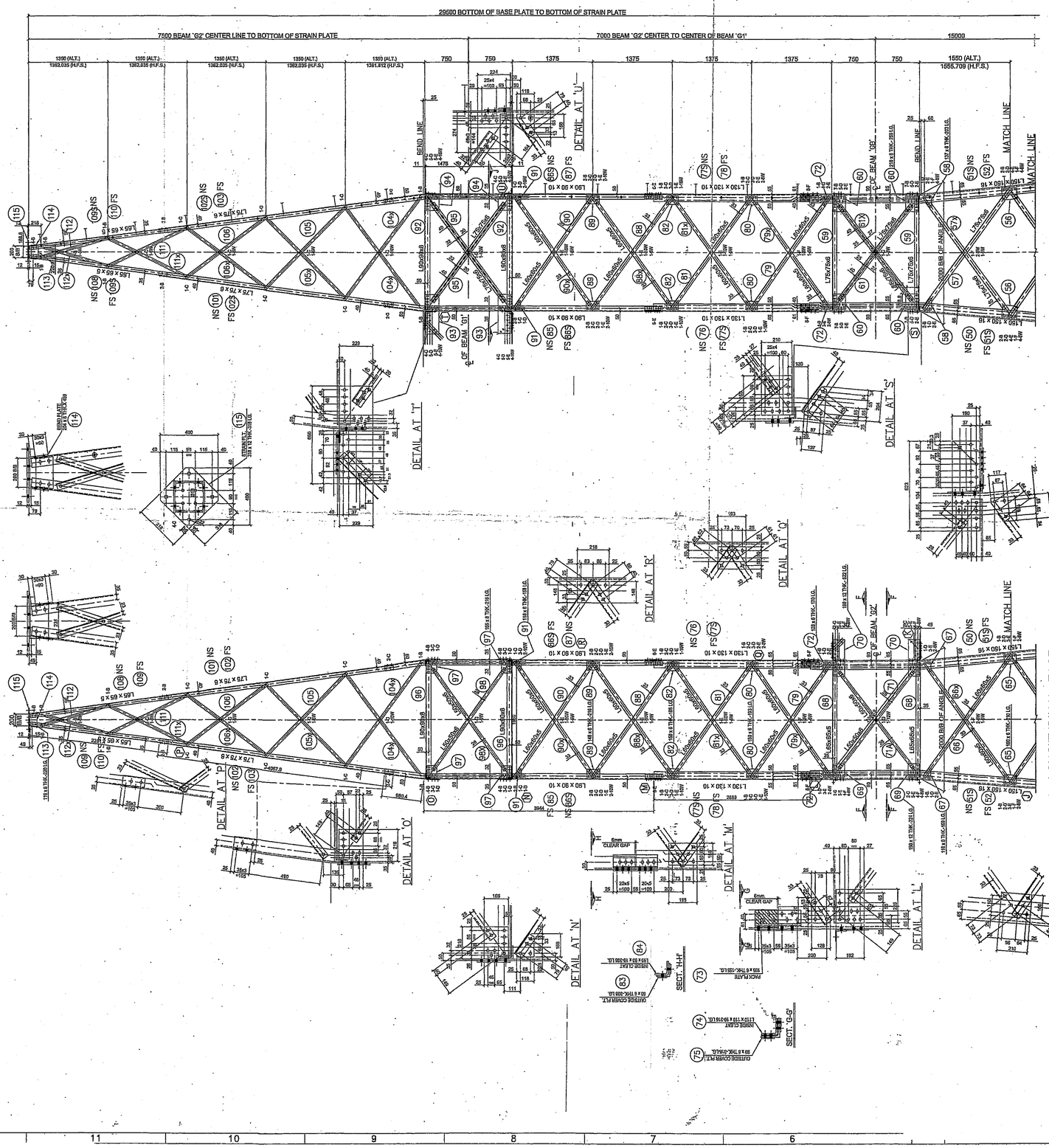
Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA

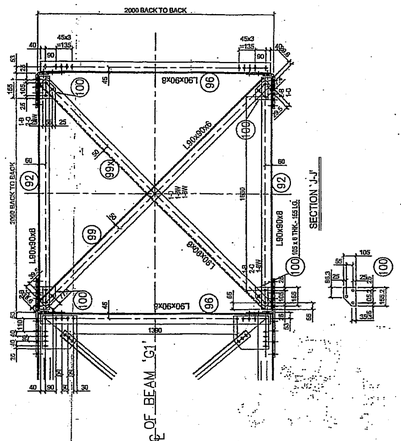
DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TL

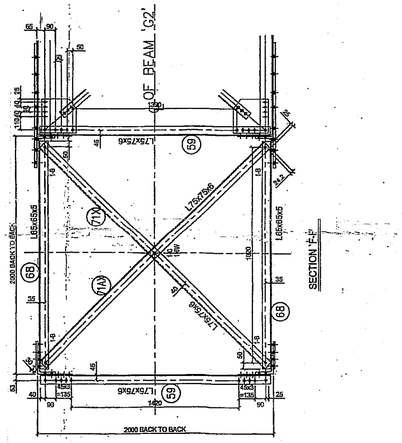
Rev. 0

Sheet 2 of 2

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT



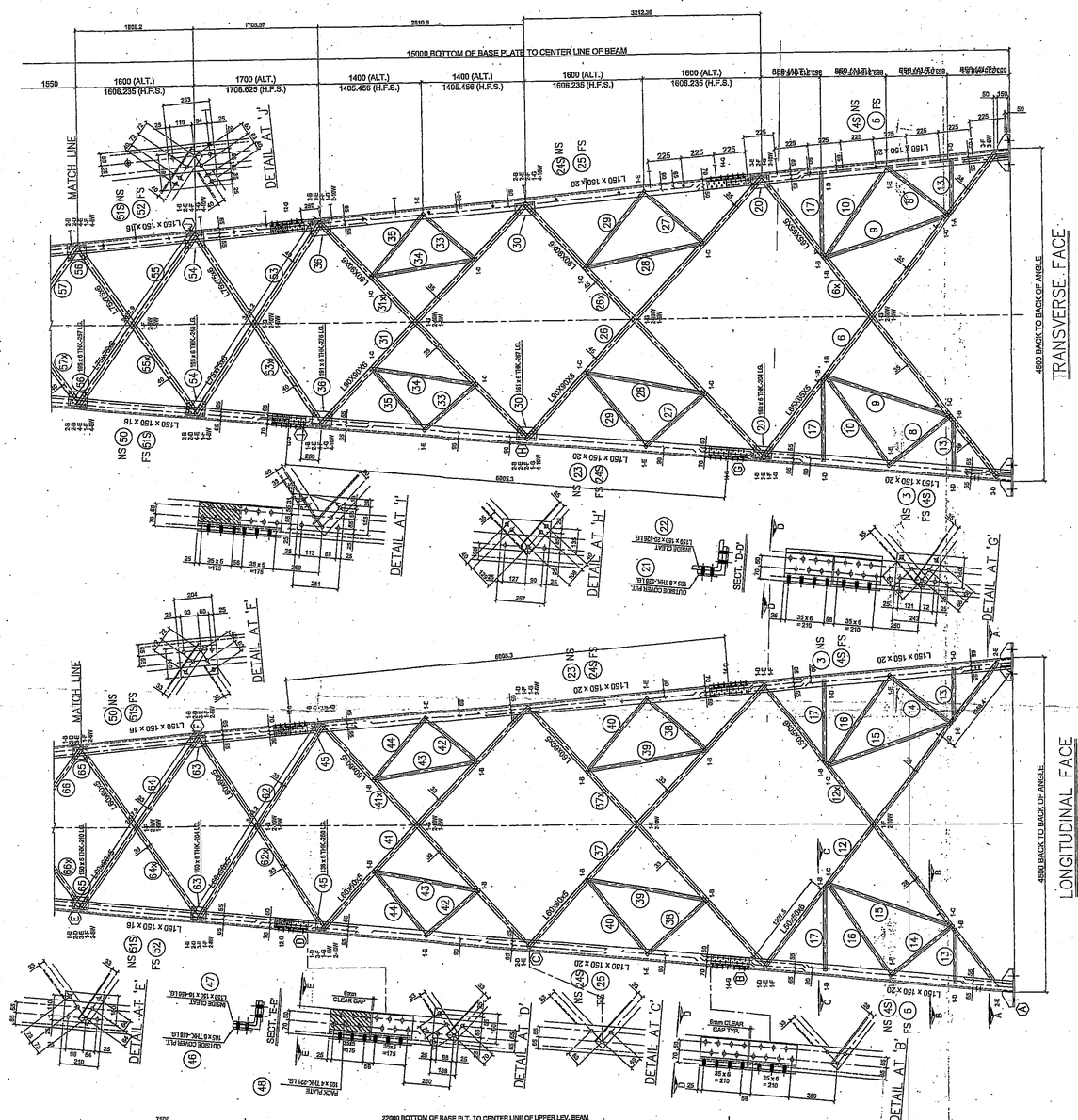

Quantity of Nuts/Bolts and Washers should be as per approved BOM.

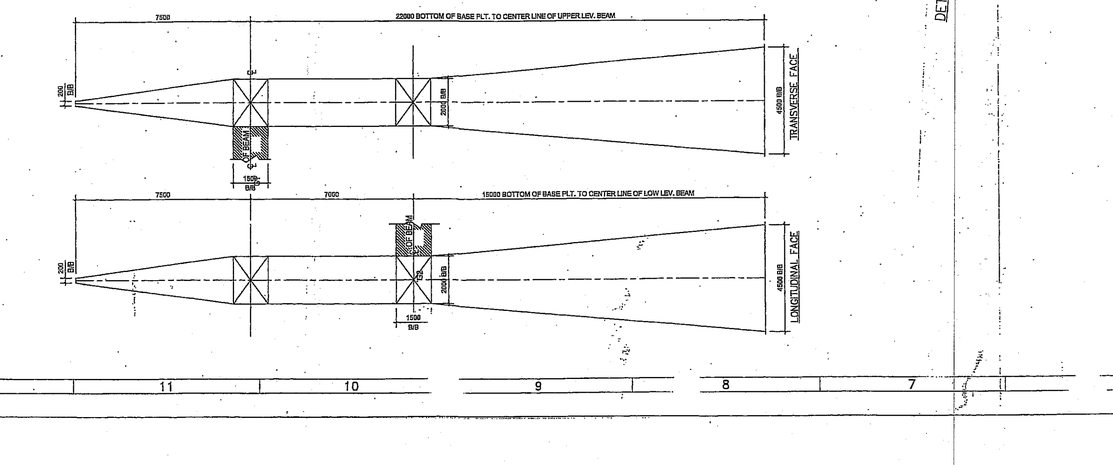
Generally Approved
S.E. KFW Projects RRVPNL JAIPUR AEN

SIEMENS LTD.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Doc. No. | | | | | | CUSTMER: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
| Scale 1 : 600 | | | | | | | |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | | | | | SEIMENS LIMITED, GURGAON | |
| | | | | Date | 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA | |
| | | | | Drawn. | GB/RK | | |
| | | | | Appr. | RK | | |
| | | | | Norm | KTV | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TM | |
| 0 | First Issue | 21.03.16 | GB | DRG. No. | | 05818/RRVPNL/C/STR/400/TOWER-TM | Rev. 0 |
| Rev. | Remarks | Date | Name | LOA No. | | RVPN/SE(P&P)/XEN(KTV)/CB-1D 1771 dated 16.10.2015 | Sheet 1 OF 2 |

PRODUCED BY AN AUTODESK EDUCATIONAL PRODUCT



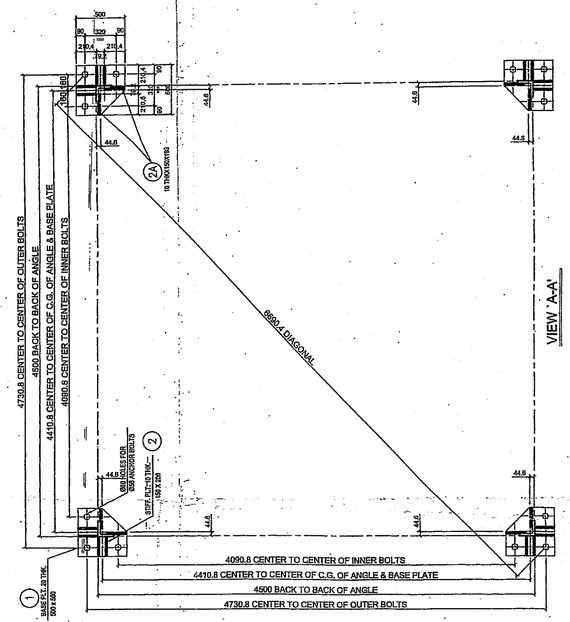



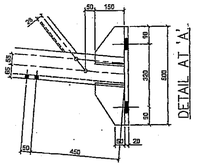

| List of 16mm ø H.R.H.Bolts, Nuts & Washers | | |
|---|---|---|
| TYPE | SIZE (Length in mm) | TOTAL QTY. |
| A | 35 mm | 24 |
| B | 40 mm | 305 |
| C | 45 mm | 254 |
| D | 50 mm | 270 |
| E | 55 mm | 218 |
| F | 60 mm | 184 |
| G | 65 mm | 240 |
| SPRING WASHER | 33 Nos. – 16 ø | 1594 |
| PACK WASHER | 5 mm | 6 |
| PACK WASHER | 6 mm | 277 |
| PACK WASHER | 8 mm | 112 |
| PACK WASHER | 10 mm | 169 |
| PACK WASHER | 12 mm | - |
| STEP BOLT | 16 mm ø | 66 |

SECTION C–C

SECTION B–B

ITEM NO. 7, 49 & 107 NOT USE




NOTES :-

1. ALL DIMENSIONS ARE IN MILLIMETRES & ELEVATIONS ARE IN METRE.
2. UNNOTED BRACINGS ARE L45 x 45 x 6 WITH 25 mm BACK MARK.
3. UNLESS OTHERWISE NOTED ALL HOLES ARE 17.5Ø HOLES FOR 16Ø BOLT.
4. ALL WELDS SHALL BE 6 mm FILLET WELD UNLESS SPECIFIED OTHERWISE.
5. UNLESS OTHERWISE NOTED ALL GUSSETS ARE 6 mm THICK.
6. a) F.C- DENOTES FLANGE CUT
   b) C.H - DENOTES CHAMFER
7. ALL STEEL MEMBERS SHALL CONFORM TO IS:2062, GRADE-A.
8. GALVANISING SHALL BE DONE AS PER I.S. 2629 / I.S. 4759. MINIMUM ZINC COATING SHALL BE 610 GM/SQ. MT.
9. ALL ITEM NOS. TO BE PREFIXED WITH 'TM'.
10. DETAILS FURNISHED & DEVELOPED IN THIS DRAWING IS BASED ON POWER GRID DRAWING NO. C - ENGG - STD - STR - 34 REV. 0 & 20, 21, REV. 0 DETAILS OF TOWER MXD. 'TM' BEAM 'GA' & 'GS' RESPECTIVELY.

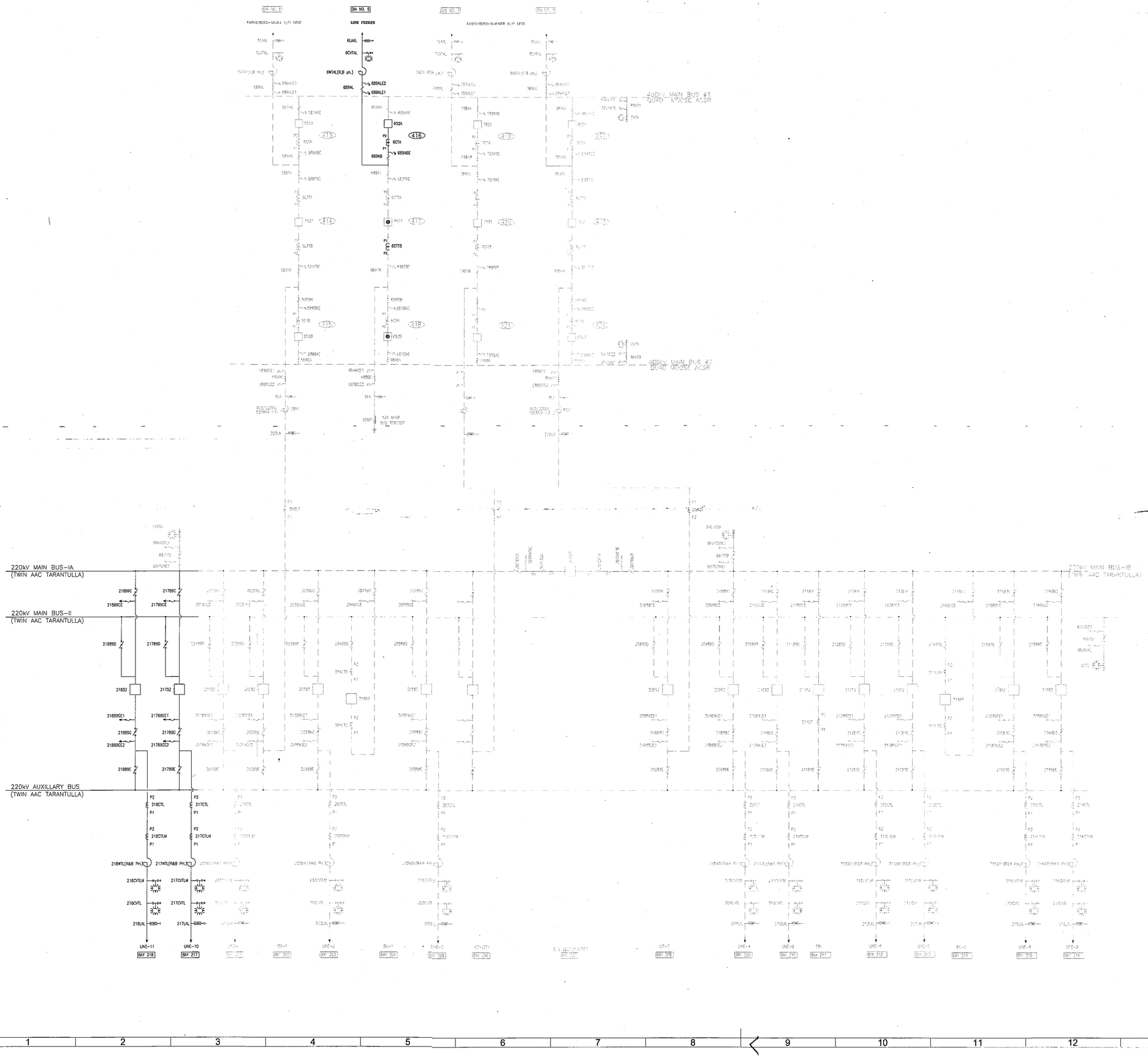
Quantity of Nuts / Bolts and Washers should be as per approved BOM.

Generally Approved
S.E. XEN KPW Projects RRVPNL JAIPUR AEN

SIEMENS LTD.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Project Doc. No. | | | | | CUSTMER: | | |
| Scale 1 : 600 | | | | | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | | |
| PROJECT: 400/220KV JAISALMEIR-2 AIS S/S & 400KV BAY AT BARMER & AKAL-1 S/S. | | | | | SEIMENS LIMITED, GURGAON | | |
| | | | | | Date | 21.03.2016 | Tower Mfg: M/S NAMDHARI INDUSTRIAL TRADERS PVT. LTD. LUDHIANA |
| | | | | | Drawn | GB/RK | |
| | | | | | Appr. | RK | |
| | | | | | Norm | KTV | DRG. TITLE: DSLP LAYOUT-400/220KV SWITCHYARD 400KV TOWER TYPE -TM |
| 0 | First Issue | 21.03.16 | GB | | DRG. No. | 05616/RRVPNL/C/STR/400/TOWER-TM | Rev. 0 |
| Rev. | Remarks | Date | Name | | LOA No. | RVPN/SE(P&P)/XEN/KPW/CB-10 1771 dated 16.10.2015 | Sheet 2 OF 2 |

841 X 594 - A1




## BOQ – 400 kV EQUIPMENTS (40 kA, 1 sec.)

| SYMBOL | LEGEND | DESCRIPTION | LOCATION | QTY. (Nos.) |
|---|---|---|---|---|
| | 52 | CIRCUIT BREAKER WITHOUT CLOSING RESISTOR 2000A, (3 PHASE) | 652A | 01 |
| | CT | CURRENT TRANSFORMER, 5 CORE, 2000A (1 PHASE) | 6CTA, 6CTTB | 06 |
| | 89 | D.B.R. ISOLATOR WITH ONE E/S 2000A, (3 PHASE)(ELECTRICALLY CANGED) | 689AB | 01 |
| | 89 | D.B.R. ISOLATOR WITH TWO E/S 2000A, (3 PHASE)(ELECTRICALLY CANGED) | 689AL | 01 |
| | CVT | 400kV CVT, 4400 PF (1 PHASE) | 6CVTAL | 03 |
| | LA | 390kV, SURGE ARRESTOR (1 PHASE) | 6LAAL | 03 |
| | WT | WAVE TRAP 2000A, 1.0mH, 1-PHASE | 6WTAL | 02 |

## BOQ – 220 kV EQUIPMENTS (40 kA, 1 sec.)

| SYMBOL | LEGEND | DESCRIPTION | LOCATION | QTY. (Nos.) |
|---|---|---|---|---|
| | 52 | 245kV CIRCUIT BREAKER WITHOUT CLOSING RESISTOR 2000A (3 PHASE) | 21752, 21852 | 02 |
| | 89 | 245kV D.B.R. ISOLATOR WITH 2E/S (MECHANICALLY GANGED) 2000A (3 PHASE) | 21789G, 21889G | 02 |
| | 89 | 245kV D.B.R. ISOLATOR WITHOUT E/S(MECHANICALLY GANGED) 2000A (3 PHASE) | 21789E, 21889E | 02 |
| | 89 | 245kV D.B.R. ISOLATOR WITH 1E/S (MECHANICALLY GANGED) 2000A (3 PHASE) | 21789C, 21889C | 02 |
| | 89 | 245KV TANDEM ISOLATOR WITHOUT E/S(MECHANICALLY GANGED) 2000A (3 PHASE) | 21789D, 21889D | 02 |
| | CT | 245kV CURRENT TRANSFORMER 5 CORE, 2000A (1 PHASE) | 217CTL, 218CTL | 06 |
| | CT | 245kV CURRENT TRANSFORMER 2 CORE, 2000A (1 PHASE) | 217CTLM, 218CTLM | 06 |
| | LA | 198 kV, SURGE ARRESTOR (1 PHASE) | 217LAL, 218LAL | 05 |
| | CVT | 245kV, CVT, 4400 PF (1 PHASE) | 217CVTL, 218CVTL | 05 |
| | CVT | 245kV, CVT, 4400 PF (1 PHASE)(METERING) | 217CVTLM, 218CVTLM | 05 |
| | WT | WAVE TRAP 2000A, 0.5mH, 1-PHASE | 217WT, 218WT | 04 |

## SYSTEM DESIGN PARAMETERS:

| DESCRIPTION | 400kV | | 220kV |
|---|---|---|---|
| SYSTEM OPERATING VOLTAGE | 400kV | | 220kV |
| MAXIMUM OPERATING VOLTAGE OF THE SYSTEM | 420kV | | 245kV |
| SYSTEM FAULT LEVEL | 40 kA for 1sec | | 40kA FOR 1 Sec. |
| SWITCHING IMPULSE WITHSTAND VOLTAGE | 1050 kVp (250/2500 micro sec.) (DRY & WET) | | - |
| FULLWAVE IMPULSE WITHSTAND VOLTAGE | 1550 kVp (ON 1.2/50 micro sec.) | | 1050 kVp (1.2/50 micro sec.) |
| 1 min. P.F. WITHSTAND VOLTAGE | 630 kV (rms) | | 460 kV (rms) |
| CREEPAGE DISTANCE | 25MM/KV | | 25MM/KV |

## REFERENCE DRAWINGS:

(1)G71770-AC200-S151-001-04 – : EXISTING SINGLE LINE DIAGRAM FOR 400/220kV JAISALMER2 S/S.

## LEGEND:

PRESENT SCOPE

FUTURE/NOT IN SIEMENS SCOPE

## GENERAL NOTES:

1. CT & CVT DETAILS WILL BE PROVIDED IN PROTECTION SLD.

Employer's Approval Stamp

Generally Approved
SE XEN AEN
KPUV Projects
RVPVNL JAIPUR

| Rev. | Rev. Date | Modification | Drawn By | Created By | Approved By |
|---|---|---|---|---|---|
| D | | | | | |
| C | | | | | |
| B | | | | | |
| A | | | | | |
| 0 | 2018.08.29 | FIRST SUBMISSION | SKA | GB | NYK |

Drawing/Document Number
(1)-G71770-AD202-S151-001-0 - P-090925_E_C1_8831_JAS_0

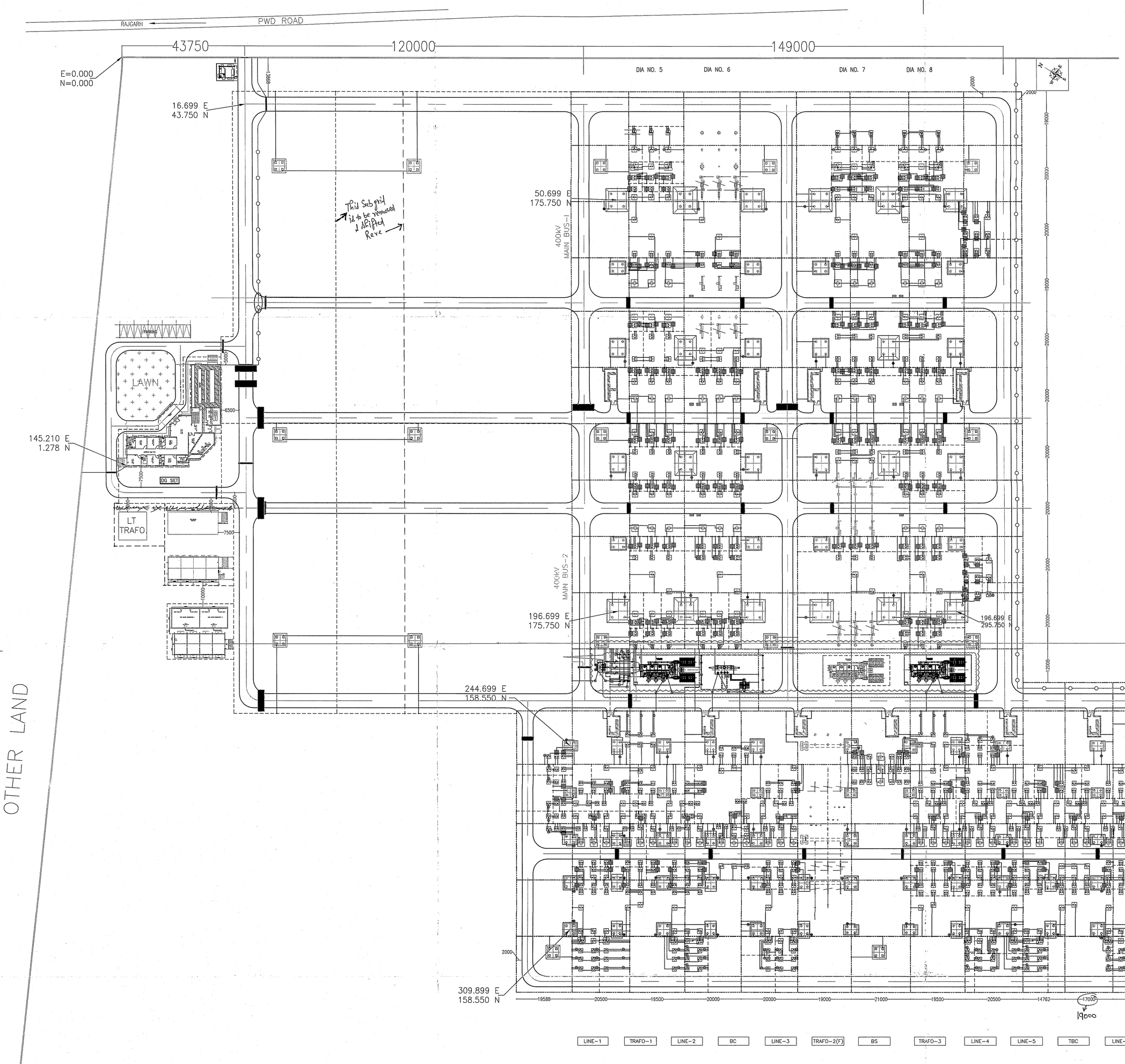
Customer
RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED.

Project
400/220kV JAISALMER-2 AIS SUBSTATION EXTENSION

| | |
|---|---|
| LOCATION | JAISALMER |
| SUB STATION TYPE | AIS SUBSTATION EXTN. |
| VOLTAGE LEVEL | 400/220kV |

Released for: PRELIMINARY | ENGINEERING APPROVAL ✓ | CONSTRUCTION

| | | | | | |
|---|---|---|---|---|---|
| Scale: NTS | Paper Size: A1 | Sign. | Date | NOA No.: RVPN/SE(C-II)/XEN-3/KW//CB-1/Add/1) dt. 27.08.2018 | |
| Responsible Dept.: EMTS | Drawn By: SKA | | 2018.08.29 | Document Type: SINGLE LINE DIAGRAM | Document Designation: C1_8831_JAS |
| SIEMENS | Created By: GB | | 2018.08.29 | Title: KEY SINGLE LINE DIAGRAM FOR 400/220kV JAISALMER-2 AIS S/S EXTN. | Document Tree: P-090925_E_C1_8831_JAS |
| | Approved By: NYK | | 2018.08.29 | | Rev. 0; Date of issue 2018.08.29; Language EN; Sheet 01 of 01 |



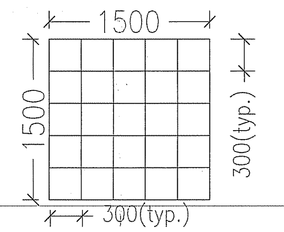

NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE SPECIFIED.
2. THIS DRAWING IS ONLY SYMBOLIC REPRESENTATION OF EARTHING CONDUCTOR LAYOUT. AT ACTUAL SITE CONDITION CONDUCTOR WILL BE ROUTED IN SUCH A MANNER SO THAT IT DOES NOT FOUL WITH ANY FOUNDATION.
3. EQUIPMENT EARTHING CONNECTION ARE DIAGRAMATIC ONLY AND WILL BE DONE AS PER SITE CONDITION TO THE NEAREST GRID AVAILABLE
4. ALL EARTHING WILL BE DONE IN ACCORDANCE WITH IEEE 80 UNLESS OTHERWISE SPECIFIED IN THE TECHNICAL SPECIFICATION
5. EACH INDIVIDUAL STRUCTURE/EQUIPMENT SHOULD BE EARTHED AND CONNECTED TO TWO DIFFERENT GRID ELECTRODES.
6. MAIN EARTHMAT CONDUCTOR WILL BE LAID 600MM BELOW FGL.
7. EARTHING CONDUCTOR CROSSING CABLE TRENCHES/DRAIN/ROAD WILL BE LAID 300MM BELOW CABLE TRENCHES/DRAIN/ROAD.
8. 50X6MM MS FLAT SHALL RUN ON TOP TIER & ALL ALONG THE CABLE TRENCHES & SAME SHALL BE EARTHED AT BOTH ENDS & AT AN INTERVAL OF 30METERS.MS FLAT SHALL BE FINALLY PAINTED WITH TWO COATS OF REDOXIDE PRIMER & TWO COATS OF POST OFFICE RED ENAMEL PAINT.
9. FENCE SHALL BE EARTHED AT ALTERNATE POST, RAIL TRACK SHALL BE EARTHED AT BOTH ENDS.
10. MAIN EARTH MAT SHALL BE LAID 2000MM BEYOND PERIPHERAL FENCE/ROAD AS APPLICABLE.
11. REFER DRAWING NO. (2)G71770-AC200-L159-002-00 & (2)G71770-AC200-L159-003-00 FOR EARTHING & DSLP OF CONTROL ROOM & FFPH BUILDING.
12. 1500X1500MM AUXILLARY EARTHMAT OF FINER MESH(300X300MM) WILL BE LAID 300MM BELOW FGL & ONLY UNDER MAIN & EARTHSWITCH OPERATING BOX OF 400/220KV ISOLATOR.
13. EARTHING CONDUCTOR AROUND BUILDING WILL BE LAID MINIMUM 1500MM FROM THE WALL.
14. 3 METER LONG, 20MM DIA DIRECTLY DRIVEN MS ROD ELECTRODE IS TO BE USED FOR STREET LIGHT POLE EARTHING.
15. TYPICAL DETAILS OF INDIVIDUAL EQUIPMENT EARTHING WILL BE PROVIDED IN SEPARATE DRAWING NO.-(1)-G71770-AC200-T110-001-0.
16. Earthing Conductors embedded in Concrete shall have approx. 50mm Concrete Cover.

LEGENDS:-

| SYMBOL | DESCRIPTION | QUANTITY |
|---|---|---|
| ——— | 40MM MS ROD FOR MAIN EARTH MAT | 7900 Mtrs. |
| — — — | 40MM MS ROD FOR SUB GRID | 3500 Mtrs. |
| ——— | 40MM MS ROD FOR EARTHING RISER | 11500 Mtrs. |
| ⊙ | 40MM DIA, 3.2M LONG MS ROD EARTH ELECTRODE (DIRECTLY DRIVEN) FOR CVT/LA | 129 Nos. |
| ⊙ | 40MM DIA, 3.2M LONG MS ROD EARTH ELECTRODE (UNTREATED PIT) FOR Inverter/LA Neut. | 88 Nos. |
| ⊡ | 40MM DIA, 3.0M LONG GI PIPE ELECTRODE (TREATED EARTH PIT) | 12 Nos. |
| ▦ | 1.5MX1.5M, 40MM DIA MS ROD, AUXILLARY EARTHMAT (304 NOS.) | 5472 Mtrs. |

REFERENCE DRAWINGS :-




Generally Approved
SIEMENS Ltd. Power Projects RAJPURA, PUNJAB

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| 2 | 0 | [illegible] | 25.11.16 |

This Supersedes Previous Rev. No.....
Previous Rev. documents must be destroyed

| | | | | | | |
|---|---|---|---|---|---|---|
| Project Doc. No. P-90925-E-C1-8771-200-0 | | | | | CUSTOMER : RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
| Scale 1:575 | | | | | | |
| PROJECT : 400/220KV JAISALMEIR-2 AIS SUBSTAION | | | | | SIEMENS LIMITED , GURGAON | |
| | | | | Date | 16.11.2016 | DRG. TITLE : MAIN EARTHMAT LAYOUT-400/220KV S/STATION | Rev. 0 |
| | | | | Drawn | GB | | |
| | | | | Chk | RK | | |
| | | | | Appr | KTV | | |
| 00 | First Issue | 16.11.16 | GB | DRG. No. | | (0)-G71770-AC200-L163-001-0 | Sheet. 1Of1 |
| Rev. | Remarks | Date | Name | LOA No. | | RVPN/SE(P&P)/XEN/KFW/ICB-1D 1771 dated 16.10.2015 | |

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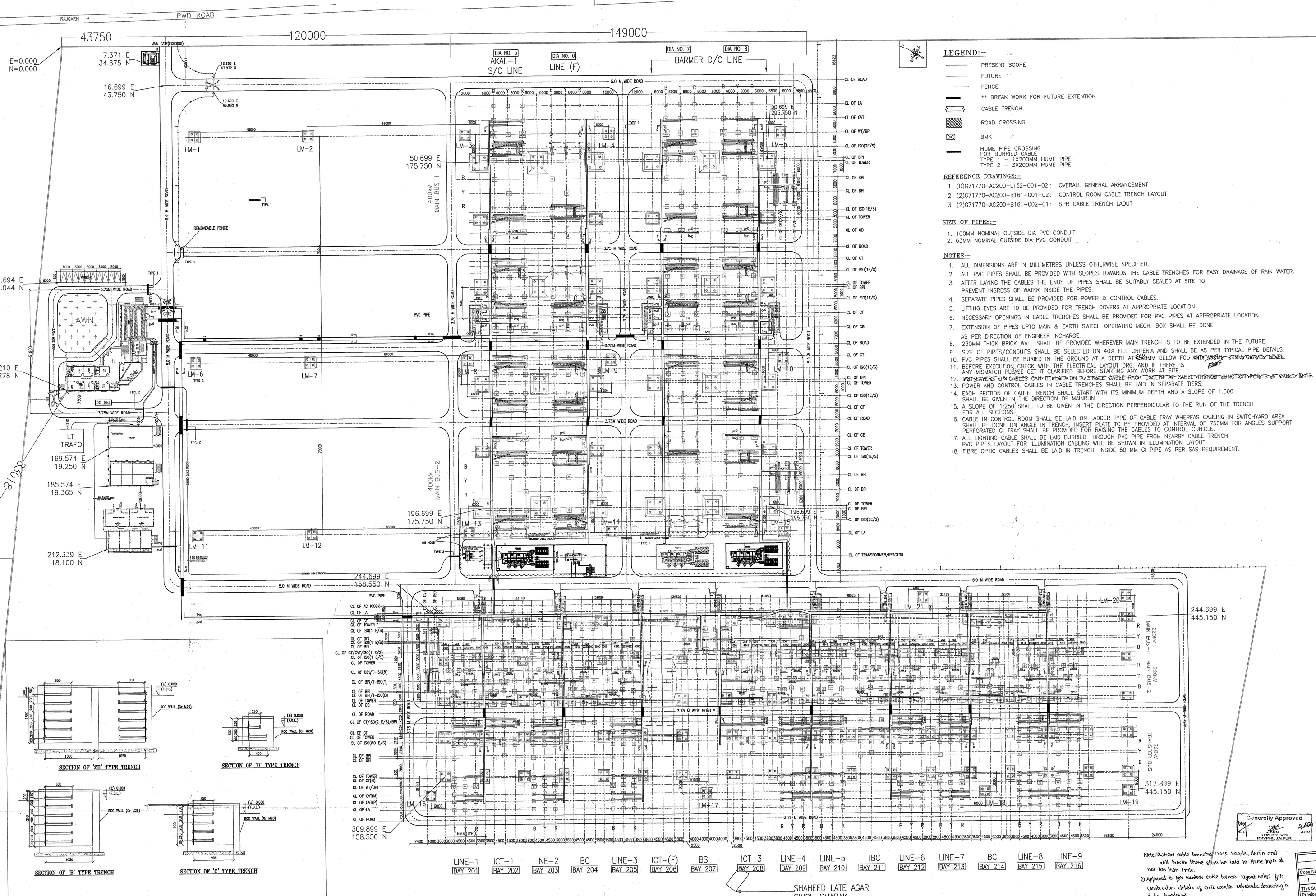
Make next application to scale




## LEGEND:-

- PRESENT SCOPE
- FUTURE
- FENCE
- ** BREAK WORK FOR FUTURE EXTENTION
- CABLE TRENCH
- ROAD CROSSING
- BMK
- HUME PIPE CROSSING FOR BURRIED CABLE
  TYPE 1 – 1X200MM HUME PIPE
  TYPE 2 – 3X200MM HUME PIPE

## REFERENCE DRAWINGS:-

1. (0)G71770-AC200-L152-001-02 : OVERALL GENERAL ARRANGEMENT
2. (2)G71770-AC200-B161-001-02 : CONTROL ROOM CABLE TRENCH LAYOUT
3. (2)G71770-AC200-B161-002-01 : SPR CABLE TRENCH LAOUT

## SIZE OF PIPES:-

1. 100MM NOMINAL OUTSIDE DIA PVC CONDUIT
2. 63MM NOMINAL OUTSIDE DIA PVC CONDUIT

## NOTES:-

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE SPECIFIED.
2. ALL PVC PIPES SHALL BE PROVIDED WITH SLOPES TOWARDS THE CABLE TRENCHES FOR EASY DRAINAGE OF RAIN WATER.
3. AFTER LAYING THE CABLES THE ENDS OF PIPES SHALL BE SUITABLY SEALED AT SITE TO PREVENT INGRESS OF WATER INSIDE THE PIPES.
4. SEPARATE PIPES SHALL BE PROVIDED FOR POWER & CONTROL CABLES.
5. LIFTING EYES ARE TO BE PROVIDED FOR TRENCH COVERS AT APPROPRIATE LOCATION.
6. NECESSARY OPENINGS IN CABLE TRENCHES SHALL BE PROVIDED FOR PVC PIPES AT APPROPRIATE LOCATION.
7. EXTENSION OF PIPES UPTO MAIN & EARTH SWITCH OPERATING MECH. BOX SHALL BE DONE AS PER DIRECTION OF ENGINEER INCHARGE.
8. 230MM THICK BRICK WALL SHALL BE PROVIDED WHEREVER MAIN TRENCH IS TO BE EXTENDED IN THE FUTURE.
9. SIZE OF PIPES/CONDUITS SHALL BE SELECTED ON 40% FILL CRITERIA AND SHALL BE AS PER TYPICAL PIPE DETAILS.
10. PVC PIPES SHALL BE BURIED IN THE GROUND AT A DEPTH AT 600MM BELOW FGL AND ABOVE STORM DRAIN LEVEL.
11. BEFORE EXECUTION CHECK WITH THE ELECTRICAL LAYOUT DRG. AND IF THERE IS ANY MISMATCH PLEASE GET IT CLARIFIED BEFORE STARTING ANY WORK AT SITE.
12. ~~TWO LAYERS OF CABLES CAN BE LAID ON TO SINGLE CABLE RACK EXCEPT AT CABLE TERMINAL JUNCTION POINTS & EASILY ENTA~~
13. POWER AND CONTROL CABLES IN CABLE TRENCHES SHALL BE LAID IN SEPARATE TIERS.
14. EACH SECTION OF CABLE TRENCH SHALL START WITH ITS MINIMUM DEPTH AND A SLOPE OF 1:500 SHALL BE GIVEN IN THE DIRECTION OF MAINRUN.
15. A SLOPE OF 1:250 SHALL TO BE GIVEN IN THE DIRECTION PERPENDICULAR TO THE RUN OF THE TRENCH FOR ALL SECTIONS.
16. CABLE IN CONTROL ROOM SHALL BE LAID ON LADDER TYPE OF CABLE TRAY WHEREAS CABLING IN SWITCHYARD AREA SHALL BE DONE ON ANGLE IN TRENCH. INSERT PLATE TO BE PROVIDED AT INTERVAL OF 750MM FOR ANGLES SUPPORT. PERFORATED GI TRAY SHALL BE PROVIDED FOR RAISING THE CABLES TO CONTROL CUBICLE.
17. ALL LIGHTING CABLE SHALL BE LAID BURRIED THROUGH PVC PIPE FROM NEARBY CABLE TRENCH, PVC PIPES LAYOUT FOR ILLUMINATION CABLING WILL BE SHOWN IN ILLUMINATION LAYOUT.
18. FIBRE OPTIC CABLES SHALL BE LAID IN TRENCH, INSIDE 50 MM GI PIPE AS PER SAS REQUIREMENT.




Generally Approved
SE (P&P) KFW Projects RVPVNL JAIPUR
AEN

Note:-1)Where cable benches cross roads, drain and nall backs there shall be laid in Hume pipes of not less than 1 mtr.
2) Approval is for outdoor cable bench layout only; for construction details of civil works seperate drawing is to be furnished.
3) For the payment purpose, 8 type bench shall be considered as C type bench.

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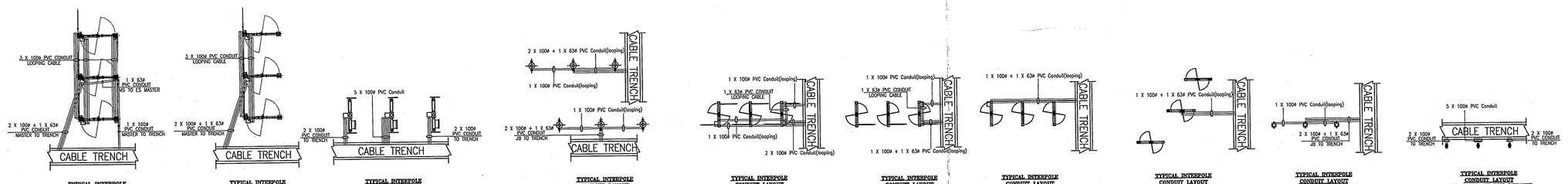
| Copy No. | Rev. No. | Release By | Date |
|---|---|---|---|
| 1 | 1 | PMI / TMI | 31/08/16 |

This Supersedes Previous Rev. No.....5.....
Previous Rev. documents must be destroyed.




| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. P-90925-E-C1-8810-200-1 | | | | CUSTOMER : RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
| Scale 1:575 | | | | | |
| PROJECT : 400/220KV JAISALMEIR-2 AIS SUBSTAION | | | | SIEMENS LIMITED , GURGAON | |
| | | | | Date 21.09.2016 | DRG. TITLE : OUTDOOR CABLE TRENCH LAYOUT — Rev. 1 |
| | | | | Drawn GB | |
| | | | | Chk RK | |
| | | | | Appr KTV | |
| 01 | Comments Incorporated | 21.10.16 | GB | DRG. No. | (0)-G71770-AC200-V259-002-1 — Sheet. 1 Of 1 |
| 00 | First Issue | 06.09.16 | GB | | |
| Rev. | Remarks | Date | Name | LOA No. | RVPN/SE(P&P)/XEN/KfW/ICB-1D 1771 dated 16.10.2015 |

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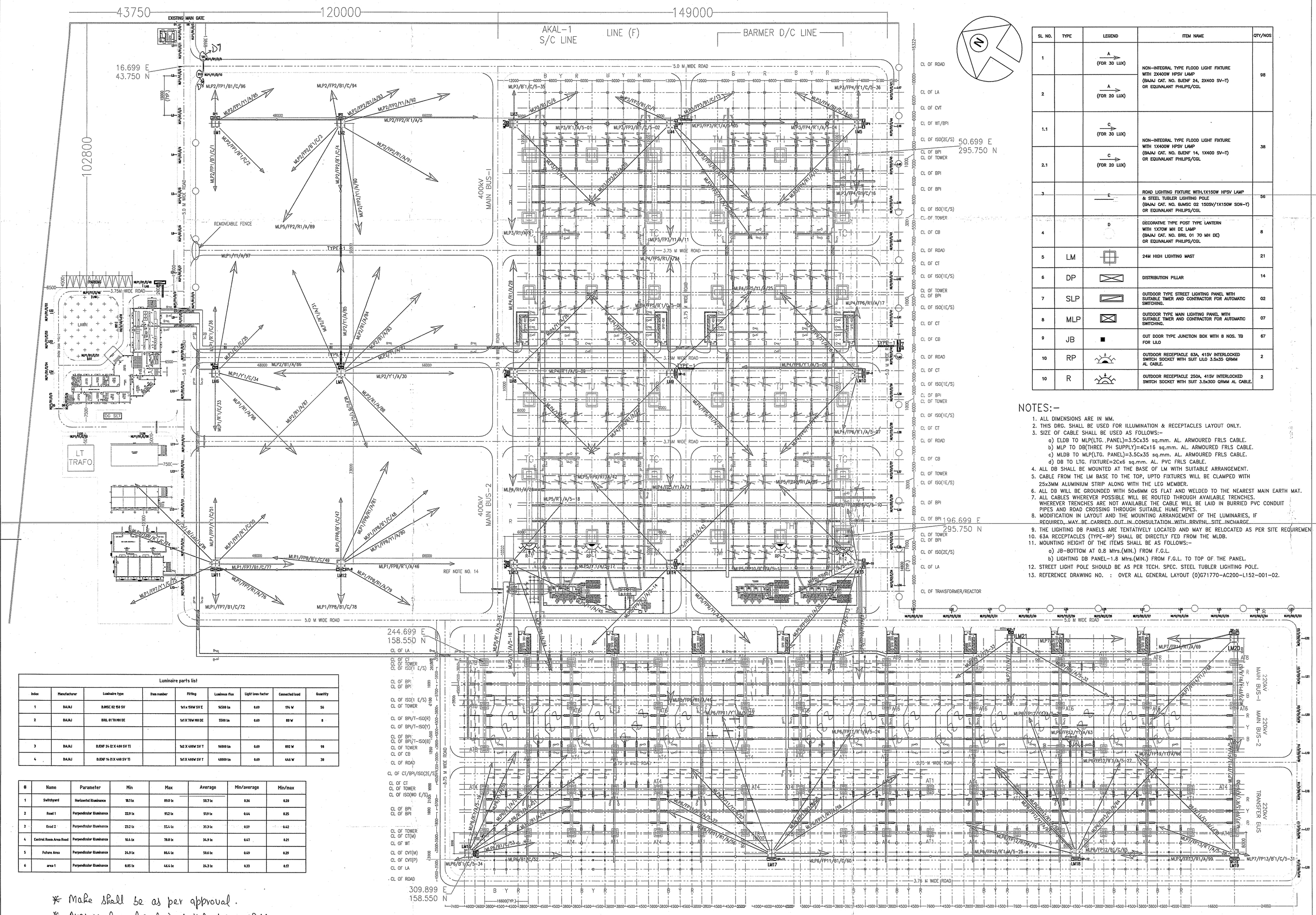



| SL. NO. | TYPE | LEGEND | ITEM NAME | QTY/NOS |
|---|---|---|---|---|
| 1 | | A (FOR 30 LUX) | NON-INTEGRAL TYPE FLOOD LIGHT FIXTURE WITH 2X400W HPSV LAMP (BAJAJ CAT. NO. BJEINF 24, 2X400 SV-T) OR EQUIVALANT PHILIPS/CGL | 98 |
| 2 | | A (FOR 20 LUX) | | |
| 1.1 | | C (FOR 30 LUX) | NON-INTEGRAL TYPE FLOOD LIGHT FIXTURE WITH 1X400W HPSV LAMP (BAJAJ CAT. NO. BJEINF 14, 1X400 SV-T) OR EQUIVALANT PHILIPS/CGL | 38 |
| 2.1 | | C (FOR 20 LUX) | | |
| 3 | | E | ROAD LIGHTING FIXTURE WITH-1X150W HPSV LAMP & STEEL TUBLER LIGHTING POLE (BAJAJ CAT. NO. BJMSC 02 150SV/1X150W SON-T) OR EQUIVALANT PHILIPS/CGL | 56 |
| 4 | | D | DECORATIVE TYPE POST TYPE LANTERN WITH 1X70W MH DE LAMP (BAJAJ CAT. NO. BRIL 01 70 MH DE) OR EQUIVALANT PHILIPS/CGL. | 8 |
| 5 | LM | | 24M HIGH LIGHTING MAST | 21 |
| 6 | DP | | DISTRIBUTION PILLAR | 14 |
| 7 | SLP | | OUTDOOR TYPE STREET LIGHTING PANEL WITH SUITABLE TIMER AND CONTRACTOR FOR AUTOMATIC SWITCHING. | 02 |
| 8 | MLP | | OUTDOOR TYPE MAIN LIGHTING PANEL WITH SUITABLE TIMER AND CONTRACTOR FOR AUTOMATIC SWITCHING. | 07 |
| 9 | JB | ■ | OUT DOOR TYPE JUNCTION BOX WITH 8 NOS. TB FOR LLO | 67 |
| 10 | RP | | OUTDOOR RECEPTACLE 63A, 415V INTERLOCKED SWITCH SOCKET WITH SUIT LLO 3.5x35 QMM AL CABLE. | 2 |
| 10 | R | | OUTDOOR RECEPTACLE 250A, 415V INTERLOCKED SWITCH SOCKET WITH SUIT 3.5x300 QMM AL CABLE. | 2 |

NOTES:–

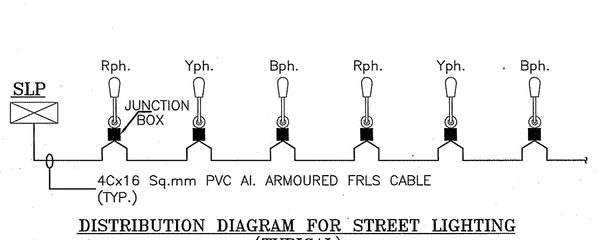
1. ALL DIMENSIONS ARE IN MM.
2. THIS DRG. SHALL BE USED FOR ILLUMINATION & RECEPTACLES LAYOUT ONLY.
3. SIZE OF CABLE SHALL BE USED AS FOLLOWS:–
   a) ELDB TO MLP(LTG. PANEL)=3.5Cx35 sq.mm. AL. ARMOURED FRLS CABLE.
   b) MLP TO DB(THREE PH SUPPLY)=4Cx16 sq.mm. AL. ARMOURED FRLS CABLE.
   c) MLDB TO MLP(LTG. PANEL)=3.5Cx35 sq.mm. AL. ARMOURED FRLS CABLE.
   d) DB TO LTG. FIXTURE=2Cx6 sq.mm. AL. PVC FRLS CABLE.
4. ALL DB SHALL BE MOUNTED AT THE BASE OF LM WITH SUITABLE ARRANGEMENT.
5. CABLE FROM THE LM BASE TO THE TOP, UPTO FIXTURES WILL BE CLAMPED WITH 25x3MM ALUMINIUM STRIP ALONG WITH THE LEG MEMBER.
6. ALL DB WILL BE GROUNDED WITH 50x6MM GS FLAT AND WELDED TO THE NEAREST MAIN EARTH MAT.
7. ALL CABLES WHEREVER POSSIBLE WILL BE ROUTED THROUGH AVAILABLE TRENCHES. WHEREVER TRENCHES ARE NOT AVAILABLE THE CABLE WILL BE LAID IN BURRIED PVC CONDUIT PIPES AND ROAD CROSSING THROUGH SUITABLE HUME PIPES.
8. MODIFICATION IN LAYOUT AND THE MOUNTING ARRANGEMENT OF THE LUMINARIES, IF REQUIRED, MAY BE CARRIED OUT IN CONSULTATION WITH RRVPNL SITE INCHARGE.
9. THE LIGHTING DB PANELS ARE TENTATIVELY LOCATED AND MAY BE RELOCATED AS PER SITE REQUIREMENT.
10. 63A RECEPTACLES (TYPE-RP) SHALL BE DIRECTLY FED FROM THE MLDB.
11. MOUNTING HEIGHT OF THE ITEMS SHALL BE AS FOLLOWS:–
    a) JB-BOTTOM AT 0.8 Mtrs.(MIN.) FROM F.G.L.
    b) LIGHTING DB PANEL-1.8 Mtrs.(MIN.) FROM F.G.L. TO TOP OF THE PANEL.
12. STREET LIGHT POLE SHOULD BE AS PER TECH. SPEC. STEEL TUBLER LIGHTING POLE.
13. REFERENCE DRAWING NO. : OVER ALL GENERAL LAYOUT (0)G71770-AC200-L152-001-02.

| MLP NO | MLP CONNECTED TO LM & DP POSITION OF DP | LUMINAIRE NO. | LUMINAIRE TYPE | TILT | ROTATION | MOUNTING HEIGHT |
|---|---|---|---|---|---|---|
| MLP-3 | LM-3 DP-3 | Luminaire 6 | C | –45 | 25 | 24 |
| | | Luminaire 5–01 | A | –60 | 00 | 24 |
| | | Luminaire 7 | A | –60 | –45 | 24 |
| | | Luminaire 8 | A | –60 | –90 | 24 |
| | | Luminaire 5–35 | C | –25 | 90 | 24 |
| | LM-4 DP-3 4 | Luminaire 9 | C | –45 | 155 | 24 |
| | | Luminaire 5–02 | C | –45 | 180 | 24 |
| | | Luminaire 10 | A | –60 | –135 | 24 |
| | | Luminaire 11 | A | –60 | –90 | 24 |
| | | Luminaire 5–03 | A | –65 | –55 | 24 |
| | | Luminaire 12 | A | –60 | –45 | 24 |
| | | Luminaire 5–04 | A | –60 | 00 | 24 |
| | | Luminaire 13 | C | –45 | 25 | 24 |
| | | Luminaire 14 | C | –45 | 155 | 24 |
| | LM-5 DP-4 5 | Luminaire 5–05 | A | –60 | –180 | 24 |
| | | Luminaire 15 | A | –60 | –135 | 24 |
| | | Luminaire 16 | C | –45 | –90 | 24 |
| | | Luminaire 5–36 | C | –25 | 90 | 24 |
| MLP-4 | LM-8 DP-8 | Luminaire 26 | A | –60 | –90 | 24 |
| | | Luminaire 27 | A | –60 | –45 | 24 |
| | | Luminaire 5–09 | A | –60 | 00 | 24 |
| | | Luminaire 28 | A | –60 | 45 | 24 |
| | | Luminaire 29 | A | –60 | 90 | 24 |
| | LM-9 DP-5 9 | Luminaire 20 | A | –60 | –45 | 24 |
| | | Luminaire 21 | A | –60 | –90 | 24 |
| | | Luminaire 22 | A | –60 | –135 | 24 |
| | | Luminaire 23 | A | –60 | 135 | 24 |
| | | Luminaire 5–08 | C | –45 | 90 | 24 |
| | | Luminaire 24 | A | –60 | 90 | 24 |
| | | Luminaire 25 | A | –60 | 45 | 24 |
| | LM-10 DP-6 10 | Luminaire 17 | A | –45 | 90 | 24 |
| | | Luminaire 18 | A | –60 | 135 | 24 |
| | | Luminaire 5–06 | A | –60 | –180 | 24 |
| | | Luminaire 19 | A | –60 | –135 | 24 |
| | | Luminaire 5–07 | A | –40 | –105 | 24 |
| MLP-5 | LM-13 | Luminaire 5–15 | A | –55 | –100 | 24 |
| | | Luminaire 5–16 | A | –60 | –90 | 24 |
| | | Luminaire 44 | A | –60 | –70 | 24 |
| | | Luminaire 45 | A | –60 | –25 | 24 |
| | | Luminaire 5–17 | A | –60 | 00 | 24 |
| | | Luminaire 5–18 | A | –50 | 50 | 24 |
| | LM-14 DP-9 11 | Luminaire 40 | A | –60 | –45 | 24 |
| | | Luminaire 41 | A | –65 | –90 | 24 |
| | | Luminaire 5–14 | A | –60 | –135 | 24 |
| | | Luminaire 42 | A | –60 | 135 | 24 |
| | | Luminaire 43 | A | –60 | 45 | 24 |
| | LM-15 DP-10 15 | Luminaire 37 | A | –60 | –90 | 24 |
| | | Luminaire 5–13 | A | –60 | –105 | 24 |
| | | Luminaire 38 | A | –60 | –130 | 24 |
| | | Luminaire 5–12 | A | –50 | –155 | 24 |
| | | Luminaire 5–11 | A | –60 | –180 | 24 |
| | | Luminaire 39 | A | –60 | 135 | 24 |
| | | Luminaire 5–10 | C | –40 | 100 | 24 |
| MLP-1 | LM-6 DP-6 | Luminaire 33 | C | –40 | –90 | 24 |
| | | Luminaire 34 | C | –45 | –15 | 24 |
| | | Luminaire 35 | C | –45 | 45 | 24 |
| | | Luminaire 36 | C | –45 | 90 | 24 |
| | | Luminaire 97 | A | –60 | 80 | 24 |
| | | Luminaire 98 | A | –60 | –45 | 24 |
| | LM-11 DP-2 1 | Luminaire 50 | C | –45 | 45 | 24 |
| | | Luminaire 51 | C | –45 | 90 | 24 |
| | | Luminaire 73 | C | –60 | 135 | 24 |
| | | Luminaire 74 | C | –55 | 160 | 24 |
| | | Luminaire 75 | C | –55 | –155 | 24 |
| | | Luminaire 72 | C | –30 | –90 | 24 |
| | LM-12 DP-3 12 | Luminaire 76 | A | –50 | –30 | 24 |
| | | Luminaire 77 | C | –50 | 00 | 24 |
| | | Luminaire 46 | A | –60 | 00 | 24 |
| | | Luminaire 47 | C | –45 | 90 | 24 |
| | | Luminaire 48 | C | –60 | 40 | 24 |
| | | Luminaire 49 | C | –55 | –180 | 24 |
| | | Luminaire 78 | C | –30 | –90 | 24 |
| | | Luminaire 79 | A | –50 | –30 | 24 |
| | | Luminaire 80 | A | –60 | 30 | 24 |
| | | Luminaire 81 | A | –60 | 65 | 24 |
| | | Luminaire 30 | A | –70 | 00 | 24 |
| MLP-2 | LM-7 DP-1 | Luminaire 31 | A | –60 | 115 | 24 |
| | | Luminaire 32 | C | –50 | –70 | 24 |
| | | Luminaire 82 | A | –60 | 25 | 24 |
| | | Luminaire 83 | A | –60 | 45 | 24 |
| | | Luminaire 84 | A | –60 | 70 | 24 |
| | | Luminaire 85 | A | –60 | 90 | 24 |
| | | Luminaire 86 | A | –45 | –180 | 24 |
| | | Luminaire 87 | A | –60 | –135 | 24 |
| | | Luminaire 88 | A | –60 | –45 | 24 |
| | LM-1 DP-1 | Luminaire 1 | C | –45 | –90 | 24 |
| | | Luminaire 2 | C | –45 | –45 | 24 |
| | | Luminaire 95 | A | –45 | 30 | 24 |
| | | Luminaire 96 | C | –25 | 90 | 24 |
| | LM-2 DP-2 | Luminaire 3 | C | –45 | –135 | 24 |
| | | Luminaire 4 | C | –45 | –90 | 24 |
| | | Luminaire 5 | A | –65 | 00 | 24 |
| | | Luminaire 89 | A | –60 | –120 | 24 |
| | | Luminaire 90 | A | –60 | –80 | 24 |
| | | Luminaire 91 | A | –60 | –30 | 24 |
| | | Luminaire 92 | A | –60 | 15 | 24 |
| | | Luminaire 93 | A | –45 | 30 | 24 |
| | | Luminaire 94 | C | –25 | 100 | 24 |
| MLP-6 | LM-16 DP-16 | Luminaire 52 | C | –55 | 00 | 24 |
| | | Luminaire 53 | C | –45 | 10 | 24 |
| | | Luminaire 54 | A | –60 | 25 | 24 |
| | | Luminaire 5–21 | A | –65 | 35 | 24 |
| | | Luminaire 5–20 | A | –65 | 45 | 24 |
| | | Luminaire 55 | A | –60 | 65 | 24 |
| | | Luminaire 5–19 | A | –55 | 75 | 24 |
| | | Luminaire 5–34 | C | –10 | –160 | 24 |
| | LM-17 DP-17 17 | Luminaire 56 | A | –60 | 160 | 24 |
| | | Luminaire 5–22 | A | –60 | 155 | 24 |
| | | Luminaire 57 | A | –60 | 135 | 24 |
| | | Luminaire 5–23 | A | –65 | 110 | 24 |
| | | Luminaire 5–24 | A | –65 | 55 | 24 |
| | | Luminaire 58 | A | –45 | 45 | 24 |
| | | Luminaire 59 | A | –60 | 30 | 24 |
| | | Luminaire 60 | C | 05 | 00 | 24 |
| | LM-18 DP-18 IY | Luminaire 5–25 | A | –60 | –180 | 24 |
| | | Luminaire 61 | A | –60 | 135 | 24 |
| | | Luminaire 62 | A | –60 | 135 | 24 |
| | | Luminaire 5–26 | A | –65 | 110 | 24 |
| | | Luminaire 63 | A | –60 | 90 | 24 |
| | | Luminaire 5–27 | A | –55 | 60 | 24 |
| | | Luminaire 64 | A | –60 | 45 | 24 |
| | | Luminaire 65 | C | –45 | 00 | 24 |
| | | Luminaire 76 | A | –60 | 165 | 24 |
| MLP-7 | LM-21 DP-21 | Luminaire 70 | A | –60 | 00 | 24 |
| | | Luminaire 5–32 | A | –60 | –30 | 24 |
| | | Luminaire 71 | A | –45 | –90 | 24 |
| | | Luminaire 5–33 | A | –45 | –145 | 24 |
| | DP-19 LM-19 19 | Luminaire 5–28 | A | –50 | 160 | 24 |
| | | Luminaire 66 | A | –60 | 135 | 24 |
| | | Luminaire 5–29 | A | –60 | 90 | 24 |
| | | Luminaire 5–30 | A | –60 | 90 | 24 |
| | | Luminaire 5–31 | C | –10 | –10 | 24 |
| | | Luminaire 69 | A | –60 | –180 | 24 |
| | DP-14 LM-20 20 | Luminaire 67 | A | –60 | –90 | 24 |
| | | Luminaire 68 | A | –60 | –135 | 24 |
| | | Luminaire 69 | A | –45 | –180 | 24 |

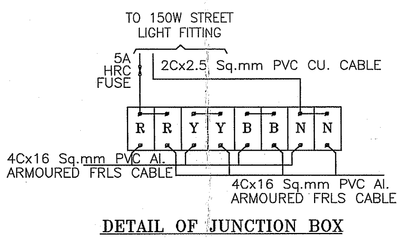
| Luminaire parts list | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Index | Manufacturer | Luminaire type | Item number | Fitting | Luminous flux | Light loss Factor | Connected load | Quantity |
| 1 | BAJAJ | BJMSC 02 150 SV | | 1x1 x 150W SV E | 16500 lm | 0.69 | 174 W | 56 |
| 2 | BAJAJ | BRIL 01 70 MH DE | | 1x1 X 70W MH DE | 5500 lm | 0.69 | 88 W | 8 |
| | | | | | | | | |
| 3 | BAJAJ | BJENF 24 12 X 400 SV T1 | | 1x2 X 400W SV T | 96000 lm | 0.69 | 892 W | 98 |
| 4 | BAJAJ | BJENF 14 11 X 400 SV T | | 1x1 X 400W SV T | 48000 lm | 0.69 | 446 W | 38 |

| SI | Name | Parameter | Min | Max | Average | Min/average | Min/max |
|---|---|---|---|---|---|---|---|
| 1 | Switchyard | Horizontal Illuminance | 19.1 lx | 89.8 lx | 58.7 lx | 0.34 | 0.28 |
| 2 | Road 1 | Perpendicular Illuminance | 22.9 lx | 91.2 lx | 51.9 lx | 0.44 | 0.25 |
| 3 | Road 2 | Perpendicular Illuminance | 22.2 lx | 55.4 lx | 37.3 lx | 0.59 | 0.42 |
| 4 | Control Room Area Road | Perpendicular Illuminance | 16.4 lx | 78.8 lx | 34.9 lx | 0.47 | 0.21 |
| 5 | Future Area | Perpendicular Illuminance | 26.9 lx | 84.4 lx | 56.6 lx | 0.48 | 0.32 |
| 6 | area 1 | Perpendicular Illuminance | 8.85 lx | 44.4 lx | 24.3 lx | 0.36 | 0.17 |

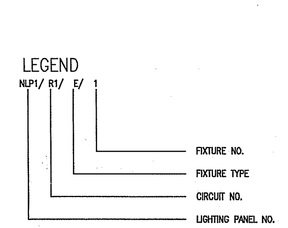
* Make shall be as per approval.
* Average lux level in switchyard area shall be maintained at 50 Lux on main equipments at first level (Equipment Connection level) & 20 lux on balance area of switchyard & road at ground level.




DISTRIBUTION DIAGRAM FOR STREET LIGHTING (TYPICAL)




DETAIL OF JUNCTION BOX




LEGEND:–

- 110 MM PVC PIPE
- 600x600 MM POOLING PIT
- HUME PIPE CROSSING FOR BURRIED CABLE TYPE 1 – 1X200MM HUME PIPE

| LINE-1 | ICT-1 | LINE-2 | BC | LINE-3 | ICT-(F) | BS | ICT-3 | LINE-4 | LINE-5 | TBC | LINE-6 | LINE-7 | BC | LINE-8 | LINE-9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BAY 201 | BAY 202 | BAY 203 | BAY 204 | BAY 205 | BAY 206 | BAY 207 | BAY 208 | BAY 209 | BAY 210 | BAY 211 | BAY 212 | BAY 213 | BAY 214 | BAY 215 | BAY 216 |

Generally Approved

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|---|---|---|---|
| 1 | 0 | [illegible] | 17/11/16 |

This Supersedes Previous Rev. No.
Previous Rev. documents must be destroyed

| | |
|---|---|
| Project Doc. No. | P-90925-E-C1-8751-200-0 |
| Scale | 1:1000 |
| CUSTOMER : | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. |
| PROJECT : | 400/220KV JAISALMER-2 AIS SUBSTATION |
| | SIEMENS LIMITED , GURGAON |

| | | | | |
|---|---|---|---|---|
| | | Date | 16.11.2016 | |
| | | Drawn | GB | |
| | | Appr. | GB | |
| | | Norm | KTV | |
| 0 | First Issue | 16.11.16 | GB | |
| Rev. | Remarks | Date | Name | LOA No. |

DRG. TITLE : OUTDOOR ILLUMINATION PLAN LAYOUT & DISTRIBUTION - 400/220kV

Rev. 0

DRG. NO. : (1)-G71770-AC200-L251-001-00

Sheet. 1of2

RVPN/SS(P&P)/XEN/KFW/ICB-1D 1771 dated 16.10.2015

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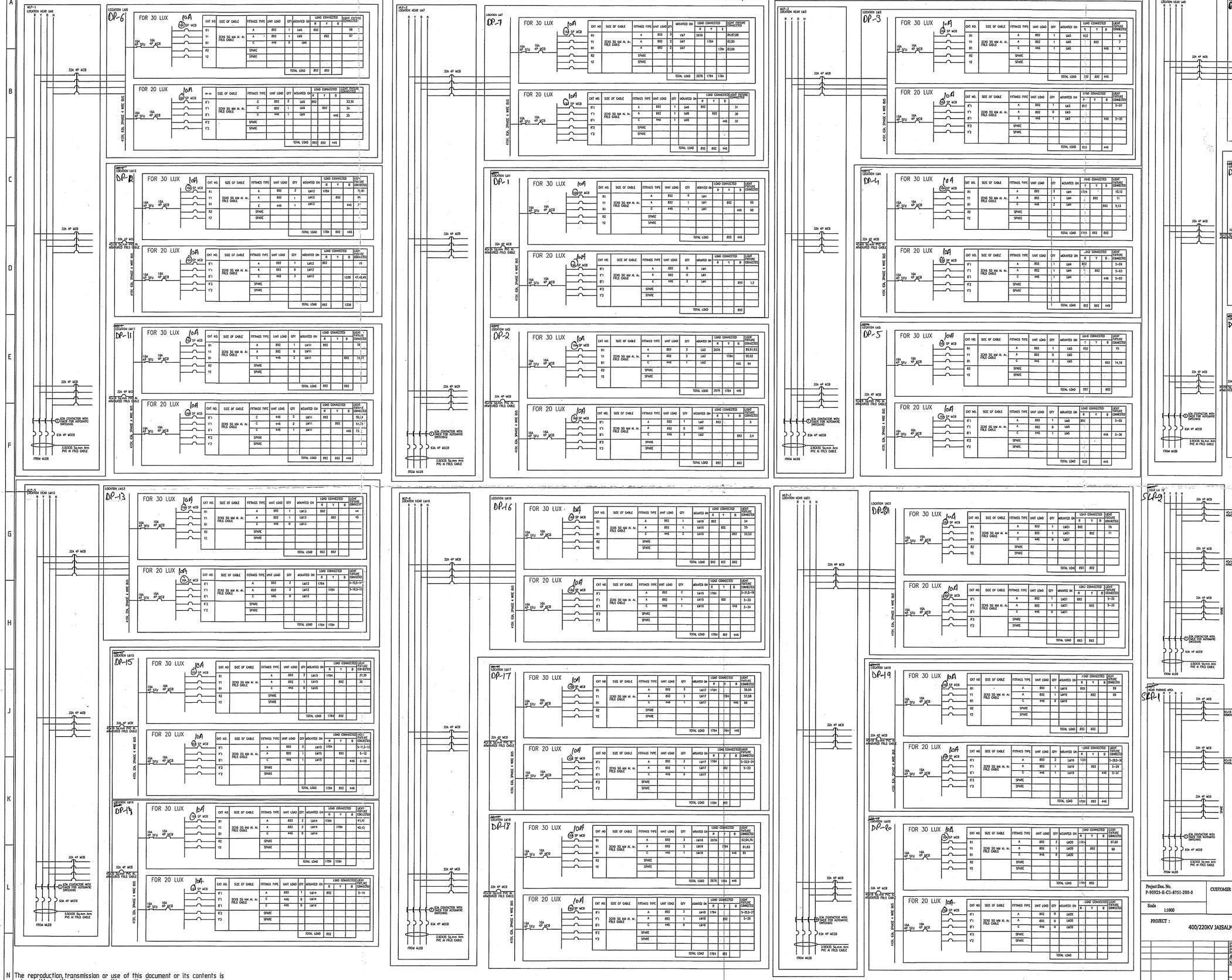

MLP-1
LOCATION NEAR LA8
R Y B N
32A 4P MCB
415V, 63A, 3PHASE, 4 WIRE BUS
63A CONTACTOR WITH ISOLATOR FOR AUTOMATIC SWITCHING
63A 4P MCCB
3.5CX35 Sq.mm Arm PVC Al FRLS CABLE
FROM MLDB
LOCATION LA8
DP-6
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA6 | 892 | | | 99 1
T1 | | A | 892 | 1 | LA6 | | 892 | | 97
B1 | | C | 446 | 9 | LA6 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | C | 892 | 1 | LA6 | 892 | | | 33,36
Y'1 | | C | 892 | 1 | LA6 | | 892 | | 34
B'1 | | C | 446 | 1 | LA6 | | | 446 | 35
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | 446 |
LOCATION LA12
DP-12
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA12 | 1784 | | | 71,81
T1 | | A | 892 | 1 | LA12 | | 892 | | 95
B1 | | C | 446 | 1 | LA12 | | | 446 | 97
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 892 | 446 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA12 | 892 | | | 15
Y'1 | | A | 892 | 0 | LA12 | | | | |
B'1 | | C | 446 | 3 | LA12 | | | 1338 | 47,48,49
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | | 1338 |
LOCATION LA11
DP-11
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA11 | 892 | | | 91
T1 | | A | 892 | 0 | LA11 | | | | |
B1 | | C | 446 | 2 | LA11 | | | 892 | 72,77
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | | 892 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | C | 446 | 2 | LA11 | 892 | | | 50,54
Y'1 | | C | 446 | 2 | LA11 | | | 892 | 51,53
B'1 | | C | 446 | 1 | LA11 | | | 446 | 73
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | 446 |
LOCATION LA13
DP-13
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA13 | 892 | | | 44
T1 | | A | 892 | 1 | LA13 | | 892 | | 45
B1 | | C | 446 | 0 | LA13 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA13 | 1784 | | | 1-11.5-14
Y'1 | | A | 892 | 2 | LA13 | | 1784 | | 1-11.5-13
B'1 | | C | 446 | 0 | LA13 | | | | |
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 1784 | |
LOCATION LA15
DP-15
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA15 | 1784 | | | 27,29
T1 | | A | 892 | 1 | LA15 | | 892 | | 36
B1 | | C | 446 | 0 | LA15 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 892 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA15 | 1784 | | | 5-11.5-12
Y'1 | | A | 892 | 1 | LA15 | | 892 | | 5-12
B'1 | | C | 446 | 1 | LA15 | | | 446 | 5-10
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 892 | 446 |
LOCATION LA14
DP-14
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA14 | 1784 | | | 41,42
T1 | | A | 892 | 2 | LA14 | | 1784 | | 42,43
B1 | | C | 446 | 0 | LA14 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 1784 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | C | 446 | 2 | LA14 | 892 | | | 50,54
Y'1 | | C | 446 | 2 | LA14 | | 892 | | 51,53
B'1 | | C | 446 | 1 | LA14 | | | 446 | 52
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | 446 |
MLP-2
LOCATION NEAR LA7
R Y B N
32A 4P MCB
415V, 63A, 3PHASE, 4 WIRE BUS
63A CONTACTOR WITH ISOLATOR FOR AUTOMATIC SWITCHING
63A 4P MCCB
3.5CX35 Sq.mm Arm PVC Al FRLS CABLE
FROM MLDB
LOCATION LA7
DP-7
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA7 | 2676 | | | 84,87,88
T1 | | A | 892 | 2 | LA7 | | 1784 | | 82,85
B1 | | A | 892 | 2 | LA7 | | | 1784 | 83,86
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 2676 | 1784 | 1784 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA7 | 892 | | | 31
Y'1 | | A | 892 | 1 | LA7 | | 892 | | 30
B'1 | | C | 446 | 1 | LA7 | | | 446 | 32
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | 446 |
LOCATION LA1
DP-1
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 0 | LA1 | | | | |
T1 | | A | 892 | 1 | LA1 | | 892 | | 95
B1 | | C | 446 | 1 | LA1 | | | 446 | 98
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | | 892 | 446 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 0 | LA1 | | | | |
Y'1 | | A | 892 | 0 | LA1 | | | | |
B'1 | | C | 446 | 2 | LA1 | | | 892 | 1,2
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | | | 892 |
LOCATION LA2
DP-2
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 3 | LA2 | 2676 | | | 89,91,93
T1 | | A | 892 | 3 | LA2 | | 1784 | | 90,92
B1 | | C | 446 | 1 | LA2 | | | 446 | 94
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 2676 | 1784 | 446 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA2 | 892 | | | 5
Y'1 | | A | 892 | 0 | LA2 | | | | |
B'1 | | C | 446 | 2 | LA2 | | | 892 | 3,4
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | | 892 |
MLP-3
LOCATION NEAR LA3
R Y B N
32A 4P MCB
415V, 63A, 3PHASE, 4 WIRE BUS
63A CONTACTOR WITH ISOLATOR FOR AUTOMATIC SWITCHING
63A 4P MCCB
3.5CX35 Sq.mm Arm PVC Al FRLS CABLE
FROM MLDB
LOCATION LA3
DP-3
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA3 | 892 | | | 1-33
T1 | | A | 892 | 1 | LA3 | | 892 | | 1-34
B1 | | C | 446 | 1 | LA3 | | | 446 | 1-35
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | 446 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA3 | 892 | | | 1-31
Y'1 | | A | 892 | 0 | LA3 | | | | |
B'1 | | C | 446 | 1 | LA3 | | | 446 | 1-35
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | | 446 |
LOCATION LA4
DP-4
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA4 | 1784 | | | 10,12
T1 | | A | 892 | 1 | LA4 | | 892 | | 11
B1 | | C | 446 | 2 | LA4 | | | 892 | 9,13
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 892 | 892 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA4 | 892 | | | 5-03
Y'1 | | A | 892 | 1 | LA4 | | 892 | | 5-03
B'1 | | C | 446 | 1 | LA4 | | | 446 | 5-02
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | 446 |
LOCATION LA5
DP-5
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA5 | 892 | | | 15
T1 | | A | 892 | 0 | LA5 | | | | |
B1 | | C | 446 | 2 | LA5 | | | 892 | 14,18
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | | 892 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA5 | 892 | | | 5-05
Y'1 | | A | 892 | 1 | LA5 | | | 446 | 5-36
B'1 | | C | 446 | 1 | LA5 | | | | |
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | | 446 |
MLP-4
LOCATION NEAR LA8
R Y B N
32A 4P MCB
4CX16 Sq.mm PVC Al. ARMOURED FRLS CABLE
63A CONTACTOR WITH ISOLATOR FOR AUTOMATIC SWITCHING
63A 4P MCCB
3.5CX35 Sq.mm Arm PVC Al FRLS CABLE
FROM MLDB
LOCATION LA8
DP-8
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA8 | 1784 | | | 26,29
T1 | | A | 892 | 2 | LA8 | | 1784 | | 27,28
B1 | | C | 446 | 0 | LA8 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 1784 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA8 | 892 | | | 2-39
Y'1 | | A | 892 | 0 | LA8 | | | | |
B'1 | | C | 446 | 0 | LA8 | | | | |
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | | |
LOCATION LA9
DP-9
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 3 | LA9 | 2676 | | | 36,39
T1 | | A | 892 | 3 | LA9 | | 2676 | | 37,38
B1 | | C | 446 | 0 | LA9 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 2676 | 2676 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 0 | LA9 | | | | |
Y'1 | | A | 892 | 0 | LA9 | | | | |
B'1 | | C | 446 | 1 | LA9 | | | 446 | 5-04
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | | | 446 |
LOCATION LA10
DP-10
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA10 | 1784 | | | 17,19
T1 | | A | 892 | 1 | LA10 | | 892 | | 18
B1 | | C | 446 | 0 | LA10 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 892 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA10 | | | | 5-07
Y'1 | | A | 892 | 1 | LA10 | | | 892 | 5-08
B'1 | | C | 446 | 0 | LA10 | | | | |
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | |
MLP-5
LOCATION NEAR LA11
R Y B N
32A 4P MCB
4CX16 Sq.mm PVC Al. ARMOURED FRLS CABLE
63A CONTACTOR WITH ISOLATOR FOR AUTOMATIC SWITCHING
63A 4P MCCB
3.5CX35 Sq.mm Arm PVC Al FRLS CABLE
FROM MLDB
LOCATION LA11
DP-11
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA11 | 892 | | | 70
T1 | | A | 892 | 1 | LA11 | | 892 | | 71
B1 | | C | 446 | 0 | LA11 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA11 | 892 | | | 5-32
Y'1 | | A | 892 | 1 | LA11 | | 892 | | 5-33
B'1 | | C | 446 | 0 | LA11 | | | | |
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | |
MLP-6
LOCATION NEAR LA16
R Y B N
32A 4P MCB
415V, 63A, 3PHASE, 4 WIRE BUS
63A CONTACTOR WITH ISOLATOR FOR AUTOMATIC SWITCHING
63A 4P MCCB
3.5CX35 Sq.mm Arm PVC Al FRLS CABLE
FROM MLDB
LOCATION LA16
DP-16
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA16 | 892 | | | 24
T1 | | A | 892 | 1 | LA16 | | 892 | | 25
B1 | | C | 446 | 2 | LA16 | | | 892 | 52,53
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | 892 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA16 | 1784 | | | 5-11.5-13
Y'1 | | A | 892 | 1 | LA16 | | 892 | | 5-20
B'1 | | C | 446 | 1 | LA16 | | | 446 | 5-34
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 892 | 446 |
LOCATION LA17
DP-17
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA17 | 1784 | | | 56,59
T1 | | A | 892 | 2 | LA17 | | 1784 | | 57,58
B1 | | C | 446 | 1 | LA17 | | | 446 | 60
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 1784 | 446 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA17 | 1784 | | | 1-22.5-24
Y'1 | | A | 892 | 1 | LA17 | | 892 | | 5-23
B'1 | | C | 446 | 0 | LA17 | | | | |
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 892 | |
LOCATION LA18
DP-18
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 3 | LA18 | 2676 | | | 83,84,86
T1 | | A | 892 | 2 | LA18 | | 1784 | | 81,83
B1 | | C | 446 | 1 | LA18 | | | 446 | 85
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 2676 | 1784 | 446 |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA18 | 1784 | | | 5-25.5-27
Y'1 | | A | 892 | 1 | LA18 | | 892 | | 5-26
B'1 | | C | 446 | 0 | LA18 | | | | |
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 892 | |
MLP-7
LOCATION NEAR LA21
R Y B N
32A 4P MCB
415V, 63A, 3PHASE, 4 WIRE BUS
63A CONTACTOR WITH ISOLATOR FOR AUTOMATIC SWITCHING
63A 4P MCCB
3.5CX35 Sq.mm Arm PVC Al FRLS CABLE
FROM MLDB
LOCATION LA21
DP-21
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA21 | 892 | | | 70
T1 | | A | 892 | 1 | LA21 | | 892 | | 71
B1 | | C | 446 | 0 | LA21 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA21 | 892 | | | 5-32
Y'1 | | A | 892 | 1 | LA21 | | 892 | | 5-33
B'1 | | C | 446 | 0 | LA21 | | | | |
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | |
LOCATION LA19
DP-19
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 1 | LA19 | 892 | | | 99
T1 | | A | 892 | 1 | LA19 | | 892 | | 88
B1 | | C | 446 | 0 | LA19 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 892 | 892 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA19 | 1784 | | | 5-28.5-30
Y'1 | | A | 892 | 1 | LA19 | | 892 | | 5-29
B'1 | | C | 446 | 1 | LA19 | | | 446 | 5-31
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 892 | 446 |
LOCATION LA20
DP-20
FOR 30 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 2 | LA20 | 1784 | | | 87,89
T1 | | A | 892 | 2 | LA20 | | 1784 | | 88,90
B1 | | C | 446 | 0 | LA20 | | | | |
R2 | | SPARE | | | | | | | |
Y2 | | SPARE | | | | | | | |
TOTAL LOAD | 1784 | 1784 | |
FOR 20 LUX
10A SP MCB
16A 4P SFU
16A 4P MCB
CKT NO. | SIZE OF CABLE | FITTINGS TYPE | UNIT LOAD | QTY | MOUNTED ON | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B'1 | 2CX6 SQ.MM Al. Ar. FRLS CABLE | A | 892 | 0 | LA20 | | | | |
Y'1 | | A | 892 | 0 | LA20 | | | | |
B'1 | | C | 446 | 0 | LA20 | | | | |
R'2 | | SPARE | | | | | | | |
Y'2 | | SPARE | | | | | | | |
TOTAL LOAD | | | |
SLP-2
LOCATION LA12
32A 4P MCB
4CX16 Sq.mm PVC Al. ARMOURED FRLS CABLE
63A CONTACTOR WITH ISOLATOR FOR AUTOMATIC SWITCHING
63A 4P MCCB
3.5CX35 Sq.mm Arm PVC Al FRLS CABLE
FROM MLDB
CKT NO. | FITTINGS TYPE | UNIT LOAD | QTY | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | C | 174 | 5 | 870 | | | 1,34,137,142,143,148
T1 | C | 174 | 5 | 870 | | | 1,35,138,141,144,147
B1 | C | 174 | 4 | | 696 | | 1,36,139,140,145
TOTAL LOAD | | 14 | 870 | 870 | 696 |
CKT NO. | FITTINGS TYPE | UNIT LOAD | QTY | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | C | 174 | 6 | 1044 | | | 1,98,119,122,125,128,131
T1 | C | 174 | 6 | | 1044 | | 1,97,120,123,126,129,132
B1 | C | 174 | 6 | | | 1044 | 1,99,121,124,127,130,133
TOTAL LOAD | | 18 | 1044 | 1044 | 1044 |
SLP-1
PUMP PADDING AREA
R Y B N
32A 4P MCB
4CX16 Sq.mm PVC Al. ARMOURED FRLS CABLE
63A CONTACTOR WITH ISOLATOR FOR AUTOMATIC SWITCHING
63A 4P MCCB
3.5CX35 Sq.mm Arm PVC Al FRLS CABLE
FROM MLDB
SPARE
CKT NO. | FITTINGS TYPE | UNIT LOAD | QTY | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
B1 | E | 174, 88 | 5, 1 | 958 | | | 1,3,4,7,7.1,10,1,11,2,1
T1 | E | 174, 88 | 3, 1 | | 958 | | 1,2,13,2,13,1,1,14,2,15
B1 | E | 174, 88 | 5, 2 | | | 1044 | 1,3,8,2,9,1,12,1,15,2,15,2,16
TOTAL LOAD | | 15, 4 | 958 | 958 | 1044 |
CKT NO. | FITTINGS TYPE | UNIT LOAD | QTY | LOAD CONNECTED R Y B | LIGHT FIXTURE CONNECTED
R2 | E | 174 | 4 | 696 | | | 1,40,1,51,1,54,1,57
Y1 | E | 174,88 | 4, 1 | | 910 | | 1,41,1,52,1,55,1,58
B2 | E | 174,88 | 3, 1 | | | 870 | 1,30,1,53,1,56,1,59
TOTAL LOAD | | 11, 2 | 696 | 870 | 870 |
Generally Approved
S.E. XEN KFW Projects RRVPNL JAIPUR
SIEMENS
CONTROL COPY
Copy No. | Rev. No. | Release By | Date
2 | 0 | PM / TPMT | 17-11-16
This Supersedes Previous Rev. No.....
Previous Rev. documents must be destroyed
Project Doc. No. P-90925-B-C1-8751-200-0
Scale 1:1000
CUSTOMER : RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED.
PROJECT : 400/220KV JAISALMER-2 AIS SUBSTATION
SIEMENS LIMITED , GURGAON
Date 16.11.2016
Drawn GB
Appr. GB
Norm KTV
DRG. TITLE : OUTDOOR ILLUMINATION PLAN LAYOUT & DISTRIBUTION - 400/220kV
Rev. 0
DRG. NO. : (1)-G71770-AC200-L251-001-00
Sheet 2 OF 2
0 First Issue 16.11.16

OVERALL GENERAL ARRANGEMENT LAYOUT - PLAN
400/220kV JAISALMER-2 SUBSTATION




KEY PLAN
(SCALE: 1:4000)

| BILL OF QUANTITY - 400kV EQUIPMENT | | |
|---|---|---|
| DESCRIPTION | SYMBOL | QTY. |
| BPI(EXCLUDING WT & ISO) | | 04 |
| LIGHTNING ARRESTOR(1ϕ) | | 03 |
| CVT(P)(1ϕ) | | 03 |
| WAVE TRAP(1ϕ) | | 02 |
| CIRCUIT BREAKER(3ϕ) | | 01 |
| CURRENT TRANSFORMER(P)(1ϕ) | | 06 |
| ISOLATOR WITH 1 E/S(3ϕ) | | 01 |
| ISOLATOR WITH 2 E/S(3ϕ) | | 01 |

| BILL OF QUANTITY - 220kV EQUIPMENT | | |
|---|---|---|
| DESCRIPTION | SYMBOL | QTY. |
| BPI (EXCLUDING WT & ISOLATOR) | | 19 |
| LIGHTNING ARRESTOR(1ϕ) | | 06 |
| CVT(P)(1ϕ) | | 06 |
| CVT(M)(1ϕ) | | 06 |
| WAVE TRAP(1ϕ) | | 04 |
| CIRCUIT BREAKER(3ϕ) | | 02 |
| CURRENT TRANSFORMER(P)(1ϕ) | | 06 |
| CURRENT TRANSFORMER(M)(1ϕ) | | 06 |
| ISOLATOR WITHOUT E/S(3ϕ) | | 02 |
| *T-ISOLATOR WITHOUT E/S(3ϕ)* | | *02* |
| ISOLATOR WITH 1 E/S(3ϕ) | | 02 |
| ISOLATOR WITH 2 E/S(3ϕ) | | 02 |

LEGENDS:

UNDER PRESENT SCOPE

EXISTING/NOT IN SIEMENS SCOPE

GENERAL NOTES:-

1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
2. LAYOUT IS DEVELOPED AS PER EXISTING DRAWINGS RECEIVED FROM CLIENT.
3. LOCATIONS OF BAY MARSHALLING KIOSK & AC KIOSK ARE TENTATIVE AND FOR DETAILS REFER CONCEPTUAL CABLE TRENCH LAYOUT DRAWING NO.- XXXX.
4. PHASE SEQUENCE SHOWN IS AS PER EXISTING LAYOUT.
5. LOCATION OF WT SHOWN ARE INDICATIVE, SITE MAY RELOCATE THESE EQUIPMENTS IN OTHER PHASES.
6. SUPPLY, ERECTION AND TERMINATION OF CONDUCTOR, SHIELD WIRE & ERECTION HARDWARE BETWEEN DEAD END TOWER AND SUBSTATION GANTRY ARE NOT IN SCOPE OF SIEMENS, HOWEVER ONLY SUPPLY OF TENSION HARDWARE FOR LINE SIDE CONDUCTOR & SHIELD WIRE IS UNDER PRESENT SCOPE.
7. FOUNDATIONS FOR WT ARE TO BE CONSTRUCTED IN ALL THE THREE PHASES.
8. FOR EQUIPMENT INSTALLATION, INDIVIDUAL EQUIPMENT DRAWINGS ARE TO BE REFERRED.

| SYSTEM DESIGN PARAMETER | | | |
|---|---|---|---|
| DESCRIPTION OF PARAMETER | UNIT | 400kV SYSTEM | 220kV SYSTEM |
| MINIMUM CLEARANCES | | | |
| BETWEEN PHASE AND EARTH (PE) | mm | 3500 | 2100 |
| BETWEEN PHASES | mm | 4200 | 2100 |
| SECTION CLEARANCE | mm | 6500 | 5000 |
| HEIGHT OF EQUIPMENT BUS CENTER (ABOVE PLINTH LEVEL) | mm | 8000 | 5500 |
| SPECIFIC CREEPAGE | mm/kV | 25 | 25 |

| CONDUCTOR DETAILS | | |
|---|---|---|
| DESCRIPTION OF EQUIPMENTS | 400kV SYSTEM | 220kV SYSTEM |
| MAIN BUS - I & II | NA | TWIN AAC TARANTULLA |
| TRANSFER BUS | NA | TWIN AAC TARANTULLA |
| JUMPERS, DROPPERS & CROSS OVER BUS | QUAD ACSR MOOSE | SINGLE AAC TARANTULLA |
| EQUIPMENT INTERCONNECTION | QUAD ACSR MOOSE / 4" IPS Al. TUBE | SINGLE AAC TARANTULLA |

REFERENCE DRAWINGS:

| | | |
|---|---|---|
| SINGLE LINE DIAGRAM | - | SINGLE LINE DIAGRAM FOR 400/220kV JAISALMER-2 SUBSTATION EXTENSION DWG. NO.: (1)-G71770-AD202-S151-001-0 - P-090925_E_C1_8831_JAS_0 |
| SUBSTATION LAYOUT | - | OVERALL GENERAL ARRANGEMENT LAYOUT FOR EXISTING 400/220kV JAISALMEIR2 SUBSTATION. DWG. NO.: (0)G71770-AC200-L152-001-02 |
| SUBSTATION LAYOUT EXTENSION | - | PLAN & SECTION LAYOUT DRAWING FOR 400/220kV JAISALMER-2 SUBSTATION EXTENSION DWG. NO.: (1)-G71770-AD202-L160-001-0 - P-090925_E_C1_8805_JAS_0 (2#SHEETS) |

Employer's Approval Stamp

Generally Approved
KDPL
KFW Projects
RRVPNL, JAIPUR

| Rev. | Rev. Date | Modification | Drawn By | Created By | Approved By |
|---|---|---|---|---|---|
| 0 | 2018.08.29 | FIRST SUBMISSION | SKA | GB | NYK |

Drawing/Document Number: (0)-G71770-AD202-L160-001-0 - P-090925_E_C1_8804_JAS_0

Customer: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED.

Project: 400/220kV JAISALMER-2 AIS SUBSTATION EXTENSION

| Scale | Paper Size | Sign. | Date |
|---|---|---|---|
| 1:500 | A0 | | |
| Responsible Dept. | Drawn By | | 2018.08.29 |
| EMTS | SKA | | |
| SIEMENS | Created By | | 2018.08.29 |
| | GB | | |
| | Approved By | | 2018.08.29 |
| | NYK | | |

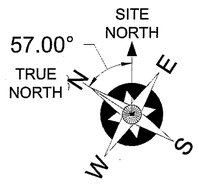
NOA No.: RVPN/SE(C-II)/XEN-3/KfW/ICB-1(Addl/1) dt.. 27.08.2018

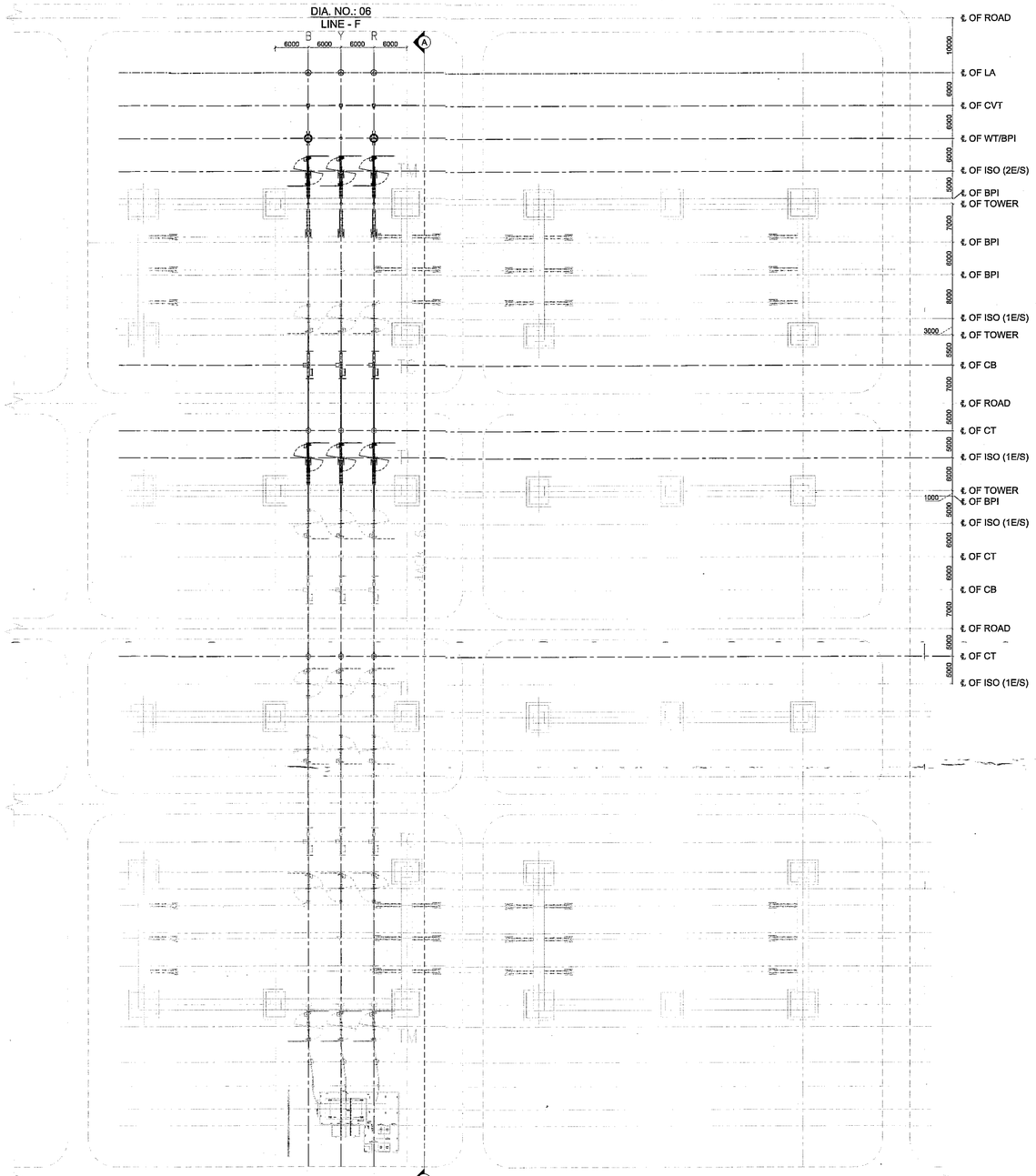
| Document Type | Document Designation |
|---|---|
| LAYOUT | C1_8804_JAS |
| Title | Document Tree |
| OVERALL GENERAL ARRANGEMENT LAYOUT DRAWING FOR 400/220kV JAISALMER-2 AIS S/S EXTN. | P-090925_E_C1_8804_JAS |

| Location | JAISALMER |
|---|---|
| SUB STATION TYPE | AIS SUBSTATION EXTN. |
| VOLTAGE LEVEL | 400/220kV |

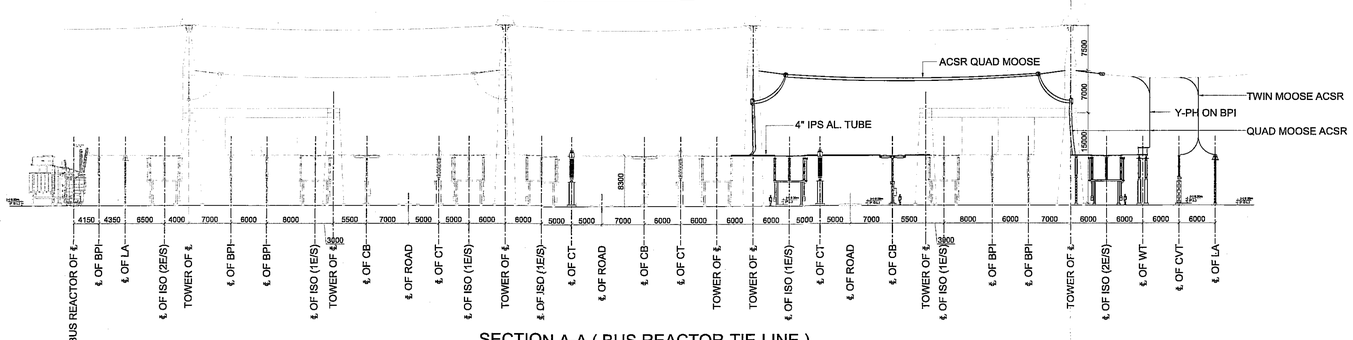
Released for: PRELIMINARY / ENGINEERING APPROVAL / CONSTRUCTION

| Rev. | Date of Issue | Language | Sheet |
|---|---|---|---|
| 0 | 2018.08.29 | EN | 01 of 01 |

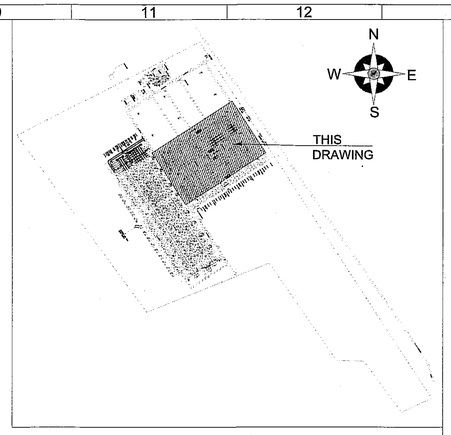



400kV SWITCHYARD PLAN




SECTION A-A ( BUS REACTOR-TIE-LINE )




KEY PLAN
(SCALE: 1:700)

| BILL OF QUANTITY - 400kV EQUIPMENT | | |
|---|---|---|
| DESCRIPTION | SYMBOL | QTY. |
| BPI(EXCLUDING WT & ISO) | | 04 |
| LIGHTNING ARRESTOR(1ϕ) | | 03 |
| CVT(P)(1ϕ) | | 03 |
| WAVE TRAP(1ϕ) | | 02 |
| CIRCUIT BREAKER(3ϕ) | | 01 |
| CURRENT TRANSFORMER(P)(1ϕ) | | 06 |
| ISOLATOR WITH 1 E/S(3ϕ) | | 01 |
| ISOLATOR WITH 2 E/S(3ϕ) | | 01 |

## LEGENDS:

——— UNDER PRESENT SCOPE

- - - - EXISTING/NOT IN SIEMENS SCOPE

## GENERAL NOTES:-

1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
2. LAYOUT IS DEVELOPED AS PER EXISTING DRAWINGS RECEIVED FROM CLIENT.
3. LOCATIONS OF BAY MARSHALLING KIOSK & AC KIOSK ARE TENTATIVE AND FOR DETAILS REFER CONCEPTUAL CABLE TRENCH LAYOUT DRAWING NO.- XXXX.
4. PHASE SEQUENCE SHOWN IS INDICATIVE AND IT SHALL BE VERIFIED AT SITE DURING EXECUTION, ALONG WITH TRANSMISSION LINE.
5. LOCATION OF WT SHOWN ARE INDICATIVE, SITE MAY RELOCATE THESE EQUIPMENTS IN OTHER PHASES.
6. SUPPLY, ERECTION AND TERMINATION OF CONDUCTOR, SHIELD WIRE & ERECTION HARDWARE BETWEEN DEAD END TOWER AND SUBSTATION GANTRY ARE NOT IN SCOPE OF SIEMENS, HOWEVER ONLY SUPPLY OF TENSION HARDWARE FOR LINE SIDE CONDUCTOR & SHIELD WIRE IS UNDER PRESENT SCOPE.
7. FOUNDATIONS FOR WT ARE TO BE CONSTRUCTED IN ALL THE THREE PHASES.
8. FOR EQUIPMENT INSTALLATION, INDIVIDUAL EQUIPMENT DRAWINGS ARE TO BE REFERRED.

| SYSTEM DESIGN PARAMETER | | |
|---|---|---|
| DESCRIPTION OF PARAMETER | UNIT | 400kV SYSTEM |
| MINIMUM CLEARANCES | | |
| BETWEEN PHASE AND EARTH (PE) | mm | 3500 |
| BETWEEN PHASES | mm | 4200 |
| SECTION CLEARANCE | mm | 6500 |
| HEIGHT OF EQUIPMENT BUS CENTER (ABOVE PLINTH LEVEL) | mm | 8000 |
| SPECIFIC CREEPAGE | mm/kV | 25 |

| CONDUCTOR DETAILS | |
|---|---|
| DESCRIPTION OF EQUIPMENTS | 400kV SYSTEM |
| MAIN BUS - I & II | NA |
| TRANSFER BUS | NA |
| JUMPERS, DROPPERS & CROSS OVER BUS | QUAD ACSR MOOSE |
| EQUIPMENT INTERCONNECTION | QUAD ACSR MOOSE / 4" IPS Al. TUBE |

## REFERENCE DRAWINGS:

| | | |
|---|---|---|
| SINGLE LINE DIAGRAM | - | SINGLE LINE DIAGRAM FOR 400/220kV JAISALMER-2 SUBSTATION EXTENSION DWG. NO.: (1)-G71770-AD202-S151-001-0 - P-090925_E_C1_8831_JAS_0 |
| SUBSTATION LAYOUT | - | PLAN & SECTION 400kV LAYOUT FOR EXISTING 400/220kV JAISALMEIR2 S/S. DWG. NO.: (0)G71770-AC200-L152-002-04 |
| SUBSTATION LAYOUT EXTENSION | - | OVERALL GENERAL ARRANGEMENT LAYOUT FOR 400/220kV JAISALMER-2 SUBSTATION EXTENSION. DWG. NO.: (1)-G71770-AD202-L160-001-0 - P-090925_E_C1_8804_JAS_0. |

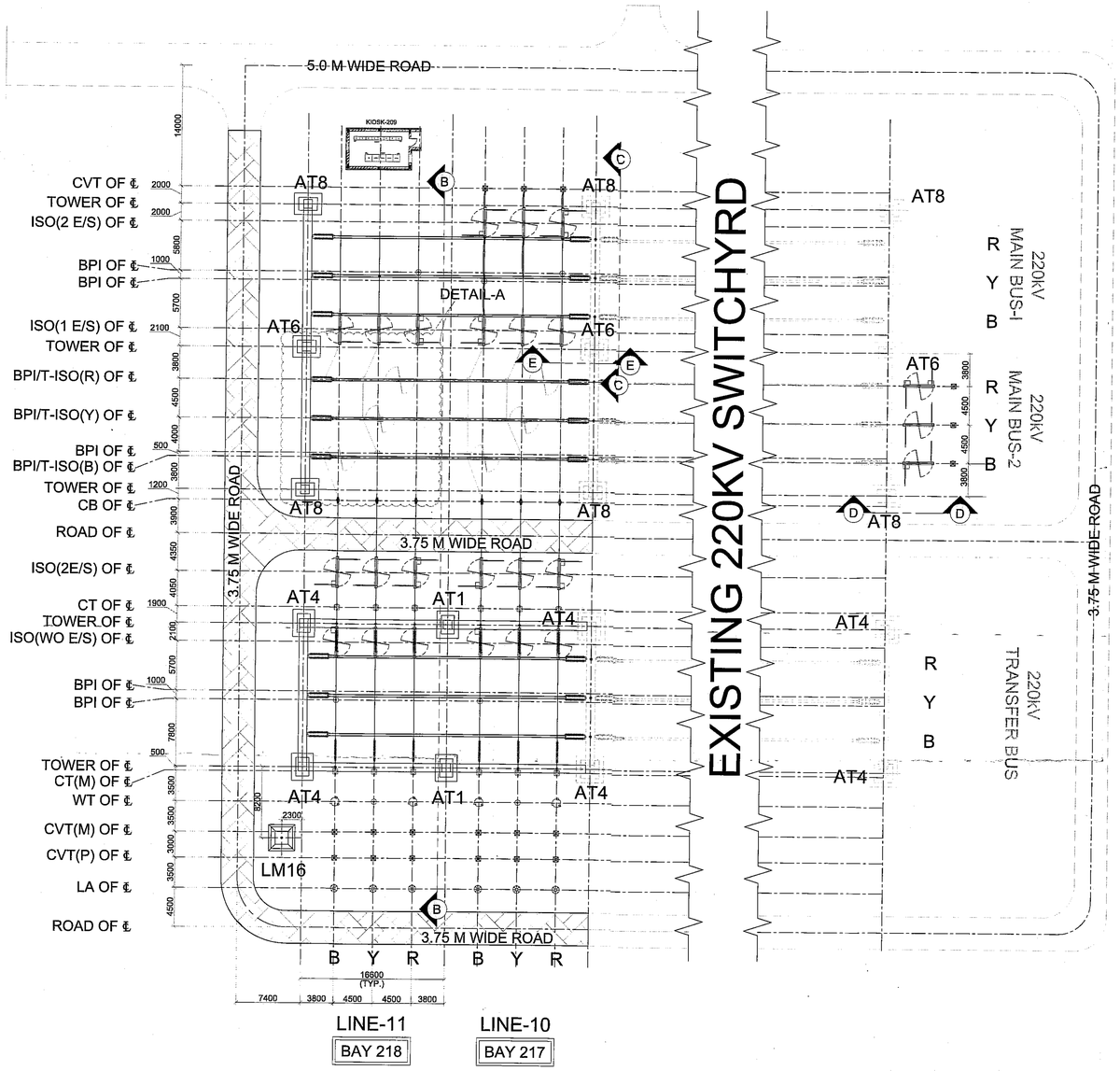
Employer's Approval Stamp

| Rev. | Rev. Date | Modification | Drawn By | Created By | Approved By |
|---|---|---|---|---|---|
| D | | | | | |
| C | | | | | |
| B | | | | | |
| A | | | | | |
| 0 | 2018.08.29 | FIRST SUBMISSION | SKA | GB | NYK |

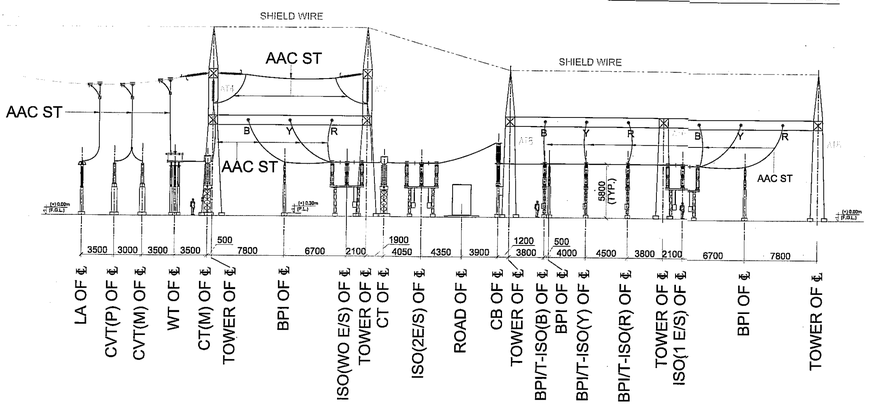
| | |
|---|---|
| Drawing/Document Number | (1)-G71770-AD202-L160-001-0 - P-090925_E_C1_8805_JAS_0 |
| Customer | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. |
| Project | 400/220kV JAISALMER-2 AIS SUBSTATION EXTENSION |
| LOCATION | JAISALMER |
| SUB STATION TYPE | AIS SUBSTATION EXTN. |
| VOLTAGE LEVEL | 400/220kV |
| Released for | PRELIMINARY |
| | ENGINEERING APPROVAL ✓ |
| | CONSTRUCTION |

| | | | | |
|---|---|---|---|---|
| Scale 1:500 | Paper Size A1 | Sign. | Date | NOA No.: RVPN/SE(C-II)/XEN-3/KIW/CB-1/Addl/1) dt., 27.08.2018 |
| Responsible Dept. EMTS | Drawn By SKA | | 2018.08.29 | Document Type LAYOUT |
| SIEMENS | Created By GB | | 2018.08.29 | Title PLAN & SECTION LAYOUT DRAWING 400/220kV JAISALMER-2 AIS S/S EXTN. |
| | Approved By NYK | | 2018.08.29 | |

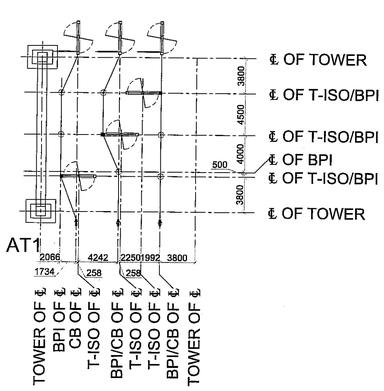
| Document Designation | Document Tree | Rev. | Date of issue | Language | Sheet |
|---|---|---|---|---|---|
| C1_8805_JAS | P-090925_E_C1_8805_JAS | 0 | 2018.08.29 | EN | 01 of 02 |



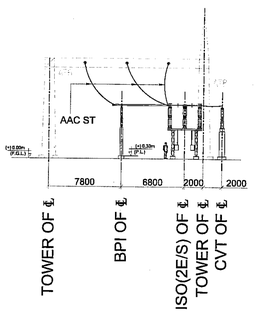

220kV SWITCHYARD PLAN



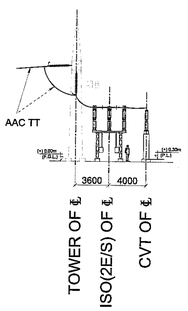

SECTION B-B - LINE BAY(TYPICAL)



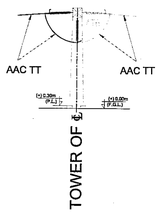

DETAIL-A




SECTION VIEW C-C




SECTION VIEW D-D

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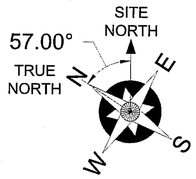
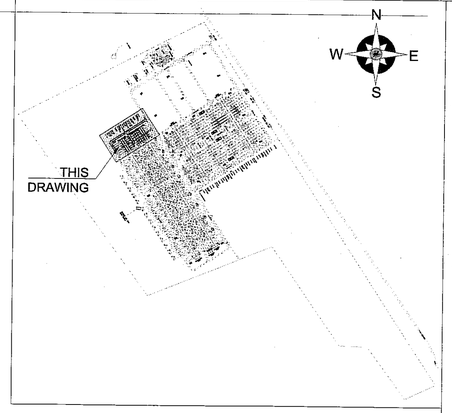



KEY PLAN
(SCALE: 1:700)

## BILL OF QUANTITY - 220kV EQUIPMENT

| DESCRIPTION | SYMBOL | QTY. |
|---|---|---|
| BPI (EXCLUDING WT & ISOLATOR) | ⊙ | 19 |
| LIGHTNING ARRESTOR(1ϕ) | ⊗ | 06 |
| CVT(P)(1ϕ) | ⊠ | 06 |
| CVT(M)(1ϕ) | ⊠ | 06 |
| WAVE TRAP(1ϕ) | | 04 |
| CIRCUIT BREAKER(3ϕ) | | 02 |
| CURRENT TRANSFORMER(P)(1ϕ) | | 06 |
| CURRENT TRANSFORMER(M)(1ϕ) | | 06 |
| ISOLATOR WITHOUT E/S(3ϕ) | | 02 |
| T-ISOLATOR WITHOUT E/S(3ϕ) | | 02 |
| ISOLATOR WITH 1 E/S(3ϕ) | | 02 |
| ISOLATOR WITH 2 E/S(3ϕ) | | 02 |

## LEGENDS:

——— UNDER PRESENT SCOPE

- - - - - EXISTING/NOT IN SIEMENS SCOPE

## GENERAL NOTES:-

1. ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
2. LAYOUT IS DEVELOPED AS PER EXISTING DRAWINGS RECEIVED FROM CLIENT.
3. LOCATIONS OF BAY MARSHALLING KIOSK & AC KIOSK ARE TENTATIVE AND FOR DETAILS REFER CONCEPTUAL CABLE TRENCH LAYOUT DRAWING NO.- XXXX.
4. FOR STRUCTURES REFER STRUCTURAL LAYOUT DRAWING.
5. PHASE SEQUENCE SHOWN IS AS PER EXISTING LAYOUT.
6. LOCATION OF WT SHOWN ARE INDICATIVE, SITE MAY RELOCATE THESE EQUIPMENTS IN OTHER PHASES.
7. SUPPLY, ERECTION AND TERMINATION OF CONDUCTOR, SHIELD WIRE & ERECTION HARDWARE BETWEEN DEAD END TOWER AND SUBSTATION GANTRY ARE NOT IN SCOPE OF SIEMENS, HOWEVER ONLY SUPPLY OF TENSION HARDWARE FOR LINE SIDE CONDUCTOR & SHIELD WIRE IS UNDER PRESENT SCOPE.
8. FOUNDATIONS FOR WT ARE TO BE CONSTRUCTED IN ALL THE THREE PHASES.
9. FOR EQUIPMENT INSTALLATION, INDIVIDUAL EQUIPMENT DRAWINGS ARE TO BE REFERED.

## SYSTEM DESIGN PARAMETER

| DESCRIPTION OF PARAMETER | UNIT | 220kV SYSTEM |
|---|---|---|
| MINIMUM CLEARANCES | | |
| BETWEEN PHASE AND EARTH (PE) | mm | 2100 |
| BETWEEN PHASES | mm | 2100 |
| SECTION CLEARANCE | mm | 5000 |
| HEIGHT OF EQUIPMENT BUS CENTER (ABOVE PLINTH LEVEL) | mm | 5500 |
| SPECIFIC CREEPAGE | mm/kV | 25 |

## CONDUCTOR DETAILS

| DESCRIPTION OF EQUIPMENTS | 220kV SYSTEM |
|---|---|
| MAIN BUS - I & II | TWIN AAC TARANTULLA |
| TRANSFER BUS | TWIN AAC TARANTULLA |
| JUMPERS, DROPPERS & CROSS OVER BUS | SINGLE AAC TARANTULLA |
| EQUIPMENT INTERCONNECTION | SINGLE AAC TARANTULLA |

## REFERENCE DRAWINGS:

| | | |
|---|---|---|
| SINGLE LINE DIAGRAM | - | SINGLE LINE DIAGRAM FOR 400/220kV JAISALMEIR2 SUBSTATION EXTENSION DWG. NO.: (1)-G71770-AD202-S151-001-0 - P-090925_E_C1_8831_JAS_0 |
| SUBSTATION LAYOUT | - | PLAN & SECTION 220kV LAYOUT FOR EXISTING 400/220kV JAISALMEIR2 S/S. DWG. NO.: (1)G71770-AD200-L152-003-03 |
| SUBSTATION LAYOUT EXTENSION | - | OVERALL GENERAL ARRANGEMENT LAYOUT FOR 400/220kV JAISALMER-2 SUBSTATION EXTENSION. DWG. NO.: (1)-G71770-AD202-L160-001-0 - P-090925_E_C1_8804_JAS_0. |

Employer's Approval Stamp

Generally Approved
KFW Projects
RVPNL JAIPUR

| Rev. | Rev. Date | Modification | Drawn By | Created By | Approved By |
|---|---|---|---|---|---|
| 0 | 2018.08.29 | FIRST SUBMISSION | SKA | GB | NYK |

Drawing/Document Number: (1)-G71770-AD202-L160-001-0 - P-090925_E_C1_8805_JAS_0

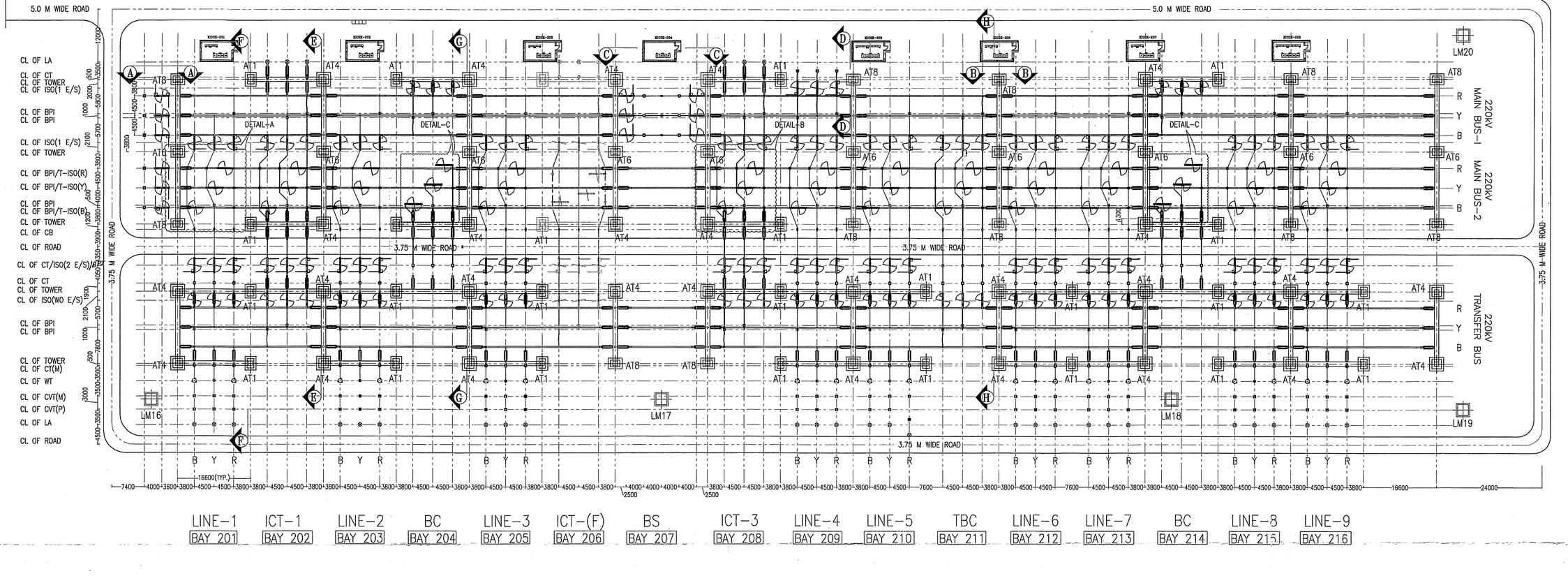
Customer: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED.

Project: 400/220kV JAISALMER-2 AIS SUBSTATION EXTENSION

LOCATION: JAISALMER
SUB STATION TYPE: AIS SUBSTATION EXTN.
VOLTAGE LEVEL: 400/220kV

Released for: PRELIMINARY / ENGINEERING APPROVAL ✓ / CONSTRUCTION

| | | | | |
|---|---|---|---|---|
| Scale: 1:325 | Paper Size: A1 | Sign. | Date | NOA No.: RVPN/SE(C-II)/XEN-3/KW/ICB-1/Addl/1) dt., 27.08.2018 |
| Responsible Dept.: EMTS | Drawn By: SKA | | 2018.08.29 | Document Type: LAYOUT; Document Designation: C1_8805_JAS |
| | Created By: GB | | 2018.08.29 | Title: PLAN & SECTION LAYOUT DRAWING 400/220kV JAISALMER-2 AIS S/S EXTN.; Document Tree: P-090925_E_C1_8805_JAS |
| SIEMENS | Approved By: NYK | | 2018.08.29 | Rev.: 0; Date of Issue: 2018.08.29; Language: EN; Sheet: 02 of 02 |




## GENERAL NOTES:-

(1) ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.

(2) MINIMUM CLEARANCES ADOPTED FOR 220kV SYSTEM AS PER SPECIFICATIONS:

| | 220KV |
|---|---|
| BETWEEN PHASES | 2100MM |
| BETWEEN PHASES-EARTH | 2100MM |
| SECTIONAL CLEARANCES | 5000MM |
| HEIGHT OF EQUIPMENT BUS CENTRE (ABOVE PLINTH LEVEL) | 5500MM |
| CREEPAGE DISTANCE | 25MM/KV |

(3) LAYOUT IS DEVELOPED AS PER TENDOR DRAWINGS RECEIVED FROM CLIENT.

(4) CONDUCTOR DETAILS:-

| | 220KV |
|---|---|
| MAIN BUS-I & II | TWIN AAC TARANTULLA |
| TRANSFER BUS | TWIN AAC TARANTULLA |
| JUMPERS,DROPPERS & CROSS OVER BUS | TWIN/SINGLE AAC TARANTULLA |
| EQUIPMENT INTERCONNECTION | 4" IPS AL. TUBE/ TWIN/SINGLE AAC TARANTULLA |

(5) LOCATIONS OF BAY MARSHALLING KIOSK & AC KIOSK ARE TENTATIVE AND FOR DETAILS REFER CONCEPTUAL CABLE TRENCH LAYOUT DRAWING NO.- XXXX

(6) FOR STRUCTURES REFER STRUCTURAL LAYOUT DRAWING.

(7) PHASE SEQUENCE SHOWN IS INDICATIVE AND IT SHALL BE VERIFIED AT SITE DURING EXECUTION, ALONG WITH TRANSMISSION LINE.

(8) LOCATION OF WT SHOWN ARE INDICATIVE, SITE MAY RELOCATE THESE EQUIPMENTS IN OTHER PHASES.

(9) SUPPLY, ERECTION AND TERMINATION OF CONDUCTOR, SHIELD WIRE & ERECTION HARDWARE BETWEEN DEAD END TOWER AND SUBSTATION GANTRY ARE NOT IN SCOPE OF SIEMENS, HOWEVER ONLY SUPPLY OF TENSION HARDWARE FOR LINE SIDE CONDUCTOR & SHIELD WIRE IS UNDER PRESENT SCOPE.

(10) FOUNDATIONS FOR WT ARE TO BE CONSTRUCTED IN ALL THE THREE PHASES.

(11) LOCATION OF LM SHOWN ARE INDICATIVE ONLY & MAY BE RELOCATED DURING DETAILED ENGINEERING.

(12) ALL TENDOM ISOLATOR & ASSOCIATED BPIS ARE ON HOLD & WILL BE FINALISED AFTER APPROVAL OF EQUIPMENT DRAWING.

(13) THE TOP OF THE VEHICLE WILL BE MAXIMUM 3200 MM ALLOW FROM ROAD TOP.

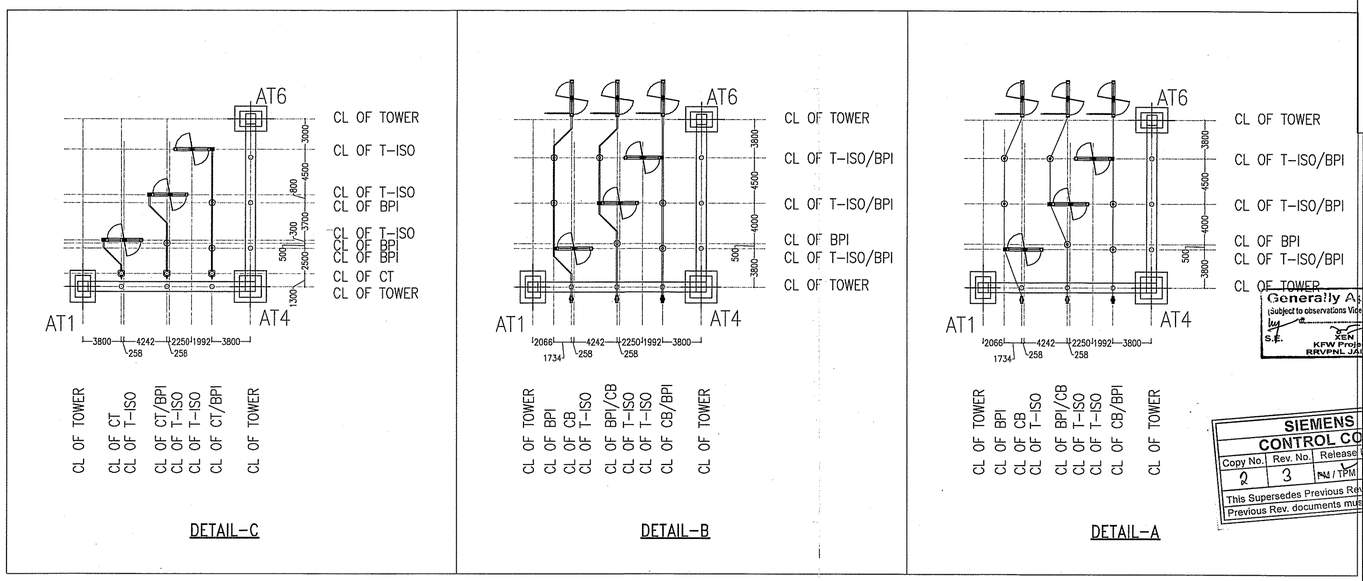
(14) ANTIWEED TREATMENT & STONE SPREADING IN FUTURE BAYS/AREA WITHIN FENCE IS NOT IN SIEMENS SCOPE.

(15) * MARKED QTY IN BOQ IS NOT MATCHING WITH PRICE SCHEDULE, HENCE NEED TO BE AMENDED.

(16) FOR EQUIPMENT INSTALLATION, INDIVIDUAL EQUIPMENT DRAWINGS ARE TO BE REFERED.

## SYMBOLOGY :

| DESCRIPTION | 220KV SYMBOL | 220KV QTY. |
|---|---|---|
| BPI(EXCLUDING WT & ISOLATOR) | ⊙ | 125 |
| LIGHTNING ARRESTOR(1-PH.) | ⊗ | 33 |
| CVT(P)(1-PH.) | ⊠ | 36 |
| CVT(M)(1-PH.) | ⊠ | 27 |
| WAVE TRAP(1-PH.) | | 18 |
| CIRCUIT BREAKER(3-PH.) | | 15 |
| CURRENT TRANSFORMER(P)(1-PH.) | | 54 |
| CURRENT TRANSFORMER(M)(1-PH.) | | 27 |
| ISOLATOR WITHOUT E/S(3-PH.) | | 12 |
| T-ISOLATOR WITHOUT E/S(3-PH.) | | 14 |
| ISOLATOR WITH 1 E/S(3-PH.) | | 16 |
| ISOLATOR WITH 2 E/S(3-PH.) | | 14 |




Generally Approved (Subject to observations Vide Letter No. ....) S.E. XEN KFW Projects RVPNL JAIPUR

SIEMENS CONTROL COPY

| Copy No. | Rev. No. | Released By | Date |
|---|---|---|---|
| 2 | 3 | 1PM / 1PM | 27/6/16 |

This Supersedes Previous Rev. No. 2
Previous Rev. documents must be destroyed

REFERENCE DRAWINGS:

RVPN/KFW/ICB-I/DRG-1(A) – TENDER SINGLE LINE DIAGRAM FOR 400/220kV JAISALMEIR2 S/S.
RVPN/KFW/ICB-I/DRG-2(A) – TENDER LAYOUT OF 400/220kV JAISALMEIR2 S/S.
(0)G71770-AD200-L152-001-02 – OVERALL GENERAL ARRANGEMENT DRAWING OF 400/220kV JAISALMEIR2 S/S.

LEGENDS :

FUTURE/NOT IN SIEMENS SCOPE OF SUPPLY
UNDER PRESENT SCOPE

| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. P90925-E-C1-8808-200-3 | | | CUSTOMER: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | | |
| Scale 1:450 | | | | | |
| PROJECT : 400/220KV JAISALMER-2 AIS SUBSTATION | | | SIEMENS LIMITED , GURGAON | | |
| | | | Date 29.12.2015 | DRG. TITLE : PLAN & SECTION LAYOUT - 220KV | Rev. 3 |
| | | | Drawn GB/SS | | |
| 3 | due to change in OGA 10.06.16 | GB | Appr. GB | | |
| 2 | Revised as per customer comments 29.02.16 | GB | Norm. KTV | | |
| 1 | Revised as per customer comments 15.01.16 | GB | | | |
| 0 | First Issue 29.12.15 | GB | DRG. No. (1)G71770-AD200-L152-003-03 | | Sheet. 1OF2 |
| Rev. | Remarks | Date | Name | LOA No. RVPN/SE(P&P)/XEN/KFW/ICB-1D 1771 dated 16.10.2015 | |

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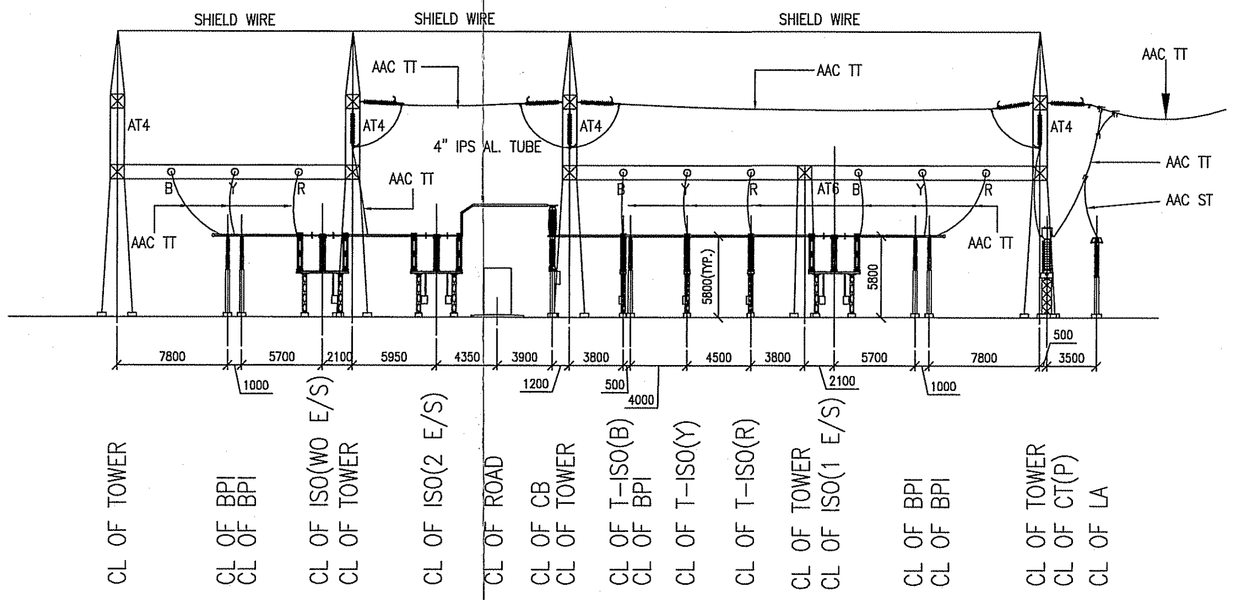
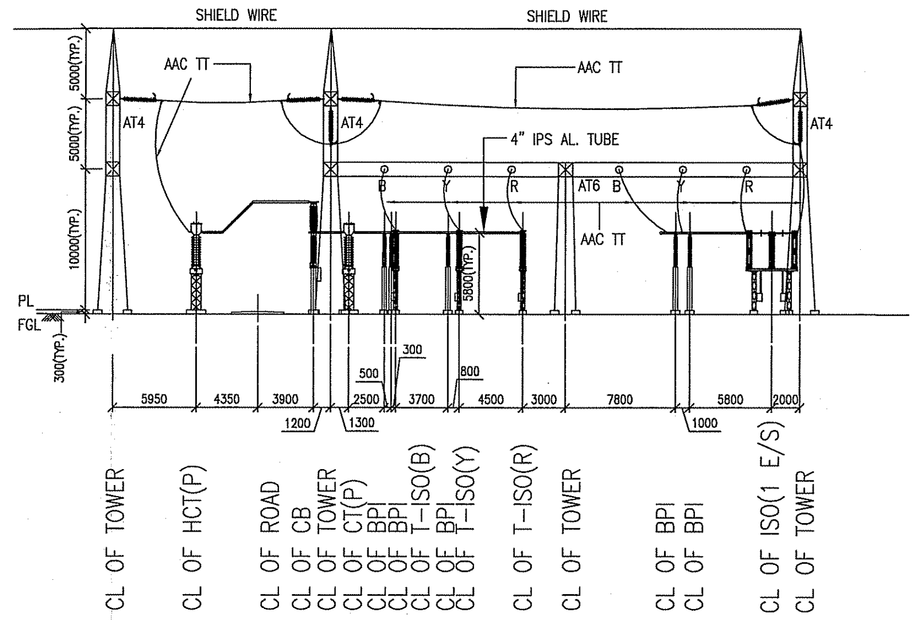
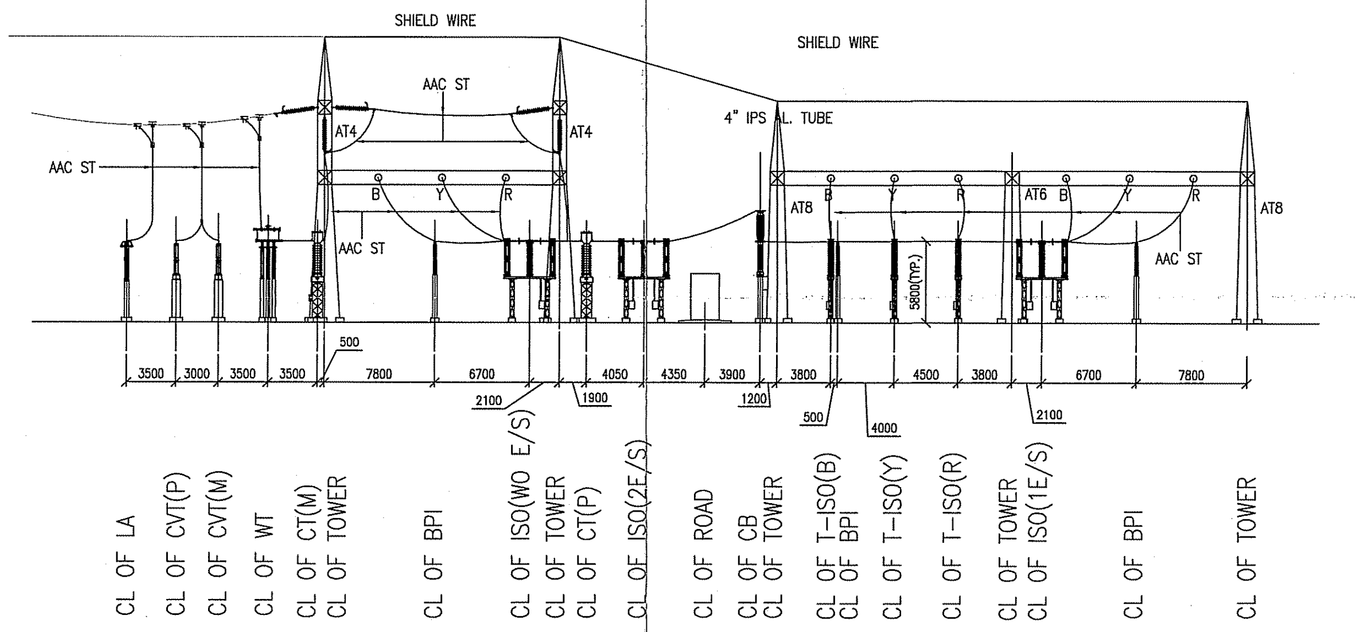


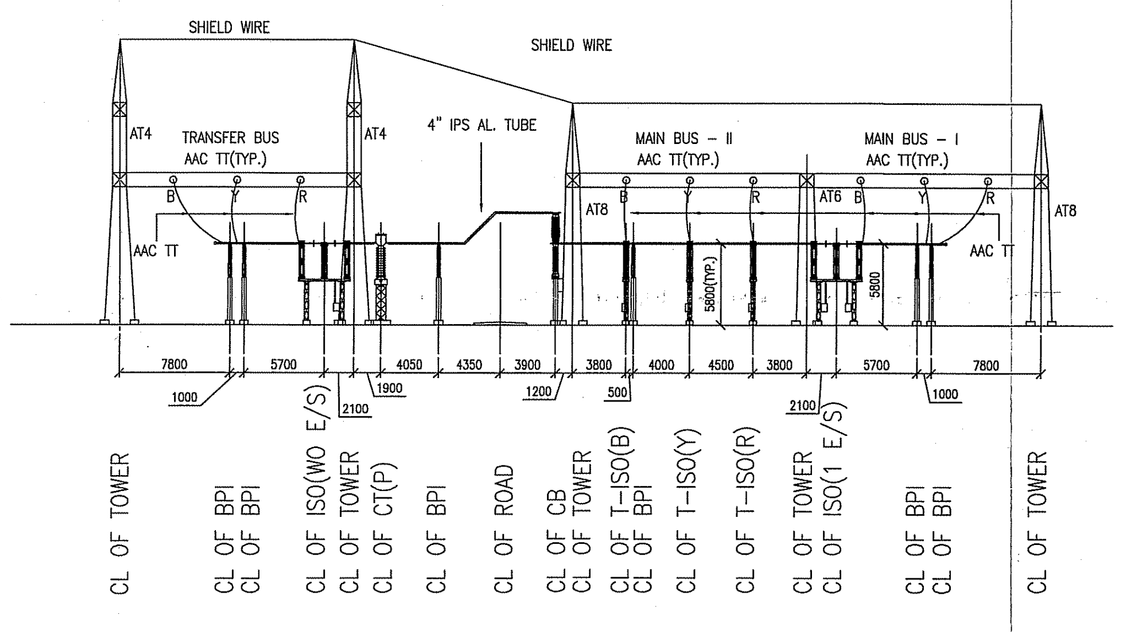

SECTION E–E – TRANSFORMER BAY(TYPICAL)



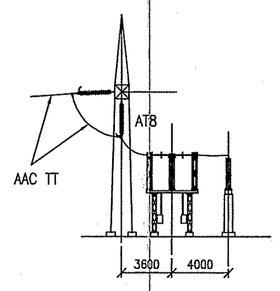

SECTION G–G – BUS COUPLER BAY(TYPICAL)



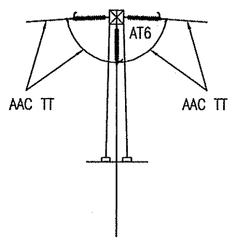

SECTION F–F – LINE BAY(TYPICAL)



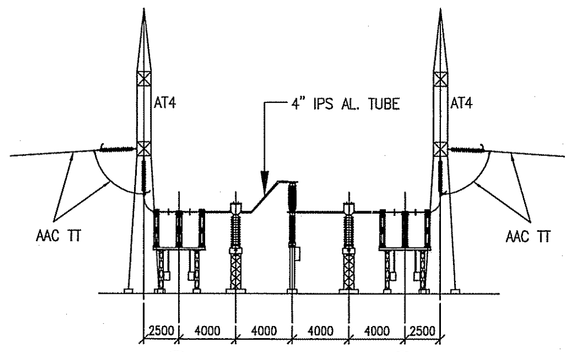

SECTION H–H – TRANSFER BUS COUPLER BAY



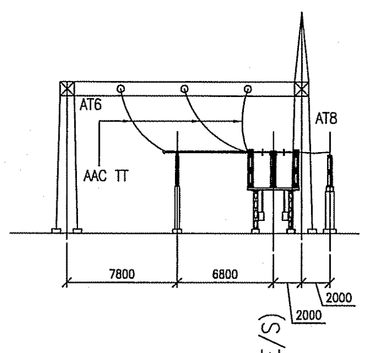

SECTION VIEW A–A




SECTION VIEW B–B




SECTION VIEW C–C




SECTION VIEW D–D

GENERAL NOTES:–

(1) ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.

REFERENCE DRAWINGS:

| | |
|---|---|
| RVPN/KFW/ICB–I/DRG–1(A) | – TENDER SINGLE LINE DIAGRAM FOR 400/220kV JAISALMEIR2 S/S. |
| RVPN/KFW/ICB–I/DRG–2(A | – TENDER LAYOUT OF 400/220kV JAISALMEIR2 S/S. |
| RVPN/KFW/ICB–I/DRG–4(B) | – TENDER SECTION LAYOUT OF 220kV JAISALMEIR2 S/S. |
| (1)G71770–AC200–L152–003–03(SH. 1OF 2) | – PLAN LAYOUT OF 220kV JAISALMEIR2 S/S. |

LEGENDS :

FUTURE/NOT IN SIEMENS SCOPE

UNDER PRESENT SCOPE

ABBREVATIONS :

TT – TWIN TARANTULA ; ST – SINGLE TARANTULA

Generally Approved (Subject to observations Vide Letter No.... dt.... KFW Employer RVPNL)

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|---|---|---|---|
| 2 | 3 | PM / TPM | 27/06/16 |

This Supersedes Previous Rev. No.....2.....
Previous Rev. documents must be destroyed

| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. P90925-E-C1-8808-200-3 | | | CUSTOMER: | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
| Scale 1:300 | | | PROJECT : | 400/220KV JAISALMER-2 AIS SUBSTATION | SIEMENS LIMITED , GURGAON |
| | | | Date 14.12.2015 | DRG. TITLE : PLAN & SECTION LAYOUT - 220KV | Rev. 3 |
| 3 | rev as per OOA rev. | 16.05.16 | GB | Drawn GB/SR | | |
| 2 | Revised as per customer comments | 29.02.16 | GB | Appr. GB | | |
| 1 | Revised as per customer comments | 18.01.16 | GB | Norm KVV | | |
| 0 | First Issue | 14.12.15 | GB | DRG.No. (1)G71770-AC200-L152-003-03 | Sheet. 2OF2 | |
| Rev. | Remarks | Date | Name | LOA No. RVPN/SE(P&P)/XEN/KFW/ICB-1D 1771 dated 16.10.2015 | | |

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## SYMBOLOGY :

| DESCRIPTION | 400KV SYMBOL | QTY. |
|---|---|---|
| BPI(EXCLUDING WT & ISO) | • | 49 |
| LIGHTNING ARRESTOR(1-PH.) | ◎ | 18 |
| CVT(P)(1-PH.) | ⊕ | 15 |
| WAVE TRAP(1-PH.) | ⊛ | 06 |
| CIRCUIT BREAKER(3-PH.) | | 10 |
| CURRENT TRANSFORMER(P)(1-PH.) | ⊗ | 36 |
| ISOLATOR WITH 1 E/S(3-PH.) | | 22 |
| ISOLATOR WITH 2 E/S(3-PH.) | | 08* |

## GENERAL NOTES:-

(1) ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
(2) MINIMUM CLEARANCES ADOPTED FOR 400/220kV SYSTEM AS PER SPECIFICATIONS:

| | |
|---|---|
| | 400KV |
| BETWEEN PHASES | 4200MM |
| BETWEEN PHASES-EARTH | 3500MM |
| HEIGHT OF EQUIPMENT BUS CENTRE (ABOVE PLINTH LEVEL) | 6000MM |
| CREEPAGE DISTANCE | 25MM/KV |

(3) LAYOUT IS DEVELOPED AS PER RENDOM DRAWINGS RECEIVED FROM CLIENT.

| | |
|---|---|
| | 400KV |
| MAIN BUS-I & II | QUAD ACSR MOOSE |
| TRANSFER BUS | NA |
| JUMPERS,DROPPERS & CROSS OVER BUS | TWIN ACSR MOOSE |
| EQUIPMENT INTERCONNECTION | 4" IPS AL TUBE/ TWIN ACSR MOOSE |

(4) CONDUCTOR DETAILS:-
(5) LOCATIONS OF AIR-WATER(AUTO)-WASH-A AS KIOSK ARE TENTATIVE AND FOR DETAILS REFER CONCEPTUAL CABLE TRENCH LAYOUT DRAWING NO:- XXXX
(6) FOR STRUCTURES REFER STRUCTURAL LAYOUT DRAWING.
(7) PHASE SEQUENCE SHOWN IS INDICATIVE AND IT SHALL BE VERIFIED AT SITE DURING EXECUTION.
(8) LOCATION OF VT SHOWN ARE INDICATIVE. SITE MAY RELOCATE THESE EQUIPMENTS IN OTHER PHASES.
(9) SUPPLY, ERECTION AND TERMINATION OF CONDUCTOR, SHIELD WIRE & ERECTION HARDWARE BETWEEN DEAD END TOWER AND SUBSTATION GANTRY ARE NOT IN SCOPE OF SIEMENS HOWEVER ONLY SUPPLY OF TENSION HARDWARE ALONG WITH TRANSMISSION LINE.
(10) SUPPLY OF 500MVA AUTO TRANSFORMER AS WELL AS 125MVAR REACTOR IS NOT IN SIEMENS SCOPE.
(11) LOCATION OF LA SHOWN ARE INDICATIVE & MAY BE RELOCATED DURING DETAILED ENGINEERING.
(12) ISOLATORS OF JKL ARE TO BE CONSIDERED IN ALL LINE THREE PHASES.
(13) INSURGREADER/REACTOR AREA & ASSOCIATED LA ON HOLD & WILL BE ENVISAGED AFTER RECEIVING INPUT DATA FROM CLIENT.
(14) FOR CONTROL ROOM BUILDING, REFER GTP DRG. NO. (X)07117O-A2200-B166-001-00.
(15) " MARKED QTY. IN BOQ IS NOT MATCHING WITH PRICE SCHEDULE, HENCE NEED TO BE AMENDED.
(16) MAIN GATE FOR SUBSTATION ENTRY IS NOT IN SIEMENS SCOPE.
(17) FOR EQUIPMENT INSTALLATION/PLACE WITHIN INDIVIDUAL COMPOUND DIMENSIONS.
(18) WIDTH OF ROAD AROUND THE CONTROL ROOM BUILDING IS 7.5M.

Location of Transformer/Reactor to be Associated LA could be placed after receiving input data.

## REFERENCE DRAWINGS:

RVPN/KFW/ICB-I/DRG-1(A) – TENDER SINGLE LINE DIAGRAM FOR 400/220kV JAISALMER2 S/S.
RVPN/KFW/ICB-I/DRG-2(A) – TENDER LAYOUT OF 400/220kV JAISALMER2 S/S.
GA07117O-A2200-LIP2-01-02 Rev.2 –

| Copy No. | Rev. No. | Releases By | Date |
|---|---|---|---|
| 2 | 3 | Pal / Tpl | 10/5/16 |

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LEGENDS :

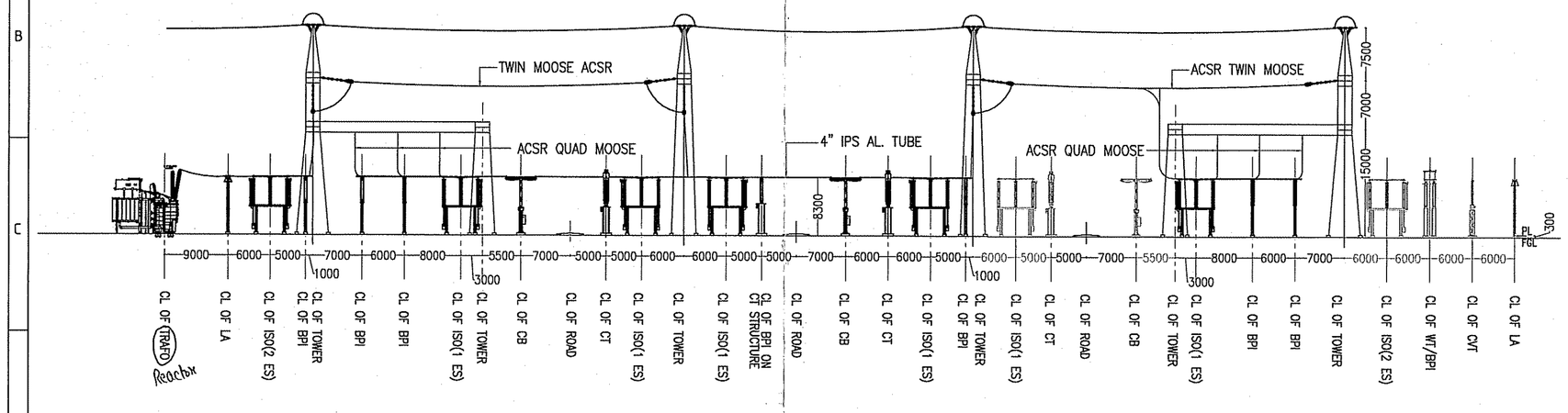
FUTURE/NOT IN SIEMENS SCOPE OF SUPPLY
UNDER PRESENT SCOPE

| | | | | | |
|---|---|---|---|---|---|
| Rev. | Remarks | Date | Name | LOA No. | |
| 0 | Issued for approval | 09.12.2015 | Dheeraj | | RVPN/SE(P&P)/XEN(PM)CE-1D 1771 dated 16.10.2015 |
| 1 | Issued for approval in CAD | 29.02.16 | GB | DRG. No. | 10F2 |
| 2 | Comments incorporated | 29.02.16 | GB | | |
| 3 | Comments incorporated | 31.03.16 | GB | | |
| 4 | Revised layout | 08.12.15 | GB | | |

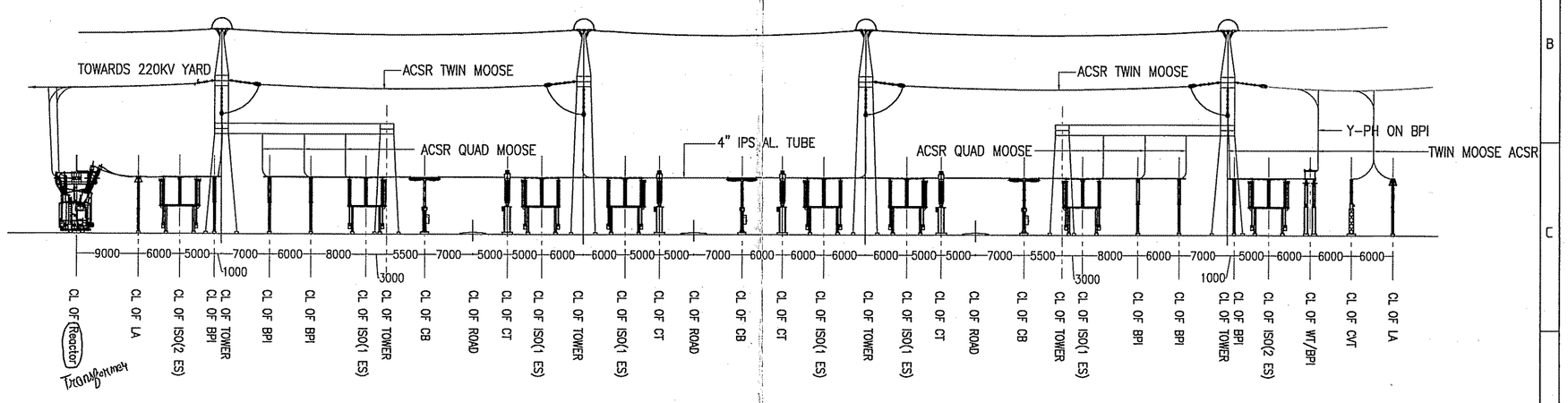
| | | | |
|---|---|---|---|
| PROJECT : | 400/220kV JAISALMER-2 AIS SUBSTATION | Drawn | SIEMENS LIMITED , GURGAON |
| | | Design | |
| | | Approved | |
| | | Sheet No. | |
| DRG. TITLE: | PLAN & SECTION LAYOUT-400KV | Sheets | 3 |
| | | Size | A1 |
| DRG. No. | (1)07117O-AC200-L152-002-03 | | Sheet. |

| | |
|---|---|
| CUSTOMER : | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. |
| Project Doc. No. | P09025-E-C1-1806-200-3 |
| Scale | 1:500 |

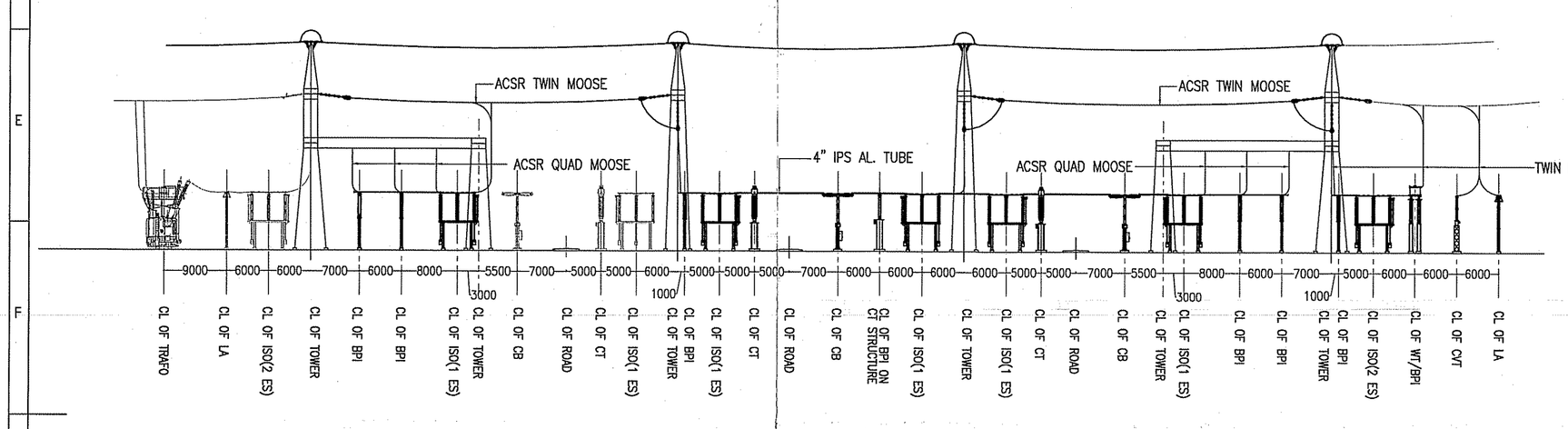
Govt. Fully Approved
Subject to observations Vide Letter No.
Date
XEN
RVPNL, JAIPUR
XEN



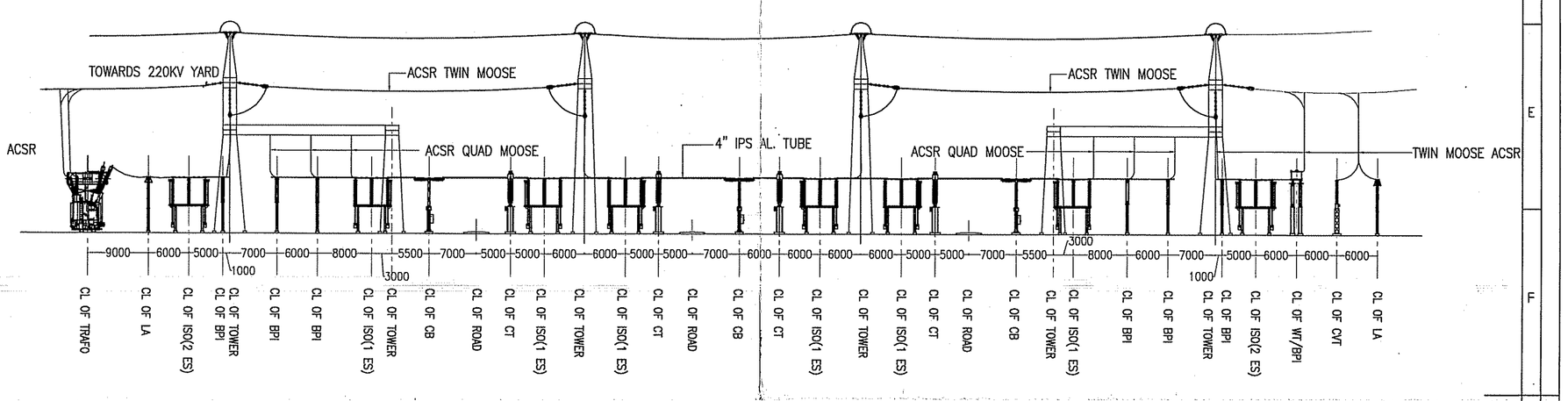

SECTION B–B ( BUS REACTOR–TIE–LINE(F) )



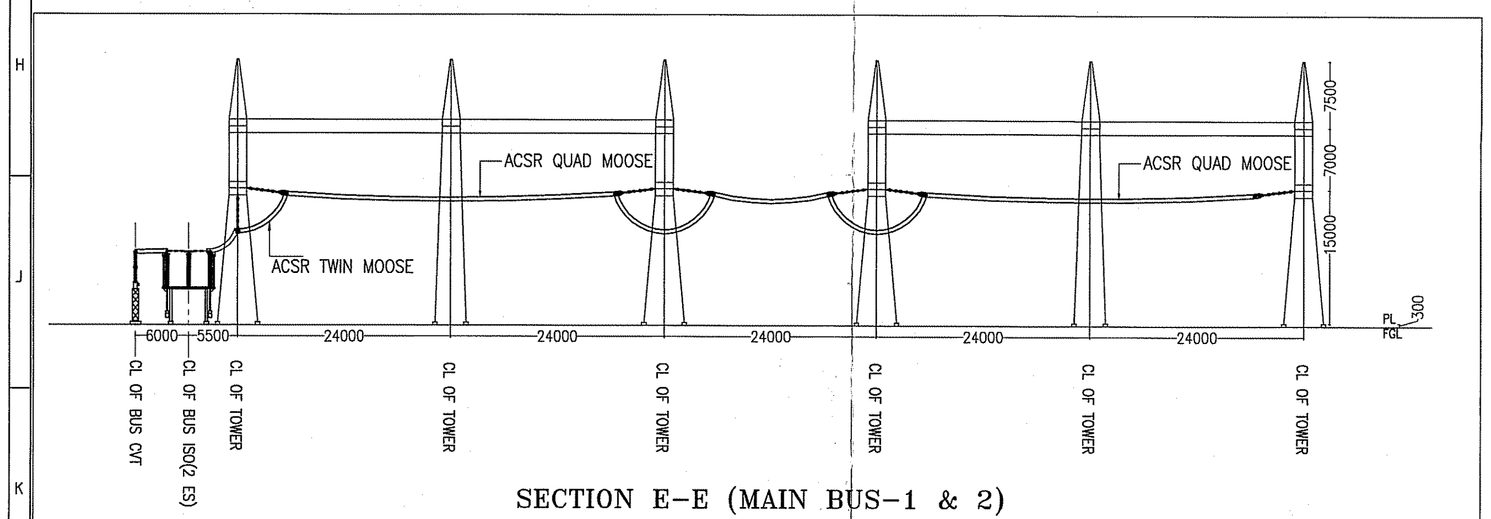

SECTION A–A( ICT1–TIE–LINE(AKAL–1) )




SECTION C–C ( ICT(F)–TIE–LINE(BARMER–2) )




SECTION D–D ( ICT–TIE–LINE(BARMER–1) )




SECTION E–E (MAIN BUS–1 & 2)

Note :- All overhead jumper shall be Y type.

Generally Approved
(Subject to observations Vide Letter No.....
dt.....)
S.E. XEN KFW Projects RRVPNL JAIPUR AEN

**GENERAL NOTES:–**

(1) ALL DIMENSIONS ARE IN MM. UNLESS OTHERWISE SPECIFIED.
(2) FOR EQUIPMENT INSTALLATION,PLEASE REFER INDIVDUAL EQUIPMENT DRAWINGS.

**REFERENCE DRAWINGS:**

RVPN/KFW/ICB–I/DRG–1(A) – TENDER SINGLE LINE DIAGRAM FOR 400/220kV JAISALMEIR2 S/S.
RVPN/KFW/ICB–I/DRG–2(A) – TENDER LAYOUT OF 400/220kV JAISALMEIR2 S/S.
RVPN/KFW/ICB–I/DRG–4(A) – TENDER SECTION LAYOUT OF 400kV JAISALMEIR2 S/S.
(1)-G71770-AC200-L152-002-03 Rev-03 Plan & Section Layout -400kV

LEGENDS :

FUTURE/NOT IN SIEMENS SCOPE
UNDER PRESENT SCOPE

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| 1 | 3 | PM / TPM | 10/6/16 |

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| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. P90925-B-C1-8808-200-3 | | | CUSTOMER: RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | | |
| Scale 1:550 | | | | | |
| PROJECT : 400/220KV JAISALMER-2 AIS SUBSTATION | | | SIEMENS LIMITED , GURGAON | | |
| | | | Date 09.12.2015 | DRG. TITLE: PLAN & SECTION LAYOUT - 400KV | Rev. 3 |
| | | | Drawn GB/SR | | |
| | | | Appr. GB | | |
| | | | Norm KTV | | |
| 3 | rev. as per OGA rev. | 09.06.16 | GB | | |
| 2 | Comments incorporate | 29.03.16 | GB | | |
| 1 | Comments incorporate | 18.01.16 | GB | DRG. No. (1)G71770-AC200-L152-002-03 | Sheet. 2Of2 |
| 0 | First Issue | 10.12.15 | GB | | |
| Rev. | Remarks | Date | Name | LOA No. RVPN/SE(P&P)/XEN/KFW/ICB-ID 1771 dated 16.10.2015 | |

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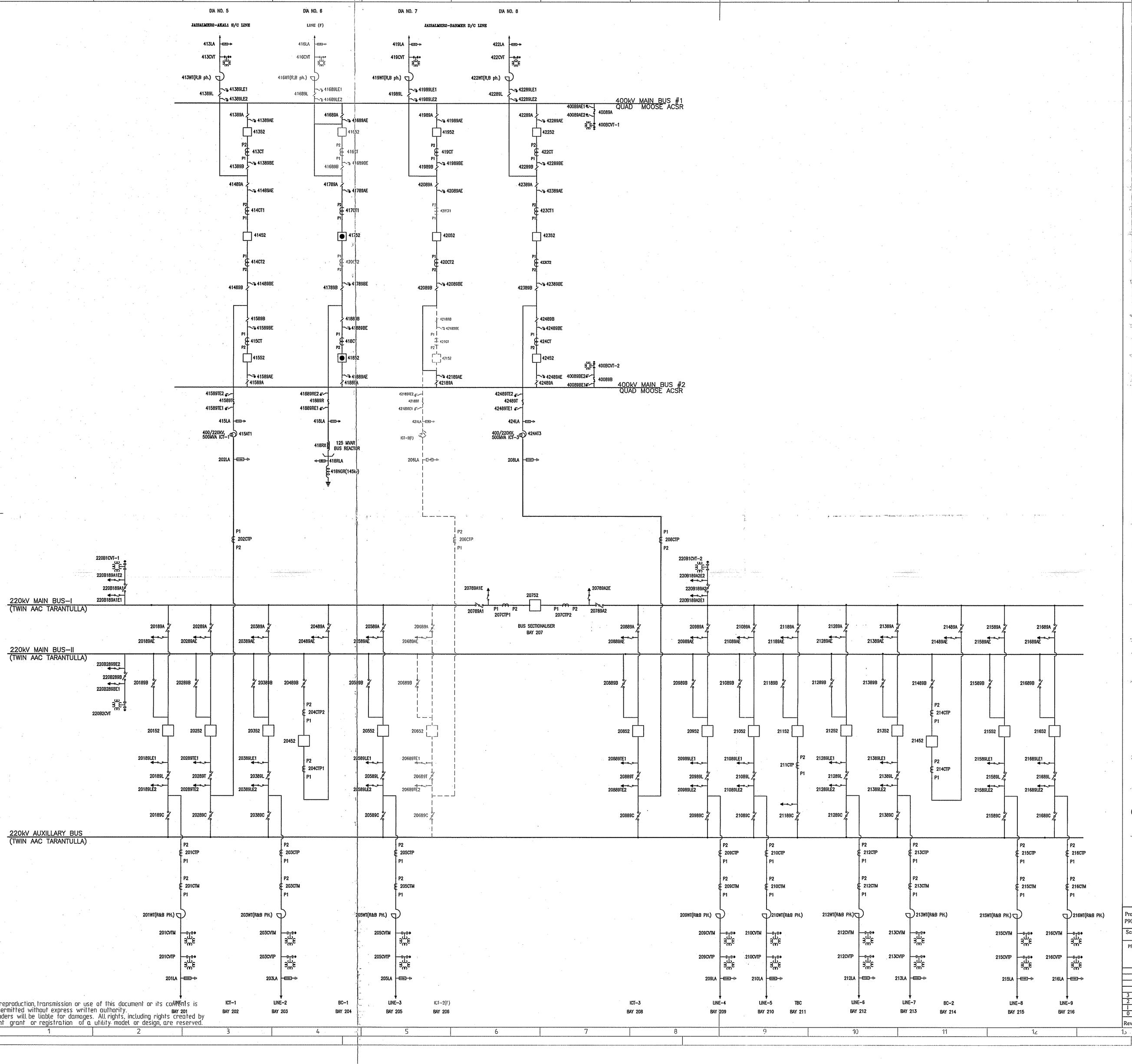


## BILL OF QUANTITY – 400 kV EQUIPMENTS (40 kA, 1 sec.)

| SYMBOL | LEGEND | DESCRIPTION | LOCATION | QTY. (Nos.) |
|---|---|---|---|---|
| | ICT | 500MVA 400/220kV AUTO TRANSFORMER (NOT IN SIEMENS SCOPE OF SUPPLY)(3PHASE) | 415AT, 424AT | 02 |
| | 52 | CIRCUIT BREAKER WITHOUT CLOSING RESISTOR 2000A, (3 PHASE) | 41352, 41452, 41552, 41652 41752, 41952, 42352, 42452. | 08 |
| | 52 | CIRCUIT BREAKER WITHOUT CLOSING RESISTOR WITH CSD, 2000A, (3 PHASE) | 42052, 42152 | 02 |
| | CT | CURRENT TRANSFORMER, 5 CORE, 2000A (1 PHASE) | 413CT, 414CT1, 414CT2, 415CT, 416CT, 417CT2, 419CT, 420CT1, 420CT2, 421CT, 423CT1, 424CT. | 36 |
| | 89 | D.B.R. ISOLATOR WITH ONE E/S 2000A, (3 PHASE)(ELECTRICALLY GANGED) | 41389A, 41389B, 41489A, 41489B, 41589A, 41589B, 41689A, 41689B 41789A, 41789B, 41889A, 41989A 41989B, 42089A, 42089B, 42189A 42189B, 42289A, 42389A, 42389B, 42489A, 42489B. | 22 |
| | 89 | D.B.R. ISOLATOR WITH TWO E/S 2000A, (3 PHASE)(ELECTRICALLY GANGED) | 41389L, 41589T, 41689L, 41989L, 42489T, 40089A, 40089B, 42189R. | 08* |
| | CVT | 400kV CVT, 4400 PF (1 PHASE) | 400BCVT-1, 400BCVT-2, 413CVT 416CVT, 419CVT | 15 |
| | RX | 125 MVAR SHUNT REACTOR (3 PHASE) ALONG WITH ASSOCIATED LA & NGR(145 CLASS) (NOT IN SIEMENS SCOPE OF SUPPLY) | 421RX/421NGR | 01 |
| | LA | 390kV, SURGE ARRESTOR (1 PHASE) | 413LA, 415LA, 416LA, 419RLA 421LA, 424LA . | 18 |
| | WT | WAVE TRAP 2000A, 1.0mH, 1-PHASE | 413WT, 416WT, 419WT. | 6 |

## BILL OF QUANTITY – 220 kV EQUIPMENTS (40 kA, 1 sec.)

| SYMBOL | LEGEND | DESCRIPTION | LOCATION | QTY. (Nos.) |
|---|---|---|---|---|
| | 52 | 245KV CIRCUIT BREAKER WITHOUT CLOSING RESISTOR 2000A (3 PHASE) | 20152,20252,20352,20552, 20652,20852,20952,21052, 21152,21252,21352,21452, 21552,21652,20752. | 15 |
| | 89 | 245KV D.B.R. ISOLATOR WITH 2E/S (MECHANICALLY GANGED) 2000A (3 PHASE) | 20189L,20289T,20389L,20589L, 20889T,20989L,21089L,21289L, 21389T,21589L,21689L, 220B189A1,220B189A2,200B289B | 14 |
| | 89 | 245KV D.B.R. ISOLATOR WITHOUT E/S(MECHANICALLY GANGED) 2000A (3 PHASE) | 20189C,20289C,20389C,20589C, 20889C,20989C,21089C,21189C, 21289C,21389C,21589C,21689C. | 12 |
| | 89 | 245KV D.B.R. ISOLATOR WITH 1E/S (MECHANICALLY GANGED) 2000A (3 PHASE) | 20189A, 20289A, 20389A, 20589A, 20689A, 20889A, 20989A, 21089A, 21189A, 21289A, 21389A, 21489A, 21589A,21689A,207B9A1,207B9A2 | 16 |
| | 89 | 245KV TANDEM ISOLATOR WITHOUT E/S(MECHANICALLY GANGED) 2000A (3 PHASE) | 20189B, 20289B, 20389B, 20589B, 20689B, 20889B, 20989B, 21089B, 21189B, 21289B, 21389B, 21489B, 21589B, 21689B. | 14 |
| | CT | 245KV CURRENT TRANSFORMER 5 CORE, 2000A (1 PHASE) | 201CTP,202CTP,203CTP,205CTP, 206CTP1,206CTP2,208CTP, 209CTP,210CTP,211CTP,212CTP, 213CTP,214CTP1,214CTP2, 215CTP,216CTP,207CTP1, 207CTP2. | 54 |
| | CT | 245KV CURRENT TRANSFORMER 2 CORE, 2000A (1 PHASE) | 201CTM, 203CTM, 205CTM, 209CTM, 210CTM, 212CTM, 213CTM, 215CTM, 216CTM. | 27 |
| | LA | 198 kV, SURGE ARRESTOR (1 PHASE) | 201LA,202LA,203LA,205LA, 208LA,209LA,210LA,212LA 213LA,215LA,216LA. | 33 |
| | CVT | 245kV, CVT, 4400 PF (1 PHASE) | 201CVT,203CVT,205CVT,209CVT, 210CVT,212CVT,213CVT,215CVT, 216CVT,220B2CVT,220B1CVT-1, 220B1CVT-2. | 36 |
| | CVT | 245kV, CVT, 4400 PF (1 PHASE)(METERING) | 201CVT, 203CVT, 205CVT, 209CVT, 210CVT, 212CVT, 213CVT, 215CVT, 216CVT. | 27 |
| | WT | WAVE TRAP 2000A, 0.5mH, 1-PHASE | 201WT, 203WT, 205WT, 209WT, 210WT, 212WT, 213WT, 215WT, 216WT. | 18 |

## SYSTEM DESIGN PARAMETERS:

| DESCRIPTION | 400kV | 220kV |
|---|---|---|
| SYSTEM OPERATING VOLTAGE | 400kV | 220kV |
| MAXIMUM OPERATING VOLTAGE OF THE SYSTEM | 420kV | 245kV |
| SYSTEM FAULT LEVEL | 40 kA for 1sec | 40kA FOR 1 Sec. |
| SWITCHING IMPULSE WITHSTAND VOLTAGE | 1050 kVp (250/2500 micro sec.) (DRY & WET) | – |
| FULLWAVE IMPULSE WITHSTAND VOLTAGE | 1550 kVp (ON 1.2/50 micro sec.) | 1050 kVp (1.2/50 micro sec.) |
| 1 min. P.F. WITHSTAND VOLTAGE | 630 kV (rms) | 460 kV (rms) |
| CREEPAGE DISTANCE | 25MM/KV | 25MM/KV |

## REFERENCE DRAWINGS:

RVPN/KFW/ICB-I/DRG-1(A) – : TENDER SINGLE LINE DIAGRAM FOR 400/220kV JAISALMER2 S/S.
RVPN/KFW/ICB-I/DRG-2(A) – : TENDER LAYOUT OF 400/220kV JAISALMER2 S/S.

(1)G71770-AC2ss-L152-001-02 Rev.2 – Overall General Arrangement.

## LEGEND:

PRESENT SCOPE
FUTURE/NOT IN SIEMENS SCOPE

GENERAL NOTES :
1. '*' MARKED QUANTITY IN BOQ ABOVE VARIES WITH THAT OF PRICE SCHEDULE.
2. CT & CVT DETAILS WILL BE PROVIDED IN PROTECTION S/D.

SIEMENS CONTROL COPY
Copy No. 2 | Rev. No. 3 | Release By RM/TPM | Date 16/1/16
This Supersedes Previous Rev. No. 2
Previous Rev. documents must be destroyed

Generally Approved
Subject to observations Vide Letter No. ..... dt. .....
SE/ XEN / AEN
KFW Projects RRVPNL JAIPUR

| | | | | | |
|---|---|---|---|---|---|
| Project Doc. No. P900225-E-C1-8801-200-3 | | | CUSTOMER : | RAJASTHAN RAJYA VIDYUT PRASARAN NIGAM LIMITED. | |
| Scale NTS | | | | | |
| PROJECT : 400/220KV JAISALMER-2 AIS SUBSTATION | | | SIEMENS LIMITED , GURGAON | | |
| | | Date 10.12.2015 | DRG. TITLE : SINGLE LINE DIAGRAM-400/220KV | | Rev. 3 |
| | | Drawn GB/RK | | | |
| | | Appr. GB | | | |
| | | Norm KTV | | | |
| 3 | Rev. as per OGA rev. 16.05.16 | GB | | | |
| 2 | Customer Comments | 22.03.16 | GB | | |
| 1 | Customer Comments | 11.01.16 | GB | DRG. No. (1)G71770-AC200-S151-001-03 | Sheet. 1OF1 |
| 0 | First Issue | 10.12.15 | GB | | |
| Rev | Remarks | Date | Name | LOA No. RVPN/SE(P&P)/XEN/KFW/ICB-1D 1771 dated 16.10.2015 | |

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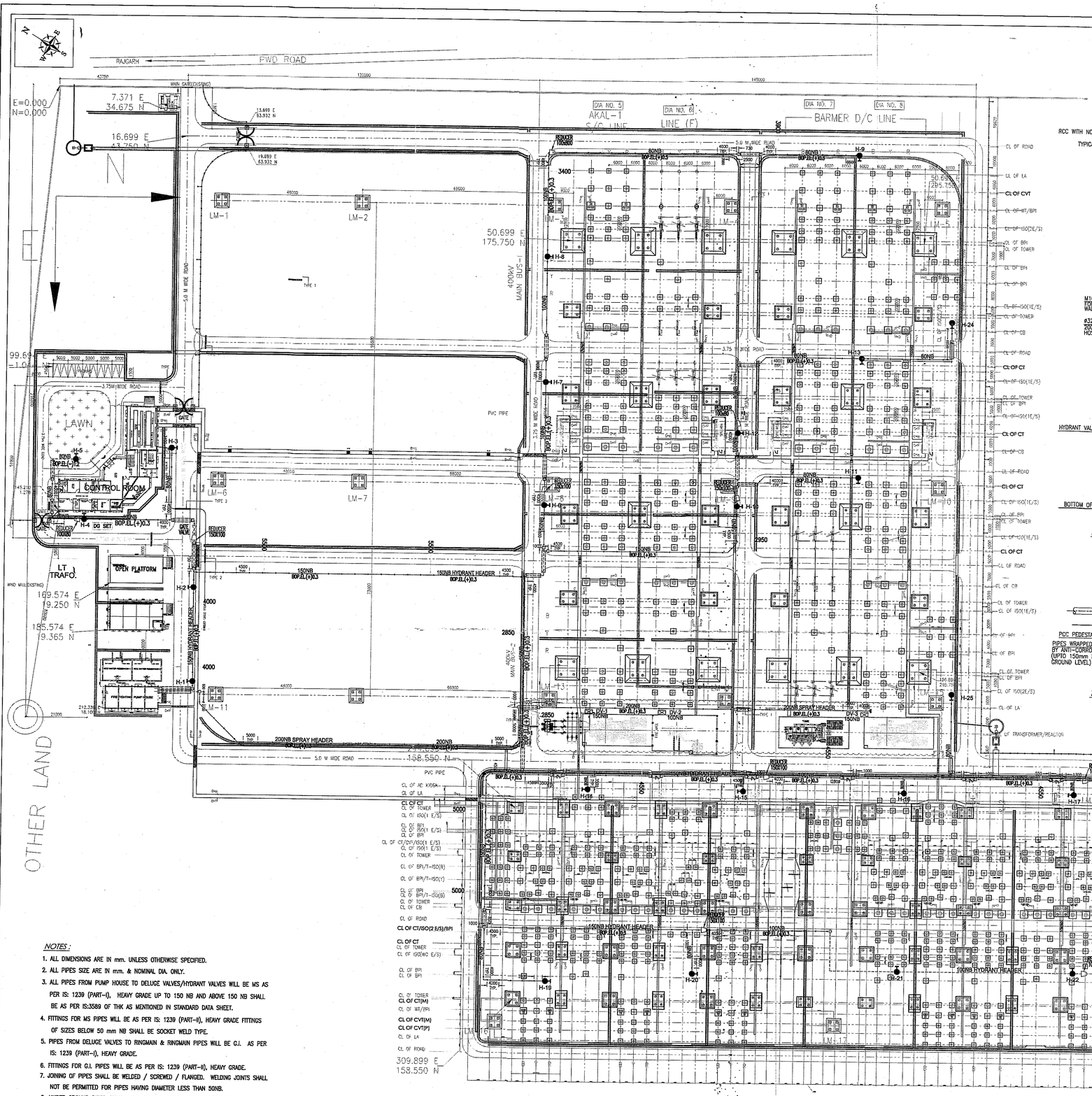
RAJGARH
PWD ROAD
MAIN GATE(EXISTING)
E=0.000
N=0.000
7.371 E
34.675 N
16.699 E
43.750 N
13.699 E
63.932 N
19.699 E
63.932 N
DIA NO. 5
AKAL-1
S/C LINE
DIA NO. 6
LINE (F)
DIA NO. 7
BARMER D/C LINE
DIA NO. 8
LM-1
LM-2
LM-3
LM-4
LM-5
LM-6
LM-7
LM-8
LM-9
LM-10
LM-11
LM-12
LM-13
LM-14
LM-15
LM-16
LM-17
LM-18
LM-19
50.699 E
175.750 N
99.699 E
1.000 N
400KV MAIN BUS-I
400KV MAIN BUS-II
220KV MAIN BUS-I
220KV MAIN BUS-II
220KV TRANSFER BUS
5.0 M WIDE ROAD
3.75M WIDE ROAD
3.75 WIDE ROAD
LAWN
CONTROL ROOM
DG SET
OPEN PLATFORM
LT TRAFO.
WIND MILL(EXISTING)
169.574 E
19.250 N
185.574 E
19.365 N
212.336 E
18.100 N
FIRE FIGHTING PARTITION
PWC PIPE
OTHER LAND
150NB HYDRANT HEADER
200NB SPRAY HEADER
100NB HYDRANT HEADER
80NB
H-1
H-2
H-3
H-4
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**Other Important Details:**

1. Space is available on both sides of existing 400kV Bays for construction of new 400kV line Bays.
2. Spare capacity is available in LT transformer.
3. ACDB & DCDB shall be in TSP scope of work.
4. Existing Battery bank is sufficient to cater the new bays.
5. In 400kV bus bar protection schemes (make Siemens) provision for addition of new bays is available. However, existing Bus Bar protection will require extension and integration with new scheme which shall be carried out by TSP. Approval of protection scheme may be obtained from RVPN by TSP.
6. Existing Hydrant system can be extended for new bays. However, technical suitability may be ascertained by bidder as per site condition.
7. The TSP has to make his own arrangement for construction water and power.
8. The operation and maintenance shall be carried out by RVPN. However, the major works such as replacement of equipment/upgradation of equipment shall be on the part of TSP.
9. The TSP is advised to follow layout design strictly as per existing sub-station layout to maintain design and homogeneity of the sub-station. The sub control room may also be built as per existing design / layout. The TSP shall be responsible for integration of the existing SCADA/ SAS. At present, Siemens Make SCADA is in operation. Any additional item required for the· integration with the existing sub-station shall be provided by the TSP. It is envisaged that before start of work the successful TSP/ Contractor shall submit their action plan, layout & technical specification to RVPN for proper co-ordination.