

**RFP No. HML / INFRA / 01 / 2021**

**REQUEST FOR PROPOSAL (RFP)  
FOR SELECTION OF  
DESIGN & BUILD CONTRACTOR  
FOR DEVELOPMENT OF PHYSICAL INFRASTRUCTURE AND  
CONSTRUCTION OF ADMINISTRATIVE BLOCK AT  
MEDIPARK IN CHENGALPATTU DISTRICT, TAMIL NADU**

**VOLUME IV  
SCHEDULE OF WORKS**

**SCHEDULE 3  
ELECTRICAL DISTRIBUTION SYSTEM**



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### **SCHEDULE 4: Electrical Distribution System**

#### **1. Design brief**

The Electrical Works Supply, installation, testing and commissioning shall comprise the following systems;

- 11KV, HT Electrical works Distribution Scheme considering overhead lines
- LT works with Transformer and LT panels for Admin Building and Common services loads
- External Lighting works
- Earthing System
- DG Works for Admin, External Lighting and Common Services
- 11KV, HT Panels, HT Cables and DP structures works
- 1.1KV, LT Cables for LT Panels
- The Contractor scope will be tapping power supply from TNEB premises (in Medipark) to the Plot Entrance through Overhead line distribution system. Further power tapping scope will be with the Plot Owner during Plot Building construction.
- The Contractor should do compulsory third party testing for all cables and wires and submit the report to the Authority.
- The Contractor scope is to get Electrical Inspectorate and TNEB permission for the energizing the HT/LT installation works for Admin, Common Services Loads
- The External Street lights works includes, OHT tank Road lighting, TNEB Substation Road Lighting, Main Entrance Existing Road Lighting as shown in the Tender Drawings

Minimum Parameters to be considered for detailed design work from the contractor as mentioned below,

#### **SCOPE OF WORKS**

11KV, HT electrical works distribution	Overhead lines with ACSR conductor
ACSR conductor as per IS398	PANTHER, DOG, RABBIT as per TNEB norms
Power demand	23.6MW
No. of over headline feeders	6Numbers (approx. 10-11 kms)
Each HT feeder capacity	Max. 5-6MW
Type of pole for overhead lines	9.0/11.0M RCC poles, 11.0 m swaged tubular poles
LT works distribution	Common services and admin building
Type of execution of LT Line	Underground cabling system
Commons services load	300KW
Transformer capacity	1No. 500KVA, ONAN, OLTC, RTCC

Panel ring main gear (I/C-1+O/G+IC-2)	1No. for power tapping
Single LBS panel	1No. for metering cubicle ON/OFF
Metering cubicle for common services load	1No. for common services and admin load
VCB panel	1No. for transformer protection
LT panels	EB-DG change over with autosynchronization, auto load sharing system
External lighting system	15 to 25LUX illumination level as per NBC norms for highway road
Type of light fixture	LED streetlights, landscape lights, hi-mast, building façade illumination
Type of streetlight poles	8.0 OR 11.0M galvanized octagonal/Circular poles
Solar LED light fixtures	Approx. 20 - 25% solar streetlight fixtures to be considered
LT cables	1.1 grade, XLPE insulated, copper/ aluminum
Earthing system	Below 5 Ohm/IS 3043 latest editions
DG (stand by power backup)	2 NOS. 250KVA, as per CPCB-II norms auto synchronization system
Civil related works	RCC trenches, RCC Hume pipes
Existing pole shifting	Existing DP structure, 9/11.0 M, 11KV pole with conductor shifting as per TNEB guidance
Existing streetlight poles	Existing 11.0M streetlight poles to be used (approx. 80 numbers) as per site condition

## 2. Load computation

Tentative total load sheet provided for arriving at the project load with respect to plot area; same to be detailed as per TNEB norms.

S. NO.	DESCRIPTION	AREA IN SQ.FT. / QTY.	75% OF PLOT AREA ARE CONSIDERED FOR CONSTRUCTION LOAD	LOAD IN KW	REMARKS
1	1.0 ACRE PLOT-1	45000	33750	371.25	1.1kw/100Sqft considered
2	1.0 ACRE PLOT-2	45000	33750	371.25	
3	1.0 ACRE PLOT-3	45000	33750	371.25	
4	1.0 ACRE PLOT-4	45000	33750	371.25	
5	1.0 ACRE PLOT-5	45000	33750	371.25	
6	1.0 ACRE PLOT-6	45000	33750	371.25	
7	1.0 ACRE PLOT-7	45000	33750	371.25	
8	1.0 ACRE PLOT-8	45000	33750	371.25	
9	1.0 ACRE PLOT-9	45000	33750	371.25	
10	1.0 ACRE PLOT-10	45000	33750	371.25	
11	1.0 ACRE PLOT-11	45000	33750	371.25	
12	2.0 ACRE PLOT-1	90000	67500	742.5	
13	2.0 ACRE PLOT-2	90000	67500	742.5	
14	2.0 ACRE PLOT-3	90000	67500	742.5	
15	2.0 ACRE PLOT-4	90000	67500	742.5	
16	2.0 ACRE PLOT-5	90000	67500	742.5	
17	2.0 ACRE PLOT-6	90000	67500	742.5	
18	2.0 ACRE PLOT-7	90000	67500	742.5	
19	2.0 ACRE PLOT-8	90000	67500	742.5	
20	COMMERCIAL / LEASABLE AREA-1	127500	95625	1051.875	
21	COMMERCIAL / LEASABLE AREA-2	106000	79500	874.5	

22	SITE FOR ADMIN/TESTING LAB/SERVICE AREA/BUSINESS CENTRE/COMMON FACILITY CENTRE	111850	83887.5	922.7625	
23	SITE FOR KNOWLEDGE MANAGEMENT-1	111850	83887.5	922.7625	
24	3.0 ACRE PLOT-1	135000	101250	1113.75	
25	3.0 ACRE PLOT-2	135000	101250	1113.75	
26	3.0 ACRE PLOT-3	135000	101250	1113.75	
27	3.0 ACRE PLOT-4	135000	101250	1113.75	
28	SITE FOR COMMERCIAL COMPLEX / CANTEEN	131487.2	98615.4	1084.7694	
29	SITE FOR COMPREHENSIVE PLUG n PLAY - HORIZONTAL AND VERTICAL DEVELOPMENT	541109.64	405832.23	4464.15453	
30	SITE FOR LOGISTIC HUB	111904	83928	923.208	
31	2.0 ACRE PLOT-9	90000	67500	742.5	
32	2.0 ACRE PLOT-10	90000	67500	742.5	
33	2.0 ACRE PLOT-11	90000	67500	742.5	
34	2.0 ACRE PLOT-12	90000	67500	742.5	
35	2.0 ACRE PLOT-13	90000	67500	742.5	
36	3.0 ACRE PLOT-5	135000	101250	1113.75	
37	3.0 ACRE PLOT-6	135000	101250	1113.75	
38	CFC AREA	83000	62250	684.75	
39	COMMON SERVICE LOADS FOR TOTAL PROJECT				
41	WTP PLANT (300KLD) (20HP)	20	746	14.92	
42	UG SUMP TO OHT - PUMPS (25HP)	25	746	18.65	
43	FLUSHING Treated water Transfer Pump (7.5 HP)	7.5	746	5.595	
44	Reject water transfer pump (2HP)	2	746	1.492	

45					
46	STP - PLANT - PHASE - 01(MBBR) (30HP)	30	746	22.38	
47	STP - PLANT - PHASE - 02(MBBR) (20HP)	20	746	14.92	
48					
49	80W LED STREET LIGHT- PHASE-1 & 2	430	80	34.4	
50					
51	HIMAST, BOLLARD, ENTRANCE ARCH LIGHTS	1	3000	3	
52					
53	SECURITY ROOM	1	1000	1	
<b>CONNECTED LOAD in KW</b>				<b>31463.9</b>	<b>KW</b>
<b>DEMAND LOAD @0.75</b>				<b>23597.9</b>	<b>KW</b>
<b>DEMAND LOAD ROUNDED OFF TO</b>				<b>23.60</b>	<b>MW</b>

## Load sheet for external admin block common services load on 500KVA transformer

Description	Area in Sq. ft / Qty / TR / HP	Load in WATTS	Total load in KW	Remarks
ADMIN				TR=AC TONNAGE, HP=HORSEPOWER
<b>LIGHTING AND FAN LOAD</b>				
GROUND FLOOR (APPROXIMATE 5700SQFT)	5700	1	5.7	Considered 1W / sqft For internal lights and fans
FIRST FLOOR & FUTURE EXPANSION	5700	1	5.7	
SECOND FLOOR & FUTURE EXPANSION	5700	1	5.7	
BUILDING FACADE & EXTERNAL LIGHTING LOAD	1	1000	1	
<b>TOTAL LIGHTING &amp; FAN LOAD IN KW</b>			<b>18.1</b>	<b>KW</b>
<b>RAW POWER LOAD</b>				
PANTRY LOAD	3	4000	12	
TOILET VENTILLATION	3	750	2.25	
UTILITY LOADS	3	2000	6	
LIFT LOAD	2	5500	11	Considered future lift
ADMIN PHE LOADS	2	3000	6	
<b>TOTAL RAW POWER LOAD IN KW</b>			<b>37.25</b>	<b>KW</b>
<b>HVAC LOAD</b>				
GROUND FLOOR (4300 SQFT OFFICE SPACE)	26.875	1200	32.25	Considered at every 160Sqft 1TR at 1.2 KW Each.
FIRST FLOOR (2000 sqft OFFICE SPACE)	12.5	1200	15	
SECOND FLOOR (2000 sqft OFFICE SPACE)	12.5	1200	15	
FIRST & SECOND FUTURE OFFICE SPACE HVAC LOAD (4000SQFT)	25	1200	30	
<b>TOTAL HVAC LOAD IN KW</b>			<b>92.25</b>	<b>KW</b>



<b>UPS LOAD</b>				
<b>GROUND FLOOR</b>				
COMPUTER LOAD	35	200	7	
PRINTERS	5	250	1.25	
MEETING HALL TABLE TOP PROJECTORS	3	500	1.5	
<b>FIRST FLOOR</b>				
COMPUTER LOAD	10	200	2	
PRINTERS	2	250	0.5	
MEETING HALL TABLE TOP PROJECTORS	1	500	0.5	
<b>SECOND FLOOR</b>				
COMPUTER LOAD	10	200	2	
PRINTERS	2	250	0.5	
MEETING HALL TABLE TOP PROJECTORS	1	500	0.5	
<b>OTHER LOADS</b>				
SERVER / HUB LOAD	3	500	1.5	
CCTV, NVR	1	1000	1	
FA, PA & ACCESS CONTROL	1	1000	1	
<b>TOTAL UPS LOAD IN KW</b>			<b>19.25</b>	<b>KW</b>
<b>PHASE-1 COMMON SERVICE LOADS</b>				
WTP PLANT (300KLD) (20HP)	20	746	14.92	
UG SUMP TO OHT - PUMPS (25HP)	25	746	18.65	
FLUSHING Treated water Transfer Pump (7.5 HP)	7.5	746	5.595	
Reject water transfer pump (2HP)	2	746	1.492	
STP - PLANT - PHASE -01(MBBR) (30HP)	30	746	22.38	
STP - PLANT - PHASE -02(MBBR) (20HP)	20	746	14.92	

80W LED STREET LIGHT-PHASE-1 & 2	430	80	34.4	
HIMAST, BOLLARD, ENTRANCE ARCH LIGHTS	1	3000	3	
<b>SECURITY ROOM</b>	1	1000	1	
<b>FIRE FIGHTING SYSTEM</b>				
Hydrant & Sprinkler Pump (Electrical driven Pump) (110HP x 2)	220	746		
Jockey pumps (15HP x 2)	15	746		
Miscellaneous loads	5	746		
<b>TOTAL ADMIN &amp; PROJECT PHASE-1 COMMON SERVICE LOAD IN KW</b>			<b>116.357 KW</b>	
<b>TOTAL ADMIN CONNECTED LOAD IN KW</b>			<b>166.9 KW</b>	
<b>TOTAL PHASE-1 COMMON SERVICES CONNECTED LOAD IN KW</b>			<b>116.4 KW</b>	
<b>TOTAL CONNECTED LOAD IN KW</b>			<b>283.2 KW</b>	
<b>CONSIDERED DIVERSITY FACTOR @0.85</b>			<b>240.7 KW</b>	
<b>DIVERSITY LOAD IN KVA AT 0.8 P.F</b>			<b>300.9 KVA</b>	
<b>RECOMMENDED 5 STAR RATED OLTC TRANSFORMER CONSIDERING</b>			<b>500.0 KVA</b>	
<b>RECOMMENDED PRIME DG SET WITH LOAD BALANCING SYSTEM</b>			<b>2Nos x 250 KVA</b>	

The above load is tentative only, the Contractor to prepare exact load on the detailed design.

### **3. Scope of works and general condition for electrical works**

#### **3.1 Scope**

- 3.1.1** The Scope of Electrical works includes 11KV overhead line design and LT works for common services works.
- 3.1.2** The contractor shall also be responsible for the overall co-ordination with internal/external agencies, project management, training of Authority's manpower, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the equipment/works.
- 3.1.3** Design of systems includes preparation of single line diagrams and electrical layouts, control and protection schematics, wiring and termination schedules, indoor and outdoor lighting/illumination and other relevant drawings & document required for engineering of all facilities under this contract, are covered under the scope of the Contractor.
- 3.1.4** The reference drawing SLD, which form a part of the specifications, are enclosed.
- 3.1.5** The Contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification.
- 3.1.6** 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.
- 3.1.7** When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.
- 3.1.8** Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under individual sections for various equipment's shall also, be accepted, however the salient points of difference shall be clearly brought out in additional information schedule with English language version of such standard. The equipment conforming to standards other than specified under individual sections for various equipment's shall be subject to client approval.

### **3.2 Services to be performed by the equipment being furnished**

- 3.2.1** All equipment's shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.
- 3.2.2** All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc. for the equipment.

### **3.3 Engineering data and drawings**

- 3.3.1** The engineering data shall be furnished by the Contractor in accordance with the Schedule for each set of equipment as specified in the Technical Specifications.
- 3.3.2** The list of drawings/documents which are to be submitted to the Authority shall be discussed and finalized by the Authority at the time of award.

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

The Contractor shall submit 4 (four) sets hardcopy along with the soft copy of drawings/design documents / data/ test reports as may be required for the approval of the Authority.

#### **3.3.3 Drawings**

- 3.3.3.1** 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, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

- 3.3.3.2** Each drawing submitted by the Contractor shall be clearly marked with the name of the Authority, Project Name, Project Title, material details with catalogue no. and the Make. 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.

**3.3.3.3** 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 Authority, if so required.

**3.3.4** The review of these data by the Authority will cover only general conformance of the data to the specifications and documents interfaces with the equipment provided under the specifications. This review by the Authority 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 Authority 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.

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

**3.3.6** All engineering data submitted by the Contractor after final process including review and approval by the Authority 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 Authority in Writing.

### **3.3.7 Approval Procedure**

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

i)	Drawings for Approval / comments / by Authority on initial submission	As per agreed schedule
ii)	Resubmission (whenever required)	Within 2 (two) weeks from date of comments including both ways postal time).
iii)	Approval or comments of resubmission	Within 2 weeks of receipt

iv)	Furnishing of distribution copies (4 Copies)	2 weeks from the date of final approval
v)	Furnishing of distribution copies of test reports (a) Test reports (4 Copies)	2 weeks from the date of final approval
vi)	Furnishing of instruction / operation manuals (2 copies per site)	As per agreed schedule
vii)	As built drawings (Three sets)	On completion of entire works

**NOTE:**

- (1) The Contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Authority or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.
- (2) The Softcopy of all Drawings/Documents along with hard copy to be submitted for all the time for review as well as approval.
- (3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
- (4) The Contractor shall furnish to the Authority catalogues/Instruction Manual of Equipment's/Switchgear/Spare parts.

**3.4 Material/Workmanship****3.4.1 General Requirement:**

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

**3.4.1.2** In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard, the Authority shall decide upon the question of

similarity. When required by the specification or when required by the Authority the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.

**3.4.1.3** The Execution of the Works shall be such that installation future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Authority.

**3.4.1.4** Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

**3.4.1.5** All materials and equipment shall be installed in strict accordance with the manufacturer's recommendations(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment as 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 manufacturer's tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer's limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

### 3.4.2 Degree of Protection

- a) The enclosures of the LT Panels to be installed shall provide degree of protection as detailed here under:
- b) All Outdoor Panels to be supplied with minimum: IP-55 protection.

### 3.5 As built drawings (both hard copy and soft copy)

At the completion of the works and before issue of the certificate of virtual completion, the Contractor shall submit to the consultant 4 sets of layout drawings (both hard copy and soft copy) drawn at approved scale indicating the complete wiring system as installed. These drawings must provide the following minimum information:

- a. A complete wiring diagram, as installed and schematic drawings showing all connections in the complete electrical system.
- b. Location of Poles, Transformer, DG, Panels, etc.
- c. Location of all earthing stations, routes, sizes of all earthing conductors, manholes, layout of earth link strips, etc.
- d. Layout and particulars of all cables.

Above indicates the general requirement. However, the Contractor must include all information desired by the client and Architects/Consultants in the final as built documents. Guidance for the preparation of as built document shall be had from the consultant.

### 3.6 Pre-commissioning tests

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Authority 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 is given in respective chapters and shall be included in the Contractor's quality assurance program.



The testing equipment required for testing and commissioning shall be arranged by the Contractor.

### **3.7 Statutory Clearances**

The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning Facility. However necessary fee shall be reimbursed by client on production of requisite documents.

### **3.8 Packaging & Protection**

**3.8.1** All the equipment's shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Authority, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Authority to repack any equipment/material at a later date, in case the need arises. 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. Authority takes no responsibility of the availability of the wagons.

**3.8.2** 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 pilings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

### **3.9 Finishing of metal surfaces**

**3.9.1** All metal surfaces shall be subjected to treatment for anti-corrosion protection. All steel conductors Including those used for earthing/grounding (above ground level) shall also be galvanized according to IS:2629.

**3.9.2** After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by staving. The second finishing coat shall be applied after inspection of first coat of painting.

**3.9.3** 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 along with the Bids for Authority's review & approval.

### **3.10 Handling, storing and installation**

**3.10.1** In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Authority 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 / Panel shall be installed in a neat, workmanlike manner so that it is level, plumb, and square and properly aligned and oriented.

**3.10.2** The Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment / Panel being procured by them separately. The Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall full cooperation to them.

**3.10.3** In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Authority. The Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

**3.10.4** Where assemblies are supplied in more than one section, The Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. The Contractor shall also do necessary adjustments/alignments necessary for proper operation of equipment / Panel. 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.

**3.10.5** The Contractor shall be responsible for examining all the shipment and notify the Authority immediately of any damage, shortage, discrepancy etc. for the purpose of Authority's information only. The Contractor shall submit to the Authority every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and

erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

**3.10.6** The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Authority in an operating condition after commissioning. The Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over the Authority, as well as protection of the same against theft, element of nature, corrosion, damages etc.

**3.10.7** The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

**3.10.8** The words 'erection' and 'installation' used in the specification are synonymous.

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

**3.10.10** The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the minimum clearances as per the statutory requirement, the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.

### **3.11 Various codes for electrical works**

#### **A. Applicable IS Standards: -**

The design engineering manufacturing and the installation shall be in accordance with established IS codes, sound engineering practices and specifications and shall conform to the statutory regulations, applicable in the country.

The Contractor shall obtain all approvals from statutory authorities e.g. Authority Electrical Engineer, pollution control boards, TNEB, TNAGEDCO, as applicable before commissioning of electrical equipment.

#### 4. Design parameters and materials

1. Execution to be as per Local Electricity Board Guidelines and all items are as per IS/BIS standard.
2. Over Headlines ACSR conductor (as per IS 398) should be Panther, Dog, Rabbit conductor with proper components to be selected based on the Load, site condition, TNEB norms and are any modification required same to be considering before the submission of final tender.
3. Selection of Poles height and type of pole (RCC/Tubular Steel swaged type Pole) to be considered depending on the no. of 11KV circuits running per pole as given in the Tender Drawing.
4. Spacing between overhead conductors to be consider as per IS/BS standard
5. V-Cross arm support strong enough to withstand resultant forces caused by insulators, their pins, and deadweight of insulator attachments, also load of the conductors, etc. as mentioned in the Technical specification.
6. C-ordination to be done at site with other services such as Civil Road Execution team, PHE Services team, etc., during execution.
7. Cradle Guarding to be considered for crossing the Road, Building Compound Line as per the site condition.
8. Sag and Span calculation to be done as per standard and same to be considered during execution.
9. Crossing of Conductors to be done by using Strain Insulators or as per standard.
10. All materials supplied to site are as per approved makes given in the Tender and as per TNEB approved vendor list.
11. Design and Preparation of GFC drawings, Shop Drawings, as built drawings are part of the Tender work.
12. Tender Drawings (Layout plan/SLD/RFP/DBR) & Technical specification are minimum requirement to the project, same to be referred for preparation of GFC/Shop drawings.
13. All materials specification to be submitted for approval before the Installation.

#### **PART-1 HT, 11KV, ELECTRICAL WORKS**

- 1) 11KV Outdoor type Ring Main Gear (RMG), 11 KV, 25 KA, 630 A, HT Outdoor Three Panel Ring Main Gear (I/C-1+O/G+IC-2) complete as per TNEB / TANGEDCO specification with all necessary accessories. RMG should be approved from TNEB before execution.
- 2) 11KV, 25 KA, 630A, HT Outdoor Single Panel Vacuum Circuit Breaker with Metering, Transformer protection relays, and tripping and alarm circuits, arrangement to be provided to connect Transformer Protection and tripping circuits to VCB panel and as per Technical specifications & TNEB norms.

- 3) Single Circuit 11 kV, 3 Phase Power Line on 11 meter supports with an Average Span of 40 meter Using PANTHER ACSR Conductor by using required overhead lines materials depending on the load, as per TNEB Regulation.
- 4) Single Circuit 11 kV, 3 Phase Power Line on 9 meter supports with an Average Span of 40 meter Using RABBIT ACSR Conductor by using required overhead lines materials depending on the load, as per TNEB Regulation.
- 5) Two Circuit 11 kV, 3 Phase Power Line on 11 meters Swaged Steel Pole Supports with an Average Span of 40 meters Using PANTHER ACSR Conductor by using required overhead lines materials depending on the load, per TNEB Regulation.
- 6) Three Circuit 11 kV, 3 Phase Power Line on 11 meters Swaged Steel Pole Supports an Average Span of 40 meters Using PANTHER ACSR Conductor
- 7) Three Circuit 11 kV, 3 Phase Power Line on 11 meters Swaged Steel Pole Supports with an Average Span of 40 meters Using PANTHER and Rabbit ACSR Conductor.
- 8) 2 Pole Structure at the Tapping Point Using RCC Pole
- 9) Overhead Lines Guarding - As per IER 87 & 88, every guard wire shall be connected with the earth at each point at which electrical continuity is broken, Every guard wire should have sufficient current-carrying the capacity to ensure the circuit rendering dead, The guard should be made of the same material as used for earth wire. Cradle guard shall be made of 6 SWG GI wire confirming to IS 2633 including netting, stretching and jointing and lacing by 10/12 SWG GI wire, binding by 14/16 SWG GI wire. - For Road crossing, Telephone line crossings, Plot premises etc.
- 10) HT METERING CUBICLE, with TOD meters, as per TNEB Norms for 500KVA Transformer for LT Common services works
- 11) 11KV /433V DISTRIBUTION TRANSFORMER - 500KVA Copper Wound, Oil Cooled, ONAN, 5Star rated, Level 3, Copper wound Distributing Transformer 11KV/433V with On load tap Changing, (OLTC) with RTCC panel, Buchholtz relay, winding temperature indicator, oil temperature indicator, magnetic oil level indicator with alarm and trip circuits, marshaling box with wiring, OLTC settings 16 Steps & 17 Position in steps of 1.25% on HV Side (+5% to -15%), HT and LT cable end boxes, stacked core with oil as per ID 1180 with all standard accessories, as per the latest IS standards, Arrangement to be provided to connect Transformer Protection and tripping circuits to VCB panel and as per Technical specifications & TNEB approved.

- 12) Civil Foundation Platform with size stone, cement concrete for Erection for Transformer / HT panels /Heavy Equipment - Construction of platform (1.5x1.5x1.2 ) meters in size stone, for Erection of transformers/Heavy Equipment including all materials, labour, excavation of (1.5x1.5x1) mt pit for foundation providing and laying cement concrete 1:4:8 for foundation laid in 1cm thick layers, well compacted curing etc., complete providing and construction of stone masonry 0.9m below ground level and 1.2m above ground level neatly hammer dressed in cement mortar 1:6 cutting complete providing pointing to stone masonry in cement mortar 1:3 after racking joint & nicely lining curing etc., plastering the concrete surfaces in cement mortar 1:4 including smooth rendering curing etc., curing at every stages completely.
- 13) CHAIN LINK FENCING - Providing chain link fencing 50mm size of 8 gauge properly stretched between rectangular poles and fixed with suitable bolts & nuts, the free ends shall be welded to the pole and block pipe at top and bottom as required including cost of all materials, labour, lead and lifts, cutting, bending wherever necessary, wastage and lapping etc., complete as per the direction of the engineer in charge for work including two coats of approved quality paint over one coat of primer paint. Providing and laying in position plain cement concrete of mix 1:3:6 for poles. The rate shall include all rectangular poles,height 2.8 meters fixed at a distance of 2meters welded together, etc. with chain link matching gate of 1.5 meters wide with hinged & locking arrangements.
- 14) SAFETY ACCESSORIES TO BE PROVIDED AT – Transformer Yard, DG Yard, Electrical rooms, etc., as per Fire Norms. - AC Chargeable Emergency Lamp 2 X 11W PL Lamp with all connected accessories, 2m X 1m Rubber Mat Suitable for 11KV installation confirming to IS, First Aid Box complete with all First Aid Medicines, Shock Treatment chart fixed in glass frame, Fire Buckets made out of 40 X 40 X 6mm MS Angle, Hand Gloves 11KV Grade, Danger Board as required by the Electrical Authorities, Fire extinguisher Co2, 4.5 kg. confirming to TAC Norms.
- 15) SERVICE CHARGES - Arranging the required details from Electricity Board duly making the formalities and arranging service of the installation with the projected charges and arranging required approval from the required government Electrical Inspectorate and permission for the energizing the HT/LT installation works. Also, this item should include charges towards arranging temporary power supply for construction and making payments, monthly bills and renewal/upgrading temporary power supply. The total Estimated Load approximately 300KVA and Transformer Capacity 500KVA.

**PART-2 LT 1.1KV, ELECTRICAL WORKS**

- 16) LT PANEL WORKS FOR PHASE-1- Design, manufacture, supplying, fixing in position, testing and commissioning of following MV switchgear panels made up of 14/16G, suitable for 415 V, 3 phase, 4 wire, 50 Hz power distribution system. The incoming and outgoing feeders shall be accommodated in a modular multitier arrangement and shall be interlocked to avoid paralleling, adequate size cable alley, painting, earthing, numbering, danger plate etc. as required as per specifications and drawings. The panels should be IP category classification with all items as per SLD and Specification.

Supply & Delivery on site of cubical type, dead front, 2mm thick sheet steel enclosed, free standing indoor type extendible panel with vermin proof hinged lockable doors for each compartment provide bus bar interconnections for incoming and outgoing including feeders earthing and painting and as per specifications. (Main door & frame = 2mm thick, partition 1.6mm thick)

The SLD spec is the minimum requirement, all switchgears short circuit current calculation to be done with respect to exact Cable length and supporting documents to be submitted for approval before Installation.

The Following Panels to be considered for the project as given in the Tender SLD

- a) MAIN LT KIOSK (OUTDOOR TYPE)
- b) MAIN EB-DG AUTO CHANGEOVER, AMF, AUTO SYNCHRONIZING & AUTO LOAD SHARING  
PANEL 200KVAR CAPACITOR PANEL
- c) MAIN WTP PANEL
- d) MAIN STP PANEL
- e) MAIN SECURITY & EXTERNAL STREET LIGHT SDB
- f) EXTERNAL STREET LIGHT SDBS (OUTDOOR TYPE) – QUANTITIES AS MENTIONED IN THE SLD
- g) HI MAST DB (OUTDOOR)

- 17) LT CABLES AND TERMINATIONS (INDOOR/OUTDOOR TYPE), DOUBLE COMPRESSION GLANDS, TINNED COPPER LUGS to be used as mentioned below,  
1.1KV LT UG Aluminum conductor Cable XLPE or heat resistant PVC insulated, PVC extruded inner sheathed, Armoured UG LT cable as per the IS - 1554 (part-1) or IS-7098 part-1, Armoring strip thickness in average + 5% and resistivity 14 Ohms/Kms (Max) as per IS -3975.
- a) 2 core 10 sq.mm

- b) 4 core 10 sq.mm
- c) 4 core 16 sq.mm
- d) 3.5 core 25 sq.mm
- e) 3.5 core 50 sq.mm
- f) 3.5 core 95 sq.mm
- g) 3.5 core 120 sq.mm
- h) 3.5 core 185 sq.mm
- i) 3.5 core 240 sq.mm
- j) 3.5 core 300 sq.mm

The above cables to be used for External Lighting, PHE Services Panels, Pumps, LT panels etc. Flexible multicore cable manufactured with electrolytic grade flexible copper with low conductor confirming to table 3 class 5 of IS:8130-1984 and (virgin) PVC insulation and sheathed suitable for working voltage upto 1100volts as per IS-694:1990 - 3Cx2.5Sqmm / 4Cx2.5Sqmm (for Street lights, inside poles).

18) EARTHING: Body and Neutral Earthing As per IS 3043 Latest Edition / Maintenance Free Copper coated Earth rod of 3 meters length having the dia of 14.2mm - 25mm with copper coating thickness of 250 microns. Earth Chamber Inspection Pit made up of concrete material. Resistance value below 5 Ohm, as per Technical Specification.

- a) GI / Copper strips inside Sleeves of proper color for grounding connections, minimum sizes as mentioned below for different components earthing,
- b) GI strip - 25x6mm
- c) GI strip - 40x6mm
- d) GI strip - 50x6mm
- e) 600x600x3mm GI plate
- f) CU strip - 25x6mm
- g) CU strip - 50x6mm
- h) 600x600x3mm Copper plate
- i) Copper wire - 8SWG

### **PART-3 EXTERNAL LED LIGHT FIXTURES AND STREET LIGHT POLES**

19) LED EXTERNAL LIGHT FIXTURES – Minimum 2 Years Warranty to be considered for all light Fixtures. Minimum 15-25Lux / to be designed as per NBC Illumination level for Primary Roads.

- a) STREETLIGHTS (80 / 90W) - LED Street light with pressure die cast aluminum housing body with optimal heat sink for better thermal dissipation. Diffuser with injection moulded & is



made of polycarbonate material with high transmission index, delivering superior light output. Rated life burning hours 50000 hr. @ lumen maintenance of 70%. CCT > 5500K, IP 66 optical and electrical compartment and impact resistance of complete luminaire > IK08. Power Factor > 0.9 with mains current should not be greater than 0.1A to 0.7A & surge protection - min 4KV along with over voltage/overload, short circuit/ mis wiring protection. Compatible for pole mounting with outer dia of 40mm to 50mm. Universal voltage driver to operate wide range from 100v to 270V 50/60Hz application. Overload & short circuit protection ensures reliable operation in spite of problem in output side. Compliance to IS 10322/IEC 60598, LM 79 & LM 80 Adherence with RoHS. UL approved MCPCB. Top Access Street light with single screw to ensure ease of maintenance at the sight site location with minimized minimal tools. LED Light fixture with .....W system power consumption. LED efficiency > 130lm/w at 1w and fixture efficiency > 75lm/w with CRI > 75. luminaire Manufacturer should have in-house facility accredited by NABL/CPRI & any government certified agency & design & development facility certified by ISO 9001:2008. Housing with supplier word mark/name shall be engraved / embossing on the die cast housing / body part. 2 years warranty against any manufacturing defect working under standard electrical condition as mentioned above should be given by LED source manufacture. Suitable for B1/B2 roads as per IS 1944 Part 1 & Part II.

- b) BOLLARD LIGHTS (8W 900MM Height) - LED Bollard light fitting of ... W with pressure die cast Aluminum housing body for optimal thermal dissipation. Lamp compartment comprising of anti-glare clear diffuser with injection moulded polycarbonate / clear glass material, delivering superior light output. Rated life burning Hrs. 50000 hr. @ Lumen Maintenance of 70%, CCT > 5500K, IP 66 optical and electrical compartment & impact resistance of complete luminaire > IK08. Power factor > 0.9 with mains, surge protection- Min 5KV along with Over voltage / Overload, Short circuit / miss - wiring protection. Universal voltage Driver to operate wide voltage range from 100V to 270V 50/60HZ application. Compliance to IS 10322/IEC 60598, LM 79 & LM 80 Adherence with RoHS. UL approved MCPCB, with 2 years warranty against any manufacturing defect working under standard electrical condition.
- c) FLOOD LIGHTS (150W / 240W) - LED Flood light with .....W system power consumption pressure die cast aluminum housing with powder coating with IP 65 protection. 1 200-270v voltage with electronic driver, PF>0.9, should meet ANSI 2G vibration test, compliance to UL/CE with class 1. System rating shall be 50K hr. @ lumen maintenance of 70%. system efficiency >80lm/w. Overload & short circuit protection ensures reliable operation in spite of problem in output side. Compliance to IS 10322/IEC 60598, LM 79 & LM 80 Adherence with RoHS. UL approved MCPCB. Top Access Street light with single

screw to ensure ease of maintenance at the site location with minimized minimal tools. LED Light fixture with .....W system power consumption. LED efficiency > 130lm/w at 1w and fixture efficiency > 75lm/w with CRI > 75. luminaire Manufacturer should have in-house facility accredited by NABL/CPRI & any government certified agency & design & development facility certified by ISO 9001:2008. Housing with supplier word mark/name shall be engraved / embossing on the die cast housing / body part. 2 years warranty against any manufacturing defect working under standard electrical condition as mentioned above should be given by LED manufacturer.

- d) 8.0 / 11.0 meters long hot dip Galvanized Octagonal Pole - Hot dip Galvanized Octagonal Pole with BSEN 10025 grade S355 JO steel plate for shaft, IS 2062 for base plate with door opening arrangements, including suitable boards, Bakelite sheet and DP MCB's of suitable capacity, 3phase connectors, as per IS specifications suitable to withstand the wind speed of 47m/sec for ...meters pole single section and single joint welded as per IS 9595/IS 10178 AWS having dimensions bottom ...mm, top ...mm with 3mm thick, suitable base plate and 4 Nos of ....long j bolts along with template and the pole shall be hot dip galvanized in single dipping with not less than 65micron as per ASTM-A123 and 153 etc.
- e) a) 8meters - Top 70mm and Bottom 135mm dia.  
b) 11meters - Top 90mm and Bottom 210mm dia.
- f) 16 meters long polygon high mast with single/multiple telescopic sections having, (minimum overlap distance of 1.5 times of top section) thickness as per BSEN 10025 grade S355 JO/ASTM A572-50 steel plate for shaft suitable to withstand the wind velocity of 47m/sec as per IS 875 part 3 (as per GA drawing).base plate as per IS 2062/ASTM A572-50. The mast shall be galvanized in single hot dip as per BSEN ISO 1461/ASTM A123 with an average 70microns as per IS 2629 and welded as per BS 5135 single L-Seam joint. The mast shall have 2way head frame with die cast LM-6 Pulleys, stainless steel axel, phosphorus bronze bearing bush press-fitted with separate guides for 2 runs of 5mm dia, stainless steel wire rope of AISI 304 grade 7/19-core, (Factor of safety of TR no-7). 2.5sqmm EPR insulated PCP sheathed trailing power cable housed inside the bottom shaft of mast with door having locking arrangements. The mast shall have power tool operating on 230/415V, 50Hz, 1/3Phases reversible geared motor. The mast shall have lantern of 2 segments, suitable dia with max load carrying capacity as per IS 1239. the mast shall be erected on existing RCC footing. The mast shall be supplied with 3mm thick template, lighting arresters of 1.2m length galvanized pipe with top arrow fitted on top of the head frame cover and GLS type aviation twin lamp fitting with wiring complete. (Excluding foundation) as per technical data. **16 meters - Top 150mm and Bottom 410mm dia.**

- g) Hot Dip Galvanized M.S Bracket suitable for outdoor luminaires and mounted on octagonal pole using necessary bolts, nuts etc. Complete Single / Double Arm Bracket with 1000-1200mm Standard 40/50MM dia.
- h) SOLAR STREET LIGHTS (20% of Normal Lighting to be considered) - Aesthetically designed 80-90watt AIO solar street light with IP 65 protected components, inbuilt MPPT charge controller, LED's with CCT of 6000-6500k with a system efficacy of min. 150 lm/watt total lumen output of 6000 lms along with lenses of wide spread 145x75 degree for better spread and throw, LED module should be Tilttable/adjustable for adjusting the Light without disturbing the mounting of the fixture, dual Mounting arrangement of aluminum die-cast for facilitating Top and side mounting, Aluminum extrusion body with Inbuilt Monocrystalline solar panel of 100wp within the fixture, Lifepo4 battery 12.8 V 24 Ah with BMS, with PIR/microwave sensor for dimming. Low voltage and charging indication, Fixture should be with over charge and deep discharge protection. Fixture should be suitable for a backup of 24 hrs. of operating time. complete system warranty should be 2 years. Certification required are LM 79 from third party, LM 80 for the LED chip, BIS for battery cell, Mounted on Existing 8.0/100.0m pole.
- i) Existing Approx. 80 Nos. Street lights to be used during Execution.

#### **PART-4 DG WORKS**

- 20) 250 KVA Diesel Generating Set with Electronic governor mounted on existing CC platform comprising of Diesel Engine Developing 159 BHP @ 1500 RPM confirming to BS 5514. The engine should be turbocharged, Air/water cooled with 10% overload for 1hour in every 12 hours of operation coupled to suitable capacity alternator rated at 415V, 0.8 PF (lag) 50 Hz, 3 phase, 4 wire system. confirming to BS 5000/IS 4722. The alternator shall be brushless type, Screen protected, revolving field, mounted on suitable Channel Iron Base Frame, Complete with suitable Silencer, capacity Fuel tank, required nos. of Batteries of 12/24V as per requirement, with Standard panel, Acoustic enclosure as per CPCB-2 Approved Norms. Also, the rate should include exhaust piping of 9Mtr with all necessary works and cost of structural steel. The DG set should suitable for Automatic start, Auto Synchronization, Auto load sharing and load dependent. The DG should provide with AMF (Auto mains failure) panel. The Cost shall include Exhaust Pipe with Silencer and Steel Stack to support for suitable height as per CPCB-II latest norms, DG civil foundation as required.

#### **PART-5 CIVIL WORKS RELATED TO ELECTRICAL WORKS**

- 1) Trench Digging of 0.6-0.75mtr. deep x 0.60 – 0.75meterwide, filling sand in excavated trench to covering with brick protection, already laid UG cable to a depth of 150mm all-round the cable in hard / soft soil to be considered for Laying Cables directly buried in Ground.
  - a) RCC HUME PIPES - NP2 class in ground complete with RCC collars, jointing with cement mortar 1:2 (1cement: 2 fine sand) including trenching (75 cm deep) and refilling etc. as required - 200, 250, 300 MM dia Hume pipe to be used.
  
- 2) RCC TRENCHES WITH HEAVY DUTY COVERS
 

Constructing watertight R.C.C. cable trench with 1:1.5:3mix (1 cement: 1.5 coarse sand: 3 graded stone aggregate 20 mm nominal size) with pre-cast RCC / SFRC covers of 50/100mm thick. Reinforcement for RCC work is 8mm diameter at 125mm center to center. Rating shall include 100x6 mm MS Plate Grouted to wall with necessary lugs welded to MS plate at 750mm center to center on both sides of walls. 75x75x6mm MS angle is welded to insert plate at an interval of 750mm. Foundation concrete 150 mm thick 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size), inside plastering 6 mm thick with cement plaster 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement finished, complete as per standard design and approved drawings. (Price shall include the cost of excavation, back filling, disposal of surplus earth dewatering as directed at site & other associated civil works). – Size:1500mm(W)x1000mm(D)
  
- 3) INSPECTION CHAMBER - HEAVY DUTY
 

Water tight brick masonry Inspection Chamber with first class bricks in cement mortar 1:6 (1 cement : 6 coarse sand), R.C.C. top slab of 150 mm thick with 1:1.5:3 mix (1 cement : 1.5 coarse sand : 3 graded stone aggregate 20 mm nominal size) with CI chamber cover for following size of trenches with frame.

Foundation concrete 150 mm thick 1:4:8 (1 cement : 4 coarse sand : 8 graded stone aggregate 40 mm nominal size), inside plastering 12 mm thick with cement plaster 1:3 (1 cement : 3 coarse sand) finished with a floating coat of neat cement and making channel in cement concrete 1:3:6 mix, M.S. foot rests including fixing in 20 x 20 x 10 cm cement conc. blocks neatly finished, complete as per standard design and approved drawings. (Price shall include the cost of excavation, back filling, disposal of surplus earth dewatering and water proofing of manholes as directed at site & other associated civil works).

  - a) 1000MMx1000MM
  - b) 750MMx750MM
  
- 4) Cast Iron Cable markers for LV & MV & HV cables as required including associated works.

5) STREETLIGHT POLE FOUNDATION

Light pole foundation, Concrete Foundation 1:2:4, 800 Dia, 1.5m Deep with above ground coping. MS Base Plate 350 x 400 x 10 thk. MS Base Plate 350 x 400 x 10 thk, J-BOLT as required Coat of Bituminous Preservative to be applied (both inside and outside) before concreting on this buried portion of pole 2 nos. of 40mm Dia Class A GI Pipe Sleeve, 1m Long for protecting the incoming and outgoing cable.

6) 2mm thick perforated cable tray of suitable size / width with powder coated paint on existing MS angle support using necessary GI bolts/nuts and washer or welding as required. Wherever required.

7) Swaged tubular pole of height 11Mtr – to be used for Overhead Lines wherever required with two coats of red oxide paint and finished with two coats of enameled paint of approved quality and color and M S base plate of suitable size welded at the bottom of the pole (as per IS) , The pole shall be erected in cement concrete depth of the pole to the ground level and the coping CC shall be up to 0.6m above the ground level as per IS 2713-7, IS 410 SP 47.

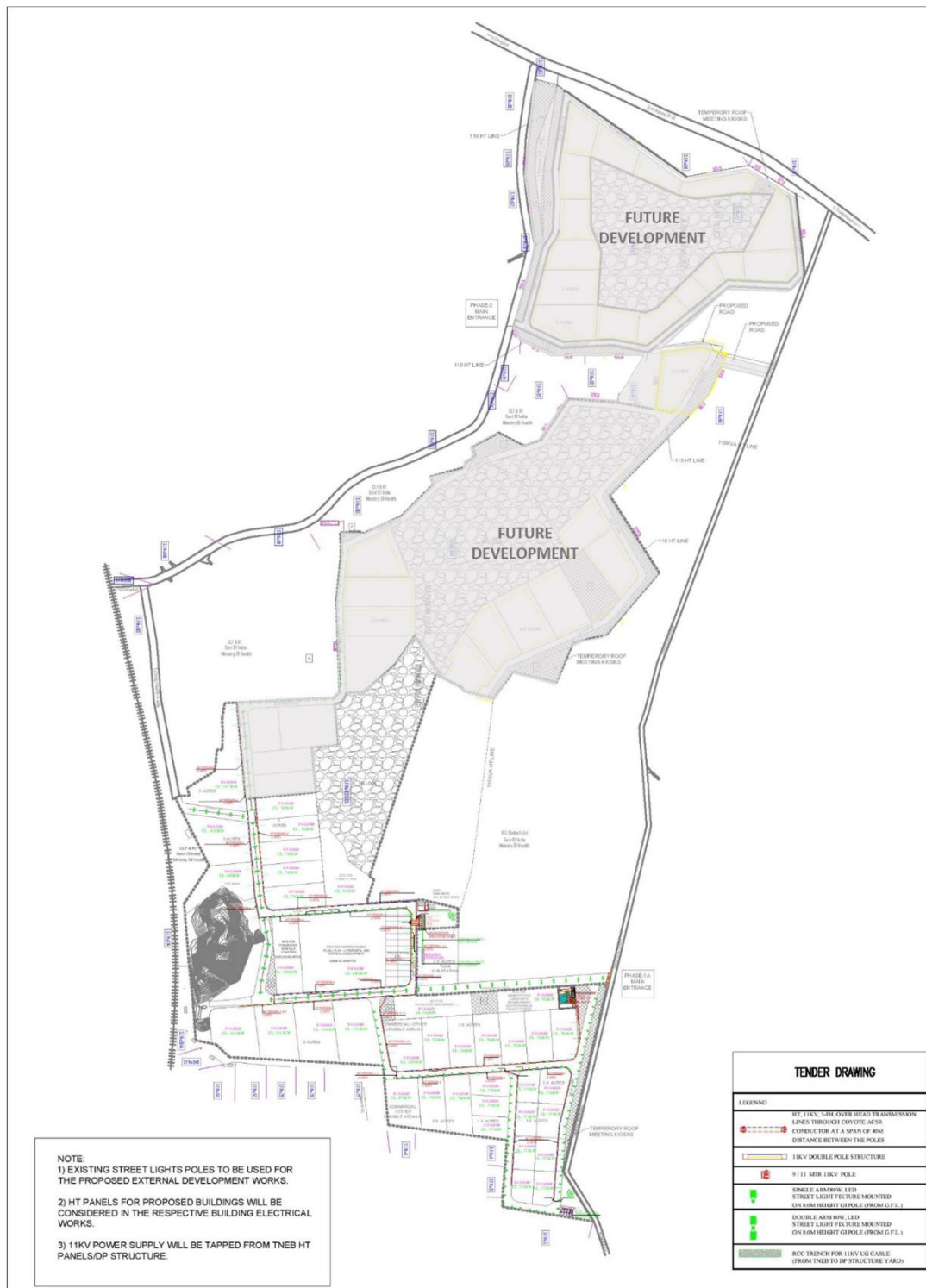
8) Internal Electrifications works including, Light fixtures, DB, switches, wires, etc. for Pump room, STP Room, Main Electrical Room Near Transformer Yard.

## 5. Drawings

Please refer to following table for reference to the Intent Diagrams (in A3 size) corresponding to this Schedule:

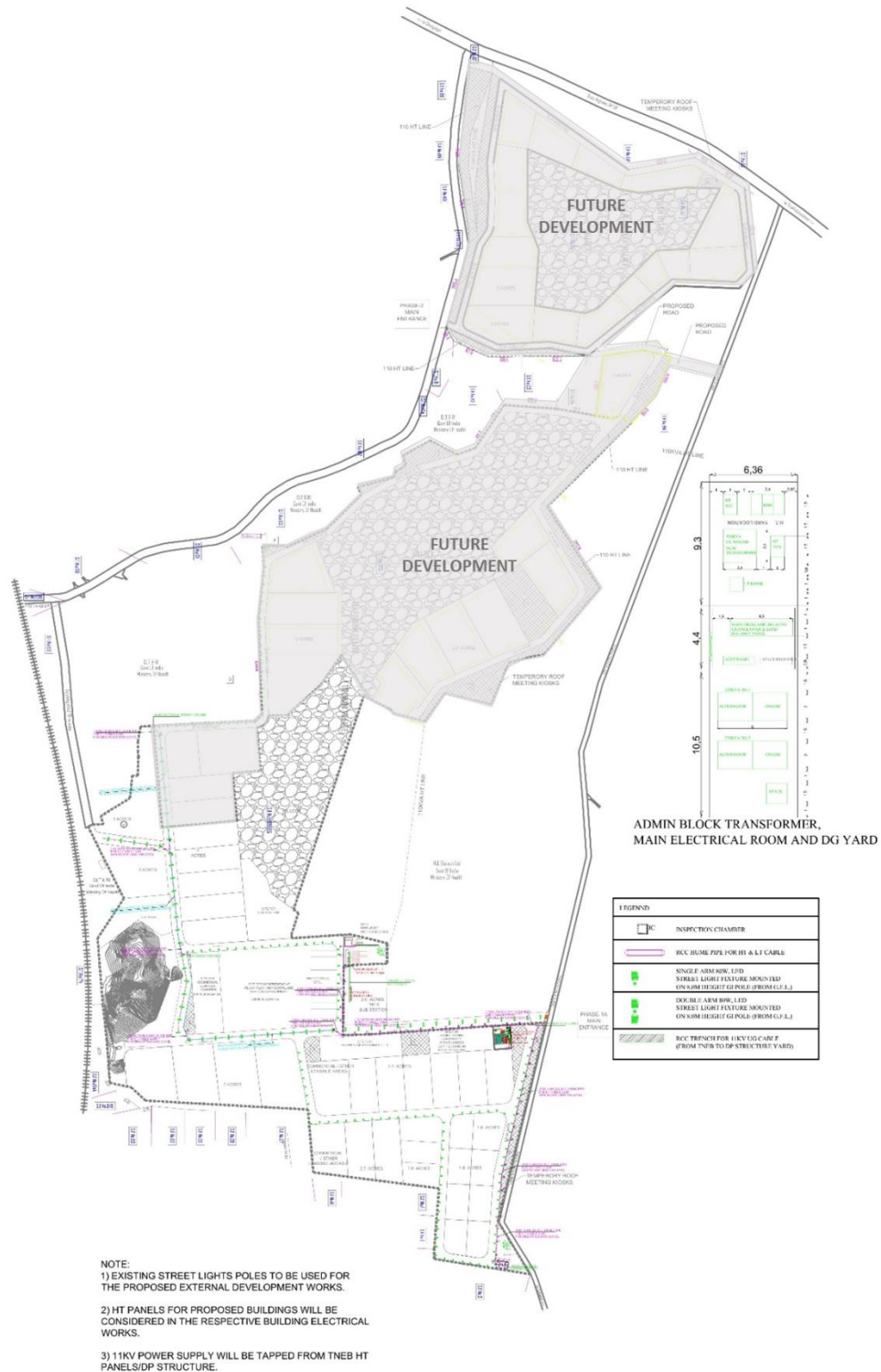
Schedule number	Reference number	Title
8	4.1	11KV overhead lines and street lighting location layout
8	4.2	Transformer, DG, yard, main electrical room, LT underground cable routing layout
8	4.3	11KV over headlines distribution detail
8	4.4	LT distribution single line diagram

## 5.1 11 KV overhead layout plan



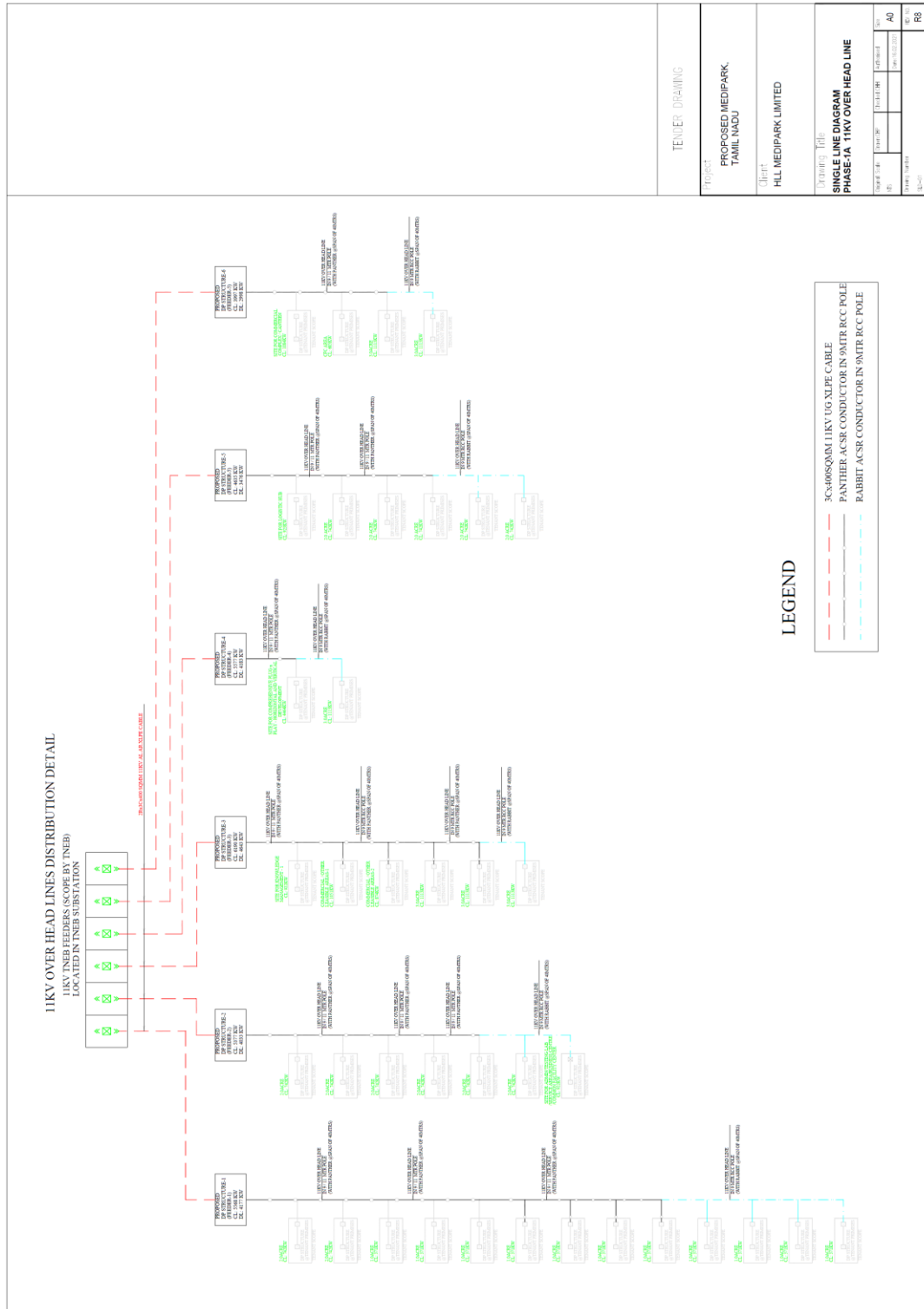


## 5.2 Electrical LT Supply Routing layout





### 5.3 Single line diagram – 11 KV overhead lines





## 6. List of approved makes

S.No	ITEM NAME	VENDORS
1	11KV, HT PANELS(VCB/LBS)	MEGAWIN, UNI POWER, OEM (ABB/SCHNEIDER/SEIMENS), TNEB APPROVED VENDORS
2	TRANSFORMERS-LEVEL-3	UNI POWER, UNIMAG, TNEB APPROVED VENDOR
3	HT AND LT CABLE	LASER, HAVELLS, POLYCAB, KEI, AVOCAB, RR CABLE
4	OVER HEAD ACSR CONDUCTOR	LASER, ASSIAN , BHARATH, TNEB APPROVED VENDOR,
5	MCBs / MCCB / ACB	SCHNEIDER, LEGRAND, ABB, SIEMENS, HAVELLS, L & T
6	CHANGE OVER SWITCH (AUTO / MANUAL)	L&T, C&S, HPL SOCOMEC, HAVELLS
7	FRLS PVC INSULATED COPPER WIRES/CABLES (UNARMoured)	FINOLEX, HAVELLS, KEI,
8	MDM (MULTIDATA METERS) / MEASURING INSTRUMENTS	ELMEASURE, L & T, SCHNEIDER
9	EXTERNAL LED LUMINAIRE	HAVELLS, LIGHTING TECHNOLOGIES, PHILIPS, BAJAJ, EVEREADY, CROMPTON
10	LT PANEL/PCC/MCC/MCBS/APFC/ PANELS/CONTROL PANELS	CPWD APPROVED VENDORS - VV SYSTEMS AND POWER PANELS PVT. LTD. / PACE SWITCHGEARS PVT. LTD/ IMPERIAL ELECTRO CONTROL PVT. LTD.
11	RESIN CAST CURRENT TRANSFORMER	AE, KAPPA, KALPA
12	AUTOMATION POWER FACTOR CONTROL RELAY	NEPTUNE , BELUK, EPCOS,
13	CAPACITORS	NEPTUNE , EPCOS, SCHNEIDER, ABB
14	CABLE GLANDS(DOUBLE COMPRESSION WITH EARTHING LINKS) / CRIMPLING LUGS	DOWELLS, COMET, BRASCO, HMI
15	CABLE JOINTING KITS	RAYCHEM, JAINSONS, 3M, DENSONS, XICON/BIRLA
16	CONTACTORS	SIEMENS, SCHNEIDER, C&S, ABB
17	EARTH LEAKAGE RELAY	ELMEASURE, L & T, SCHNEIDER
18	PUSH BUTTONS	L&T, SIEMENS, BCH, C&S, ESSEN DEINKI, TEKNIC, ABB
19	SELECTOR SWITCHES & ROTARY SWITCHES	KAYCEE, L&T, SIEMENS, GE, VAISHNO, SALZER, BCH, ABB
20	INDICATING LAMPS	SIEMENS, L&T, VAISHNO, RAAS CONTROLS, TEKNIC, C&S, KAYCEE, ABB
21	TERMINALS	ELMEX, WAGO, CONNECTWELL
22	SYNCHRONIZATION / AUTO LOAD SHARING RELAY	GCP -2000 SERIES / PLC BASED / WOODWARD

## **7. Technical specification for HT and LT works**

### **7.1 HT electrical works**

#### **7.1.1 11KV HT switchgear**

### **A.1 Technical specification for 11 KV switchgear and panel**

#### **1.0 General:**

The switchgear shall be Outdoor type, of single bus bar, air insulated totally enclosed metal clad type suitable for operation on the above 3 phase, 3 wire, 50 Hz, AC earthed system.

#### **2.0 Constructional feature:**

2.1 Switchgear shall comprise of circuit breaker of specified type. The cubicle is basically divided into 4 compartments viz., circuit breaker compartment, metering compartment, bus bar compartment and CT & cable compartment.

2.2 Switchgear shall be dust, moisture and vermin proof. Suitable ventilation arrangement shall be provided such that there is no accumulation of ionized gas in any compartment containing live equipment.

2.3 All doors, panels, removable covers shall be gasketed all around with neoprene gaskets. The cubicle enclosure shall conform to IP55 class.

2.4 Metal enclosed unit shall comprise of minimum 2 mm thick channel sections/structural frame enclosed completely by metal sheets of the thickness not less than 2 mm, smooth finished, leveled and free from flaws. The sheet steel shall be cold rolled. Cubicle shall be constructed by bolting various channel sections.

#### **2.5 Painting:**

2.5.1 All sheet steel work shall be phosphated in accordance with the following procedure and in accordance with relevant standards.

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

- 2.5.3 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.
- 2.5.4 After phosphating, thorough finishing shall be carried out with clean water, followed by final rinsing with diluting dichromatic solution and even drying.
- 2.5.5 The phosphate coating shall be sealed by the application of two coats of ready mixed, stove type zinc chromate primer.
- 2.5.6 After application of the primer, two coats of finishing synthetic enamel paint shall be applied with finish coat followed by stoving. The second finishing coat shall be applied after completion of tests. The color for the finishing paint as per the customer requirement.
- 2.5.7 Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.
- 2.5.8 The final finished thickness of paint on steel shall not be less than 100 microns and shall not be more than 150 microns.
- 2.5.9 Finished painted appearance of equipment shall present an aesthetically pleasing appearance, free from dents and uneven surface.
- 2.6 Switchgear design shall comprise of fully compartmental, executing having separate vertical sections for each circuit. Separate segregated compartments of earthed metal partitions shall be provided for circuit breakers. Instruments, relays, buses, current transformers, voltage transformers and cable boxes, bus bars to adjacent cubicles shall be taken through seal off bushings or insulating pads. Compartments with doors for access to operating mechanism shall be so arranged as not to expose high voltage circuits. Switchgear cubicles/compartments shall be provided with hinged doors on the front with facility for padlocking door handles.
- 2.7 Structure, buses and control wiring through shall be so designed and arranged to make further extensions readily feasible. The openings provided for this shall be closed with proper dust, moisture and vermin proof gang plates for the outer panels.

- 2.8 Instruments, relays and control devices shall be mounted flush on hinged door of metering compartment located in the front portion of cubicle made for minimum 2 mm thick leveled, smooth finish steel free from flaws. Panel door shall be supported by strong hinges and braced in such a manner as to ensure freedom from sagging, bending and general description of panel or hinged parts.
- 2.9 Circuit breaker carriage shall be fitted with positive guide so as to ensure proper alignment.
- 2.10 Switchgear cubicles shall be provided with sheet metal plates 2 mm thick (min). Cubicles with bottom cable entry shall be fitted with removable gland plates for fixing cable termination systems.
- 2.11 Metal sills in the form of metal channels properly drilled shall be supplied along with anchor bolts for mounting the switchgear cubicles. These shall be dispatched in advance so that they may be installed and leveled when concrete floors are cast.
- 2.12 All corresponding components of circuit breaker cubicles of same rating shall be interchangeable with one another.
- 2.13 Each switchgear cubicle shall be fitted with a label on the front and rear of the cubicle. Each switchgear shall also be fitted with label and indicating the switchgear designation, rating and duty. Each relay, instrument, switch fuse and other devices shall be provided with separate label. Size and wording of the labels shall be subject to approval. Material for nameplate shall be plastic sheets 2/3 mm thick or approved equivalent. The letter shall be white on black background. The nameplates shall be held by self-tapping screws. The size of the nameplates shall be proportionate to the respective equipment.

### **3.0 Safety interlocks and features:**

Switchgear shall be provided with the following interlocks:

- 3.1 Withdrawal (or) engagement of a circuit breaker shall not be possible unless it is in the open position.
- 3.2 Operation of a circuit breaker shall not be possible unless it is fully in-service position or withdrawn for test position or fully drawn out. It shall not be possible to close the circuit

breaker in service position, without completing the auxiliary circuits between fixed and moving position.

- 3.3 Withdrawal (or) engagement of the breaker shall not be possible unless the associated circuit breaker is in the open position. Both electrical and mechanical interlocks shall be provided for the purpose.
- 3.4 Compartment door of the breaker shall not open unless the associated breaker and isolator are in open position. Padlocking facility shall be provided both in service and isolated position.
- 3.5 Circuit breaker cassette shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary main isolating contacts when the breaker is withdrawn. Padlocking facility shall be provided for locking the shutters positively in the closed position of the shutters. It shall however be possible to open the shutters intentionally against spring for testing purposes. The shutters or orifices shall be clearly labeled 'BUSBARS' and 'CABLES' respectively.
- 3.6 The breaker carriage shall be earthed before the main circuit breaker controls are plugged in the stationary contacts. Positive earthing of circuit breaker/frame truck shall be maintained in the connected position.
- 3.7 Caution name plate, Caution Live Terminals shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, i.e., incoming terminals of main isolators, incoming breakers, tie breakers etc.

#### **4.0 Main bus bars:**

- 4.1 Main bus bars shall be of aluminum of high conductivity.
- 4.2 Bus bars shall be located in totally enclosed air insulated earthed metal enclosure and segregated from all other compartments of the cubicles and shall be mounted on epoxy resin cast type insulators. Direct access or accidental contact with bus bars and primary connections shall not be possible. No small wiring or other equipment shall be mounted within the bus bar chamber. To provide a seal between adjacent cubicles, bus bars shall preferably be taken through seal off brushings or insulating panels.

- 4.3 The main bus bar of switchgear section shall be aluminum of suitable capacity with high safety factor for specified current rating.
- 4.4 3-phase bus shall be adequately spaced and fully insulated for unearthed (or) resistance earthed system of rated voltage with  $\pm 12 \frac{1}{2} \%$  tolerance.
- 4.5 The bus shall be color coded and arrangement shall conform to relevant standard. The complete length of bus bar shall be insulated preferably with heat shrinking sleeves of proper grade.
- 4.6 All the bus connections, joints and taps shall be supplied with contact grease in the mating surface.
- 4.7 All bus bar joints, and bus tap joints shall be silver faced, plain and spring washers shall be provided to ensure good contacts at the joints and taps.
- 4.8 Bus bars shall be rated in accordance with the service conditions and the rated continuous and short time current ratings specified. The min. temperature of the bus bars and bus bar connections when carrying rated normal current at rated frequency shall not exceed 90 Deg. C.
- 4.9 Bus bars shall be adequately supported on insulators to withstand dynamic stresses due to short circuit current specified.
- 4.10 Bus bars shall be air insulated and phase segregated by means of insulated phase barriers. Bus Bar Supports and phase barriers shall Resin Cast with 33KV Di-Electric & Mechanical Strength.
- 5.0 Circuit breaker:**
- 5.1 Circuit breakers shall be of specified type conforming to relevant standards and shall be of horizontal draw out type. Circuit breakers of the same current rating shall be interchangeable. Circuit breakers shall comprise of three separate identical single pole units operated through a common shaft by the operating mechanism.
- 5.2 Circuit breakers shall be suitable for switching duty of transformer capacity.



- 5.3 Circuit breaker along with its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movements both ways.
- 5.4 Circuit breaker shall be provided with
- a) An emergency mechanical trip device
  - b) Mechanical ON-OFF indicators
  - c) Operation counter.
- 5.5 There shall be 'Service', 'Test' and 'Fully withdrawn' positions of breakers. In the 'Test' position, the circuit breaker shall be capable of being tested for operation without energizing the power circuits, i.e., the control circuits shall remain undisturbed while power contacts shall be disconnected. This facility shall be lockable to prevent unauthorized operation. Separate limit switches each having a min. of 6 'NO' and 6 'NC' contacts shall be provided for both 'Service' and 'Test' positions of the circuit breakers.

These contacts shall be rated for 10 Amp, 240 V AC and 1.0 Amp (Inductive breaking) at specified DC voltage.

## **6.0 Operating mechanism:**

- 6.1 Circuit breaker shall be power operated by a motor charged spring operated mechanism. Main poles of the breakers shall be such that unless otherwise specified, the maximum difference between instants of contacts touching during closing shall not exceed half cycle of rated frequency.
- 6.2 Operating mechanism shall be for pumping electrically and mechanically under every method of closing (except during manual closing of a breaker for maintenance). A latch-checking switch shall be provided on mechanically trip free mechanism to prevent re-closure before the breaker latches have reset.
- 6.3 Main poles of breakers shall operate simultaneously. 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.
- 6.4 Mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and will not cause tripping or closing operations of the power operated closing devices. When

the circuit breaker is already closed, failure of any auxiliary spring shall not cause damage to the circuit breaker or endanger the operator.

- 6.5 Mechanical indicators shall be provided to show if the circuit breaker is open or closed, whether in service, isolated or earthed positions. It shall be located in a position where it will be visible to the operator standing in front of the switchgear with cubicle door enclosed. A separate mechanical indicator shall show the three principal positions of the circuit breaker carriage.
- 6.6 Mechanical trip and close devices shall be provided for manual operation of the breaker. Access to mechanical closing device shall be from the front of the cubicle only. Padlocking facility shall be provided to the closing device. Provision shall be provided for slow manual closing of the circuit breakers for maintenance purpose and one operating device for this purpose shall be provided with such switchgear.
- 6.7 Working parts of the mechanism shall be corrosion-resisting material. Bearings, which require grease, shall be equipped with Pressure Relief type grease fittings. Bearing, pin, bolts, nuts and other parts shall be adequately pinned and locked to prevent loosening or changing adjustment with repeated operation of the breaker.
- 6.8 Auxiliary switches mounted on the fixed positions of the breaker and directly operated from the breaker operating mechanism on each breaker having 6 'NO' and 6 'NC' potential free contacts rated for 10 Amp, 240 V, AC and 1 Amp (inductive breaking) specified DC voltage shall be provided. The contacts shall be in addition to those utilized in the control circuit of each breaker and shall be exclusively meant for the purchaser's use in external interlocks and controls.
- 6.9 **Spring operating mechanism:**
  - 6.9.1 Spring operated mechanism, shall be complete with motor, operating spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit.
  - 6.9.2 As long as power is available to the motor, a continuous sequence of closing and opening operations shall be possible. After failure of power supply to the motor, at least one open-close-open operating of the circuit breaker shall be possible.

- 6.9.3 Breaker operation shall be independent of the motor, which shall be used solely for compressing the spring.
- 6.9.4 Closing action of the circuit breaker shall compress the opening spring ready for tripping.
- 6.9.5 When closing springs are discharged, after closing a breaker, closing springs shall automatically be charged for the next operation.
- 6.9.6 Motor shall be such that it requires only about 30 seconds for fully charging spring.
- 6.9.7 Mechanical indicators to indicate charged and discharged condition of spring shall be provided.
- 6.9.8 Means shall be provided to slowly open and close the breaker manually for maintenance purpose when the operating power is not available.

## **7.0 Operating mechanism control:**

Each cubicle shall be provided with a control switch close/normal/trip. Electrical tripping shall be performed by shunt trip coils. 'Red' and 'Green' indicating lamps shall be provided on cubicle door to indicate breaker close and open positions. All indicating lamps shall be provided with series resistors and shall be suitable for operation on specified DC voltage.

- 7.1 Following indication lamps shall be provided in each cubicle:

Breaker in 'Service' position	: RED
Breaker in 'Open' position	: GREEN
Breaker 'Ready to close'	: BLUE
Trip circuit is 'Healthy'	: WHITE
Breaker in 'Closed' position	: RED
Breaker 'Auto Trip' position'	: AMBER
Breaker 'Test' position	: YELLOW

## **8.0 Earthing:**

- 8.1 An earthing bus as per IEC Code of Practice shall be provided at the bottom and extreme throughout the length of the switchgear. It shall be bolted/welded to the frame of each unit and breaker/earthing contact bar.

- 8.2 The earth bus shall have sufficient cross-sections to carry the momentary short circuit and short time fault current for 3 second as specified without exceeding max. allowable temp. rise as per relevant IS/IEC Code.
- 8.3 Suitable clamp type terminals at each end of the earth bus shall be provided to suit the size of the Purchaser's earthing conductor.
- 8.4 All non-current carrying metal work of the switchboard shall be effectively bounded to the earth bus.
- 8.5 Bolted joints, splices, tapes etc., to the earth bus shall be made with at least two bolts.
- 8.6 Hinged doors and other bolted covers shall be earthed through flexible copper earthing braids.
- 8.7 CT & PT base plates are effectively connected to main earth bus by min. 50 x 5 mm Cu strip.
- 8.8 The circuit breaker frame/carriage shall be earthed before the main circuit breaker contacts are plugged in the fixed contacts.
- 8.9 **Circuit / Bus bar earthing facility:**
  - 8.9.1 It shall be possible to connect earth circuit by three position isolator/earthing switch specially designed along with circuit breakers for this purpose.

It shall not be possible to connect the earthing device unless associated circuit breaker is open and in withdrawn position. The earthing units shall be interlocked to ensure that all possible sources of supply to the associated section of bus bars or cables are positively isolated before earthing can be applied. After the earthing device is connected, the earthing connection shall be achieved by closing the circuit breaker in the normal manner. Provision shall be made for locking the circuit breaker in earthed position, for either bus bar or circuit earthing. With the circuit breaker in earthed position, electrical tripping of circuit breaker shall be rendered inoperative before closing and shall remain in-operative when closed. In the circuit breaker earthed position only, manual tripping shall be possible. The interlock scheme shall be subjected to approval.

Interlocks shall be provided to ensure that no source can be connected to the bus bars or cable while earth is applied.

The minimum of units equipped for bus bar earthing shall be one number.

## **9.0 Cubicle module accessories and wiring:**

Cubicle accessories and wiring shall include the following accessories:

9.1 Inter-cubicle wiring between cubicles shall be carried out by the Contractor. Separate schematics, internal, inter-cubicle wiring diagrams and external cable connection diagrams for each cubicle shall be furnished by the suppliers. The external connection drawings shall indicate all external connections to be made from the respective cubicles to remote equipment.

9.2 It shall be the responsibility of the supplier to select relays with proper characteristics.

All spare contacts of the relays and switches shall be wired up to the terminal block for future use when required. All main protective relays shall be supplied with in-built testing facility.

Two separate sets of switch fuse units shall be supplied to tripping and closing circuits of breaker.

Terminal blocks (including 10% spare terminals) with complete internal wiring and inter-cubicle wiring as required.

Multi-way block complete with necessary binding screws and washers and plastic marking strips for terminal identification shall be furnished for terminating cubicle wiring and outgoing cables. Terminal block provided in the panel shall have dropout facility for testing purposes.

The terminal block shall be grouped according to circuit functions and shall at least 10% spare terminals. Individual terminals in each block shall be serially numbered in accordance with the drawing.

The terminals shall be clamp/stud type, suitable for connection of at least 2 no. copper conductor cable per terminal. Compression type (solderless) lugs shall be furnished for

each terminal. Screw type terminals with screw directly impinging on conductor are not acceptable.

Not more than two wires shall be connected to any terminal. If necessary, any number of terminals shall be jumpered together to provide wiring points.

All accessories such as selector switch, breaker control-switch with indicating lamps. 'Test' and 'Service' position limit switches shall be included in the suppliers' scope of supply.

Inter-cubicle looping of control and cubicle space heating suppliers for all panels of the switchgear shall be carried out.

### 9.3 **Space heaters:**

Space heaters of suitable rating controlled by a switch and fuse or MCB with indicating lamps shall be provided in each cubicle to prevent moisture condensation within the enclosure.

A bulk-head fitting shall be provided in each circuit breaker cubicle for interior illumination.

Fuses and links shall be provided to enable individual circuits to be isolated from bus wires without disturbing other circuits. Each of the DC circuit shall be provided with two fuses-one in the positive and other in the negative for 2 wire, DC grounded system of specified voltage.

Wiring shall be done with min. 2.5 sq.mm. Stranded copper conductor PVC insulated.

For heater circuits, the bus wire shall be of adequate size so as to meet the load requirement of different motor space heaters and panel space heaters.

Each wire shall be identified at both ends with wire designation in accordance with the Contractor's wiring diagram. Interlinking type PVC identification ferrules shall be used.

All wire terminations shall be made with ring-tongue compression type connectors. Wires shall not be spliced between terminal points.

The wires shall be suitably grouped in bunches by non-metallic wiring cleats or bands with each bunch adequately supported along its run to prevent sagging due to flexibility or vibration.

Through wiring trough shall be furnished for wiring between switchgear cubicles. All wiring required for interlocking between the cubicles of switchgear shall be furnished by the Contractor.

Tough bushings are to be provided in the openings of the cubicles used for inter-panel wiring.

Whenever possible, metallic hose shall be used for wiring between compartments and cubicles.

Plug points rated for 240 V, single phase, 50 Hz, 10 Amp complete with an ON-OFF switch in the interior of each cubicle for connection of hand lamps.

#### **10.0 Meters:**

- 10.1 All indicating meters shall be 96 sqmm size moving iron instrument, flush mounting with accuracy of +/- 2% of full scale. Each meter shall be provided with zero adjuster, accessible from the front.
- 10.2 All instruments shall be 1.0 accuracy and as per SLD. In case of discrepancy b/w specification and SLD, SLD will prevail over technical specification Catalogue of all meters describing complete technical particulars of the meters shall be furnished. Accuracy curves, if not included in the catalogue, shall be furnished separately.
- 10.3 All integrating meters shall be provided with test blocks for current and Pressure coils for testing at site, without interrupting their recording while on service.

#### **11.0 Cable termination systems:**

- 11.1 Cable termination systems shall be provided in the switchgear for XLPE type cables with aluminum conductor.
- 11.2 Suitable cable terminating arrangements complete with all accessories shall be furnished.

- 11.3 All cable termination systems shall be suitable for bottom entry of cables at rear of the switchgear and shall be of sufficient height and size to facilitate cable termination. They shall be designed to provide adequate clearances. The gland plates shall not be less than 300 mm above floor level.
- 11.4 Connecting leads of adequate size with terminal clamps for connecting cable termination system terminals to switchgear equipment terminals shall be included.
- 11.5 Cable termination systems shall withstand the short circuit rating of the switchgear.
- 11.6 Necessary number of cable glands shall be provided for terminating auxiliary, power and control cables. Gland plates shall permit termination of additional cables without removing or disconnecting the existing glands and cables.
- 11.7 Glands shall be of heavy-duty industrial type double compression which shall be of brass casting machine finished and complete with check nut, washers, neoprene, compression ring, etc.

#### **12.0 Control fuses:**

All control fuses shall be link type HRC fuses. Screw in type HRC fuse shall not be acceptable.

#### **13.0 Current and voltage transformers:**

- 13.1 Current and voltage transformers shall conform to the requirements of relevant standards. They shall be of Resin cast Iron type and shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit and momentary current ratings of the switchgear. Current transformers shall be located on the fixed portions of the switchgear cubicle.
- 13.2 Current transformers shall have polarity marks marked on each transformer and at the associated block. Facility shall be provided for short-circuiting and earthing the CT secondary at the terminal blocks.
- 13.3 CT's shall have adequate burden, saturation factor, etc., to meet the requirements of metering and relaying. It shall be the Contractor's responsibility to co-ordinate the CT parameters with the requirements of metering and relaying furnished.



- 13.4 A voltage-limiting device shall be connected across the secondary winding of each CT to protect it and personnel against over voltage in the event of an open circuit.
- 13.5 Voltage transformers shall be of the draw-out type. VT's shall be of single-phase type and each single-phase VT shall be housed in a separate sheet metal compartment. VT's shall be protected on their primary and secondary sides by current limiting fuses with interrupting ratings corresponding to breaker rating. It shall be possible to replace the secondary fuses safely when the switchgear is energized. Provision shall be made such that the primary fuses can be handled only in the de-energized position.
- 13.6 VT burden shall be suitable for the relaying/metering/synchronizing provided. It shall be the Contractor's responsibility to co-ordinate the VT burden with the requirements of the equipment provided by him.

#### **14.0 Auxiliary relays, timing relays etc.:**

All auxiliary relays, timing relays and other general-purpose relays as may be required shall be furnished.

##### **14.1 Relay rating:**

Relays shall be rated for operation with 1A, 5A, CT secondary current and 110 V PT secondary voltage. No. of contacts and contact rating of relays shall suit the job requirements. All relays shall be set to their current operating point at the factory prior to shipment.

##### **14.2 Testing facility:**

All main protective relays shall be supplied with in-built testing facility.  
All relays shall be draw-out type only.

#### **15.0 Name plate:**

- 15.1 Name plates of approved design shall be furnished at the front and at the back of each cubicle. Rating plates for each circuit breaker and name plate for each instrument, relay and switches as mounted on the face or inside of the cubicle, shall also be furnished.

- 15.2 Instruments and devices mounted on the front face of the switchgear shall be identified on the rear also with the respective nameplates.
- 15.3 Material for nameplate shall be a plastic sheet, 3 mm thick or approved equivalent. The letters shall be white on black background.
- 15.4 The nameplates shall be held by self-tapping screws. The size of the nameplates shall be proportionate to the respective equipment.

**15.5 Auxiliary control power supply:**

**15.5.1 AC power supply for Space Heater and Cubicles, illumination lamp:**

Each switchgear panel shall be provided with space heaters. The space heaters shall be rated 240 Volt, 1 phase, 50Hz supply. For cubicle illumination, the vendor shall provide receptacle at suitable location of each switchgear cubicle so that hand lamp connection may be taken from it during inspection and maintenance. The receptacle shall be suitable for 240 v, 1 phase, 50 Hz supply. Each space heater and receptacle circuit shall be provided with ON-OFF switch and HRC cartridge type fuses. The space heater provided in the breaker cubicle shall be located in such a place so as to avoid overheating of any breaker parts.

**15.5.2 DC POWER SUPPLY FOR CONTROL AND PROTECTION:**

The power for breaker control, indication and protection shall be taken from specific DC voltage +/- 10% DC supply from station battery. Two independent DC feeders shall be taken to two ends of switchgear for breaker control protection and indication. The bidder shall provide two separate double pole switches of adequate rating at that point so that in case of failure of one cable, the DC power supply can be maintained over the duplicate feeder.

At each cubicle, both power supplies, 24V DC and 240 V AC shall be provided with isolating switches for trouble shooting purpose.

**16.0 Inspection, testing and certificates:**

- 16.1 Tests shall be carried out at Manufacturer's work under his care and expenses.

- 16.2 All routine and acceptance tests as per IS: 3427-1969 / IEC-298 latest edition shall be carried out on the metal enclosed switchgear.
- 16.3 All routine and acceptance tests on CB's shall be carried out as per relevant India/British/IEC standard.
- 16.4 Type test reports /certificates issued by CPRI OR any other 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) covering tests as per relevant IS / IEC code shall be furnished by the vendor for the breaker supplied by him.
- 16.5 Any other tests, as per the relevant Indian Standards shall also be carried out upon the Purchaser's request without any additional cost to the purchaser.
- 16.6 Six sets of copies of Test Reports/Certificates shall be submitted by the vendor to the Authority for all the items without any extra cost to the purchaser.
- 16.7 For the purpose of inspection, prior information of min. 15 days shall be given to the Authority for sending his authorized representative to witness the tests.

**17.0 Drawing, data and manuals:**

- 17.1 The vendor shall submit six numbers of the following drawings for approval.
  - 17.1.1 Outline dimensional drawing of the switchgear showing general arrangement and indicating the space required in front for withdrawal, power and control cable entry points, location of various devices and terminal blocks, etc.
  - 17.1.2 Foundation plan and loading.
  - 17.1.3 Cross section with parts list, bill of materials and relay cubicle door front view with cutout details.
  - 17.1.4 Detailed single- and three-line diagram of switchgear showing protection, metering etc.
  - 17.1.5 Control schematic diagram of each breaker showing all safety and operation interlocks, annunciation, etc.

17.1.6 Wiring diagram with terminal board disposition.

17.1.7 Complete relay technical particulars and recommended settings.

**18.0** Any other relevant data, drawing and information necessary for review of the items under Clause 17.1 whether specifically mentioned or not, shall be furnished by the vendor along with this information.

**19.0** Before starting manufacture of the equipment, the vendor has to take approval of these design drawings from the purchaser in writing.

**20.0** The vendor shall supply one set of reproducible and 4 sets of all drawings along with the dispatch of panels.

**21.0 PACKING AND TRANSPORT:**

The switchboard shall be sent to site by Road transport, packed in wooden crates. These shall be wrapped with polythene sheets before being placed in position to prevent damage to the finish. Crates shall have slide bottom for handling.

**A.2 DATA SHEET-1 FOR 350MVA, 630 A, 25KA, 11KV VACUUM CIRCUIT BREAKER UNIT****VCB PANEL CONSISTS OF**

630 Amp of basic rating totally enclosed, single bus bar, floor mounting, metal clad. Outdoor extensible type, flush fronted, horizontal draw out & horizontal isolation type Vacuum Circuit Breaker suitable for installation in 11 kV, 3 phase, 3 wire, 50 Hz AC system having neutral resistance earthed with a fault level of 350MVA at 11 kV & equipped with:

Outdoor panel constructed from sheet steel of 14 gauges for Outdoors shell including sloping MS Canopy and 14 Gauge for internal doors. Metering Panel and Internal partitions. The panel should be provided with louvered ventilators and screening strips to prevent ingress of rodents. The panel should be provided with rear entry Air Insulating cable box for cable termination for incoming power cables.

- Housing for circuit breakers carriage
- Mechanical interlock and safety gear including padlocking arrangements.
- 25 KA 11 kV, 630 A, basic rating Vacuum Circuit Breaker having rupturing capacity of 350 MVA at 11kV comprising of:
- Assembly of 3 Vacuum with epoxy support insulators and self-aligning finger type isolating contacts.
- Truck having integral racking-in device or intersection and withdrawal of VCB complete with necessary interlocks.
- Trip free manually charged spring power closing mechanism with manual closing mechanism with tripping push buttons and mechanical breaker with closed/open spring charged/discharged indication.
- Stored energy for motor operation of 24V DC
- Mechanical Operation Counter.
- Electrical release coil of 110 V DC.

- The shunt trip coil of 110 V DC.
- Breaker operated auxiliary switch-6 N/O & 6 N/C contacts
- Suitable Size of Bus bar chambers including a set of 3 phase 630 Amp, Aluminum bus bars, Air insulated with heat shrinkable sleeves.
- Main earth bus by min. 50 x 5 mm Cu strip.
- 230 V, AC Single Phase 80 Watt rated strip type heater.
- Current Transformer chamber incorporating-
- Suitable capacity and type of CT's for both Measurement and Protection as shown in the Single Line Diagram.
- Rear cable termination: Provision for terminating 11 kV Cable as mentioned in the SLD using Heat Shrinkable Terminating kit.
- Instrument panel fitted with
  - 1 - Multicore Cable box
  - 1 - Suitable kWh meter with MDI
  - 1 - Suitable kVAh with MDI
  - 1 - 96 sqmm Ammeters with Selector Switch
  - 1 - 96 sqmm Voltmeter with Selector Switch
  - 1 - Instantaneous non-directional, IDMT relay with 3O/C+ 1 EF (50/51/50N/51N)
  - 1 - Trip Circuit Supervision Relay suitable for 110-volt DC (98)
  - 1 - Non lockable breaker control (TNC) switch
  - 3 - Indicating lamps for breaker ON/OFF/AUTOTRIP
  - 1 - Trip Circuit Healthy Trip Lamp
  - 1 - Local/Remote Selector Switch
  - 1 - Panel illumination lamp
- a) Tripping Coil 24Vdc.
- b) Closing Coil 24Vdc

- c) Spring charge motor 230V AC & Mechanical indication.
- d) Breaker Control Switch, 16A
- e) Current Transformer 40/20A/5+5A (Dual Ratio/Core), Analog/Digital Ammeter 96 Sq.mm with selector switch, 3P with Off position.  
Core I: CL-1.0, 15VA  
Core II: CL-5P10, 15VA
- f) Breaker Status Indicating Lamp On (Red), 24Vdc
- g) Breaker Status Indicating Lamp Off (Green), 24Vdc
- h) Breaker Status Indicating Lamp Trip (Amber), 24Vdc
- i) Breaker Status Indicating Lamp Spring Charged (Blue) 230Vac
- j) Illumination Push Button, 'Trip Ckt Healthy Check' White with 1NO, 24Vdc
- k) Digital Ammeter, 0-50A, CTR-/5A, 96x96mm, Aux Supply - 24Vdc, CL-1.0
- l) Resin cast Potential Transformers, 3P, 100VA, Class:1, Voltmeter, Analog/Digital Voltmeter, 96 sq.mm with selector switches 3P with off position
- m) 30/C & 1E/F Numerical IDMT Relay, Aux. supply 24Vdc Low Set
- n) Master trip relay, 3NO+1NC Contact Aux Supply - 24Vdc  
Auxiliary relays or tripping facility to be considered in VCB panel during any one function failure in the Transformer
  - 1) Oil Temperature High Alarm
  - 2) Oil Temperature High Trip
  - 3) Winding Temperature High Alarm
  - 4) Winding Temperature High Trip
  - 5) Pressure release valve Alarm
  - 6) Buchholz relay High Alarm
  - 7) Buchholz relay High Trip

- o) PowerPack Input-230Vac, Output-24Vdc, with 15 mins backup located in metering compartment.
- p) Space Heater 230Vac, 60W with isolator to prevent moisture ingress.
- q) Thermostat (25-75°C)
- r) 16A DP MCB 10kA
- s) 20A Fuse Base
- t) 2A HRC fuse
- u) 6A HRC Fuse
- v) 15A Neutral Link Dropout Type
- w) VCB Terminals suitable to receive 3Cx120sqmm 11KV XLPE Cable in I/c & O/g side.
- x) Detailed GA and wiring diagram to be submitted.



**A.3 DATA SHEET-2 FOR 350MVA, 630 A, 11KV LOAD BREAK SWITCH UNIT:****SINGLE LBS PANEL**

FABRICATION of OUTDOOR Type **Load Break Switch Panel** should be made out of 2.0 mm Cold rolled, Mild steel, Metal clad, Free standing, totally enclosed, Cubicle type, Fully compartmentalized, Outdoor installations & Suitable for operation on 11kV, 3Ph., 50 Hz., AC earthed system.

The panel shall contain the equipment components as described below along with complete with bus bar inter connections control wiring, Designation labels, Caution notices, EB Sealing and pad locking facilities wherever required and as per Electricity Board requirement. Necessary space provision for entry of HT cables from the bottom through detachable gland plates.

Also, the Panel shall meet TNEB, norms and specifications,

The Panel shall be finished with Powder Coating.

LBS panel shall consists of

- 1 no. On Load Air Brake switch with Earth switch 3P, 630A, 11kV, 350MVA, 25kA.
- Earth Fault Relay with Core Balance Current Transformer (CBCT).
- 630A, Aluminum bus bar of suitable Rating, 3 $\phi$ , Air insulated with heat shrinkable sleeves.
- Earth: 50 x 5mm Tin coated Copper Bus bar.
- Bus bar Supports: Resin Cast with 33KV Di-Electric & Mechanical Strength.

#### **A.4 SPECIFICATION FOR ERECTION, TESTING & COMMISSIONING OF 11 KV SWITCHGEAR BREAKER PANELS / LOAD BREAK SWITCH PANEL**

**1.0** Unloading, Inspection, Storage, Installation, Testing & Commissioning of Switchgear shall be in accordance with (IS latest edition) and manufacturers' instruction.

##### **2.0 Handling:**

Switchgear and all its accessories shall be handled carefully in its upright position as indicated in the packing case. Lifting lugs and jacking pads shall be used for lifting of the switchgear, while using jacking pads utmost care shall be taken in proper application of jacks. Where switchgear is dragged or pulled on sleepers or rollers, traction eyes provided at the bottom frame shall be used with suitable wire ropes and shackles.

##### **3.0 Storage:**

Equipment shall be stored under shelter in a well-ventilated dry place and covered by suitable polythene or tarpaulin covers for protection against moisture. Where excess moisture/damp conditions prevail, and storage is for longer duration, space heaters provided shall be energized temporarily.

##### **4.0 General requirements:**

Environment within the switch room shall be kept to acceptable limits to allow equipment storage and installation to take place without damage.

Under no circumstances shall any item of equipment be forced. Every fitting will have been checked in the Manufacturers' works and if force is required, the equipment shall be rechecked, realigned and the necessary corrective action taken until force is not required.

Only the correct size and type of tools shall be used in the erection of switchgear.

Should finish paint chip off or crinkle during transit/handling installation, the Contractor shall arrange for repainting the equipment at site at his own cost.

## **5.0 Foundations and positions:**

Base Plates of Switchgear shall be installed as per vendor shop drawing. Foundation for Switchgear shall be in the correct position to match the fixings of the switchgear and in accordance with dimensions given on the drawings. Correct clearances and location of cables inlet/outlet shall be checked in relation to trenches Routing Layout Plans.

## **6.0 Installation:**

Installation of switchgear shall be executed in accordance with the Vendor's information.

Only nuts, bolts and washers supplied with switchgear shall be used for bolting switchgear, bus bars, etc.

The center section shall be installed first (in its final position), such that when the complete switchboard is finally erected, correct clearances are obtained.

Before placing each section, checks shall be made for any items such as bushings, taps, wires, links, packing, etc., that need to be threaded or inserted, before placing of the adjacent section, ensuring that such items are not tightened.

Final placing of sections to either side of the center section shall be undertaken alternately, with leveling and shimming as necessary.

Serial numbers of each unit shall be checked against arrangement drawings to ensure that each section occupies its correct position.

Bolts shall be placed through each side panel and hand-tightened accurately, ensuring lining-up the switchboard until the whole switchboard is installed.

Each section shall be bolted, and tight, to the fixing channel.

Fixing bolts shall be used in every position that has been provided for them.

Bus bar contact surfaces and tee-off connector surfaces shall be checked to ensure that they are clean on both sides.

After cleaning, faces shall be wiped with a clean rag to remove all dust; particular care

shall be taken to keep metal dust from bus bar insulation.

Starting at the center section and working outwards in each direction, floor fixing bolts shall be tightened on each unit in turn, taking up even pressure on each bolt.

As each panel is complete, checks shall be made to confirm that it is perfectly vertical. All units shall be complete in this manner. Between fixing of sections, bus bars and insulators shall be checked to ensure that no strain is placed on them.

Following tightening of each section, alignment shall be checked to ensure that all with draw able units can be inserted and withdrawn. All doors shall be checked for proper operation.

Working from the center, each pair of side panels shall be tightened together. All buses and earth connection shall be tightened.

Working from the center section, bus bars shall be tightened, and insulators checked.

Positioning and tightening of bus bars shall be such that no strain is placed on insulators, tee-off connectors, etc., and bus bars are correctly aligned.

All extraneous material, objects, etc., shall be removed from the bus bar chamber and bus bar covers replaced.

## **7.0 Earthing and bonding:**

Switchboard shall be earthed and bonded in accordance with the earthing layout design drawings, the Manufacturers' instructions.

## **8.0 Instruments and relays:**

Any instruments or relays supplied loose with switchboards shall be fitted and connected in accordance with the vendor's diagrams.

All relays shall be cleaned of dust and shall have all packing and shipping stops removed. Compressed air shall not be used to clean internal relay parts.

Before any loose items are fitted, they shall be checked against the drawings to ensure

that they are fitted in the correct position on the correct section.

#### **9.0 Wiring:**

Switchboard will be completely internally wired in the Manufacturers' works, but all internal panel wiring shall be done at site, they shall be connected in accordance with the wiring diagrams.

When loose items of equipment have been fixed, they shall be connected in accordance with the wiring diagrams.

#### **10.0 Tests:**

The following preliminary checks and pre-commissioning tests shall be carried out before commissioning the switchgear in the presence of Consultants/Architect's representatives.

#### **11.0 Preliminary checks:**

- a) Check nameplate details according to specification.
- b) Check for physical damage.
- c) Check tightness of all bolts, clamps and connecting terminals.
- d) Check earth connection.
- e) Check cleanliness of insulators and bushings, arc chambers.
- f) Check if all moving parts are properly cleaned and lubricated.
- g) Check if space heaters provided.

#### **12.0 Precommissioning checks:**

- a) Check alignment of breaker trucks for free movement. Check correct operation of shutters.
- b) Closing/opening operation
- c) Check control wiring for correctness of connections, continuity and IR values.
- d) Manual operation of breakers.
- e) Power supply closing/opening operation manually and electrically.
- f) Breaker closing and anti-pumping operation.
- g) Breaker local/remote opening / closing.
- h) Values for resistance and minimum pick up voltage of coils.
- i) Contact resistance of all sites assembled bus bars.

- j) Simultaneous closing of all three phases.
- k) Check electrical and mechanical interlocks provided.
- l) Check on spring charging motor correct operation of limit switches and time of charging.
- m) Check on CT's/PT's Polarity/Ratio.
- n) All functional checks with the relays, meters, alarm scheme, interlock as per scheme with primary/secondary injection kits.

### **7.1.2 Transformers**

#### **B.1 TECHNICAL SPECIFICATION OF TRANSFORMERS**

##### **1.0 Scope:**

The following specification covers the supply, testing and commissioning of transformer required for the proposed project.

##### **2.0 General information:**

Transformer shall be designed, manufactured and equipped with accessories in accordance with this specification and the applicable standards indicated below.

The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance and service.

Transformers shall be suitable for the following ambient conditions: -

Design ambient temperature : 50 Deg C.

Maximum humidity : 100 %

##### **3.0 Code and standards:**

3.1 The transformer shall conform to the requirement of the latest revisions of the following codes and standards.

Installation and maintenance of transformers, code of practice Latest IS Code 2026 /1180 Level-3

3.2 Whenever Indian Standards are not available, the transformer shall conform to relevant International Standards.

##### **4.0 Design criteria:**

4.1 The transformers shall be oil filled type and designed for natural cooling (ONAN)

4.2 The transformer impedance shall be as specified to limit the fault level on the LV side. The

neutral of the voltage winding will be solidly grounded.

- 4.2 The transformers with all accessories shall be capable of withstanding the thermal and mechanical effects of short circuits at the terminals of any winding without adverse effect.
- 4.4 Account shall be taken of the different forms of system fault that can arise in service, such as line to earth faults associated with the relevant system and transformer earthing conditions. The short circuit levels will be as specified in the Data Sheet.
- 4.5 The transformer shall be capable of continuous operation at its rated output without exceeding the temperature limits as below,
  - a) In top oil by thermometer ..... 50 Deg. C. above ambient temperature
  - b) In winding by resistance ..... 55 Deg. C. above ambient temperature
- 4.6 Overloads shall be allowed within the conditions defined in the loading guide of the applicable standard. Under these conditions, no limitations by terminal bushings, on load tap changers or other auxiliary equipment shall apply.
- 4.7 The transformers shall be capable of continuous normal operation at its rated output under the following conditions.
  - a) Voltage varying by + / - 10 %
  - b) Frequency carrying by + / - 3 %
- 4.8 The transformer shall be designed and constructed so as not to cause any undesirable Interference in Radio or communication circuits.
- 4.9 Steel bolts and nuts exposed to the atmosphere shall be either galvanized or zinc passivated.
- 4.10 Explosion relief vent should be located on the top cover and directed in such a way that on bursting of diaphragm; the oil forced out will not fall in any of the auxiliary equipment of the transformer and the other electrical equipment in the vicinity.



**5.0 Transformer tank:**

- 5.1 The tank shall be of electrically welded construction and fabricated from sheet of adequate thickness. Tanks shall be hydraulically tested to ensure that they are leak proof and subjected to vacuum test.
- 5.2 The tank shall have adequate strength to withstand without any deformation, mechanical shock during transportation and oil filling by vacuum.
- 5.3 The tank shall also be provided with two numbers of grounding pads for earthing.

The transformer tank shall be provided with sets of bi-directional flat wheels for rolling the transformer parallel to either centerline.

Jacking pads, lifting eyes and pulling lugs shall be provided to facilitate lifting and movement of the transformer, filled with oil. All heavy removable parts shall be provided with eye bolt for ease of handling.

- 5.4 The transformer top shall be provided with a detachable tank cover with a bolted flanged gasket joint. Lifting lugs shall be provided for removing the cover. If necessary, the surface of the cover shall be suitably sloped so that it does not retain rainwater.
- 5.5 Adequate space shall be provided at the bottom of the tank for collection of sediments.
- 5.6 The transformer base shall be designed to permit skidding of the complete transformer unit in any direction. Pulling eyes shall be provided for moving the transformer in either direction.
- 5.7 The Gasketed joints used for the tank, manhole covers bushings, and other bolted attachments shall be oil tight and so designed that the gasket will not be exposed to the weather.
- 5.8 Tank shall be provided with a pressure release device, which shall operate at a pressure below the test pressure for the tank and radiators. The device shall be rain proof after blowing and shall be provided with a device visible from ground to indicate operation. An equalizer pipe connecting the pressure relief device to the conservator shall be supplied.

- 5.9 Materials in contact with oil shall be as such as not to contribute to the formation of acid in oil.
- 5.10 Inspection covers of manholes of sufficient size to be provided for access to leads, winding, bottom terminals of bushings and taps.
- 5.11 Oil sampling taps shall be provided with valve at top and bottom to collect sample of oil from the tank for testing.
- 5.12 To facilitate the oil filtration by streamline filter, suitable inlet and outlet taps with valves at the bottom and at the top of the tank on diagonally opposite corners shall be provided. The valves at the bottom may be used as drain valve.
- 5.13 Thermometer pocket for top oil temperature measurement by liquid thermometer shall be provided.
- 5.14 Marshalling kiosk boxes, etc. shall be weatherproof having a degree of protection IP55.
- 5.15 Cooling tubes or radiators shall permit every part of the cooling surface to be cleaned by hand and shall be suitably braced to protect them from mechanical shock. Each radiator bank shall be detachable type and provided with oil isolating valves at either side.

The transformer tank shall be fitted with a double diaphragm type of explosion relief vent at the top with equalizer pipe connections to oil conservator.

Explosion relief vent should be located on the top cover and directed in such a way that on bursting of diaphragm; the oil forced out will not fall in any of the auxiliary equipment of the transformer and the other electrical equipment in the vicinity.

## **6.0 Core and coil:**

- 6.1 The core shall be built up of high quality, low loss, non-ageing high permeability grain oriented cold rolled silicon steel lamination with very low magnetization losses and annealed to relieve and develop excellent magnetic proportion.
- 6.2 The core clamping frames shall be provided with lifting eyes for the purpose of taking and inspecting the core with windings mounted thereon and shall have ample strength to take

the full weight of the core and winding assembly. The core assembly shall be electrically connected to the transformer tank for effective core earthing.

- 6.3 Insulating material shall be of proven design. Coils shall be so insulated that voltage stresses are minimum.
- 6.4 The windings shall be from electrolytic copper conductor of high conductivity. The windings shall be duly sectionalized. Similar coils shall be connected by accessible joints braced welded and finished smooth.
- 6.5 Coil assembly shall be securely positioned with spacers, pressed board cylinders, barriers and shall be so arranged as to allow free circulation of the oil.
- 6.6 All leads from the windings shall be suitably supported to prevent damage from vibration or short circuit stresses.
- 6.7 The core & coil assembly shall be rigidly braced and fixed to the tank so that no shifting or deformation occurs during transport and installation or during short circuits.
- 6.8 The finally assembled core with all the clamping structure shall be free from deformation and shall not vibrate during operation.
- 6.9 The core clamping structure shall be designed to minimize Eddy Current loss.
- 6.10 The end turns on the high voltage windings shall have reinforced insulation to withstand any of the voltage surges likely to occur during switching or any other abnormal system conditions.

#### **7.0 Internal earthing:**

- 7.1 All internal metal parts of the transformer, with the exception of individual laminations, core bolts and their individual clamping plates shall be earthed.
- 7.2 The top clamping structure shall be connected to the tank by a copper strap. The bottom clamping structure shall also be earthed.

- 7.3 The magnetic circuit shall be connected to the clamping structure at one point and this shall be brought out of bushing. A disconnecting link shall be provided on transformer tank to facilitate disconnections from the ground for IR measurement purpose.

#### **8.0 Tappings:**

- 8.1 The transformer shall be capable of delivering its rated output at any position.
- 8.2 The winding including the tapping arrangement shall be designed to preserve the electromagnetic balance between HV and LV winding at all voltage ratios.

#### **9.0 Insulating oil:**

The insulating oil shall conform to the latest revision of IS: 335 properly inhibited for prevention of sludge.

The necessary first filling oil shall be supplied for the transformer. 10 % excess oil shall also to be provided to take care of wastages in non-returnable containers suitable for outdoor storing.

#### **10.0 Terminal arrangement:**

- 10.1 The HV terminals shall be brought to an air insulated disconnecting chamber forming a weatherproof assembly.
- 10.2 The secondary terminations shall be brought to an air insulated disconnecting chamber, which in turn is connected to bus-duct box connection as required forming a weatherproof assembly.
- 10.3 The LT side provision to be made for 500KVA – 800A, TPN, Bus Bar.
- 10.4 The disconnecting chamber shall be air-insulated bushings, drain plugs, relief vent, levels glass, removable links and removable covers shall be provided for the disconnecting chamber. The high current carrying conductor plates shall be non-magnetic.

Phase to phase and phase to ground clearance with the chamber shall be such as to enable

Either the transformer or each cable to be subjected to HV tests.

**11.0 Neutral terminal:**

- 11.1 The size of the neutral bushings shall be as that of phase bushings on the LT side, two bushings/bus bar shall be provided for neutral, on through topside wall bushings to the LV bus duct and the other connections to earthing. A neutral CT of required ratio, burden and knee point voltage should be mounted inside the transformer for restricted earth fault protection. This will be a matched current transformer, which will be mounted in HT switchgear. Secondary of the CT to be brought out to bushing mounted in an IP 55 cover suitable for connection to control cable.

Earth portion of the cable end box shall be provided with two nos. grounding pads suitable for 50 x 5 mm Copper flat.

**12.0 Temperature indicators:**

- 12.1 One set of dial type thermometers with a pointer to register highest temperature attained for oil temperature indication / winding temperature indication shall be supplied and fitted inside the marshaling box. Two separate sets of contacts shall be provided, one for alarm and the other for circuit breaker trip on higher temperature.

**13.0 Build on radiators:**

The following accessories shall be provided for radiator.

- 13.1 Top and bottom shut-off valves and blanking plates on each radiator.
- 13.2 Lifting Lugs.
- 13.3 Top oil filling plug.
- 13.4 Air release plug at top.
- 13.5 Oil drain plug at bottom.

**14.0 Conservator tank:**

- 14.1 The conservator tank shall be connected with the main tank by a pipe through Buchholz relay (having separate sets of contacts for alarm and tripping) with isolating valves at both ends.
- 14.2 The conservator tank shall be provided with dial type (magnetic) level indicator visible from ground level and fitted with low oil level alarm contact.
- 14.3 A weatherproof-dehydrating breather shall be provided with silica gel as the dehydrating agent.

**15.0 Marshaling box:**

- 15.1 A dust, vermin and weatherproof marshaling box suitable for out-door use shall be provided. The box shall contain terminal blocks meant for Buyer's control cable connections and all auxiliary devices. The marshaling box shall be provided with a blank detachable plate for mounting the control cable glands. The control glands are not within the scope of this specification. The marshaling box shall have glass front for reading the temperature indicators from outside degree of protection IP 55.

**16.0 Gas and oil activated relay (Buchholz relay):**

- 16.1 A double float type Buchholz relay as per specified standards shall be provided. All gases evolved in the transformer shall collect in this relay. The relay shall be provided with a test cock suitable for a flexible pipe connection for checking its operation. A 5 mm copper pipe shall be connected from the relay test cock to a valve located about 1.25 m above ground level to facilitate sampling with the transformer in service. The device shall be provided with two electrically independent under grounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure. These contacts shall be wired up to the transformer-marshaling box. The relay shall be provided with shut-off valves on the conservator side as well as the tank side.

**17.0 Wiring:**

- 17.1 Wiring for winding & oil temperature indicators, magnetic level gauge, Buchholz relay contacts and neutral CT etc. provided on the transformer shall be wired up to the terminal

blocks inside the marshaling box by means of 2.5 sq.mm (4 Sqm for CTs) flexible PVC copper cables. Wires shall be identified at the terminations by numbered plastic ferrules.

- 17.2 Not more than two wires shall be connected to one terminal, 10 % spare terminals shall be provided.
- 17.3 Auxiliary supply to all indicators, alarms and trip contacts provided shall be suitable for operation on a suitable in A.C /D.C.
- 17.4 All devices & terminals blocks within the marshaling box shall be clearly identified by symbols corresponding to these used on applicable schematic or wiring diagram.

#### **18.0 Metal treatment and painting:**

- 18.1 All steel surfaces shall be thoroughly cleaned by sand blasting or chemical agents as required to produce a smooth surface, free of scale, rust and grease.
- 18.2 All paints shall be carefully selected to withstand tropical heat, rain, etc. The paint shall not scale-off, crinkle, or be removed by abrasion due to normal handling.
- 18.3 Tanks are coated inside with oil and heat resistant paint. The external surfaces shall be given a coat of high-quality zinc chromate primer followed by two coats of high-quality paint as per IS 5 – 1961.

#### **19.0 Tolerances on performance guarantees:**

- 19.1 The permissible tolerances on the performance guarantee are as follows

- |                                  |  |
|----------------------------------|--|
| a) Voltage ratio at No. Load     | : 0.5 % of the declared ratio, Proposed Losses shall be as per IS 1180, Star rated specification, Star, Level3 |
| b) No. Load loss- 500 kVA        | : 1430 W   |
| c) Full Load loss- 500 kVA       | : 4100 W   |
| d) Impedance at the 75 Degree C. | : 0.05 +/- 10% or as per relevant IS code  |

**20.0 Tests:****20.1 Routine tests:**

During manufacture and on completion, transformers shall be subjected to the routine tests as laid down in IS 2026 / 1180 Level-3.

In addition, the following tests shall be performed on each transformer.

After fabrication, each tank fitted with all valves, covers, etc. shall be tested for leaks with normal head of liquid plus 0.352 kg/sqcm. for a period of 12 hours. If any leak occurs, the test shall be conducted after all leaks have been repaired.

The tank shall be subjected to vacuum as per CBIP specification.

Test on Oil Samples as per IS-335-1993.

**20.2 Type tests:**

The transformer shall conform to all type tests in accordance with the latest issues of IS 2026 / 1180 Level-3 and Type Test Reports to be submitted for approval of the Authority/consultants.

**21.0 Test certificates:**

21.1 Six (6) copies of test certificates including for bought-out items like relays, valves, etc., shall be furnished to the Buyer, along with complete identification of data including serial number of the transformer.

21.2 The Buyer will depute his representative to witness any (or) all the tests.

21.3 If the tolerances exceed the limits prescribed in standards Buyer has right to reject the transformer.

**22.0 Packing:**

Packing should be of high quality to avoid any damage of the equipment's during transit.



**23.0 Drawings/ details/ documents:**

- 23.1 A general outline drawing of each transformer shall be furnished with the offer. The drawing shall indicate dimensions, net weights, quality of insulating oils, general constructional features, dimensions of the largest part to be transported, etc.
- 23.2 After acceptance of the offer, the Seller shall furnish drawings for approval.
- 23.3 General arrangement drawing showing the plan, front elevation, side elevation, foundation plan, complete with details of bill of material, detailed dimensions, net weights, details/ drawings of HV/LV terminals, cable boxes, LT trucking arrangements, clearances between HV/ LV terminals etc.
- 23.4 Control and wiring diagram for marshaling boxes, with interconnection details of cable sizes and number of cores required between various equipment such as relays, marshaling box, etc.
- 23.5 The seller before dispatch of the equipment shall furnish four copies of all final approved drawings.
- 23.6 Any other relevant drawing and data necessary for operation and maintenance purpose shall be furnished.
- 23.7 Six sets of instruction manual of transformer, its various fittings & gauges (the manual shall clearly indicate the installation methods, check-ups and tests to be carried out before commissioning of the equipment's) shall be furnished to Authority.

**B.2 SPECIFICATION FOR ERECTION, TESTING & COMMISSIONING OF TRANSFORMER**

**1.0** Inspection, storage, installation, testing & commissioning of transformers shall be in accordance with IS: 1886 (Latest Edition)-/10028 - Code of Practice for installation and maintenance of transformers, and manufacturer's instructions. The Contractor shall submit detail inspection and testing programs for field activities, covering areas right from received materials stage upto commissioning stage as per above mentioned IS Code. In the inactive checks and tests are given below,

**2.0 Preliminary checks:**

- a) Compare nameplates details with the specifications.
- b) Check for any physical damage, in particular of bushings.
- c) Check tightness of all bolts, nuts, clamps, gasketing and connecting terminals.
- d) Check cleanliness of bushings.
- e) Check for oil leakage and oil level.
- f) Breather condition, check whether, breathing line is free, silica gel is reactivated, oil is available at the bottom.
- g) Check for clearances, particularly in case of bus ducts.
- h) Water tightness of terminal boxes and bus ducts.
- i) Earthing of transformer tank and neutral bushing.
- j) Releasing of air from bushings (very important) Buchholz Relay.
- k) Check that the transformer is correctly installed with reference to its phasing.

**3.0 General checks:**

- i. Check that the transformer is properly installed and there is no possibility of any movement during operation.

- ii. Check whether earthing connections have been properly done.
- iii. Check whether all radiator valves and valves in the feed pipes between main tank and their respective conservators are open, while all drain, filter and sampling valves are closed.
- iv. Check whether oil is at the proper level in the:
  - a) Transformer tank
  - b) Conservator
- v. Check that no air pockets are left in the tank.
- vi. Check that all thermometer pockets are filled with oil.
- vii. Check heaters wherever provided in marshalling box, cubicles, etc.
- viii. IR Values
- ix. Rating and voltage Connections made proper and tested.

## **B.3 SPECIFICATION FOR ON LOAD TAP CHANGER GEAR**

### **1.0 Scope:**

This specification covers on load tap changing gear (OLTCG) for transformers.

### **2.0 Codes and standards:**

The design manufacture and performance of equipment shall comply with all currently applicable standards, regulations and safety codes in the locality where the equipment will be installed. Nothing in this specification shall be construed to relieve Seller of this responsibility.

### **3.0 General requirements:**

- 3.1 OLTC Gear shall be oil immersed, high speed, and non-inductive transition resistor type and shall be suitable for controlling from local position or electrically from remote. The same shall be suitable for Automatic Voltage Regulation (AVR).
- 3.2 The OLTC gear shall be designed to complete successfully tap changes for the current to which transformer can be loaded i.e.100 % of the rated current. Devices shall be incorporated to present tap change when through current is in excess of the safe current than the tap change can handle.
- 3.3 When a tap change has been commenced, it shall be completed independently of the operation of the control relays and switches.
- 3.4 Oil in compartments, which contain the making and breaking contacts of the OLTC, shall not mix with oil in other compartments of the OLTC or with transformer oil. Gases released from these compartments shall be conveyed by a pipe to separate oil conservator. A Buchholz relay shall be installed in the above pipe. The conservator shall be provided with a prismatic oil level gauge.
- 3.5 Oil filled compartments shall be provided with filling plug, drain valve with plug, air release vent, oil sampling device, inspection opening with gasketed and bolted cover with lifting handles.

#### 4.0 OLTC driving mechanism:

4.1 OLTC driving mechanism and its associated control equipment shall be included in an outdoor damp, dust and vermin proof. Weatherproof cabinet consisting of the following:

- A) Driving motor suitable for 415 V, 3 Phase or 230 V single phase 50 Hz A.C. external supply.
- B) Motor drive/starting contactor with overload protection HRC fuses, single phase preventor and motor duty switch with indicating lamp.
- C) Reversing contactors (Electrically and Mechanically inter-locked with forward contactor).
- D) Raise-Lower Spring return to normal type of control switch.
- E) Local-Remote maintained contact type selector switch.
- F) Mechanical tap position indicator showing the tap number and tatted tap voltage with facility/contacts for the tap position indicator on the Remote-Control Panel.
- G) Limit switches and mechanical stops to prevent motor over travel in either direction.
- H) Out of step switch and stopping relay, Directional sequence switch.
- I) Suitable device to permit only one tap change at a time on manual operation.
- J) Manual operating device.
- K) Mechanical operation counter to register accumulated number of tap changes.
- L) Anti-condensation space heater with MCB and thermostat suitable for 240 V, 50 Hz.
- M) Interior light fitting with door switch and 3 pins, 5 Amp socket outlet with switch and MCB.
- N) Panel lock/Pad lock arrangement for the hinged for of cubicle.
- O) Un-drilled removable cable gland plate for cable entry including necessary cable glands.
- P) Rating and diagram plate made of stainless steel.
- Q) Nameplates made of anodized Aluminium.

## 5.0 The RCP (Remote Control Panel):

The OLTC Remote Control requirements accessories shall be housed in indoor type cubicle made of 14/16G M.S. sheet floor mounting free standing type, dust and vermin proof construction. The wiring will be done by PVC insulated copper conductor of 1100 V grade and fitted with numbered interlocked ferrules. The instruments indicating lamps, switches, etc., shall be flush mounted on the front of the panel.

### The RCP shall consist of:

- a) Raise-lower spring return to normal control switch.
- b) Tap position indicator marked with tap number.
- c) Auto-Manual maintained contact type selector switch.
- d) Sequence selector switch.
- e) Automatic Voltage Control Relay with U/V & O/V trip and alarm.
- f) Necessary auxiliary relays.
- g) Indicating Lamps for:
  - i. Tap Change in Progress.
  - ii. Lower Limit reached.
  - iii. Upper Limit reached.
- h) Audio/Visual Annunciation for following with hooter, accepts PB, reset PB and flusher circuit.
  - i. AC supply failure to On Load Control Gear (ONCG) / Meter.
  - ii. Drive motor 'Auto Trip'.
  - iii. Out of step.

Any other alarm considered essentially by supplier.

- i) Cubicle illuminating lamp with door switch.
- j) Terminal strips/block internal wiring, nameplates, control transformer.
- k) Cubicle locking arrangement.
- l) Cable glands for cables.
- m) Anti-condensation space heater with MCB and thermostat.
- n) Terminal blocks, earthing bus terminals, fuses, internal wiring complete, etc.
- o) Auto control devices consisting of:
  - i. Voltage setting, voltage sensing and voltage regulating device.
  - ii. A time delay device/timer in the range of 5-25 seconds in both 'raise' & 'lower' operations. The time delay shall apply only to the first step of a tap change.

## 6.0 ELECTRICAL CONTROL:

The control circuits shall provide the following electrical control features:

An interlock to cut-off electrical control automatically on intimation of manual control.

Positive completion of a tap changes once initiated even in case of power supply failure

'Step by Step' operation to ensure only one tap change to take place even if the tap change control switch is stuck or in the operated position by actuation of emergency limit switches.

Cut-off of electrical control when it tends to operate the tap beyond its extreme portion.

Interlock to prevent an impulse being given to reverse the tap change direction while a tap change operation is already under progress, until the mechanism comes to rest and rests circuit for a fresh operation.

Necessary Contacts/Switches for signalling at the remote-control board as requires and remote indication of the tap position.

## **7.0 MAINTAINABILITY:**

Tap changer being an accessory of transformer which has moving parts carrying the full load current, the need for preventive maintenance at regular intervals is very essential to reduce the down time on the transformer due to the tap changer maintenance. The following points to be given due importance in the design of the tap changer.

The dismantling of the OLTC gear from the transformer shall be simple and take minimum time. This shall enable annual preventive maintenance to be completed in one day.

Inspection covers to be provided at the critical places, which are easily accessible on the OLTC tank. This shall enable half-yearly inspection of the moving parts to be completed within the duration of an hour.



**B.4 DATA SHEET-3 FOR TRANSFORMERS**

<b>Sl. N.</b>	<b>PARTICULARS</b>	<b>11kV/433V</b>
<b>1.0</b>	Ratings	500 KVA with OLTC, as per IS 2026 / 1180, Level-3
<b>2.0</b>	Winding Materials	Copper
<b>3.0</b>	Service	Outdoor
<b>4.0</b>	Type of Cooling	ONAN
<b>5.0</b>	<b>Temp.Rise above 50 Deg.Ambient</b>	
5.1	In oil by thermometer	50 Deg.C.
5.2	In winding by resistance	55 Deg.C.
<b>6.0</b>	No. of phase & cycle	3 phase, 50 Hz
<b>7.0</b>	Winding per phase	Two
<b>8.0</b>	Fault level	
8.1	HV System	350 MVA, 25KA
<b>9.0</b>	<b>Rated Voltage (Line to Line)</b>	
8.1	HV	11,000 volts
8.2	LV	433 volts
<b>10.0</b>	Basic Impulse Level	75 kV Peak
<b>11.0</b>	<b>Inter-phase Connection</b>	
11.1	HV/LV	Delta/Star

<b>12.0</b>	Vector Group reference	Dyn 11
<b>13.0</b>	Tap Changer %	16 Steps & 17 Position in steps of 1.25% on HV Side (+5% / -15%) for OLTC
<b>14.0</b>	System Grounding	Solidly grounded on LV Side
<b>15.0</b>	Terminal Arrangement	
15.1	HV	Cable end box (Outdoor to receive HT CABLE of size 3C x 95 Sq.mm XLPE end termination Raychem make)
15.2	LV	Suitable for 800A, TPN, Bus Bars for 500 KVA Transformer
<b>16.0</b>	<b>Neutral Terminal</b>	
16.1	HV	Nil
16.2	LV	Minimum 2 Nos. 50x5mm Copper Flat / Solidly Earthed
<b>17.0</b>	<b>External Painting</b>	Epoxy coated / TNEB SPEC.
<b>18.0</b>	<b>Accessories:</b>	
	Power Transformers of above ratings shall be supplied with the accessories as per schedule of each transformer but not necessarily limited to it.	
18.1	Oil filling hose with Plug/Cover.	
18.2	Conservator with sump and drain valve with Plug/Cover.	
18.3	Oil level indicator with maximum and minimum level markings.	

- 18.4 Thermometer Pockets –1no.
- 18.5 Air released plug on tank cover.
- 18.6 Lifting lugs and jacking lugs.
- 18.7 Top filter valve-1no.
- 18.8 Dehydrated breather with silica gel and oil seal and connecting pipes.
- 18.9 Rating and terminal marking plate.
- 18.10 Two nos. Body earthing terminals with lugs.
- 18.11 Drain cum bottom filter valve.
- 18.12 Base channel with two wing holes/lugs.
- 18.13 150 mm dia. type oil temperature indicator with maximum reading pointer and alarm and trip contact suitable for AC/DC supply.
- 18.14 First filling of transformer oil.
- 18.15 Buchholz relay with alarm and trip contacts with necessary piping-2 nos. (transformer + OLTC).
- 18.16 Oil temperature indicator with relay.
- 18.17 Winding temperature indicator with relay.

Standard accessories not mentioned above.

#### **19.0 SPARES for Transformers:**

The essential spares as mentioned below shall be supplied along with each transformer without any extra cost over and above of the accessories as mentioned in clause 18.

- a) One member of each type of Bushings / Cable Box accessories.

- b) One Buchholz Relay with contact.
- c) Oil Temperature Indicator with contacts.
- d) WTI with contacts.
- e) Magnetic oil gauge.
- f) One cooling fan.

### **7.1.3 HT CABLES**

#### **C.1 SPECIFICATION FOR HT CABLES**

##### **1.0 Scope:**

This specification covers the technical requirements of design, manufacture, test and supply of 3 core HT cable complete for efficient and trouble-free operation.

The laying, testing and commissioning of cable at site shall be done by the Contractor.

The cables shall be properly packed for transportation, supply and delivery at site.

##### **2.0 Standards:**

2.1 The materials covered by this specification shall unless and otherwise stated, as designed, constructed and tested in accordance with latest revisions of the relevant Indian Standards.

IS 7098-1973 OR IEC60502-2 1998 : XLPE Insulated Armored Aluminum Cables

##### **3.0 Rating:**

3.1 The conductors shall conform to IS 8130-1976 (amended up to date).

##### **4.0 Testing and inspection:**

Tests shall be carried out at manufacturers' works under his care and expense.

The cables shall conform to all 'Type & Routine Tests' test listed in the relevant IS.

Six copies each of the above test certificates shall be submitted to the Authority.

##### **5.0 Packing, marking and transport:**

Cable should have proper identification mark e.g. cable size, year of manufacturing, voltage class, etc. including the manufacture's name.

## **6.0 Cable installation:**

### **6.1 Storing:**

On receipt of HT cables at site, cables shall be inspected to detect any damage. The ends of cable shall be in sealed condition. After inspection, cable shall be located in a proper place.

### **6.2 Cable Laying:**

HT cables shall be laid in trenches or ducts unless and otherwise specified. Generally, laying, jointing and commissioning shall be as per regulations of local authorities.

### **6.3 Cables and cable entries:**

Particular attention is drawn to the Contractors, responsibilities in safeguarding cables installed in outdoor locations and unfinished buildings. Such equipment is particularly vulnerable to damage from water and dust penetration. The installation work is proceeding, covers temporarily removed from trenches/entries for purpose of installation shall be reassembled on completion of the work and replaced when such work is suspended or otherwise left incomplete. Similarly, all entries shall at times be effectively sealed against ingress of water and dust, e.g., Duct entries shall be sealed by the insertion of proprietary stopper plugs or approved means.

### **6.4 Handling of Cables:**

Storage & handling of cable before and during installation shall be executed with regard to Manufacturers' recommendations. Cable drums if any, shall be rotated only in the direction indicated on the drum, and open ends of cable shall be effectively sealed after cutting to prevent ingress of moisture, using heat shrink end caps.

### **6.5 Cable Pulling:**

Armored cables shall be installed with the aid of specially manufactured rollers, in order to prevent damage to outer sheaths. Cables up to 38 mm diameter shall be installed by hand. However, larger cables, with the approval of the Company Site Representative, may be installed with the assistance of a winch. Any such winch shall be equipped with a suitable tensioning device and indicator and operated by a competent operator.

Drum jacks, cable rollers and other equipment shall be of the correct type for the cable being installed.

#### **6.6 Cable Bending:**

At all times, utmost care shall be exercised to prevent excessive bending or twisting of cable during installation.

Changes in direction in cable trenches, racks or trays shall provide for a minimum cable-bending radius of 10 to 12 times the overall cable diameter.

#### **6.7 Cable jointing:**

Cables shall be run in continuous unbroken lengths. Any requirement for cable jointing shall be executed only with the approval of the Company Site Representative.

All cable jointing shall be executed by fully trained tradesmen who have passed an approved course of instruction in such work for the operating voltage level concerned. Written confirmation in this respect shall be furnished to the Company site Representative by the Contractor.

#### **6.8 Protection from Moisture:**

Each cable system shall be installed either where it will not be exposed to rain, dripping water, steam, condensed water, etc., or be of a type designed to withstand such exposure.

In damp situations and wherever they are exposed to weather, all metal sheaths and armor of cables, metal conduit, ducts, ducting trunking clips and their fixings, shall be of corrosion-resistant material or finish and shall not be placed in contact with other metal with which they are liable to generate electrolytic action.

For conductors insulated with impregnated paper, exposed conductor & insulation at terminals and cable joints shall be protected from ingress of moisture by being suitably sealed.

## 6.9 Cable Termination:

All work on the termination of cables shall be executed by fully trained & competent tradesmen who have passed an approved course of instruction in such work for the operating voltage level concerned. Written confirmation in this respect shall be furnished to The Company Site Representative by the Contractor.

Within terminal boxes, an adequate length of cable tail shall be provided to enable each cable core to be connected to any terminal, in accordance with the approved method of termination for each equipment.

For multicore terminal/junction boxes, an adequate length of cable tail shall be left to allow for remarking and termination of each core, i.e., a 25 mm diameter loop prior to entry of cable core into each terminal.

All connections at a cable termination shall be mechanically & electrically sound and shall be protected against mechanical damage or any vibration liable to occur. They shall not impose any appreciable mechanical strain on fixing of the connection and shall not cause any harmful mechanical damage to the cable conductor or equipment. Conductors of cables shall be terminated in a manner suitable for the terminal arrangement of the equipment concerned.

Prior to final connection, all cable shall be checked for continuity and insulation resistance and correct installation.

The appropriate check sheets shall be complete by the Contractor and accepted by The Company Site Representative, prior to final connection.

## 6.10 Glands, seals and Shrouds:

The entire body of a cable shall enter a gland & the outer sheath of a cable shall not be removed before entering the weatherproof seal. Cable shall be on a straight axis from a point immediately before entering a gland.

Cable glands shall securely retain the cable without damage to the outer sheath or armor.

Glands shall be correctly sized and of a type suitable for installation in each respective



type of enclosure.

All glands shall be correctly sized and of a type which will maintain the integrity of the equipment within which they are to be installed. Such factors as use of insulated plastic enclosure and explosion proof type protection shall be taken into account when selecting glands.

All mechanical glands shall be of the hexagon type; knurled type glands shall not be used.

Earth continuity of brass glands & terminations shall be achieved by rigid clamping of armor within each gland and intimate contact between threaded components of glands and equipment.

Brass glands terminating in unthreaded enclosures shall be provided with earth continuity by attachment of earth continuity bonds.

Terminations of mineral insulated cable shall be provided with sleeves having a temperature rating equal to that of the seals.

Cores of sheathed cables, from which the sheath has been removed and without sheathed cables shall be enclosed with conduit, ducting or trunking system according to the design specification.

#### **6.11 Terminal Connecting Lugs:**

Cable tails of conductors of 10 sqm and above shall be fitted with double compression type terminal connection lugs, using tools specially designed for use with such lugs.

At all terminal connections, cable conductors shall be fitted with correctly sized cable sockets of the crimped compression type. Soldered connections shall be employed only where their use is unavoidable. Solder used shall have a melting point of not less than 185 Deg.C. and cable lugs or thimbles shall be the correct type and size for each conductor. Packing of oversized lugs shall not be permitted.

Compression joints shall be made using proprietary sets of lugs and indent dies, correctly sized and shaped for each specified conductor concerned. Use of mixed lugs and dies of different manufacture or systems shall not be permitted.

**6.12 Sealing of Cable Transits:**

Openings made or provided in or through building walls, floors, etc., shall be effectively sealed.

Cable entries into trenches (in switch rooms, etc.) shall be effectively sealed after cables have been laid. Unused cable entries and cable entries in equipment also shall be effectively sealed.

Opening through roofs and external walls shall be made weatherproof, including installation of flashing and/or rain hoods to prevent the entry of driving rain, seepage of water, dust, etc.

**6.13 Single-Core Cables:**

Each set of single-core cables comprising a three-phase circuit shall be run close together in trefoil formation.

All cable gland-mounting plates for single-core cables shall be inspected to ensure they are non-magnetic material.

When installed in ducts, each trefoil group shall be installed in a single duct.

**6.14 Cable Supports:**

Every cable and conductor used as fixed wiring shall be supported in such a way that it is not exposed to undue mechanical strain and so that there is no appreciable mechanical strain on the terminations of the conductor. Account shall be taken of the mechanical strain imposed by the supported mass of the cable or conductor.

Conduit, ducting and trunking shall be properly supported and of a type that is either suitable for any risk of mechanical damage which may be met in normal conditions of service, or adequately protected against such damage.

Installation shall take into account longitudinal expansion and contraction that may occur with variation of temperature under normal operating conditions.

## 6.15 Underground Cables:

### 6.15.1 General Requirements:

All excavation, cable protection, backfilling and surface restoration and installation of cable markers, protection tiles and warning tape shall be in accordance with the Electrical drawings.

Construction of cable trenches, their bedding and backfilling shall be executed in accordance with Electrical Drawings.

Where excavations are required near footings, foundations, concrete floors, etc. earthwork under and in the vicinity of these excavations shall not be disturbed and all backfill shall be well consolidated.

Installations shall be so arranged that all trenches are excavated and backfilled in a minimum period of time, care shall be taken to ensure that all cables, for a particular route are made available at site, before trenches are excavated.

When planning the excavation sequence for cable trenches, the Contractor shall take care to obstruct access.

Adequate safety precautions shall be observed at all excavations by the provision of safety barriers, warning notices, shoring, etc.

Cables installed under roads shall be in accordance with the Electrical Drawings.

Cables to be installed in underground ducts, conduits or pipes, shall be of a type that incorporates a sheath and/or Armor, suitably resistant to any mechanical damage likely to be caused during drawing in.

Physical separation between HV, LV, telecom and instrument cables laid within the same cable trench shall be in accordance with Electrical Drawings.

UG cable routes shall avoid close proximity to pipe crossings and parallel pipe runs. Physical separation between cables and pipes shall be not less than 300 mm and cables should cross underneath pipes.

If a cable route is in close proximity to underground pipes carrying hot liquids or gases, or which are regularly steam cleaned, the pipe shall be insulated in order to limit its outside temperature to a maximum of 60 Deg.C. In these cases, cables may be run above pipes.

Buried cables shall be identified with their full cable numbers, as detailed on the cable schedule, as both termination points. Cable numbers shall be embossed on a metallic strip and installed on cables using proprietary cables ties. Sample of which shall be approved before use.

Cable route and cable joint markers shall be installed visibly at ground surface level in accordance with the Electrical Drawings.

When cable routing is not definitely indicated on a design layout drawing, the Contractor shall submit full of his proposed routing to The Company Site Representative for approval. Routing details shall be shown clearly on the Contractors work drawings.

#### **6.15.2 Cable Installation:**

Installation of direct buried cables shall not be commenced until the entire route has been excavated and prepared ready to receive the cable.

If cable is left exposed above ground, it shall be coiled and suitably protected against damage.

Laying patterns, as indicated on the layout drawings, shall be adhered to.

Unavoidable crossings shall be made either in the cable cellar directly underneath the corresponding switchgear panel, or at the branching-off point of a particular cable from the main trench. Care shall be exercised to keep the whole installation tidy in these areas.

Ends of hard-floored cable trenches, ducts or pipes shall slope down into surrounding soil, to avoid cable damage following possible setting of soil.

## 6.16 Above ground:

### 6.16.1 General Requirements:

Cable shall be laid on rack or trays in accordance with laying patterns indicated on layout drawings.

All cable outlets from a duct system, all joints in a duct system, and all joints between such a system and another type of ducting or conduit shall be formed so that joints are mechanically sound. During cable pulling, cables shall not be damaged.

Spacing between cable racks, trays or cable ladders and structures, wall or columns, shall be at least 50 mm.

Metal parts of cable racks and trays shall be bonded between each section and connecting to the common earth grid.

Cables shall be fixed to cable racks and trays by proprietary ties, straps and/or clamps where indicated on the layout drawings and as specified in the design specification. The cable ties, straps and clamps shall be capable of retaining the cables during short circuit stresses, and if nylon/plastic ties are used, they shall be UV-resistant.

Where cables, conduits, ducts or trunking pass through fire-resistant structural elements such as walls and floors designated as fire barriers, openings made shall be sealed according to the appropriate degree of fire resistance. In addition, where cables conduits or conductors are installed in channels, ducts, trunking or shafts that pass through such elements, suitable internal fire-resistant barriers shall be provided to prevent spread of fire.

Enclosure for conductors and their joints/terminations, which are subjected to dust conditions, shall be protected to IP 54 (refer to IEC 79).

Cables shall not be installed on exterior wall faces of buildings, ceilings or support structures without the specific approval of The Company Site Representative. Spacing between cable and structure or similar shall be at least 10 mm.

For horizontal runs of cable on structures, cables shall be adequately cleated such that no

sags occur in cabling.

All cables shall be supported by saddles, cleats or other supports as indicated on the layout drawings such that no mechanical forces are imposed on cable glands.

Cable saddles shall be double-fixing, Half-section saddles shall not be used. Fixing of saddles by means of explosive tools shall not be permitted.

Cleats shall firmly clamp cable without distorting or damaging cable.

Cables sheathed with rubber, PVC or equal, may be supported by a catenary wire, either continuously bound to support cable or attached at intervals. For cables supported by a catenary wire incorporated in accordance with minimum heights indicated on the layout drawings.

For spans without intermediate supports, terminal supports, terminal supports shall be arranged so that undue strain is not placed on conductors or insulation of cable. Adequate precautions shall be taken against any risk of chafing of cable sheath. Minimum specified height above ground and length of spans shall be in accordance with the layout drawings.

#### 6.17 **Testing:**

Cables shall be tested at site as follows:

1. Before shifting of cables from the yard to the site, insulation resistance shall be carried out on the cable and readings recorded in the presence of the Site Representative.
2. On cable being laid prior to sand bedding, an IR shall be conducted and recorded in the presence of the Site Representative.
3. On the cable trench, route being completed, and compaction done, an IR shall be conducted and recorded in the presence of the Site Representative.
4. Before end terminations are made, an IR shall be conducted to ensure the cable is in order.
5. On terminations being completed prior to connecting to the equipment, the following tests shall be conducted:

- a) An IR done on the cable/termination.
- b) Cable/term subject to a Hipot (Hipotential) Test. The voltage to be applied shall be as per manufacturers' recommendations and in co-ordination with Authority/Consultants.
- c) An IR done on completion of the above Hipot test and compared to item (a).
- d) All tests shall be done and recorded in the presence of the Site Representative.

## 7.0 11KV OVERHEAD LINE'S SPECIFICATION AND INSTALLATION

The Overhead Transmission Lines carried through ACSR (Aluminum Conductor Steel Reinforced) Conductor.

The Panther and Rabbit type ACSR conductor are to be considered for the 11KV, HT Transmission Lines of approved makes with all test certificates from Authorized Agencies / Authorities.

11 kV, 3 Phase Power Line on 9 meters / 11 meters Supports with an Average Span of 40 meters using COYOTE / RABBIT ACSR Conductor with all necessary insulators, clamps etc.

The type of ACSR conductor and routing to be done as per the TNEB instructions and guidelines.

### **Voltage Rating for LA:**

- 1) The rated voltage of lightning arresters shall be 9 KV (rms).
- 2) This will be applicable to the effectively earthed 11 KV systems co-efficient of earth not exceeding 80 percent as per IS: 4004 with all the transformer neutrals directly earthed.

### **Tests for LA:**

- The following routine and type tests as laid down in IS: 3070 (Part-I) shall be carried out.
- Routine Test: Dry Power frequency spark over test.
- Type Tests (Confirmation):

- 1. Voltage withstands tests of arrester insulation.

2. Power frequency spark over test
3. Hundred percent 1.2/550 microsecond impulse spark over test
4. Front-of-wave impulse sparks over test.
5. Residual voltage test.
6. Impulse current withstand test.
7. Operating duty test.
8. Temperature cycle test on porcelain housing.
9. Porosity test on porcelain components.
10. Galvanizing test on metal parts.

#### **11 KV DROP-OUT FUSE CUTOUTS: (IS: 9385 (part-I to III).)**

The distribution fuse cutouts shall be outdoor, open, drop-out expulsion type fuse cutouts suitable for installation in 50 Hz, 11 KV distribution system.

The rated voltage shall be 12 KV.

The rated current shall be 100 A.

#### **Rated Lighting Impulse withstands Voltage for Fuse:**

- To earth and between poles 75 KV (Peak)
- Across the isolating distance of fuse base 86 KV (Peak)

#### **Rated One Minute Power Frequency Withstand Voltage (Wet & Dry) for Fuse:**

- To earth and between poles 28 KV (rms)
- Across the isolating distance 32 KV (rms)

#### **Temperature Rise Limit for Fuse:**

- Copper contacts silver faced 650C
- Terminals 500C
- Metal parts acting as spring the temperature shall not reach such a value that Elasticity of the metal is changed

#### **Rated Breaking Capacity for Fuse:**

- The rated breaking capacity shall be 8 KA (Asymmetrical).

#### **Construction Details for Fuse:**

- The cutouts shall be of single vent type (downward) having a front connected fuse carrier suitable for angle mounting.



- All ferrous parts shall be hot dip galvanized in accordance with the latest version of IS: 2632. Nuts and bolts shall conform to IS: 1364. Spring washers shall be electro-galvanized.

**Fuse Base Top Assembly:**

- The top current carrying parts shall be made of a highly conductive copper alloy and the contact portion shall be silver plated for corrosion resistance and efficient current flow.
- The contact shall have a socket cavity for latching and holding firmly the fuse carrier until the fault interruption is completed within the fuse.
- The top assembly shall have an aluminum alloy terminal connector. The top assembly shall be robust enough to absorb bulk of the forces during the fuse carrier closing and opening operations and shall not over-stress the spring contact. It shall also prohibit accidental opening of the fuse carrier due to vibrations or impact.

**Fuse Base Bottom Assembly:**

- The conducting parts shall be made of high strength highly conductive copper alloy and the contact portion shall be silver plated for corrosion resistance and shall provide a low resistance current path from the bottom fuse carrier contacts to the bottom terminal connector.

**Fuse Carrier Top Assembly:**

- The fuse carrier top contact shall have a solid replaceable cap made from highly conductive, anticorrosive copper alloy and the contact portion shall be silver plated to provide a low resistance current path from the Fuse Base Top Contact to the Fuse Link.
- It shall make a firm contact with the button head of the fuse link and shall provide a protective enclosure to the fuse link to check spreading of arc during fault interruptions.
- The fuse carrier shall be provided with a cast bronze opening eye (pull ring) suitable for operation with a hook stick from the ground level to pull-out or close-in the fuse carrier by manual operation.

**Fuse Carrier Bottom Assembly:**

- The fuse carrier bottom assembly shall be made of bronze castings with silver plating at the contact points to efficiently transfer current to fuse base.

- It shall make smooth contact with the fuse base bottom assembly during closing operation. The bottom assembly shall have a lifting eye for the hook stick for removing or replacing the fuse carrier.

**Fuse Base (Porcelain):**

- The fuse base shall be a bird-proof, single unit porcelain insulator with a creepage distance (to earth) not less than 320 mm. The top and bottom assemblies as also the middle clamping hardware shall be either embedded in the porcelain insulator with Sulphur cement or suitably clamped in position.
- For embedded components, the pull-out strength should be such as to result in breaking of the porcelain before pulling out occurs in a test. For porcelain insulators, the beam strength shall not be less than 1000 kg.

**Fuse Tube:**

- The fuse tube shall be made of fiber glass coated with ultraviolet inhibitor on the outer surface and having arc quenching bone fire liner inside.
- The tube shall have high bursting strength to sustain high pressure of the gases during fault interruption.
- The inside diameter of the fuse tube shall be 17.5 mm. The solid cap of the fuse carrier shall clamp the button head of the fuse link, closing the top end of the fuse and allowing only the downward venting during fault interruption.

**Type Tests (IS: 9385 Part I & II) for Fuse:**

- Dielectric tests
- Temperature rise test

**Mounting Arrangement for Fuse:**

- The cutouts shall be provided with a suitable arrangement for mounting these on 74 X 40 mm or 100 X 50 mm channel cross arm in such a way that the center line of the base is at an angle of 15 to 20 deg from the vertical and shall provide the necessary clearances from the support.
- Mounting arrangement shall be made of high strength galvanized steel flat and shall be robust enough to sustain the various stresses encountered during all operating conditions of the cutout.

**11 KV PORCELAIN INSULATORS: (IS: 731 and IS: 3188):**

- The porcelain shall be sound, free from defects, through verified and smoothly glazed. Unless otherwise specified, the glaze shall be brown color.

- The glaze shall cover all the porcelain parts of insulators except those areas which serve as support during firing are left unglazed for the purpose of assembly.
- The design of insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
- The porcelain shall not engage directly with hard metal. Cement used in construction of insulators shall not cause fracture by expansion or loosening by contraction and proper care shall be taken to locate the individual parts correctly during cementing.
- The cement shall not give rise to chemical reaction with metal fittings and its thickness shall be as uniform as possible.
- The insulators should preferably be manufactured in automatic temperature-controlled kilns to obtain uniform baking for better electrical and mechanical properties.
- Both pin and strain insulators shall conform to Type B of IS: 731. The strain insulators shall be of Tongue and Clevis type.

**Test Voltage for Insulator:**

- Highest System Voltage: 12 KV (rms)
- Visible Discharge Test: 9 KV (rms)
- Wet Power Frequency Withstand Test 35 KV (rms)
- Power Frequency Puncture Withstand Test (Pin Insulator): 105 KV (rms)
- Power Frequency Puncture Withstand Test (Strain Insulator): 1.3 times the actual dry flashover voltage of the insulator.
- Impulse Voltage Withstand Test: 75 KV (rms)

**Failing Load for Insulator:**

- Mechanical Failing Load (For Pin Insulators only): The insulators shall be suitable for a minimum failing load of 10 KN applied in transverse direction.
- Electro-Mechanical Failing Load (For Strain Insulators): The insulators shall be suitable for a minimum failing load of 70 KN applied axially.

**Creepage Distance for Insulator:**

- Highest System Voltage: 12KV
- Heavily Polluted Atmosphere Pin Insulator: 320mm
- Heavily Polluted Atmosphere Strain Insulator: 400mm

**Tests: (As per IS: 731) for Insulator.**

1. Visual examination
2. Verification of dimensions

3. Visible discharge test
4. Impulse Voltage withstand Test
5. Wet Power Frequency Voltage withstand Test
6. Temperature Cycle Test
7. Mechanical Failing Load Test
8. 24-hour Mechanical Strength Test for Strain Insulators
9. Puncture Test
10. Porosity Test
11. Galvanizing Test
12. Electro-Mechanical Failing Load Test

#### **Routine Tests for Insulator**

1. Virtual examination
2. Mechanical routine test
3. Electrical routine test

#### **Acceptance Test for Insulator**

1. Verification of Dimensions
2. Temperature Cycle Test
3. Electro-Mechanical Failing Load Test
4. Puncture Test
5. Porosity Test
6. Galvanizing Test

#### **Marking for Insulator:**

- Name or trademark of manufacturer
- Month and year of manufacture
- Minimum failing load in KN
- ISI certificate mark, if any
- Markings on porcelain shall be printed and shall be supplied before firing.

#### **Pin Insulators:**

- The pins shall of single piece obtained preferably by the process of forging.
- They shall not be made by joining, welding, shrink fitting or any other process using more than one-piece material. The pins shall be of good finish, free from flaws and other defects.
- The finish of the collar shall be such that sharp angle between the collar and the shank is avoided. Aluminum ferrous pins, nuts and washers, except those made of stainless

steel, shall be galvanized. The threads of nuts and tapped hole when cut after galvanizing shall be well oiled or greased.

**Dimensions for Pin Insulators:**

- Pins shall be of small steel head type S 165 P as per IS: 2486 (Part-II) having stalk length of 165 mm and shank length of 150 mm with minimum failing load of 10 KN.

**Tests: (IS: 2486 (Part-I)) for Pin Insulators**

- Checking of threads on heads
- Galvanizing test
- Visual examination test
- Mechanical test
- Galvanizing test
- Mechanical test
- Visual examination test

**Helically Formed Pin Insulator Ties:**

- Helically formed ties used for holding the conductor on the pin insulator shall be made of aluminum alloy or aluminized steel or aluminum clad steel wires and shall conform to the requirements of IS: 12048. The ties shall be suitable for pin insulator dimensions of Pt.- I and conductor sizes specified.
- Elastomer pad for insulator shall be used with the ties to avoid abrasion of the conductor coming into direct contact with the insulator.

**Cross arm strap conforming to IS: 2486 (Pt. – II).**

- Aluminum alloy die cast thimble-clevis for attaching to the tongue of strain, insulator on one end and for accommodating the loop of the helically formed dead-end fitting at the other end in its smooth internal contour.
- The thimble shall be suitable for all sizes of ACSR conductors as specified. The thimble clevis shall be attached to the insulator by a steel cutting pin used with a non-ferrous split pin of brass or stainless steel.
- The thimble shall have clevis dimensions as per IS: 2486 (Pt – II).
- Helically formed dead end grip having a prefabricated loop to fit into the grooved contour of the thimble on one end and for application over the conductor at the other end.
- The formed fitting shall conform to the requirement of IS: 12048.

**Fittings for strain Insulators of Ball & Socket Type:**

- Cross arm strap conforming to IS: 2486 (Pt-II).
- Forged steel ball eye for attaching the socket end of the strain insulator to the cross-arm strap.
- Forgings shall be made of steel as per IS: 2004. Aluminum alloy thimble-socket made out of permanent mould cast, high strength aluminum alloy for attaching to the strain insulator on one end and for accommodating the loop of the helically formed dead-end fittings at the other end in its smooth internal contour.
- The thimble socket shall be attached to the strain insulator with the help of locking pin as per the dimensions given in IS: 2486 (Pt-II).

**Tests**

- The helically formed fittings for strain insulators shall be subjected to tests as per IS: 12048.
- The other hardware fittings shall be tested as per IS: 2486 (Part-I).

**Fittings for strain Insulators with Helically Formed Conductors Dead-End Grips:****Fittings for Strain Insulators of Tongue & Clevis Type**

The fittings shall consist of the following components:

1. Cross arm strap conforming to IS:2486 (Pt.II)-1989.
2. Aluminum alloy die cast thimble-clevis for attaching to the tongue of strain insulator on one end and for accommodating the loop of the helically formed dead-end fitting at the other end in its smooth internal contour. The thimble shall be suitable for all sizes of conductors ranging from 7/2.11mm to 7/3.35mm ACSR. The thimble clevis shall be attached to the insulator by a steel cutter pin used with a non-ferrous split pin of brass or stainless steel. The thimble shall have clevis dimensions as per IS:2486 (Pt.II)-1989.
3. Helically formed dead-end grip having a prefabricated loop to fit into the grooved contour of the thimble on one end and for application over the conductor at the other end. The formed fitting shall conform to the requirement of IS:12048-1987.

**Note:** As the helically formed fittings are made to suit specific sizes of conductors, the purchase should clearly specify the number of fittings required for each size of conductor

**Fittings for strain Insulators with Conventional Dead-end Clamps Alternative to Fitting Covered:**

Fittings for strain insulators with conventional dead-end clamps for use with tongue & clevis or ball & socket type insulators shall consist of the following components:

1. Cross arms strap conforming to IS:2486 (Pt.II)-1989
2. Dead-end clamp made of aluminum alloy to suit ACSR conductors from 7/2.11mm to 7/3.35mm. The ultimate strength of the clamp shall not be less than 3000 Kg. The shape and major dimensions of clamps suitable for B&S and T&C insulators are shown in figures 7 & 8 respectively.

#### **GUY STRAIN INSULATORS: (IS: 5300)**

- The porcelain insulator shall be sound, free from defects, thoroughly verified and smoothly glazed.
- The design of the insulator shall be such that the stresses to expansion and contraction in any part of the insulator shall not lead to its deterioration.
- The glaze, unless otherwise specified, shall be brown in color.
- The glaze shall cover the entire porcelain surface parts except those areas that serve as supports during firing.

#### **Type for Guy Insulators:**

- The standard guy strain insulators shall be designations 'A' and 'C' as per IS: 5300.
- The recommended type of guy strain insulators for use on guy wires of overhead lines of different voltage levels are as follows:
- Power Line Voltage :11KV
- Designation of Insulators: C
- Dry one-minute Power Frequency withstand Voltage: 27 KV (rms)
- Wet one-minute Power Frequency withstand Voltage: 13 KV (rms)
- Minimum Failing Load: 88(KN)

#### **Tests: (IS: 5300) for Guy Insulators.**

1. Visual examination
2. Verification of dimensions
3. Temperature cycle test
4. Dry one-minute power frequency voltage withstand test
5. Wet one-minute power frequency voltage withstand test
6. Mechanical strength test
7. Porosity test
8. Acceptance Tests: (to be conducted in the following order)
9. Verification of dimensions
10. Temperature cycle test
11. Mechanical strength test
12. Porosity test

**Marking for Guy Insulators:**

- Name or trademark of the manufacturer.
- Year of manufacture.
- ISI certificate mark, if any
- Marking on porcelain shall be applied before firing.

**Type of Insulators for Guy Insulators:**

- The standard guy strain insulators shall be of designations 'A' and 'C' as per IS:5300.
- The recommended type of guy strain insulators for use on guy wires of overhead lines of different voltage levels are as follows:

Line Voltage	Designation of Insulator
415/240 Volt	A Type
11KV	C Type

**Basic Insulator Level for Guy Insulators:**

Designation of Insulator	Dry one min power frequency withstands	Wet one min power frequency withstands
A Type	18 KV (rms)	8 KV (rms)
C Type	27 KV (rms)	13 KV (rms)

**Mechanical Strength for Guy Insulators:**

The insulators shall be suitable for the minimum failing loads specified as under:

Designation of Insulator	Minimum Failing Load
A Type	44 KN
C Type	88 KN

**Routine Test as per Tests (IS: 5300) for Guy Insulators:**

1. Visual examination
2. Verification of dimensions
3. Temperature cycle test
4. Dry one-minute power-frequency voltage withstand test
5. Wet one-minute power frequency voltage withstand test
6. Mechanical strength test
7. Porosity test



**Acceptance Tests** (to be conducted in the following order):

1. Verification of dimensions
2. Temperature cycle test
3. Mechanical strength test
4. Porosity test

**Danger notice plates:**

- As per provisions of IE Rules 1956, Danger Notice Plates in Hindi or English and, in addition, in the local language with the sign of skull and bones are required to be provided on power line supports and other installations.
- It is further stipulated in the I.E. Rules that such Notice Plates are not required to be provided on supports like PSCC, tubular, wood, steel rails, etc. which cannot be climbed easily without the aid of ladder or special appliances.
- To adopt a uniform pattern and for helping easy procurement, a specification on Danger Notice Plates has been drawn up.

**Standards of Danger Plate**

- The Danger Notice Plates shall comply with IS:2551-1982.

**Dimensions of Danger Plate**

- Two sizes of Danger Notice Plates as follows are recommended:
  1. For display at 415 V installations – 200x150mm
  2. For display at 11 KV (or higher voltages) installations – 250x200mm
- The corners of the plate shall be rounded off.
- The location of fixing holes as shown in Figs. 1 to 4 is provisional and can be modified to suit the requirements of the purchaser.

**Lettering of Danger Plate**

- All letterings shall be centrally spaced. The dimensions of the letters, figures and their respective position shall be as shown in figs.
- The size of letters in the words in each language and spacing between them shall be so chosen that these are uniformly written in the space earmarked for them.

**Languages of Danger Plate**

- Under Rule No. 35 of Indian Electricity Rules, 1956, the Authority of every medium, high and extra high voltage installation is required to affix permanently in a conspicuous position a danger notice in Hindi or English and, in addition, in the local language, with the sign of skull and bones.

- The type and size of lettering to be done in Hindi is indicated in the specimen danger notice plates shown in Fig. 2 and 4 and those in English are shown in Figs.
- Adequate space has been provided in the specimen danger notice plates for having the letterings in local language for the equivalent of 'Danger', '415', '11000' and 'Volts'.

**Material & Finishing of Danger Plate:**

- The plate shall be made from mild steel sheet of at least 1.6mm thick and vitreous enameled white, with letters, figures and the conventional skull and crossbones in signal red color (refer IS:5-1978) on the front side. The rear side of the plate shall also be enameled.

**Tests of Danger Plate:**

- The following tests shall be carried out:
  1. Visual examination as per IS:2551-1982
  2. Dimensional check as per IS:2551-1982
  3. Test for weather proofness as per IS:8709-1977 (or its latest version)

#### 7.1.4 ACSR CONDUCTOR

##### 1. Scope

This section covers design, manufacture, testing before dispatch, packing, supply and delivery for Destination of Kms of ACSR Rabbit and Panther Conductor.

##### 2. Standards

The Conductor shall also comply in all respects with the IS:398(Part-II)- 1996 with latest amendments unless otherwise stipulated in this specification. The ACSR Conductor shall also conform to the following's standards.

##### Indian Standards

1. 1 IS:209-1979 Specification for Zinc BS-3436-1961
2. IS:398-1996 Specification for aluminum conductors for overhead transmission purposes. Part-II Aluminum conductors IEC-209-1966 Galvanized steel reinforced BS-215(Part-II)
3. IS:1521-1972 Method of Tensile Testing of Steel wire ISO/R89-1959
4. IS:1778-1980 Reels and Drums for Bare conductors BS-1559-1949
5. IS:1841-1978 E.C. Grade Aluminum rod produced by rolling
6. IS:2629-1966 Recommended practice for Hot Dip Galvanizing of iron and steel
7. IS:2633-1986 Method of testing uniformity of coating of zinc coated articles.
8. IS:4826-1968 Galvanized coatings on round steel wires. ASTMA472-729
9. IS:5484-1978 E.C. Grade Aluminum rod produced by continuous casting and rolling.
10. IS:6745-1972 Methods of determination of weight of zinc-coating of zinc coated iron and steel articles BS-443-1969 Offers conforming to standards other than IS-398 shall be accompanied by the English version of relevant standards in support of the guaranteed technical particulars to be furnished.

### 7.1.5 RCC AND PSCC (PRE-STRESSED CEMENT CONCRETE) POLES for 11KV LINES

- The basic design parameters for these poles as given in Clause 6 of this Specification were approved by the Fifth Conference on standardization of Specifications and Construction Practices in Rural Electrification held in May 1974.
- Some of these design parameters which were based on certain foreign codes/practices and certain other provisions of this Specification, although at variance with the stipulations of **IS:1678 –1960**, had been adopted to achieve economy in the designs. However, these modifications have since been incorporated in the revised **IS:1678 – 1978**.
- This Specification covers PSCC poles with an overall length of 7.5 M, 8.0 M and 9.0 M suitable for use in overhead 11 KV lines and double pole structures for 11/0.4 KV substations.

#### **Application Standard for PSCC Pole:**

- **IS: 1678-1978**, Specification for prestressed concrete poles for overhead power, traction and telecommunication lines.
- **IS: 2905-1966**. Methods of test for concrete poles for over-head power and telecommunication lines.
- **IS: 7321-1974**. Code of practice for selection, handling and erection of concrete poles for over-head power and telecommunication lines.

#### **Average Permanent Load for PSCC Pole:**

- That fraction of the working load which may be considered of long duration over a period of one year.

#### **Load Factor for PSCC Pole:**

- The ratio of ultimate transverse load to the transverse load at first crack.

#### **Transverse for PSCC Pole:**

- The direction of the line bisecting the angle contained by the conductor at the pole. In the case of a straight run, this will be normal to the run of the line.

#### **Transverse Load at First Crack for PSCC Pole:**

- For design, the transverse load at first crack shall be taken as not less than the value of the working load.

**Working load for PSCC Pole:**

- The maximum load in the transverse direction, that is ever likely to occur, including the wind pressure on the pole.
- This load is assumed to act at a point 600 mm below the top with the butt end of the pole planted to the required depth as intended in the design.

**Ultimate Failure for PSCC Pole:**

- The conditions existing when the pole ceases to sustain a load increment owing to either crushing of concrete or snapping of the prestressing tend on or permanent stretching of the steel in any part of the pole.

**Ultimate Transverse Load for PSCC Pole:**

- The load at which failure occurs, when it is applied at a point 600 mm below the top and perpendicular to the axis of the pole along the transverse direction with the butt end of the pole planted to the required depth as intended in the design.

**Application for PSCC Pole:****9.0 M Poles**

- These poles shall be used for double pole structures of distribution transformer centers as per REC Construction Standards F-1 to F-4 and for special locations in 11 KV and L.T. Lines, such as road crossings etc.

**Materials for PSCC Pole:****(1) Cement**

- The cement used in the manufacture of prestressed concrete poles shall be ordinary or rapid hardening port land cement conforming to **IS: 269 – 1976** (Specification for ordinary and low heat port land cement) or **IS: 8041 E-1978** (Specification for rapid hardening port land cement)

**(2) Aggregates**

- Aggregates used for the manufacture of pre-stressed concrete poles shall conform to **IS: 383 – 1970** (Specification for coarse and fine aggregates from natural sources for concrete). The nominal maximum size of aggregates shall in no case exceed 12mm.

**(3) Water**

- Water should be free from chlorides, sulphates, other salts and organic matter. Potable water will be generally suitable.

#### **(4) Admixtures**

- Admixtures should not contain Calcium Chloride or other chlorides and salts which are likely to promote corrosion of pre-stressing steel.

#### **(5) Pre-stressing Steel**

- The pre-stressing steel wires, including those used as untensioned wires should conform to **IS: 1785 (Part-I) – 1966** (Specification for plain hard drawn steel wire for prestressed concrete. Part-I cold drawn stress relieved wire), **IS: 1785 (Part-II) – 1967** (Specification for plain hard-drawn steel wire). or **IS: 6003 – 1970** (Specification for indented wire for pre-stressed concrete).
- The type designs given in Annexure-I are for plain wires of 4 mm diameter with a guaranteed ultimate strength of 175 Kg/mm<sup>2</sup>.

#### **(6) The concrete mix:**

- It shall be designed to the requirements laid down for controlled concrete (also called design mix concrete) in **IS: 1343 – 1980** (Code of practice for prestressed concrete) and **IS: 456 – 1978** (Code of practice for plain and reinforced concrete), subject to the following special conditions;
  1. Minimum works cube strength at 28 days should be at least 420 Kg/cm<sup>2</sup>.
  2. The concrete strength at transfer should be at least 210Kg/cm<sup>2</sup>.
  3. The mix should contain at least 380 Kg. of cement per cubic meter of concrete.
  4. The mix should contain as low a water content as is consistent with adequate workability. If it becomes necessary to add water to increase the workability, the cement content also should be raised in such a way that the original value of water cement ratio is maintained.

#### **Design Requirements for PSSC Pole:**

- The poles shall be planted directly in the ground with a planting depth of 1.5 meters.
- The working load on the poles should correspond to those that are likely to come on the pole during their service life. Designs given in Annexure-I are for 140 Kg. and 200 Kg. Applied at 0.6 M from top.
- The factor of safety for all these poles shall not be less than 2.5.
- The average permanent load should be 40% of the working load.
- The F.O.S. against first crack load shall be 1.0.
- At average permanent load, permissible tensile stress in concrete shall be 30 Kg/cm<sup>2</sup>.

- At the design value of first crack load, the modulus of rupture shall not exceed 55.2 kg/cm<sup>2</sup> for M-420 concrete.
- The ultimate moment capacity in the longitudinal direction should be at least one fourth of that in the transverse direction.
- The maximum compressive stress in concrete at the time of transfer of prestress should not exceed 0.8 times the cube strength.
- The concrete strength at transfer shall not be less than half the 28 days strength ensured in the design, i.e.  $420 \times 0.5 = 210 \text{ Kg/cm}^2$ .
- For model check calculations on the design of poles, referred to in Annexure-I, a reference may be made to the REC "Manual on Manufacturing of solid PSCC.

#### **Dimensions and Reinforcements for PSCC Pole:**

- The cross-sectional dimensions and the details of prestressing wire should conform to the particulars given in Annexure-I.
- The provisions of holes for fixing cross-arms and other fixtures should conform to the REC standards referred to in clause 4 of this specification and in accordance with the construction practices adopted by the State Electricity Boards.

#### **Manufacture for PSCC Pole:**

- All prestressing wires and reinforcements shall be accurately fixed as shown in the drawings and maintained in position during manufacture. The un tensioned reinforcement, as indicated in the drawings, should be held in position by the use of stirrups which should go around all the wires.
- All wires shall be accurately stretched with uniform prestress in each wire.
- Each wire or group of wires shall be anchored positively during casting. Care shall be taken to see that the anchorages do not yield before the concrete attains the necessary strength.

#### **Cover for PSCC Pole:**

- The cover of concrete measured from the outside of the prestressing tendon shall be normally 20 mm.

#### **Welding & Lapping of Steel for PSCC Pole:**

- The high tensile steel wire shall be continuous over the entire length of the tendon.
- Welding shall not be allowed in any case. However, jointing or coupling may be permitted provided the strength of the joint or coupling is not less than the strength of each individual wire.

**Compacting for PSCC Pole:**

- Concrete shall be compacted by spinning, vibrating, shocking or other suitable mechanical means. Hand compaction shall not be permitted.

**Curing for PSCC Pole:**

- The concrete shall be covered with a layer of sacking, canvas, hessian or similar absorbent material and kept constantly wet up to the time when the strength of concrete is at least equal to the minimum strength of concrete at transfer of prestress. Thereafter, the pole may be removed from the mould and watered at intervals to prevent surface cracking of the unit, the interval should depend on the atmospheric humidity and temperature.

**The prestressing wires for PSCC Pole:**

- It shall be de tensioned only after the concrete has attained the specified strength at transfer (i.e. 210 Kg/cm<sup>2</sup>). The cubes cast for the purpose of determining the strength at transfer should be cured, as far as possible, under conditions similar to those under which the poles are cured.
- The transfer stage shall be determined based on the daily tests carried out on concrete cubes till the specified strength indicated above is reached. Thereafter the test on concrete shall be carried out as detailed in **IS: 1343 – 1960** (Code of practice for prestressed concrete).
- The manufacturer shall supply when required by the purchaser or his representative, result of compressive test conducted in accordance with **IS: 456 -1964** (Code of practice for plain and reinforced concrete) on concrete cubes made from the concrete used for the poles.
- If the purchaser so desires, the manufacturer shall supply cubes for test purposes and such cubes shall be tested in accordance with **IS: 456 – 1964** (Code of practice for plain and reinforced concrete).
- The de tensioning shall be done by slowly releasing the wires, without imparting shock or sudden load to the poles. The rate of de tensioning may be controlled by any suitable means either mechanical (screw type) or hydraulic.
- The poles shall not be de tensioned or released by cutting the prestressing wires using flames or bar croppers while the wires are still under tension.

**Separate eyehooks or holes for PSCC Pole:**

- It shall be provided for handling and transport, one each at a distance of 0.15 times the overall length, from either end of the pole.



- Eyehooks, if provided, should be properly anchored and should be on the face that has the shorter dimension of the cross-section. Holes, if provided for lifting purposes, should be perpendicular to the broad face of the pole.
- Stacking should be done in such a manner that the broad side of the pole is vertical. Each tier in the stack should be supported on timber sleepers located at 0.15 times the overall length, measured from the end. The timber supports in the stack should be aligned in a vertical line.
- Poles should be transported with their broad faces placed vertically and in such a manner that shocks are avoided. Supports should be so arranged that they are located approx. at a distance equal to 0.15 times the overall length from the ends.
- The erection of the pole should be carried out in such a way that the erection loads are applied so as to cause moment with respect to the major axis. i.e. the rope used for hoisting the pole should be parallel to the broader face of the pole.

#### **Testing of RCC / PSCC Pole:**

##### **Transverse Strength Test**

- Poles made from ordinary Portland cement shall be tested only on the completion of 28 days and poles made from rapid-hardening cement only on the completion of 14 days, after the day of manufacture.
- The pole may be tested in either horizontal or vertical position. If tested in horizontal position, provisions shall be made to compensate for the overhanging weight of the pole, for this purpose the over-hanging portion of the pole may be supported on a movable trolley or similar device.
- The pole shall be rigidly supported at the butt end for a distance equal to the agreed depth of planting i.e. 1.5 M.
- Load shall be applied at a point 600 mm from the top of the pole and shall be steadily and gradually increased to design value of the transverse load at first crack. The deflection at this load shall be measured.
- A prestressed concrete pole shall be deemed not to have passed the test if visible cracks appear at a stage prior to the application of the design transverse load for the first crack.
- The load shall then be reduced to zero and increased gradually to a load equal to the first crack load plus 10% of the minimum ultimate transverse load and held up for 2 minutes.
- This procedure shall be repeated until the load reaches the value of 80 per cent of the minimum ultimate transverse load and thereafter increased by 5 per cent of the

minimum ultimate transverse load until failure occurs. Each time the load is applied, it shall be held for 2 minutes.

- The load applied to prestressed concrete pole at the point of failure shall be measured to the nearest five Kilograms.
- The pole shall be deemed not to have passed the test if the observed ultimate transverse load is less than the design ultimate transverse load.

#### **Measurement of Pole Cover for PSCC Pole:**

- After completion of the transverse strength test, the sample pole shall be taken and checked for cover.
- The cover of the pole shall be measured at 3 points, one within 1.8 meters from the butt end of the pole, the second within 0.6 meter from the top and the third at an intermediate point and the mean value compared with the specified value.
- The mean value of the measured cover should not differ by more than ( $\pm$ )1 mm from the specified cover. The individual values should not differ by more than ( $\pm$ ) 3 mm from specified value.
- If these requirements are not met, the workmanship with reference to aligning of the end plates and prestressing wires and assembly of moulds should be improved and inspection at pre-production stage tightened suitably.

#### **Marking for PSCC Pole:**

- The pole shall be clearly and indelibly marked with the following particulars either during or after manufacture but before testing at a position so as to be easily read after erection in position.
  1. Month and year of manufacture
  2. Transverse strength of pole in Kg.
  3. Maker's serial No. and mark

#### **Main Points should be look after for Overhead Line Installation:**

##### **Overhead lines:**

- The general precautions during storage and handling of shall be taken in accordance with relevant IS code.
- While laying the conductor shall be taken from top of the drum and the repeated in the direction of arrow on it. Care shall be taken to avoid contact with steel works, fence, etc. by giving soft wood protection, using wooden rollers.
- Proper tools shall be used during stringing work. During stringing operation standard sag table or chart shall be followed and care shall be taken to ensure that there are

- no kinks in the conductor. Joints in conductors shall be staggered. Mid span joints in conductors shall be avoided.
- After stringing the conductor, it shall be clamped permanently with shackle or strain clamps. An angle or section shall be selected while pulling up conductors.

**Jumpers:**

- While stringing, sufficient length shall of conductors be kept at shackle terminations for making jumpers. Jumpers shall be neat and as far as possible symmetrical to run of conductors. These shall be made to prevent occurrence of faults due to wind or birds. PG clamps may be preferred to bind of conductors at jumper location or service taps.

**Cross Arms:**

- The function of line support (pole) is to support the line conductors at a safe distance from ground whereas the function of cross arms is to keep the conductors at a safe distance from each other and from the pole. Cross Arm is a cross-piece fitted to the pole top end portion by means of brackets, known as pole brackets, for supporting insulators. Cross arms are of various types such as MS channel, angle iron, or wooden. These may be straight, U-shaped, V-shaped, or zigzag shaped, as shown in the below image.
- Steel cross arms are stronger and are to be used on steel poles.
- The length of the cross arms shall be suitable for the spacing of the conductors. Cross arms shall be suitable and strong enough to withstand the resultant forces caused by insulators, their pins, and deadweight of insulator attachments, etc.
- To avoid birdcage on HT lines, V-shaped cross arms are used with pin insulators while straight cross arms are used with disc insulators.
- The cross arm is fixed to the pole in such a manner that the load of the conductors is taken by the cross arm and not the clamp or bolt that fixes the cross arm to the pole.
- The cross arms shall be made of MS Structural steel. The length of cross arms shall be suitable for accommodating the number of insulators on them with spacing of conductor.
- A gap of minimum 50 mm shall be left from the center of pin hole to end of cross arm on either side.
- The cross arm shall be complete with pole clamp made of MS flat of size not less than 50 x 6 mm with necessary nuts, bolts, washers, etc. The length of cross arm for carrying guard wires shall always run not less than 300 mm beyond outer most bare conductor of configuration. Cross arms shall be properly clamped to the support taking into consideration the orientation of lines.

**Porcelain insulators and fittings:**

- The porcelain insulators shall be confirming to IS 731 – 1971 for overhead lines. This shall be glazed, crack / burr free.
- The insulator shall have adequate mechanical strength, high degree of resistance to electrical puncture and resistance to climatic and atmospheric attack.
- All iron parts shall be hot dip galvanized & all joints shall be airtight. Pin insulators / shackle insulators / disc insulators shall be erected on cross arms and 'D' iron clamp shall be used or as specified by Engineer-in-charge. Shackle insulators shall be used in conjunction with 'D' iron clamps when configuration of conductor is vertical.
- These shall also be erected on cross arm at intermediate support in case of long lines, deviation from straight lines. Care shall be taken that insulators are not damaged during erection.

**Binding material:**

- Binding of conductor with the insulator shall be done with soft aluminum wire / conductor. The binding of conductor to insulator shall be sufficiently firm and tight to ensure that no intermittent contact develops. The end of binding wire shall be tightly twisted in close spaced spiral around the conductor to ensure good electrical contact and strengthen the conductor.

**Supports and spacing of poles:**

- Support of overhead line shall be of adequate strength confirming in all respects to rules 76 of Indian electricity rules.
- Pole spacing and clearance between lowest conductor above the ground level across / along the street shall be in accordance with rule 85 of Indian electricity rules. Suitable foundation shall be provided for erection of poles.
- The foundation shall include excavation in all types of soil and rocks and back filling, RCC, reinforcement, formwork.
- Excavation for foundations for poles / stay / strut: After the location of supports / stay are pegged accurately, the excavation work shall be taken up and care should be taken while excavating that pits are not oversized.
- The pit should be excavated in the direction of the line. The depth and size of pit shall be such that normally 1/6th of the length of pole is buried in the ground and suitable for foundation of support.
- For stay the position of pit shall normally be such stay makes as large an angle as possible with the support and it shall be in the range of 40 to 60 degrees.

- The length of stay rod shall project 450 mm above the ground level. The pit for strut shall be located at a distance not less than 1.8M from the pole.
- The depth of pit shall be such that at least 1.2M of the strut is buried in the ground.

#### **Stay / strut:**

- Stay set shall consist of stay rod, anchor plate, bow tightened / turn buckle, thimbles, stay wire and stain insulators.
- The stay rod shall be with stay grip in case of turn buckle is used instead of bow tightened. The entire stay set assembly shall be galvanized. The stay wire shall be either 7/4.0 mm diameter or 7/3.15 mm diameter GI having tensile strength of not less than 70 kgf/sq mm and confirming to IS 2141.
- The anchor plate shall be of MS galvanized and not less than 300 mm x 300 mm x 6.4 mm thick. The stay rod / buckle rods shall be minimum 16/19 mm diameter galvanized steel rod having tensile strength not less than 42 kgf/sq mm. Minimum length of stay rod and buckle shall be 1800 mm and 450 mm respectively.

#### **Erection stay sets:**

- The anchor plate shall be galvanized MS plate. The stay rod with anchor plate shall be embedded in cement concrete 1:3:6. A stay shall be provided at all angle and terminal poles. Double stay shall be provided at all dead ends and in such case, these shall be as far as possible to be set parallel to each other.

#### **Cradle/Cage guard:**

- All metal supports of overhead lines and metallic fitting attached shall be permanently and effectively earthed. Cage guard / cradle guard shall be made of 6 SWG GI wire confirming to IS 2633 including netting, stretching and jointing of cage and lacing by 10/12 SWG GI wire, binding by 14/16 SWG GI wire.

#### **Danger boards:**

- All supports carrying HV lines shall be fitted with danger plates confirming to IS 2551 at height of 3 M from ground indicating the voltage of line. The script shall be both in 'English/Hindi'.

#### **Anti-climbing devices:**

- Necessary arrangement for preventing unauthorized persons from ascending any of the supports and structure carrying HV lines without the aid of ladder or special appliance shall be made.

- Unless otherwise specified barbed wire confirming to IS 278 having four points barbed spaced 75 +/- 12 mm apart shall be wrapped helically with a pitch of 75 mm around the limb of support and firmly commencing from the height of 3.5 M and up to 5 or 6 M as directed by the engineer.

### 7.1.6 Tubular Steel Poles for Overhead Lines

#### 1. Scope:

This specification covers the general requirements towards design, manufacture, testing at manufacturers works, supply and delivery for tubular steel poles of circular cross section (swaged type) for overhead lines.

#### 2. Standards:

The tubular steel poles shall conform to the latest edition of Indian Standard specification IS: 2713 (Part –I, III): 1980 or any other authoritative standards (as amended up to date) except where specified otherwise in this specification.

#### 3. Topography and climatic condition:

The materials offered, shall be suitable for operation in tropical climate and will be subjected to the sun and inclement weather and shall be able to withstand wide range of temperature variation. For the purpose of design, average atmospheric temperature may be considered to be 50°C with humidity nearing saturation.

#### 4. Materials:

- 4.1. The materials used in construction of tubular steel poles shall be of the tested quality of steels of minimum tensile strength 540 MPa (: 55 Kgf/mm<sup>2</sup>).
- 4.2. The materials, when analyzed in accordance with IS: 228 (Part-III: 1972) and IS: 228 ( Part-IX) shall not Show Sulphur and phosphorous contents of more than 0.060 percent each.

#### 5. Types, Size and construction:

- 5.1 Tubular Steel Poles shall be swaged type.
- 5.2 Swaged poles shall be made of seamless or welded tubes of suitable lengths swaged and jointed together. No circumferential joints shall be permitted in the individual tube lengths of the poles. If welded tubes are used, they shall have one longitudinal weld seam only: and the longitudinal welds shall be staggered at each swaged joint.
- 5.3 Swaging may be done by any mechanical process. The upper edge of each joint shall be chamfered if at an angle of about 45°. The upper edge need not be chamfered if a

circumferential weld is to be deposited in accordance with clause No. 5.3 2 of IS: 2713 (Part-I):1980.

- 5.4 The length of joints on swaged poles shall be in accordance with clause No. 5.4 of IS: 2713 (Part-I): 1980.
- 5.5 Poles shall be well-finished, clean and free from harmful surface defects. Ends of the poles shall be cut square. Poles shall be straight, smooth and cylindrical. The weld joints, if any, shall be of good quality, free from scale, surface defects, cracks, etc.
- 5.6 Tolerances for outside diameter, thickness, length, weight and straightness shall be in accordance with IS:2713 (Part-I): 1980.
- 5.7 The poles shall be coated with black bituminous paint conforming to IS: 158-1968 throughout, internally and externally, upto the level which goes inside the earth. The remaining portion of the exterior shall be painted with one coat of red oxide primer as specified in IS: 2074-1979.'

## **6. Earthing Arrangements:**

For earthing arrangement, a through hole of 14mm diameter shall be provided in each pole at a height of 300mm above the planting depth.

## **7. Tests and Test Certificates:**

- 7.1. The following tests shall be conducted on finished poles:
  - A. Tensile test and chemical analysis for Sulphur and phosphorous,
  - B. Deflection test,
  - C. Permanent set test, and
  - D. Drop test.
- 7.2. In addition to above verification of dimensions as per IS: 2713 (Part-III) : 1980 shall be carried out during acceptance lots.
- 7.3. Number of poles selected for conducting different tests shall be in accordance to clause No. 10.1.1 and No. 10.1.12: of IS: 2713 (Part-I) 1980.
- 7.4. Tests shall be carried out before supply of each consignment at the manufacturers works



and test certificates should be submitted to the purchaser for approval prior to delivery.

7.5. Re-tests, if any, shall be made in accordance with IS: 2713 (Part-I) 1980.

7.6. Purchaser reserves the right to inspect during manufacturing and depute his representative to inspect/test at the works.

7.7. If any extra cost is required for carrying out the above specified tests, the same shall be borne by the manufacturer.

#### **8. Marking:**

8.1. The poles shall be marked with designation, manufacturer's identification, year of manufacture and name of the purchaser: Employer Name;

8.2. The poles may also be marked with the ISI certification mark.

#### **9. Guaranteed technical particulars:**

9.1. The manufacturer shall furnish all necessary guaranteed technical particulars in the prescribed Performa enclosed hereinafter.

#### **10. Performances: -**

10.1. The manufacturer shall furnish a list of the major supplies effected during the last 3 (three) years indicating the volume of supply and actual delivery dates.

10.2. Manufacturer may not be considered if the past manufacturing experience is found to be less than 3 (three) years.

#### **11. Deviation: -**

Any deviation in technical specification shall be clearly indicated with sufficient reasons thereof. Purchaser shall however reserve the right to accept and/or reject the same without assigning any reasons whatsoever.

**ANNEXURE – 'A'****SPECIFIC TECHNICAL REQUIREMENTS FOR  
TUBULAR STEEL POLES : SWAGED TYPE**

	9 meters long	11 meters long	13 meters long	12 meters long
1) Standard	IS: 2713 ( Pat-I and III): 1980 as amended upto date			
2) Type of Pole	Swaged Type			
3) Designation	540 SP 28	540 SP 52	540 SP 72	410 SP 60
4) Overall Length	9 meters	11 meters	13 meters	12 meters
5) Planting depth	1.5 meters	1.8 meters	2.0 meters	2.0 meters
6) Height above ground	7.5 meters	9.2 meters	11.0 meters	10.0 meters
7) Effective length of Each section.				
a) Bottom	5.0 meters	5.6 meters	5.80 meters	5.80 meters
b) Middle	2.0 meters	2.7 meters	3.60 meters	3.10 meters
c) Top	2.0 meters	2.7 meters	3.60 meters	3.10 meters
8) Outside diameter and Thickness of each Section.				
a) Bottom	139.7x 4.50 mm	165.1x4.50 mm	219.1x5.90 mm	165.1x5.40mm
b) Middle	114.3x3.65 mm	139.7x4.50 mm	193.7x4.85 mm	139.7x4.50 mm
c) Top	88.9x3.25 mm	114.3x3.65 mm	165.1x4.50 mm	114.3x3.65 mm
9) Joint Length ( in cm.):				
a) Bottom (J2)	30 cm.	35 cm.	45 cm.	35 cm.
b) Top (J1)	23 cm.	30 cm.	40 cm.	30 cm.
10) Approximate weight of Pole	113 Kg.	175 Kg.	343 Kg.	208 Kg.
11) Point of application of load below/top (mtr.)	0.3 mtr.	0.6 mtr.	0.6 mtr	0.6 mtr
12) Breaking load ( inKgf )	478	567	1084	469
13) Working load with factor of Safety : 2.5 ( in Kgf )	191	227	435	188
14) Crippling load ( inKgf )	339	403	770	333
15) Load for permanent set Not exceeding 13mm (in Kgf)	232	276	527	228
16) Load for Temporary Deflection of 157.5 mm (in Kgf)	76	74	121	61
17) Tolerance	As per IS : 2713 ( Part-I & Part-III): 1980			
18) Finish	-do-			
19) Manufacturing clause	-do-			

## **7.2 LT PANELS / P.C.C. / M.C.C. electrical works**

### **7.2.1 LT Panels**

#### **7.2.1.1 Type of panel:**

All the PSCC's / PDB's / MCC's shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phase / single phase, 415 / 230 volts, 50 Hz.

The PSCC's / MCC's shall be designed to withstand the heaviest condition at site, with minimum expected ambient temperature of 45 degree Celsius, 80 percent humidity and dusty weather.

Should conform to Indian Electricity Act and rules (till last amendment) & approved as per FIA norms.

**Note: -**

All codes and standards mean the latest edition where not specified, otherwise the installation shall generally follow the Indian Standard codes of practice or relevant British Standard Codes of Practice in the absence of corresponding Indian Standards.

#### **7.2.1.2 Structure:**

The PSCCs, MCCs & PDBs shall be metal clad enclosed and be fabricated out of high quality CRCA sheet, suitable for indoor installation, front operated, free standing and floor mounting type.

CRCA sheet steel used in the construction of PSCCs / MCCs / PDBs shall be 2mm thick for structure, main frame & Doors, 1.6 mm thick for shrouds/Internal partition and 3 mm thick for gland plate and shall be folded and braced as necessary to provide a rigid support for all components. Joints of any kind in sheet shall be seam welded, all welding slag grounded off and welding pits wiped smooth with plumber metal.

The PSCCs / MCCs / PDBs shall be totally enclosed, completely dust and vermin proof and degree of protection being no less than IP-42 and for OUTDOOR PANELS –IP55, Gaskets between all adjacent units and beneath all covers shall be provided to render the joints dust proof. All doors and covers shall be fully gasketed with neoprene gaskets and shall be

lockable.

All panels and covers shall be properly fitted and secured with the frame, and holes in the panel correctly positioned. Fixing screw shall enter into holes tapped into an adequate thickness of metal or provided with bolts and nuts.

A base channel of 75 mm x 75 mm x 5 mm or as per the weight of the panel shall be provided at the bottom.

PSCCs / MCCs / PDBs shall be arranged in multi-tier formation. The PSCCs / MCCs / PDBs shall be of adequate size to facilitate enough space for maintenance and cooling. The size of the PSCCs / MCCs / PDBs shall be designed in such a way that the internal space is sufficient for hot air movement, and the electrical component does not attain temperature more than 40°C over an ambient temperature of 50°C while carrying rated current. Openings shall provide for natural ventilation, but the said openings shall be screened with fine wire mesh.

Knockout holes of appropriate size and number shall be provided in the PSCCs / MCCs / PDBs in conformity with number, and size of incoming and outgoing conduits / cables.

Alternatively, the PSCCs / MCCs / PDBs shall be provided with removable sheet plates at top and bottom to drill holes for cable / conduit entry at site.

The PSCCs / MCCs / PDBs shall be designed to facilitate easy inspection, maintenance and repair.

The PSCCs / MCCs / PDBs shall be sufficiently rugged in design and shall support the equipment without distortion under normal and short circuit condition they shall be suitable braced for short circuit duty.

The panel shall have sufficient space at least 20% of outgoing feeders with wiring provision for future use.

The front of each compartment shall be provided with hinged single leaf door with locking facilities. Panel shall be provided with suitable lifting facilities. MCCB/ACBs and accessories shall be of fixed/draw out type as per Legend provided in the SLD.

#### **7.2.1.3 Protection class:**

All the indoor PSCCs / MCCs / LT PANELs shall have protection class of Outdoor Panels IP-55.

#### **7.2.1.4 Powder coating:**

All sheet steel material shall undergo seven-tank process after all the necessary shearing and other mechanical works are completed. After the seven-tank process powder coating treatment shall be adopted using powder of reputed make. After the powder coating is complete welding in the panel or any sort of shearing, bending or cutting activity shall not be done. The color shall be Siemens Grey RAL 7032/Smoke Gray Or as per local norms.

#### **7.2.1.5 Circuit compartment:**

Each circuit breaker and switch fuse units shall be housed in separate compartments and shall be enclosed on all sides. Sheet steel hinged lockable door shall be duly inter-locked with the breaker / switch fuse units in ON and OFF position. Safety interlocks shall be provided for non-opening of the door when the breaker is in ON position. Safety interlock with operating handle shall be provided. All MCCB shall be Rotary Handled, Operating Mechanically.

The door shall not form integral part of the draw out position of the circuit breaker. All instruments and indicating lamp shall be mounted on the compartment door. Sheet steel barriers shall be provided between the tiers in a vertical section.

#### **7.2.1.6 Instrument compartment:**

Separate and adequate compartment shall be provided for accommodating instruments, indicating lamp, control contactors, relays and control fuses etc. These components shall be accessible for testing and maintenance without any danger of accidental contact with live parts of the circuit breaker, switch fuse units, bus bars and connections.

#### **7.2.1.7 Busbars:**

The bus bar shall be air insulated and made of high quality, high conductivity, high strength aluminum and as per relevant IS code. The bus bar shall be for three phases and neutral system with separate neutral and earth bar. The busbar and interconnection between busbar and various components shall be of high conductivity, hard drawn,

electrolytic aluminum. The busbar shall be of rectangular cross section designed to withstand full load current for phase busbar and full rated current for neutral busbar and shall be extendable type on either side. The busbar shall be rated for the frame size of the main incoming breaker. The busbar shall have uniform cross section throughout the length. Ratio of 1 sqmm = 0.8 A shall be adopted for tinned aluminum bus bars. The busbars to be sized based this ratio.

The busbar and interconnection shall be insulated with heat shrinkable PVC sleeves and be color coded as per relevant IS. The busbar shall be supported on unbreakable, non-hygroscopic DMC/SMC/FRP insulated supports at sufficiently close interval to prevent busbar sag and shall effectively withstand electromagnetic stresses in the event of short circuit capacity of 35 / 50 KA, as mentioned in the SLD.

The busbar shall be housed in a separate compartment. The busbar shall be isolated with 3 mm thick FRC sheet to avoid any accidental contact. The busbar shall be arranged such that minimum clearances between the bus bar are maintained as per relevant IS/BIS.

All busbar connection shall be done by drilling holes in busbars and connecting by chromium plated bolt and nuts. Additional cross section of busbar shall be provided in all PSSCs / MCCs / PDBs to cover-up the holes drilled in the busbars. Spring and flat washers shall be used for tightening the bolts.

All connection between busbar and circuit breaker / switches and between circuit breaker/ switches and cable terminals shall be through solid copper strips of proper size to carry full rated current. These strips shall be insulated with insulating strips.

Aluminum earth bus of suitable size shall be provided at the bottom of the panel throughout the length. Similarly, suitable size of Copper strip in each vertical section for earthing the individual equipment/accessories shall be provided and connected to main horizontal bus.

#### **7.2.1.8 Electrical power & control wiring connection:**

Terminal for both incoming and outgoing cable shall be suitable for 1100 volts grade, aluminum/copper conductor PVC / XLPE insulated and sheathed, armored cable and shall be suitable for connections of solder less sockets for the cable size as indicated on the appended drawing for the PSSCs, MCCs, PDBs.

Both control and power wiring shall be brought out in cable alley for ease of external connections, operation and maintenance. Control and power wiring shall not be mingled. Both control and power terminals shall be properly shrouded.

10% spare terminal shall be provided on each terminal block. Sufficient terminals shall be provided on each terminal block so that not more than one outgoing wire connected per terminal.

Terminal strip for power and control shall preferably be separated from each other by suitable barriers of enclosures.

Wiring inside the module for power, control protection and instrument etc. shall be done with use of 1100 V conforming to IS 694 and IS 8130. For current transformer circuits and other control wiring shall be done with 2.5 sq mm copper conductor wires. All door frames of L.T switch boards shall be earthed with bare braided copper wire. All conductors shall be crimped with solder less sockets at the ends before connections are made to the terminals.

Particular care shall be taken to ensure neat and orderly laying of the wiring. Identification ferrules shall be tagged to all the wire termination for ease of identification and to facilitate and testing. The color coding shall be as per latest edition of IS:375.

Final wiring diagram of the PSCC, MCC, PDB power and control circuit with ferrules number shall be submitted along with the PSCC/MCC/PDB as one of the documents.

#### **7.2.1.9 Terminals:**

The outgoing terminals and neutral link shall be brought out to a cable alley suitably located and accessible from the panel front. The current transformer for instrument metering shall be mounted on the disconnecting type terminal blocks. No direct connection of incoming and outgoing cables to internal components connection of the distribution board is permitted. Only one conductor may be connected in one terminal.

#### **7.2.1.10 Wireways:**

A horizontal PVC wire way with screwed covers shall be provided at the top/bottom to take interconnecting control wiring between different vertical sections.

**7.2.1.11 Cable compartment:**

Cable compartment of adequate size shall be provided in the PSCCs, MCCs, and PDBS for easy termination of all incoming and outgoing cables entering from top. Adequate support shall be provided in the cable compartment.

**7.2.1.12 Earthing:**

Aluminum earth bus bar of minimum 25 mm x 5 mm size shall be provided in the PSCCs, MCCs, PDBS for the entire length of panel. As per the rating of the main bus bars the size of earthing bus bar shall be decided. The framework of the PSCCs, MCCs, PDBs shall be connected to this earth busbar. Provisions shall be made for connection from earth busbar to the main earthing bar coming from the earth pit on both sides of the PSCCs, MCCs, PDBs.

The earth continuity conductor of each incoming and outgoing feeder shall be connected to this earth bar. The armor shall be properly connected with earthing clamp and the clamp shall be ultimately bonded with the earth bar.

**7.2.1.13 Labels:**

Engraved Aluminum sheet labels shall be provided on all incoming and outgoing feeders. Single line circuit diagram showing the arrangements of circuit inside the distribution board shall be pasted on inside of the panel door and covered with transparent laminated plastic sheet.

**7.2.1.14 Name plate:**

A prominent engraved name plate with panel designation in bold letter shall be fixed at top of the central in panel. A separate name plate giving feeder details shall be provided for each feeder module door.

Inside the feeder compartment, the electrical component, equipment's, accessories like switchgear, contactor, lamp, relays etc. shall suitably be identified by prominent engraved identification plates.

Engraved nameplates shall be of Aluminum strip of black color and WHITE letters format. Inscription and lettering sizes shall be subject to Authority's approval.



Nameplate shall be fastened by counter sunk screws / riveted and not by adhesives.

Suitable stenciled paint marks shall be provided inside the panel/module identification of all equipment's in addition to the plastic sticker labels. These labels shall be partitioned so as to be clearly visible and shall have the device number, as mentioned in the module wiring design.

#### **7.2.1.15      Danger notice plate:**

The danger plate shall be affixed in a permanent manner on operating side of the panel.

The danger notice plate shall indicate danger notice both in Hindi, English & local language (Kannada) and with a sign of skull and bones.

The danger notice plate in general shall meet to requirements of local inspecting authorities.

Overall dimension of the danger notice plate shall be 200 mm wide and 150 mm high. The danger notice plate shall be made from minimum 1.6 mm thick mild steel sheet and after due pre-treatment to the plate, the same shall be painted white with vitreous enamel paint on both front and rear surface of the plate.

The letter, the figure, the conventional skull and bones shell etc. shall be positioned on the plate as per recommendations of IS: 2551.

The said letter, the figure and the sign of skull and bones shall be painted in single red color as per IS: 5-2007.

#### **7.2.1.16      Internal components:**

The PSSC / MCC / PDB shall be equipped complete with all type of required number of MCCB, switch fuse unit, contactor, relays, fuses, meters, instruments, indicating lamps, push buttons, equipment, fittings, bus bar, cable boxes, cable glands etc. and all the necessary internal connections /wiring as required and as indicated on relevant drawings (SLD). Components necessary for proper complete functioning of the PSSC/MCC/PDB but not indicated on the drawing shall be supplied and installed on the PSSC/MCC/PDB.

All part of the PSSC / MCC/ PDB carrying current including the components, connections, joints and instruments shall be capable of carrying their specified rated current continuously, without temperature rise exceeding the acceptable values of the relevant specifications at any part of the PSSC / MCC / PDB.

#### **7.2.1.17 Inspections / testing:**

Authority, his consultant and their authorized representative shall have the right to inspect and test or get inspected and tested the goods at the works of the Seller any time during manufacture and prior to dispatch.

The PSSC / MCC / PDB shall be inspected and checked as per inspection manual of the PSSC / MCC / PDB manufacturer.

Various electrical components and accessories of the PSSC / MCC / PDB shall be checked for their functionality & as per drawing for the respective PSSC / MCC / PDB.

The PSSC / MCC / PDB shall be checked for rigid mounting, earthing connections, proper rating and size of components, internal wiring, etc.

All mechanical fasteners and electrical connections shall be checked and tightened before installation.

#### **Type Test**

Type test certificate of LT panels shall be provided

#### **Routine Test:**

Prior to dispatch of the PSSC / MCC / PDB following tests shall be carried out.

- a) All routine tests specified in relevant India/British standards/NBC shall be carried out on all circuit breakers.
- b) Mechanical endurance test shall be carried out by closing and opening of all the MCCB's, MCB's switches etc.

- c) Over voltage and Insulation resistance test shall be carried out between phases and between phase to earth bus.
- d) All the interlocks, controls and tripping mechanism of the switchgears shall be tested for their proper functioning.
- e) Continuity test, Control circuit test shall be carried out. Also, HV test on secondary wiring and components on which such test is permissible (2 kV for one minute).
- f) Simulating external circuits for remote operation of breaker, remote indicating lights and other remote operations, if any.
- g) Pick up and dropout voltages for shunt trip and closing coils.
- h) Measurement of power required for closing/trip coil of the breaker.
- i) Protective relay operation shall be tested by primary or secondary injection method (wherever applicable).
- j) Operation of all meters CT polarity & ratio test.

Vendor shall provide all facilities such as power supply, testing instruments and apparatus required for carrying out the tests. Required copies of test certificates for all the tests carried out along with copies of test certificates and certificates from sub-vendor for the major components (and or for the items which are deemed reasonable by the Authority) procured from them are to be submitted before dispatch of switchboards/Panels.

### **Drawings and information**

The vendor shall furnish following drawings/documents.

- i. General arrangement drawing of the switchboard, showing front view, plan, foundation plan, floor cut-outs/trenches for external cables, elevations and sections with weights.
- ii. Sectional drawings of the circuit breaker panel, showing general constructional features, mounting details of various devices, bus bars, current transformers, cable boxes, terminal boxes for control cables etc.

- iii. Schematic and control wiring diagram for circuit breaker and protection including indicating devices, metering instruments, alarms, space heaters etc.
- iv. Terminal plans showing terminal numbers, ferrules marking, device terminal numbers, function etc.
- v. Relay wiring diagrams.
- vi. Equipment list.

Vendor shall furnish required number of copies of above drawings for Authority's review, fabrication of switch boards shall start only after Authority's clearance for the same. After final review, required number of copies and reproducible shall be furnished as final certified drawings.

The information furnished shall include the following.

- i. Technical literature giving complete information of the equipment.
- ii. Erection, Operation and Maintenance manual complete with all relevant information, drawings and literature for auxiliary equipment and accessories, characteristics curves for relays etc.
- iii. A comprehensive spare parts catalogue.

## **7.2.2 L. T. Switchgears:**

### **7.2.2.1 General**

The type, size, and rating of the components shall be as indicated on the relevant single line diagrams.

### **7.2.2.2 Miniature circuit breaker (MCB):**

Miniature circuit breakers shall be quick make and break and break type conform with British standard IEC: 898-1987 and IS: 8828 as amended up to date. The housing of MCBs shall be heat resistant and having high impact strength. The fault current of MCBs shall not be less than 10000 amps (10KA), at 230 volts. The MCBs shall be flush mounted and shall be provided with trip free manual operating mechanism with mechanical "ON" and "OFF" indications.

The circuit breaker dollies shall be of trip free pattern to prevent closing the breaker on a faulty current.

The Each pole of the breaker shall be provided with inverse time thermal overload and instantaneous over current tripping elements, the overload or short circuit devices shall have a common trip bar in the case of DP and TPN miniature circuit breakers. All the MCB's shall be tested/certified as per Indian Standard, prior to Installation.

Tripping characteristics of the MCBs (B/C/D curve) should be based on the load connected to the MCB

### **7.2.2.3 MCB (For control, Indication and metering Circuit):**

MCBs used in control, indication and metering circuit shall be of approved make.

### **7.2.2.4 Moulded case circuit breaker: (Class P-2 Duty)**

MCCB shall conform to the latest IS: 13947/IEC: 947

The MCCB shall be air brake type and having quick make quick break with trip free operating mechanism.

Housing of the MCCB shall be of heat resistant and flame-retardant insulating material.

Rotating Handle Operating handle (RHOM) of the MCCB shall be in front and clearly indicate ON / OFF (or) TRIP positions. In case of 4 pole MCCB the neutral shall be defined and capable of offering protection.

The MCCB shall be provided with Thermal based trip units as provided in the SLD. All the releases shall operate on common trip bus bar so that in case of operation of any one of the releases in any of the three phases, it will cut off all the three phases and thereby single phasing of the system is avoided.

The MCCB whenever called for in the drawings shall be provided with Overload, Short Circuit protection

The MCCB shall provide two sets of extra auxiliary contacts with connections for additional controls at future date.

#### **7.2.2.5 Contactors:**

The contactor shall meet with the requirements of IS: 2959 /BS: 775.

The contactors shall have minimum making and breaking capacity in accordance with utilization category.

If the contactor forms part of a distribution board then a separate enclosure is not required, but the installation of the contactor shall be such that it is not possible to make an accidental contact with live parts.

#### **7.2.2.6 Multi data meter**

Flush mount 96 x 96 x 80 mm Load manager type meter of accuracy class 1 as per IS 13779/IEC 62052-11 & 62053-21 shall be provided. The meter shall be capable of simultaneous sampling of voltage and amperes. It shall have low burden on PT and CT shall have bright display, shall view 3 parameters together and shall have auto scaling from kilo to mega to giga units, shall have programmable CT, PT ratios. Communication with PC; PLC DCS shall be possible through RS 485 serial port. It shall be dust proof, tamper proof with data import export option.

Parameters to be monitored shall be Frequency, Line to line and average and line to neutral and average voltage, phase wise and average current, phase wise and total KVA, KW and P.F. reading and KWH monitoring.

User programmable facility for delta 2e and star 3e measurement, C.T. and P.T. ratios, Sensing shall be 3 phase, 4 wire measuring True RMS with voltage input range of 110 to 415 V nominal and current input of 5 amps or 1 amps as per field configuration. Current range shall be from 50 mA to 6A and burden on PT or CT shall be Max 5 VA.

Accuracy for kW / kWh shall be as per IS 13779 / CBIP88/62052-11 & 62053-21, for kVar/kVarh 2% and for all other parameters 1% for class 1. Digital readout shall be of 3 rows of 4 digits each with 7 segments bright red LED. Input frequency shall be 50Hz / +/- 5%.

Resolution for power parameters shall be for 4 digits and energy parameters shall be 8 digits. Display update shall be at every 15 seconds for demand parameters and 1 sec for other parameters. Temperature range shall be 0-50°C and humidity <95% non-condensing.

Display parameters shall be as follows:

Instantaneous –VLL, VLn, A, F, KVA, kW, PF  
Individual phases of above parameters.

Integrated – kVAh, kWh, Run hours, On hours & Interruption.

#### **7.2.2.7 Current transformer:**

Where called for, CT's shall be of Resin Cast type provided for current measuring. Each phase shall be provided with separate CT of class I accuracy and VA burden as shown in SLD for operation of associated metering and controls. Current transformer shall be in accordance with IS: 2705 as amended up to date.

#### **7.2.2.8 Push button:**

The push button unit shall comprise of the contact element, a fixing holder, and push button actuator. The push button shall be momentary contact type. The contacts shall be of silver or silver alloy and rated at 10 Amps. Continuous current rating. The actuator shall be of

stranded type and color as per its usage for ON, OFF and Trip.

#### **7.2.2.9 Indicating lamp:**

Indicating Lamp shall be LED type and shall be supplied complete with translucent covers to diffuse the lamp light. Indicating lamps shall be part of push buttons.

Color shade for the indicating lamps shall be as below:

ON indicating lamp	:	RED
OFF indicating lamp	:	GREEN
TRIP indicating lamp	:	Amber
PHASE indicating lamp	:	Red, Yellow, and Blue.

#### **7.2.2.10 Workmanship: -**

The Contractor shall erect the panel at site in co-ordination with the supplier if required. He should check for loose ends on the part of the supplier and shall inform client and consultant for the same. Physical and continuity tests shall be carried out by the Contractor. Also, the field tests carried out by the supplier shall be recorded by the Contractor.

#### **7.2.2.11 Tools**

One complete set of all special or non-standard tools required for installation, operation and maintenance of the switchboard shall be provided. The manufacturer shall provide a list of such tools individually priced with his quotation.

#### **7.2.2.12 Spares**

The manufacturer/tenderer shall also supply a complete list of commissioning spares and tools. The same shall be included in the bid price. No extra payment shall be made on account of non-availability of spares during commissioning.

#### **7.2.2.13 Deviations**

Deviation from specification must be stated in writing at the quotation stage.

In absence of such a statement, it will be assumed that the requirements of the specifications are met without exception.



### **7.2.3 Drawings and documents to be furnished by tenderer**

**7.2.3.1** After award of the contract for approval (4 copies) & distribution (as per General Requirements) along with softcopy.

- a) General arrangement drawings of capacitor Banks and Capacitor Control Panels Indicating overall and other dimensions and weight.
- b) Control schematic with coordinated terminal mounting and wiring diagram for all the equipment.
- c) A complete bill of materials of all equipment and accessories of Capacitors and Control Panels covering technical particulars, quantity, make of bought out Items etc.
- d) Manufacturers catalogues of major bought out items.
- e) Erection, maintenance and operation manual.
- f) Any other drawings/information pertinent to this equipment, if required by Authority.

### **Inspection and tests**

At Manufacturer's Works

- a) Routine tests of each capacitor and capacitor control panel shall be carried out in compliance with relevant Indian Standards.
- b) Routine test certificates as per IS for bought out items shall be furnished for Authority's approval.

At site Complete assembled and installed equipment will be inspected and necessary tests shall be carried out as per manufacturer's recommendations and relevant National Building codes and standards.

## **A CABLE LAYING**

- a) Cable network shall include power, control, lighting and communication cables, which shall be laid in trenches, cable trays or conduits as detailed in the relevant drawings. Erection of cable trays as required shall be the responsibility of the Contractor. Cable routing given on the layout drawings shall be checked in the field to avoid interference with structures, piping or air-conditioning ducts, and minor adjustments shall be done to suit the field conditions, wherever deemed necessary, without any extra cost.
- b) High voltage, medium voltage and other control cables shall be separated from each other by adequate spacing or running through independent pipes, trenches or cable trays, as applicable.
- c) All cable routes shall be carefully measured, and cables cut to the required lengths, leaving sufficient length for the final connection of the cable to the terminal of the equipment. The various cable lengths cut from the cable reels shall be carefully selected to prevent undue wastage of cables. The quantity indicated in the cable schedule is only approximate. The Contractor shall ascertain the exact requirement of cable for a particular feeder by measuring at site and avoiding interference with structures, foundation, pipe work or any other works.
- d) Cables as far as possible shall be laid in complete uncut lengths from one termination to the other.
- e) Straight through joints if required shall be made by using epoxy resin type jointing kit.
- f) Cables shall be neatly arranged in the trenches / trays in such a manner so that crisscrossing is avoided and final take off to the switchgear is facilitated. Arrangements of cables within the trenches / trays shall be the responsibility of the Contractor.
- g) All cables will be identified close to their termination point by cable numbers as per cable schedule. Cable numbers will be punched on aluminum straps (2mm thick), securely fastened to the cable and wrapped around it. Alternatively, cable tags shall be circular in construction to which cable numbers can be conveniently punched.
- h) Each underground cable shall be provided with identity tags of lead securely fastened every 30 meters of underground length with at least one tag at each end before the cable enters the ground.

- i) All temporary ends of cables must be protected against dirt and moisture to prevent damage to the insulation. For this purpose, ends of all PVC insulated cables shall be tapped with an approved PVC or rubber insulating tape. Use of friction tape or other type of tape is not permitted. Lead sheathed cables shall be plumbed with lead alloy.
- j) RCC cable trenches with removable covers as shown on the drawings will be provided by the Contractor. Concrete cable trenches shall be filled with sand where specified to avoid accumulation of hazardous gases. RCC covers of trenches, in process areas shall be effectively sealed to avoid ingress of chemicals etc. Removal of concrete covers for purposes of cable laying and reinstating them in their proper positions after the cables are laid shall be done by the Contractor at no extra cost.
- k) Cables shall be handled carefully during installation to prevent mechanical injury to the cables. Ends of cables leaving the trenches shall be provided with a protective pipe or cover, until such times the final termination to the equipment is completed.
- l) Directly buried cables shall be laid underground in excavated cable trenches where specified on layout drawings. Trenches shall be of sufficient depth and width for accommodation of all cables correctly spaced and arranged with a view of heat dissipation and economy of design.

Depth of burying shall allow minimum 750 mm soil cover for LT cables as per standard.. Cables shall be laid in trenches at depth as shown in the drawing. Before cables are placed, the trench bottom shall be filled with a layer of sand not less than 50mm for LT cables. The sand shall be leveled, and the cables laid over it. The cables shall be covered with 150 mm of sand on top of the largest diameter cable, and sand shall be hand pressed. A protective covering of 75 mm thick second-class red bricks shall be then laid flat. The remainder of the trench shall then be backfilled with soil, rammed and leveled.

As each row of cables is laid in place, and before covering with sand, every cable shall be given an insulation test in the presence of the engineer. Any cable, which proves defective, shall be replaced before the next group of cables are laid.

All wall openings shall be effectively sealed after installation of cables to avoid leakage of water.

- m) Where cables rise from trenches to control station, lighting panels etc., they shall be taken in vertical trays for mechanical protection.

Cable ends shall be carefully pulled through the conduits to prevent damage to the cable. Where required, approved cable lubricant shall be used for this purpose. Where cable enters conduit, the cable should be bent in large radius. Radius shall not be less than the recommended bending radius of the cables specified by the manufacturer.

- n) After the cables are installed and all testing is complete conduit ends above ground shall be plugged with a suitable weatherproof plastic compound / PUTTI for sealing purpose. Alternatively, G.I. lids or PVC bushes shall be employed for sealing purposes. The cost for the same shall be deemed to be included in the installation of PVC pipe and no separate payment shall be done.
- o) Where cables pass through foundation walls or other underground structures, the necessary ducts or openings will be provided in advance for the same. However, should it become necessary to cut holes in existing foundations or structures the Contractor shall determine the location, and obtain approval of the engineer in charge before cutting is done.
- p) At road crossing and other places where cables enter pipe sleeves adequate bed of sand shall be given so that the cables do not slack and get damaged by pipe ends after back filling.
- q) Drum number of each cable from which it is taken shall be recorded along with the cable number in the cable schedule.
- r) Cables installed above ground shall be run in trays exposed on walls, ceiling, structures and shall be run parallel or at right angles to beams, walls or columns. Cables shall be so routed that they will not be subjected to heat from adjacent hot piping or vessels.
- s) Individual cables or small groups which run along structures / walls etc. will be by means of 16 SWG G.I. saddles on 25 x 6 mm saddle bars. The cost of saddle and saddle bars shall be deemed to have been included in the installation of cables and no separate payment shall be made on this account. They shall be rigidly supported on structural steel and masonry, individually or in groups, as required. If drilling of steel must be resorted to, approval must be secured, and steel must be drilled where the minimum weakening of the structure will result. Cables shall be supported so as to prevent unsightly sagging. In general distance between supports shall be approximately 300 mm for cables upto 25 mm diameter and maximum 450 mm for cables larger than 25 mm diameter.

- t) All PVC Pipes shall be laid as per requirements. Before fabrication of various profiles of pipe by hydraulically operated bending machine (which is to be arranged by the Contractor), all the burs from the pipes shall be removed. PVC pipes buried in soil, bitumen coating shall be applied on the buried lengths. Installation of PVC Pipes shall be undertaken well before paving is completed and necessary coordination with paving agency shall be the responsibility of the Contractor. The open ends of pipes shall be suitably plugged with G.I. plugs/PVC Glands after they are laid in final position. G.I. Plugs/PVC Glands shall be supplied by the Contractor at no extra cost.
- u) Cable laid on supporting angle in cable trenches, structures, columns and vertical run of cable tray shall be suitably clamped by means of G.I. saddles / clamps, whereas cable in horizontal run of cable trays shall be tied by means of nylon cords.
- v) Supporting steel shall be painted before laying of cables. The painting shall be done with one coat of red lead paint and two coats of approved bituminous aluminum paint.

**B. WORKMANSHIP: -**

The cable shall be laid as mentioned above, the trench shall be terminated in Manholes with specified size of R.C.C. hume pipes as shown in drawing. Cable markers shall be provided throughout the route of cable at 10 mts distance. The trenches shall be refilled after the cable is laid and the Ground level shall be done as per original after pressing the same. The cables shall be checked for insulation resistance and continuity tests shall be carried out.

## 7.2.4 1.1 KV grade L.T. cables and cable termination

### A. Specifications

#### L. T. XLPE CABLE:

##### General:

The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in the original drums with manufacturer's name, size and type clearly written on the drums.

All cables shall be adequately protected against any risk of mechanical damage to which they may be liable in normal conditions of handling during transportation, loading, unloading etc.

The cable shall be supplied in single length i.e. without any intermediate joint or cut unless specifically approved by the client.

The cable ends shall be suitably sealed against entry of moisture, dust, water etc. with cable compound as per standard practice.

##### Conductor:

Uncoated, annealed copper / aluminum, of high conductivity, up to 4 mm<sup>2</sup> size the conductor shall be solid Circular and above 4 mm<sup>2</sup> the conductors shall be stranded compacted shaped.

##### Insulation:

Cross link polyethylene (XLPE) extruded insulation rated at 70°C.

##### Core Identification:

Two cores	:	Red and Black
Three cores	:	Red, Yellow and Blue
Four cores	:	Red, Yellow, Blue and Black

Single core : Green for earthing.

Black shall always be used for neutral and green shall be used for earthing.

**Assembly:**

Two, three or four insulated conductors shall be laid up, filled with non-hygroscopic material and covered with an additional layer of thermoplastic material.

**Aarmor:**

Galvanized steel flat strip / round strips applied helically in single layers complete with covering the assembly of cores.

**Sheath:**

The inner sheath shall be of PVC type. Outer sheath shall be of an extruded type layer of suitable PVC TYPE-ST-2 material compatible with the specified ambient temp. of 50°C and operating temperature of cables. The sheath shall be resistant to water, ultraviolet radiation, fungus, termite and rodent attacks. The color of outer sheath shall be black.

Sequential length marking along with size and other standard parameters shall be required at every 1.0 meters on the outer sheath.

**Testing:**

Finished cable tests at manufacturers works: The finished cables shall be tested at manufacturer's works for all the routine tests for all the length and size of cables to be delivered at site and the certificate for the same shall be furnished to client. If required, the cables shall be tested in presence of the client's representative.

- 1) Voltage test: Each core of cable shall be tested at room temperature at 3 KV A.C. R.M.S. for duration of 5 minutes.
- 2) Conductor resistance test: The D.C. resistance of each conductor shall be measured at room temperature and the results shall be corrected to 20°C to check the compliance with the values specified in the IS 8130.

Cable tests before and after laying cables at site:

1. Insulation resistance test between phases, phase to neutral and phase to earth.
2. Continuity test of all the phases, neutral and earth continuity conductor.
3. Earth resistance test of all the phases and neutral.

**TESTING INSTRUMENTS SHALL BE OF REPUTED MAKE AND SHALL HAVE VALID CALIBRATION.**

All the tests shall be carried out in accordance with the relevant IS code of practice and Indian Electricity Rules. The vendor shall provide necessary instruments, equipment's and labor for conducting the above tests and shall bear all the expenses in connection with such tests. All tests shall be carried out in the presence of client and the results shall be prescribed in forms and submitted.

**Cable Marking:**

The outer sheath shall be legibly embossed at every meter with following legend:

ELECTRIC CABLE: 1100 V, SIZE: \_\_C X \_\_\_\_ MM<sup>2</sup> with Manufacturers name, year of manufacturing and ISI symbol.

**Sealing Drumming and Packing:**

After tests at manufacturer's works, both ends of the cables shall be sealed to prevent the ingress of moisture during transportation and storage.

Cable shall be supplied in length of 500 mts or as required in non-returnable drums of sufficiently sturdy construction.

Cables of more than 250 meters shall also be supplied in non-returnable drums.

The spindle hole shall be minimum 110 mm in diameter.

Each drum shall bear on the outside flange, legibly and indelibly in the English literature, a distinguishing number, the manufacturer's name and particulars of the cable i.e. voltage grade, length, conductor size, cable type, insulation type, and gross weight shall also be clearly visible. The direction for rolling shall be indicated by an arrow. The drum flange shall



also be marked with manufacturer's name and year of manufacturing etc.

**Cable Termination:**

- a. All LT cables up to 1100 V grade shall be terminated at the equipment by means of double compression type cable glands of aluminum / copper conductor. Cable glands to be supplied by the Contractor should be preferably of leading and approved brands only. They shall have a screwed nipple with conduit, electrical thread and check nut.
- b. Power cables shall be identified with Red, Yellow and Blue PVC tapes. Where copper to aluminum connections are made necessary, bimetallic washers shall be used. For trip circuit identification, additional red ferrules shall be used only in the particular cores of control cables at the termination points in the switchgear / control panels and control switches.
- c. In case of control cables all cores shall be identified at both ends by their terminal numbers by means of PVC ferrules, or self-sticking cable markers. Wire numbers shall be as per the schematic / wiring / interconnection diagrams. The Contractor shall have the samples of PVC ferrules / cable markers approved before starting of the work.
- d. Where threaded cable gland is screwed into threaded opening of different size, suitable galvanized threaded reducing bushing of approved type shall be used, at no extra cost. The Contractor shall drill holes for fixing glands wherever necessary at no extra cost. Gland plate shall be of non-magnetic materials / aluminum sheet in case of single core cables.
- e. The cable shall be taken through glands inside the panels or any other equipment such as motors. The individual cores shall then be dressed and taken along the cableways (if provided) or shall be fixed to the panels with polyethylene straps. Only control cables of single strand and lighting cables may be directly terminated on to the terminals.
- i. In case of termination of cables at the bottom of a panel over a cable trench having no access from the bottom, close fit hole should be drilled in the bottom plate for all the cable in on line: then the bottom plate should be split into parts along the center line of holes. After installation of bottom plate and cables, it should be sealed with cold setting compound. Cables shall be clamped over the open armoring to connect it to the earth bus.

- f. Cable leads shall be terminated at the equipment terminals by means of crimped type solder less connectors as manufactured by leading and approved companies / brands. Crimping shall be done by hand crimping / hydraulically operated tool and conducting jelly shall be applied on the conductor. Insulation of the leads should be removed immediately before the crimping. Conductor surface shall be cleaned and shall not be left open.

## **B. WORKMANSHIP**

Cables shall be laid in the routes marked in the drawings. Where the route is not marked, the Contractor shall mark it out on the drawings and also on the site and obtain the approval of the CLIENT AND/OR ITS ARCHITECT before laying the cable. Procurement of cables shall be on the basis of actual site measurements and the quantities shown in the schedule of work shall be regarded as a guide only.

Cables shall be laid on walls, cable trays, inside shafts or trenches. Saddling or support for the cable shall not be more than 500 mm apart. Plastic identification tags shall be provided at every 30 m.

Cables shall be bent to a radius not less than 12 (twelve) times the overall diameter of the cable or in accordance with the manufacturer's recommendations whichever is higher.

In the case of cables buried directly in ground, the cable route shall be parallel or perpendicular to roadways, walls etc. unless marked on drawing by architect / consultant. Cables shall be laid on an excavated, graded trench, over a sand or soft earth cushion to provide protection against abrasion. Cables shall be protected with brick or cement tiles on all the three sides as shown on drawings. Width of excavated trenches shall be as per drawings. Back fill over buried cables shall be with a minimum earth cover of 750 mm to 1000 mm. The cables shall be provided with cables markers at every 10 meters and at all loop points.

All cables shall be full runs from panel to panel without any joints or splices. Cables shall be identified at end termination indicating the feeder number and the Panel/Distribution board from where it is being laid. Cable termination for conductors up to 4 sq.mm. may be insertion type and all higher sizes shall have compression type lugs. Cable termination shall have necessary brass glands. The end termination shall be insulated with a minimum of six half-lapped layers of PVC tape. Cable armoring shall be earthed at both ends.

In case of cables entering the buildings. It would be done duly only through pipes. The pipes shall be laid in slant position, so that no rainwater may enter the building. After the cables are tested the pipes shall be sealed with M. seal & then tarpaulin, shall be wrapped around the cable for making the entry watertight.

### **Testing**

MV cables shall be tested upon installation with a 500 V Megger and the following readings established:

1. Continuity on all phases.
2. Insulation Resistance: Between conductors and All conductors & ground.

All test readings shall be recorded and shall form part of the completion documentation.

Cable joints shall be done as per regular practice and check shall be carried out for loose connections and leakages. Insulation cutting shall be done properly taking care that no area of the conductor remains exposed. Crimping shall be done with the help of hydraulic tool. Proper insulation tape shall be applied at the cable and lug joint.

Format for cable testing certificate:

- a. Drum no. from which cable is taken :
  - b. Cable from \_\_\_\_\_ to \_\_\_\_\_
  - c. Length of run of this cable \_\_\_\_\_ meter
  - d. Insulation resistance test
    - Between core 1 to earth \_\_\_\_\_mega-ohm
    - Between core 2 to earth \_\_\_\_\_mega-ohm
    - Between core 3 to earth \_\_\_\_\_mega-ohm
    - Between core 1 to core 2 \_\_\_\_\_mega-ohm
    - Between core 2 to core 3 \_\_\_\_\_mega-ohm
    - Between core 1 to core 3 \_\_\_\_\_mega-ohm
- Duration used:

### 7.2.5 Light fixtures

#### A. SPECIFICATIONS

Streetlights and Landscape Light fixtures to be considered as per Schedule specifications, makes or equivalent models, with warranty, etc. of other approved brands shall be installed. The fixtures shall be complete with drivers and shall be prewired by the manufacturer.

All Outdoor fixtures should have high efficiency LED Lamp and same shall be confirmed by manufacturer.

Solar LED Street Lights to be considered as per the Schedule specification.

### 7.2.6 EARTHING

All electrical equipment is to be earthed by connecting two earth strips from the frame of the equipment to a main earth ring. The earth ring will be connected via several earth electrodes.

Following equipment shall be earthed.

- a. Non-current carrying metallic parts of electrical equipment such as switchgear, panel boards, motor control centers, etc.

The shop drawing for earthing system shall be prepared by the Contractor based on the GFC drawing issued by consultants and be got approved by Authority/Architect. The work shall be done in accordance with approved drawings.

#### A. SPECIFICATION

##### i) Plate Electrode Earth Station: -

The earth electrode shall be plate of COPPER PLATE with Copper Strip of required size as per BOQ prepared at ground level.

The earth resistance shall be maintained with a suitable soil treatment. The resistance of each earth station should not exceed 5 ohms.

Where the above stated earth resistance is not achieved, necessary improvement shall be made by additional provisions, such as additional electrode(s), different type of electrode or artificial chemical treatment of soil etc. as may be directed by engineer-in-charge.

The earth lead shall be fixed to the pipe with a nut and safety set screws. The clamp shall be permanently accessible.

G.I. pipe with funnel of approved quality shall be used for watering the earth electrode \ station.

The block masonry chamber with Cast Iron hinged cover shall be provided for housing the above referred funnel and pipe.

The hardware and other consumable for earthing installation shall be brass or hot dip galvanized iron material as shown on the drawing.

## ii) **Earth Leads and Connections:**

Copper lead shall have a phosphor content of not over 0.15%. At road crossing necessary Hume pipes shall be laid. Earth lead run on surface of wall or ceiling shall be fixed on saddles so that strip is at least 8 mm away from the wall surface.

The complete earthing system shall be mechanically and electrically bonded to provide an independent return path to the earth source.

## **B. WORKMANSHIP: -**

Following activities shall be carried out for the earthing station

- Excavation in hard murrum.
- Laying Watering pipe.
- Brick masonry with hinged covers.
- Charcoal and Salt fill.
- Earth station should be 2 mt. away from wall of foundation
- Keep 5.0 mt. distance between two earth pits.
- The pit should be minimum 10ft deep. (3.5 meter)
- The earth resistance should not exceed 5 ohm.

- All earth pits of same category shall be interlinked with strip.

**Following points shall be followed strictly.**

The plate electrode, as far as practicable, shall be buried below permanent moisture level but in no case not less than 3.0 M below finished ground level.

The plate electrode shall be kept clear of the building foundation and in no case, it shall be nearer by less than 2 M from outer face of the respective building wall \ column.

The plate electrode shall be installed vertically and shall be surrounded with 150 mm. thick layers of Charcoal dust and Salt mixture.

20-40 mm. dia. G.I. pipe for watering, shall run from top edge of the pipe electrode to the mid-level of block masonry chamber.

Top of the pipe shall be provided with G.I. funnel and screen for watering the earth \ ground through the pipe.

The funnel with screen over the G.I. pipe for watering to the earth shall be housed in a block masonry chamber as shown in the drawing.

The masonry chamber shall be provided with a Cast Iron hinged cover resting over the Cast Iron frame, which shall be embedded in the block masonry.

Construction of the earthing station shall in general be as shown in the drawing and shall conform to the requirement on earth electrodes mentioned in the latest edition of Indian Standard IS: 3043, Code of Practice for Earthing Installation.

The earth conductors inside the building shall properly be clamped / supported on the wall with Galvanized Iron clamps and Mild Steel Zinc Passivated screws / bolts. The conductors outside the building shall be laid at least 600 mm. below the finished ground level.

The earth conductors shall either terminate on earthing socket provided on the equipment or shall be fastened to the foundation bolt and / or on frames of the equipment. The earthing connection to equipment body shall be done after removing paint and other oily substances from the body and then properly be finished.

Over lapping of earth conductors during straight through in joints, where required, shall be of minimum 75mm. long.

The earth conductors shall be in one length between the earthing grid and the equipment to be earthed.

Additional equipment earthing shall be done with Cu strip / Bare Cu Wire as per size indicated in drawing.

Lightening arrestors shall be installed at topmost point of the building. The quantity for the same shall be designed & specified to cover total building area. Early streamer emission type arrestor shall be connected to separate earth pit with Cu Strip.

**Following tests shall be carried out:**

The entire earthing installation shall be tested as per requirements of Indian Standard Specification IS: 3043.

The following earth resistance values shall be measured with an approved earth megger and recorded.

- ◆ Each earthing stations
- ◆ Earthing system as a whole
- ◆ Earth continuity conductor

Earth conductor resistance for each earthed equipment shall be measured which shall not exceed 5 Ohm in each case.

Measurements of earth resistance shall be carried out before earth connections are made between the earth and the object to be earthed.

**C. MARKING**

- i. Earth bars/terminals at all switch boards shall be marked permanently, either as "E" or as
- ii. Main earthing terminals shall be marked "SAFETY EARTH-DO NOT DISCONNECT"

## **7.2.7 Testing of installation**

### **7.2.7.1 Scope**

This chapter describes the details of tests to be conducted in the completed internal electrical installations, before commissioning.

### **7.2.7.2 General**

#### **7.2.7.2.1 Tests**

On completion of installation, the following tests shall be carried out: -

- 1) Insulation resistance test.
- 2) Polarity test of switch.
- 3) Earth continuity test.
- 4) Earth electrode resistance test.

#### **7.2.7.2.2 Witnessing of tests**

Testing shall be carried out for the completed installations, in the presence of and to the satisfaction of the Engineer-in-charge by the Contractor. All test results shall be recorded and submitted to the Department.

#### **7.2.7.2.3 Test instruments**

All necessary test instruments for the tests shall be arranged by the Contractor if so, required by the Engineer-in-charge.

### **7.2.7.3 Testing of earth continuity path**

The earth continuity conductor, including metal conduits and metallic envelopes of cables in all cases, shall be tested for electric continuity. The electrical resistance of the same along with the earthing lead, but excluding any added resistance, or earth leakage circuit breaker, measured from the connection with the earth electrode to any point in the earth continuity conductor in the completed installation shall not exceed one ohm.



#### 7.2.7.4 Measurement of earth electrode resistance

7.2.7.4.1 Two auxiliary earth electrode, besides the 'test' electrode, are placed at suitable distance from the test electrode. A measure current is passed between the 'test' electrode to be tested and an 'auxiliary' current electrode and the potential difference between the 'test' electrode and 'auxiliary' electrode potential is measured. The resistance of the test electrode is then given by:

$$R=V/I$$

Where,

R	-	Resistance of the test electrode in ohms,
V	-	Reading of the voltmeter in volts.
I	-	Reading of the ammeter in amps.

7.2.7.4.2 (i) Stray currents flowing in the soil may produce serious errors in the measurement of earth resistance. To eliminate this, hand driven generator is used.

(ii) If the frequency of the supply of hand driven generator coincides with the frequency of stray current, there will be wandering of instrument pointer. An increase or decrease of generator speed will cause this to disappear.

7.2.7.4.3 At the time of test, the test electrode shall be separated from the earthing system.

7.2.7.4.4 The auxiliary electrodes shall be of 13 mm diameter mild steel rod driven up to 1 m into the ground.

7.2.7.4.5 All the three electrodes shall be so placed that they are independent of the resistance area of each other. If the test electrode is in the form of a rod, pipe or plate, the auxiliary current electrode 'c' shall be placed at least 30 m away from it, and the auxiliary potential electrode 'B' shall be placed mid-way between them.

7.2.7.4.6 Unless three consecutive readings of test electrode resistance agree, the test shall be repeated by increasing the distance between electrodes A and C up to 50 m, and each time placing the electrode B midway between them.

7.2.7.4.7 On these principles, "Megger Earth Tester", containing a direct reading ohm-meter, a hand driven generator and auxiliary electrodes are manufactured for direct reading of earth resistance of electrodes.

**7.2.7.5 Test certificate**

On completion of an electrical installation (or an extension to an installation), a certificate shall be furnished by the Contractor, countersigned by the certified supervisor/Authority Engineer under whose direct supervision the installation was carried out. This certificate shall be in the prescribed form as provided in the National Building Code of India, PART 8 BUILDING SERVICES – SECTION 2 ELECTRICAL AND ALLIED INSTALLATIONS, ANNEX E, (Clause 9.3.2.6), FORM OF COMPLETION CERTIFICATE (REFER NBC LATEST VERSION).