CHHATTISGARH STATE POWER TRANSMISSION CO. LTD.
(A Govt. of Chhattisgarh undertaking) (A successor company of CSEB)
CIN- U40108CT2003SGC015820 GSTIN-22AADCC5773E1ZX

OFFICE OF EXECUTIVE DIRECTOR (PLANNING & PROJECT)
Third Floor, SLDC Building, CSEB Campus
Dangania, Raipur (C.G.)-492013

Phone: 0771-2574209/14/41 Fax: 0771-2574246
Website: - www.cspc.co.in/csptcl, email:- cepnp.csptcl@cspc.co.in

TENDER SPECIFICATIONS

TR-20/05

(VOLUME – II OF III)

PACKAGE FOR CONSTRUCTION OF 220/132/33 KV SUB-STATIONS AT DALDALSEONI (RAIPUR) AND ASSOCIATED 220 KV DCDS RAITA-DALDALSEONI LINE (RL-30 KM APPROX.) ON TURNKEY BASIS
(Through E-Bidding)

RFx No. 8100021991

INDEX

Section-II

TECHNICAL SPECIFICATIONS/CONDITION FOR SUPPLY OF TOWER, FOUNDATION AND FABRICATION FOR CONSTRUCTION OF LINE

SECTION – II-A

TECHNICAL CONDITIONS

CONTENTS

CONTENTS

SECTION -II-B

TECHNICAL CONDITIONS FOR SUPPLY OF LINE CONDUCTOR, EARTHWIRE, INSULATORS, LINE STRINGING HARDWARE FITTINGS AND CONDUCTOR & EARTHWIRE ACCESSORIES FOR CONSTRUCTION OF LINE.

CONTENTS

SECTION-II B-PART (i)
TECHNICAL SPECIFICATIONS

CONTENTS

SECTION-II B- PART (ii) (a)
TECHNICAL SPECIFICATIONS OF GROUNDWIRE

CONTENTS

16.	Lay Length Check
17.	Galvanizing Test
18.	Torsion Test
SECTION-II B- PART (ii) (b) **TECHNICAL SPECIFICATIONS OF O.P.G.W. AND ASSOCIATED HARDWARE**	
CONTENTS	
Clause	**Description**
1.	Introduction And General Information:
1.1	Scope
1.2	General Requirements
1.3	Contractor Responsibilities And Obligations
1.4	Applicable Standards
1.5	References
2.	Specification And Functional Description Of Fibre Optics Material
2.1	Fibre Optic Cabling
SECTION-II B-PART (iii) **TECHNICAL SPECIFICATIONS OF INSULATORS**	
	CONTENTS
Clause No.	**Description**
1.0	Technical Description of Disc Insulators
2.0 (A)	Standard Technical Particulars for insulator & insulator strings for 400KV transmission line
2.0 (B)	Standard Technical Particulars for insulator & insulator strings for 220 KV transmission line
3.0	Tests and Standards
4.0	Tests on Complete Strings with Hardware Fittings
SECTION-II B- PART (iv) **TECHNICAL SPECIFICATIONS OF HARDWARE FITTINGS, ACCESSORIES FOR CONDUCTOR & ACCESSORIES FOR EARTHWIRE**	
CONTENTS	
Clause	Description
1.0	Technical Description of Hardware Fittings
2.0	Accessories for ACSR MOOSE Conductor
3.0	GS Earth wire Accessories
4.0	Standard Technical Particulars
5.0	Type Tests & Standards
6.0	Annexure-A
7.0	Annexure-B
SECTION-II B- PART (v) **VENDOR LIST**	
CONTENTS	
SL.NO.	**Item(s)**
1.	ACSR conductor “Moose”
2.	Ground Wire 7/3.66 mm
3.	Stringing hardware
4.	Disc Insulators

5.	Bolts & Nuts and Washers
6.	Danger Plate/ Phase Plate/ Number Plate/ circuit Plate/ Earthing / Counter Poise Earthing
7.	OPGW

SECTION - II–C

TECHNICAL CONDITIONS FOR ERECTION, TESTING AND COMMISIONING (SURVEY AND SOIL INVESTIGATION, STUB SETTING, ERCTION OF TOWER, STRINGIING ETC.)	
CONTENTS	
Sl.No.	**Particulars**
1.0	Scope Of Work
1.A	General
1.1	Requirement of Transmission Line
1.3	Survey & route of the transmission line
1.4	Tower location
1.5	Clearance from ground, building, trees etc.
1.6	Preliminary schedule
1.7	Check Survey.
2	**SOIL INVESTIGATION/GEO TECHNICAL SPECIFICATION**
2.1	General
2.2	Scope
2.3	Field Investigation for Soils
2.4	Laboratory Testing
2.5	Rates and Measurements
2.6	Code and standard references
3	**FOUNDATION**
3.0 & 3.1	Excavation
3.2	Benching
3.3	Setting of stubs
3.4	Placement of reinforcement
3.5	Concrete
3.6	Backfilling and removal of stub templates
3.7	Curing
3.7.1	Shoring of pits
3.8	Tower earthing
3.8.1	Counter poise earthing
3.9	Building stone revetment
3.10	Tower Erection, Stringing And Installation Of Line Materials
3.11	Tower erection / assembly
3.12	Treatment of minor galvanization damage
3.13	Tightening punching and welding of bolts and nuts
	STRINGING
3.14	Insulator hoisting :-
3.15	Handling of conductor and earth wire
3.16	Repairs to conductors
3.17	Crossings

Section-III

SECTION – I

TECHNICAL SPECIFICATION FOR SUB-STATION

1. TECHNICAL SPECIFICATION FOR CIVIL WORKS FOR 220/132/33 KV SUB-STATION

1. **SCOPE :-**

This specification covers civil works like construction of Control Room Building. Peripheral fencing with iron main gate of the switchyard, construction of earth pits, concrete road, cable trenches, sanitation & water supply arrangement, excavations, back filling, yard levelling/metalling, foundations of all equipments/structures etc., including materials viz., steel, cement, metal, sand etc. Water has to be arranged by the contractor at his own cost. Also, storage space for equipments and site office will be arranged by the contractor at his own cost. The labour hutments & model sanitary arrangement have to be provided by the contractor at his own cost.

1. CIVIL WORKS: - The technical specifications for civil works, shall be as follows:-

1.1. Construction of Control Room Building and all civil works at 220/132/33 KV switch yard viz; x-mer / equipment foundations cable trenches, yard fencing, yard levelling, metalling, earth pits, gate, sump tank, Bay marshalling room (Kiosk), approach roads, rain water harvesting pit, sign boards, arrangement of slope protection works, drainage arrangement of yard, complete water supply arrangement etc. is covered in the scope of contract. All materials shall be of best quality conforming to relevant Indian Standards and Codes. In case of any conflict between Standards/Code and Technical Specification the provisions of Standards/ Code shall prevail.

The Contractor shall furnish all labour, tools, equipment, materials, temporary works, constructional plant and machinery, fuel supply, transportation and all other incidental items not shown or specified but as may be required for completion of the works in accordance with approved drawings, specifications and direction of Engineer-in-charge.

All materials including cement, reinforcement steel and structural steel etc. shall be arranged by the contractor. All testing of constructional material required as per relevant BIS codes shall be arranged by the contractor at his own cost at site.

All the construction material shall have to be got approved prior to use, from Engineer-in-charge of CSPTCL.

The bidder shall fully appraise himself of the prevailing geographical, topographical & climatic conditions at the proposed site, including monsoon patterns, local conditions and site specific parameters, availability of all construction materials as per specifications and shall include for all such conditions and contingent measures in the bid, including those which may not have been specifically brought out in the specifications/ Bill of Quantity.

Bidders are advised to visit the substation site prior to submission of offer & take into account all factors like required levelling, retaining wall, approach road, if required, slope protection etc., before quoting the rates.

1.2. **DRAWINGS**

The Contractor shall execute the work at site as per drawings provided by CSPTCL. Civil drawings of the equipment foundations, control room, rain water harvesting pit, burnt oil tank, road, retaining wall, chain link mesh fencing etc. shall be readily provided by CSPTCL. **However drawings for some equipments which are make dependant viz. Circuit breaker, lighting mast, capacitor bank, etc. shall be**

provided by CSPTCL only after foundation layout drawings and load details for such equipments are made available to CSPTCL by successful bidder.

1.3. **DESCRIPTION OF OIL RECOVERY SYSTEM:-**

The oil recovery system shall be provided below all Transformers in order to avoid spread of fire by the oil in case of any major failure of transformer. The oil collecting pit and burnt oil tank shall be connected with NP3 hume pipes of 450 dia. for which no extra payment shall be made.

2. SITE PREPARATION :-

2.1. **Clearing, Levelling**

2.1.1. Material unsuitable for laying of foundations shall be removed and replaced by suitable fill material as per approval of CSPTCL.

2.1.2. Backfill material around foundations or other works shall be suitable for the purpose for which it is used and compacted to the density described under Compaction. Excavated material not suitable or not required for backfill shall be disposed off in areas as directed by CSPTCL.

2.1.3. Site clearing, levelling: - Before the work is commenced, the area described and shown on plan shall be cleared by the contractor at his own cost, of all obstructions, including abandoned brick masonry/concrete/steel structures, loose stones, materials, vegetation such as grass, shrubs, bushes and stumps of trees, roots etc. as directed. The product of the clearing shall be stacked in such places and in such manner as instructed by the Engineer-in-charge of CSPTCL and the ground left in a perfectly clean condition. The useless materials obtained by the clearing should be removed from the area and disposed off as directed by the Engineer-in-charge of CSPTCL for which no payment will be made by CSPTCL. All holes or hollows whether originally existing or produced by digging and up roots shall be carefully filled up with earth well rammed and levelled off as directed. On completion of the works, the site around the building structures shall be cleared by the contractor at his own expense to the satisfaction of the Engineer-in-charge of CSPTCL.

The excavated material shall be the property of CSPTCL & its storage, use or disposal, shall be done as directed by the Engineer in charge of CSPTCL

2.1.4. The contractor shall level the entire area up to desired level through cutting/filling. The excavated material if found suitable may be used by the contractor for levelling. However royalty/taxes as decided by concerned CSPTCL authority on such use shall be borne by the contractor. In case hard rock is obtained in excavation then such material shall be taken in MAS of CSPTCL for proper record.

2.2. **Excavation and Backfill:**

2.2.1. Excavation and backfill for foundations shall be in accordance with the relevant code.

2.2.2. Whenever water table is met during the excavation, it shall be dewatered and water table shall be maintained below the bottom of the excavation level during excavation, concreting and backfilling.

2.2.3. When embankments are to be constructed on slopes of 15° or greater, horizontal benches or steps with horizontal and vertical faces shall be cut in the original

slope prior to placement of embankment material. Vertical faces shall measure not more than 1 m in height.

2.2.4. Embankments adjacent to abutments, culverts, retaining walls & similar structures shall be constructed by compacting the material in successive uniform horizontal layers not exceeding 15 cm in thickness (of loose material before compaction). Each layer shall be compacted as required by means of mechanical tampers plate vibrator/rollers approved by the Engineer-in-charge of CSPTCL following procedure outlined under compaction. Rocks larger than 10 cm in any direction shall not be placed in embankment adjacent to structures.

2.2.5. Earth embankments of roadways and site areas adjacent to buildings shall be placed in successive uniform horizontal layers not exceeding 20 cm in thickness in loose stage measurement and compacted to the full width specified. The upper surface of the embankment shall be shaped so as to provide complete drainage of surface water at all times.

2.3. **Compaction**:

2.3.1. The density to which fill materials shall be compacted shall be as per relevant IS and as per direction of engineer-in-charge. All compacted sand filling shall be confined as far as practicable. Backfilled earth shall be compacted to minimum 90% of Maximum Dry Density. The sub grade for the roads and embankment filling shall be compacted to minimum 90% of Maximum Dry Density.

2.3.2. At all times unfinished construction shall have adequate drainage. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.

2.3.3. Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the centre of the road or towards the building as applicable. Rolling will also be required on rock fills. No compaction shall be carried out during rain.

2.3.4. Drainage arrangement like Katcha drain should be made around periphery of substation yard so that storm water does not foul construction area / substation yard.

2.4. **Requirement for fill material under foundation:**

The thickness of fill material under the foundations shall be such that the maximum pressure from the footing, transferred through the fill material and distributed onto the original undisturbed soil will not exceed the allowable soil bearing pressure of the original undisturbed soil. For expansive soils the fill materials and other protections etc. to be used under the foundation is to be got approved by CSPTCL.

3. ANTI WEED TREATMENT & METAL SPREADING:

3.1. **Scope of work:**

The Contractor shall furnish all labour, equipment and materials required for complete performance of the work in accordance with the approved drawings, specification and direction of CSPTCL. **Metal spreading along with coarse sand layer shall be done in the areas of the switchyard under present scope of work. However the metal**

spreading along with underlying layer in future areas within fenced area shall also be provided in case step potential without metal layer is not well within safe limits.

3.2. **General requirement:**

The material required for site surfacing/ metal filling shall be free from all types of organic materials and shall be of standard quality and as approved by CSPTCL.

3.2.1. The material to be used for metal filling/ site surfacing shall be crusher broken hard metal of 40mm nominal size (ungraded single size) conforming to Table 2 of IS:383 – 1970.

(a) Sieve Analysis limits (Gradation) (IS : 383 – Table – 2)

Sieve Size	% passing by weight
63 mm	100
40 mm	85-100
20 mm	0-20
10 mm	0-5

"One Test" shall be conducted for every 500 cum.

(b) Hardness, flakiness as required for surfacing courses are given below:

a. Hardness

Abrasion value (IS: 2386 Part-IV) – not more than 40%

Impact value (IS: 2386 Part-IV) – not more than 30% and frequency shall be one test per 500 cum. with a minimum of one test per source.

b. Flakiness Index

One test shall be conducted per 500 cum. of aggregate as per IS: 2386 Part – I and maximum value is 25%.

3.2.2. After all the structures/equipments are erected, anti weed treatment shall be applied in the switchyard where ever metal spreading along with underlying layers is to be done and the area shall be thoroughly de-weeded including removal of roots. The recommendation of local agriculture or horticulture department may be sought where ever feasible while choosing the type of chemical to be used. The anti weed chemical shall be procured from reputed manufacturers. The doses and application of chemical shall be strictly done as per manufacturer's recommendation. Nevertheless the effectiveness of the chemical shall be demonstrated by the contractor in a test area of 10m x 10m (approximately) and shall be sprinkled with water at least once in the afternoon everyday after 48 hours of application of chemical. The treated area shall be monitored over a period of two to three weeks for any growth of weeds by the Engineer – in- charge. The final approval shall be given by Engineer – in – charge based on the results.

3.2.3. Engineer-in-charge shall decide final formation level so as to ensure that the site appears uniform devoid of undulations. The final formation level shall however be very close to the formation level indicated in the approved drawing.

3.2.4. After anti weed treatment is complete, the surface of the switchyard area shall be maintained, rolled/compacted to the lines and grades as decided by Engineer-in charge. The sub grade shall be consolidated by using half ton roller with suitable water sprinkling arrangement to form a smooth and compact surface. The roller shall run over the sub grade till the soil is evenly and densely consolidated and behaves as an elastic mass.

3.2.5. In areas that are considered by the Engineer-in-Charge to be too congested with foundations and structures for proper rolling of the site surfacing material by normal rolling equipments, the material shall be compacted by plate compactor. Due care shall be exercised so as not to damage any foundation structures or equipment during rolling & compaction.

3.2.6. Over the prepared sub grade, first 100 mm thick layer of stone dust shall be laid as per direction of engineer-in-charge of CSPTCL in the area excluding roads, drains, cable trenches as per detailed drawing. However in case of BC soil in top strata the thickness of this layer shall be 200 mm. For easy drainage of water, minimum slope of 1:1000 is to be provided from the ridge to the nearest drain. The ridge shall be suitably located at the centre of the area between the nearest drains. The above slope shall be provided at FGL only.

3.2.7. A final layer of 100 mm thickness of crusher broken hard metal of 40 mm nominal single size (ungraded) shall be spread uniformly over underlying layer of stone dust.

3.2.8. The quantity of filling shall be measured in cubic metres through stack measurements and voids shall be deducted as follows from stack measurements:-

S. No.	Particulars	% age voids to be deducted
01.	Metal	8 %

3.2.9. Stonedust layer shall be measured after compaction.

4. STORM WATER DRAINAGE & RAINWATER HARVESTING:

4.1. It shall be total responsibility of contractor to provide drainage system of entire yard as per direction of Engineer in charge of CSPTCL. No extra payment shall be made on this account.

4.2. In addition to drainage of rainwater, the contractor shall make arrangement for rainwater harvesting also.

4.3. Rainwater harvesting shall be done by providing one number recharge structure with rain water harvesting and soak pit arrangement. The recharge structure shall be suitably located within the substation. Branch drains from the main drain and cable trenches carrying rainwater from entire switchyard shall be connected to the recharge structure by RCC drain /hume pipes. For RCC drains suitable RCC cable trench section without MS angles shall be used. No extra payment shall be made for these RCC drain/hume pipes. Overflow arrangement from recharge structure shall be provided and the overflow shall be taken through trench/closed conduit (NP3 pipe) of approved size/dia. up to nearest available natural drainage at such a level to completely ensure effective drainage in all seasons. No extra payment shall be made on this account.

5. ROADS AND CULVERTS:

5.1. All the roads in the scope of contract shall be reinforced concrete road as per drawing provided by CSPTCL.

5.2. Layout of the roads shall be as per approved LUP drawing for the substation. Adequate turning space for vehicles shall be provided and bend radii shall be set accordingly. Road to the Transformer shall be as short and straight as possible.

5.3. Road construction shall be as per IRC standards.

5.4. Adequate provision shall be made for road drainage.

6. FOUNDATION / RCC CONSTRUCTION:-

6.1. General:-

6.1.1. Work covered under this Clause of the Specification comprises the construction of foundations and other RCC constructions for switchyard structures, equipment supports, trenches, drains, jacking pad, pulling block, control cubicles, bus supports, Transformer/Reactors, marshalling kiosks, auxiliary equipments&systems buildings, tanks or for any other equipment or service and any other foundation required to complete the work. This clause is as well applicable to the other RCC constructions.

6.1.2. Concrete shall conform to the requirements mentioned in latest IS: 456 and all the tests shall be conducted as per relevant Indian Standard Codes. A minimum grade M20 – nominal mix 1:1½:3 concrete shall be used for all construction works unless specified otherwise.

It may please be noted that the metal to be used for P.C.C./R.C.C. works shall be hard stone metal only.

6.1.3. If the site is sloping, the foundation height will be adjusted to maintain the exact level of the top of structures to compensate such slopes.

6.1.4. The switchyard foundation's top shall be minimum 200 mm above finished yard level.

6.1.5. **Minimum 100 mm thick lean concrete (1:4:8)** shall be provided below all underground structures, foundations, trenches etc. to provide a base for construction.

6.1.6. **OPC / PPC of approved and reputed brand** shall be used in construction works and test certificate from manufacturer shall have to be submitted to engineer in charge of CSPTCL for kind of cement being used.

6.1.7. **Cable trenches: -** All cable trenches shall be constructed as per drawing provided by CSPTCL.

6.1.8. **CABLE TRENCHES:-**

All cable trenches shall be constructed as per drawing provided by CSPTCL.

1. **External cable trenches**.-

Y-1 Buried Type Cable Trench. - The buried cable trench shall be constructed in following manner:-

Layer- I : 100 mm thick layer of bricks.
Layer-II : 200 mm layer of sand with cable embedded in between.
Layer-III: 100 mm thick layer of bricks.
Layer-IV: 100 mm backfilling with soil upto FGL.
Note:- The cables shall be kept at the centre of sand layer.

(k) **RCC cable trenches** shall be constructed for branch cable trench (Y-2 type and Y-3 type & Y-4 type).

Y-2 Type Branch Cable Trench – Cable trench having dimension of 325 mm (W) x 305 mm (D) with cable tray of 300 mm placed on hot dip galvanised supporting angles at a height of 150 mm above the bottom surface of the trench. The top cover of this cable trench shall be useful for path way & shall be provided with doubly reinforced RCC Covers having stiffener & proper lifting arrangements as per approved drawings, specifications, direction and approval of Engineer-In-Charge of CSPTCL.

Y-3 Type Branch Cable Trench – This type of RCC Cable trench having dimension of 850 mm (W) x 650 mm (D) with two tiers of cable tray of 450 mm width placed on hot dip galvanised supporting angles at a height of 150 mm and 450mm above the bottom surface of

the trench for placing AC supply cables and control cables separately. Cable trench covers shall be doubly reinforced R.C.C. covers as per approved drawings, specifications, direction and approval of Engineer-In-Charge of CSPTCL.

Y-4 Type Main Cable Trench –This type of RCC cable trench having dimension of 1200 mm (W) x 1000 mm (D) with three tiers of cable tray of 600 mm width placed on hot dip galvanised supporting angles at a height of 200 mm, 450 mm and 700 mm above the bottom surface of the trench. The top cover of these cable trenches shall be useful for path way for operating and maintenance staff. The Cable trench shall be covered with RCC cast in situ slab (fixed slab). At every 2.0 meter distance, 700mm wide openings shall be provided and the openings shall be covered with 6.0 mm thick steel chequered plate. The chequered plate covers shall be duly stiffened and fixed to the frame grouted in cable trench wall and RCC top slab, as per approved drawings, specifications, direction and approval of Engineer-In-Charge of CSPTCL.

- **RCC cable trenches** suitably designed to take super imposed load, with adequate inside dimensions, **weep hole arrangements with 50 dia weep holes @ 1.5m c/c spacing horizontally and 1.0m c/c vertically with inverted filter at back**, chases support hot dip galvanised MS angle for cable tray, RCC covers (min. 90 mm thick) with reinforcement on both faces etc. complete with proper bed slope for efficient drainage up to recharge structure.
- The cable trenches and precast removable RCC cover (with groove & lifting arrangement) shall be constructed using RCC of M20 grade.
- The cable trench walls shall be designed for the following loads.
  i) Dead load of 155 kg/m length of cable support +75 kg on one tier at the end.
  ii) Triangular earth pressure + uniform surcharge pressure of 2T/m2.
- Cable trench covers shall be designed for self weight of top slab +UDL of 2000 kg/m2 + concentrated load of 200 kg at centre of span on each panel.
- Cable trench crossing the road / rails shall be designed for class A loading of IRC/ relevant IS code.
- Trenches shall be drained. Necessary sumps be constructed and sump pumps if necessary shall be provided. Cable trenches shall not be used as storm water drains but, it should be capable to drain water from yard area.
- All metal parts inside the trench shall be connected to the earthing system.
- Cables from trench to equipments shall run in hard conduit pipes.
- Trench wall shall not foul with the foundation. Suitable clear gap shall be provided.
- The trench bed shall have a slope of 1/ 1000 along the run & 1/250 Perpendicular to the run.
- All the construction joints of cable trenches i.e. between base slab to base slab and the junction of vertical wall to base slab as well as from vertical wall to wall and all the expansion joints shall be provided with approved quality PVC water stops of approx. 230 x 5 mm size for those sections where the ground water table is expected to rise above the junction of base slab and vertical wall of cable trenches.
- Cable trenches shall be provided at the ends with grating of 16mm plain bar. However inside control room the end of Cable trenches should be provided with retaining wall.
- Cement mortar for cable trenches shall be 1:6 for masonry and 1:6 for 12mm thick plaster.

6.2. Admixture & Additives:

6.2.1. Only laboratory tested & established approved admixtures shall be used in the concrete. When more than one admixture is to be used, each admixture shall be batched in its own batch and added to the mixing water separately before discharging into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

6.2.2. Admixtures in concrete shall conform to IS: 9103. The water proofing cement additives shall conform to IS: 2645. Concrete Admixtures/ Additives shall be approved by Owner.

6.2.3. The Contractor may propose and CSPTCL may approve the use of a water-reducing set-retarding admixture in some of the concrete. The use of such an

admixture will not be approved to overcome problems associated with inadequate concrete plant capacity or improperly planned placing operations and shall only be approved as an aid to overcoming unusual circumstances and placing conditions.

6.2.4. The water-reducing set-retarding admixture shall be an approved brand of Lignosulphonate type admixture.

6.2.5. The water proofing cement additives shall be used as required/ advised by CSPTCL.

7. CHAIN LINK FENCING AND GATE:

Fencing and gate shall be provided as per drawing provided by CSPTCL.

7.1. Product materials:

The minimum requirements are as follows:

7.1.1. **Chain link mesh (with galvanization) in accordance to IS: 2721**

1.	Size of opening in mesh	:	75mm x 75mm
2.	Nominal wire size	:	8 gauge diameter
3.	Height of chain link mesh	:	2400 mm

7.1.2. **Posts**

(i) The posts shall be hot dip galvanized iron angle posts of size 65x65x6 at 2.5m c/c spacing with **45x45x5** angle galvanized iron bracings at top and bottom of mesh. The vertical posts shall have further V shaped extension of 450 mm (vertical height) over the chain link mesh top. Six rows of barbed wires with weight not less than 9.38 kg per 100 m shall be provided in the V shaped portion. Two Nos. GI wire of min 8 gauge shall be provided between top & bottom bracing angles along the entire length of mesh which shall be tightened to provide stiffness to mesh. **Strainer posts shall be provided at every corner and at every 10th post. Strainer posts shall be provided on either side of vertical post and from inner side as well.**

(ii) Fencing top shall be provided with galvanized barbed wire. Barbed wire shall conform to IS: 278. The barbed wire may consist of not more than two splices per reel. The barbed wire shall be formed by twisting two line wires, one containing the barbs. The barbed wire shall be designed as Type A of IS: 278 and shall be galvanized.

(iii) Barbed wire arms shall be same as intermediate and straining post.

(iv) Fittings and hardware: cast aluminum alloy or galvanized steel, malleable or ductile cast iron turnbuckles to be drop forged.

(v) For every 50 reels or part there of samples of the barbed wire and the individual line wires shall be put to tensile test and in case of failure to conform to the tensile properties given below, two additional tests of each kind shall be made on the samples cut from other reels.

(vi) GI chain link mesh shall be as per IS: 2721. Mesh size 75 mm and nominal wire size shall be 8 gauge diameters.

TENSILE PROPERTIES

Tensile strength of line wire	: 39 to 59 kg/sq. mm
Minimum breaking load of complete barbed wire	: 370 kg

On the results of these additional tests, the whole or portion of the barbed wire shall be accepted or discarded by the CSPTCL authorities as the case may be.

(vii) **The whole assembly of angles shall be hot dip galvanized. The zinc coating shall be minimum 610 gram per sq. meter. The purity of zinc shall be 99.95% as per IS: 209.**

7.1.3. **Brick Wall below mesh**

Brick masonry wall of Min. 200 mm thickness shall be provided at bottom of mesh with plastering, 75 mm thick coping of **PCC 1:2:4** grade, painting with exterior paint of reputed and approved brand etc. complete in all respects. The wall shall be min. 200 mm below natural ground level, and, 200 mm above FYL. PCC (1:3:6) of 100 mm thickness and 300 mm width shall be provided below wall in hard soil **for depth of wall upto 400 mm. However if the overall depth of wall exceeds 400 mm, the thickness of wall and width of PCC shall be designed to bear the superimposed loads.** In case of black cotton soil in foundation 200mm thick brick wall shall be provided over RCC bracing beam of min size 200x 200 mm. The height of wall shall be such that the top of wall shall be 200 mm above FYL.

7.2. **Installation:**

7.2.1. **Mesh**:-

(i) Mesh shall be installed leaving at least **6 m clearance** from equipment/ structures along the switchyard line as per approved General Arrangement drawing (LUP).

(ii) Hole /pit for Post of shall be excavated by approved method.

(iii) All posts shall be 2.50m apart measured parallel to ground surface. Posts shall be set in 1:3:6 Plain Cement Concrete block of minimum **0.40x0.40x0.6m** depth (**in side natural ground level**) in hard soil in cutting zone and the top of foundation shall be extended upto FYL. In case of fencing in filling zone the depth of foundation shall be increased so that min. 0.60 m foundation depth falls **in side natural ground level** and top of fondations shall be extended upto FYL The fencing angle shall be grouted up to 100 mm from bottom of foundation in each case.In case of black cotton soil in foundation 200 mm dia single under reamed 3500 mm deep inside NGL. **Pile foundation shall be provided with 200 X 300 mm bracing beam. The beam top shall be 100 mm above FYL.**

(iv) Posts shall be braced and held in plumb position and true alignment and elevation until concrete has set.

(v) Mesh shall not be installed until concrete has cured a **minimum of 7 days**.

(vi) Mesh shall be fixed to the posts and bracing angles **at 4** locations in each angle using MS flat each of **30x3 mm, 100 mm long through 2 nos. of bolts (12 mm diameter)** on each flat.

(vii) The painting pattern of brick masonry wall shall be decided by Engineer-in-charge. It shall be preferable to paint the alternate wall in different colour pattern such that it gives better aesthetic look. **The paint shall be Ultima/Weather coat brand.**

7.2.2. **Gate** :-

(i) The gate shall be made as per approved drawing.

(ii) The gates shall be fabricated with welded joints to achieve rigid connections. The gate frames shall be painted with one coat of approved steel primer and two coats of synthetic enamel paint.

(iii) The gates shall be provided with suitable locking arrangement.

(iv) Steel rollers shall be provided below gates with grouted guide.

(v) Gate shall be installed as per General arrangement drawing (LUP) .

(vi) The gate shall be made of medium duty M.S. pipe conforming to relevant IS Codes with welded joints. The main frame (outer frame) of the gate shall be made of 50mm dia pipe medium quality & vertical pipes of 25mm dia medium quality pipes @ 100mm c/c spacing. Other details shall be as per approved drawing.

8. WATER SUPPLY FOR BUILDINGS & EARTH PITS

Two number 150 mm dia tubewells at different locations, each with minimum 5000 litre per hour yield, 2 Nos. overhead (interconnected) HDPE water tanks of 1000 litre capacity each above control room building at corner location above toilet of control room building roof for supplying water to all the earth pit through gravity, complete water supply arrangements from both the bores to all the water tanks, from over head water tanks to building and from both the bores as well as from both 1000 litre tank to all the earth pits, with submersible pumps, panels, cables, water tanks, GI pipe lines, all fittings, fixtures etc. of approved make as per specifications, in standard manner, as per direction of engineer in charge of CSPTCL. **The supply network to all the earth pits shall be closed loop type ensuring supply from both the ends with designed sizes of pipes to ensure effective supply of water to all the earth pits. Schematic drawing shall be prepared by the contractor indicating the layout and details of each water supply scheme which shall be got approved before actual start of work including all other incidental items not shown or specified but as may be required for complete performance of the works.**

Each Bore well shall be provided with **3-phase water cooled** submersible pumps of **KSB/Kirlosker make** of **minimum 2 H.P.** or more as per requirement /directions of CSPTCL's site engineer with Crompton **Greaves /Havells** make control panels and **Finolex/ Havells** make cables.

9. SEWERAGE SYSTEM

9.1. Sewerage system shall be provided for control room building by contractor.

9.2. The Contractor shall construct septic tank and soak pit suitable for 50 users.

10. OTHER TECHNICAL DETAILS

10.1. **15mm cement** plaster of mix 1:6 (1cement: 6 sand) shall be provided on the smooth side of walls.

10.2. **6 mm cement** plaster of mix 1:3 (1 cement: 3 sand) to all ceiling.

10.3. **20mm cement** plaster of mix 1:6 (1 cement: 6 sand) on rough side of wall.

10.4. **CONTROL ROOM:** The Control room drawing as per Company's standard practice has been furnished with the tender specification. Mineral fibre false ceiling shall be provided in C/R hall, A.E. and Carrier room .The clear height between floor top and Ceiling bottom shall be not less than 3.6 metre The false ceiling shall comprise 600 x 600 x 15 mm (minimum) mineral fibre tiles of type RH 90 of Armstrong or equivalent make of minimum 3.0 Kg/Sq.m. weight and 85% sound absorption capacity as per direction and approval of Engineer-in-charge of CSPTCL. The tiles shall be laid over

Armstrong Prelude XI exposed grid system with main runner spacing as 1200 mm c/c securely fastened to structural ceiling at 1200 mm c/c. Perimeter trim shall be Armstrong wall angle secured to wall at 450 mm c/c as per direction of Engineer-in-charge of CSPTCL.

10.5. All internal wall surfaces / ceiling of Control Room Building & BMR (Kiosk) shall be applied Birla/J.K /Asian cement based water proof putty. Painting on all internal walls and ceilings with **plastic emulsion paint** of Asian/ICI/Nerolac/Berger brand to give an even shade (two or more coats). Over plaster first apply cement primer then, putty over it paint primer & then painting is to be done.

10.6. All external wall surfaces of Control Room Building & BMR (Kiosk) shall be applied Birla/JK/Asian cement based exterior garde water proof putty. Painting on all external walls with **Ultima or Weather Coat or Weather Shield brand** to give an even shade (two or more coats). Over plaster first apply cement primer then, putty over it paint primer & then painting is to be done.

10.7. Enamel Painting with synthetic enamel paint of approved brand and manufacture of required colour to give an even shade shall be provided on the steel glazed doors, windows, ventilators and rolling shutters in various buildings as per approved drawings. Two or more coats over an under coat of suitable shade with primer paint of approved brand and manufacture.

10.8. Two or more coats of **Touch wood brand polish** with a coat of wood filler shall be provided on the wooden doors. Final coating shall be of poly urethrin (PU) spray.

10.9. Filter room and store room in Control Room building shall be provided **52** mm thick cement concrete flooring with **metallic** concrete hardener topping over 40 mm thick layer of cement concrete 1:2:4 (1 cement : 2 coarse sand : 4 graded metal aggregate 20 mm nominal size) and top layer 12 mm thick concrete consisting of mix 1: 2 (1 cement hardener mix : 2 metal aggregate 6 mm nominal size) by volume with which "metallic" hardening compound shall be mixed as per manufacturer's instructions. 20 mm thick Cement plaster skirting (up to 15 cm height) with cement mortar 1:3 (1 cement: 3 fine sand) mixed with metallic concrete hardener in same ratio as for floor finish with a floating coat of neat cement shall be provide in Filter room and store room.

10.10. 1st Quality double charge ceramic glazed floor Group V tiles (anti-skid) of size and thickness as directed by CSPTCL Engineer conforming to IS: 13755 of **NITCO /KAJARIA/BELL/JOHNSON/REGENCY**, make shall be provided in toilet floor area in all colour shades as approved by Engineer-in-charge of CSPTCL laid on 20mm thick cement mortar 1:4 (1 cement : 4 coarse sand) including pointing the joints with white cement and matching pigment etc complete. Each tile should be tested with wooden hammer after three days of fixing.

10.11. 1st quality double charge ceramic glazed tiles conforming to IS : 13753 of minimum thickness 5mm of approved make like **NITCO/BELL/JOHNNSON/REGENCY/KAJARIA** make shall be provided in toilet wall in all colours shade of any size as approved by Engineer-in-charge of CSPTCL in dados (height upto 2.4 m) over 12mm thick bed of cement mortar 1:3 (1 cement : 3 coarse sand) and jointing with grey cement slurry @3.3kg per sq m including pointing in white cement mixed with pigment of matching shade complete.

10.12. All Brick Works shall be with cement mortar 1:6 (1 cement: 6 coarse sand). Half brick work masonry shall be with cement mortar 1:4 (1 cement: 4 coarse sand). Bricks to be used shall be **fly ash bricks having compressive strength of 35 kg/Sq.cm as per approval of engineer in charge of CSPTCL.**

10.13. The toilet frames and shutters will be PVC as per following specifications.

10.13.1. PVC door frame made from rigid PVC hollow sections fixed to wall using 10 x 100 mm wood screws screwed to wooden plug prefixed in wall at a distance of not more than 500 mm centre to centre with door frame made from rigid PVC hollow section of size 55 x 40 mm having an average outer seam thickness of 3 mm horizontal and vertical section jointed together using aluminium angles of size 25 x 25 x 2 mm.

10.13.2. PVC glazed shutters made up of rigid PVC hollow sections used for shutters frame with paneling of rigid PVC multi-chamber hollow sections having tongue and groove joints fixed with aluminium cleats brackets self tapping screws brass butt hinges complete fixed in position wooden pieces of required sizes to be inserted in PVC hollow section for screws and hardware. The PVC hollow frame section shall be of size 75 x 37 mm with an outer seam average thickness of 2.0 mm for horizontal and vertical styles of shutter frame and lock rail of 105 x 37 mm with an average seam thickness of 2 mm long with paneling made from rigid PVC hollow multi-chamber sections of 100 x 12 mm size with an average seam thickness of 1.00mm to be fixed to the frame work using rigid PVC self locking snap beading of size 15 x 13 mm complete as per the direction of Engineer-in-charge of CSPTCL.

10.14. **Anti termite treatment** shall be carried out for all buildings and also wherever required and as per direction of engineer in charge of CSPTCL. Only preconstruction anti-termite treatment should be done with approved chemical of required concentration.

10.15. M.S. Rolling shutters as per approved drawing shall be provided and fixed interlocked together through their entire length and jointed together at the end by end locks mounted on specially designed pipe shaft with brackets along with ball bearing for rolling shutter, side guides and arrangements for inside and outside locking with push & pull operation including the cost of providing and fixing necessary 27.5 cm long wire springs grade No. 2 & G. I. top cover of MIN. 1.25 mm thickness for rolling shutters 80 x 1.25 mm M. S laths with 1.25 mm thick top cover.

10.16. Flooring of Control Room Building is to be provided with “double shot” Vitrified tiles (Size 600 x 600 mm) having thickness of 10 mm confirming to IS 15622:2006 (except in Battery Room, toilet and filter room) with proper sub base and base concrete. After preparing proper base a bed of cement & sand (1:4) of thickness 30 mm shall be made on which the tiles shall be fixed with cement paste. Only Asian/ Jhonson / Kajaria/ BELL / NITCO/REGENCY make Vitrified tiles shall be used. The flushing skirting shall be done up to 150 mm from FFL.

10.17. **Anodised aluminium** work for doors, windows, ventilators and partitions shall be provided and fixed in buildings with extruded built up standard tubular and other sections of approved make conforming to IS:733 and IS : 1285, **anodised transparent or dyed to required shade** according to IS : 1868. (Minimum anodic

coating of grade AC 15) fixed with rawl plugs and screws or with fixing clips, or with expansion hold fasteners including necessary filling up of gaps at junctions at top, bottom and sides with required PVC/neoprene felt etc and joined mechanically wherever required including cleat angle, Aluminium snap beading for glazing / paneling, stainless steel screws including glazing and fittings as specified.

Shutters of doors, windows and ventilators shall be provided and fixed with hinges/pivots fittings wherever required including PVC/neoprene gasket.

10.18. **SECTION FOR ALUMINIUM WINDOWS, DOOR & VENTILATOR:**

10.18.1. Aluminium anodised doors/Ventilators made out of extruded aluminium section conforming to IS : 733 IS : 1285 & IS : 1868 with outer frame size 101.6 x 44.45 x 1.90 mm weighing 1.54 kg/m and shutter frame made from aluminium section 47.62 x 44.45x1.9 mm weighing 0.97 kg/m for vertical style and top rail, bottom and lock rail are made from aluminium section 101.6 x 44.45 x 1.9 mm weighing 1.64 kg/m including jointing with extruded aluminium cleats neoprene rubber gasket bevelled edge beading screws and 5.0 mm thick glass for door and reflective glass for ventilator of good quality (weight 13.50 kg/sq.m) and make including all fittings of superior quality (decorative type) such as door handle tower bolts hinges etc. Complete including applying a coat of lacquer, duly fixed in walls with 16x3.15 lugs 10 cm long embedded in CC blocks 15x10x10 cm size in cc 1:3:6 or with wooden plug and screws or with rawl plugs and screws or with fixing clips or with bolts and nuts as required as per direction of Engineer-In-Charge.

10.18.2. Aluminium anodized two track sliding window made out of extruded aluminium section conforming to IS : 733 IS : 1285 & IS : 1868 with outer frame size 63.50 x 38.10 x 1.80 mm weighing 1.148 kg/m and track top section of size 62x31.50x1.50 mm weighing 0.77 kg/m, track bottom section of size 62 x 31.50 x 1.50 mm weighing 0.81 kg/m, shutter handle section 39.40 x 17.70 x 1.50 mm weighing 0.58 kg/m, interlock section 39.40 x 17.70 x 1.50 mm weighing 0.60 kg/m, top & bottom section 39.40 x 17.70 x 1.50 mm weighing 0.55 kg/m, superior quality guide locks, neoprene whether strips and 5mm thick reflective glass of good quality and make (weight 13.50 kg/sq.m), complete including applying a coat of lacquer duly fixed in walls with 16 x 3.15 mm lugs 10 cm long embedded in CC blocks 15 x 10 x10 cm size in CC 1:3:6 or with bolts and nuts as required as per direction of Engineer-In-Charge.

10.18.3. Aluminium anodized three track sliding window made out of extruded aluminium section conforming to IS : 733 IS : 1285 & IS : 1868 with outer frame size 101.6 x 44.45 x 1.99 mm weighing 1.66 kg/m and track top section of size 91.8x31.7x1.50 mm weighing 0.983 kg/m , track bottom section of size 91.8x31.7x1.50 mm weighing 1.125 kg/m, shutter frame handle section 39.40 x 17.70 x 1.50 mm weighing 0.58 kg/m, interlock section 39.40 x 17.70 x 1.50 mm weighing 0.60 kg/m, top & bottom section 39.40 x 17.70 x 1.50 mm weighing 0.55 kg/m, including superior quality guide locks, neoprene whether strips and 5mm thick reflective glass of good quality and make (weight 13.50 kg/sq.m), complete including applying a coat of lacquer duly fixed in walls with 16 x 3.15 mm lugs 10 cm long embedded in CC blocks 15 x 10 x10 cm size in CC 1:3:6 or with bolts and nuts as required as per direction of Engineer-In-Charge.

10.18.4. Aluminium anodized fixed partition and like made out of extruded aluminium section conforming to IS : 733 IS : 1285 & IS : 1868 with outer frame of size 63.5 x 38.1 x 1.80 mm weighing 1.148 kg/m including jointing with extruded aluminium cleats neoprene weather stripping gasket bevelled edge beading screws and 5 mm thick reflective glass (weight 13.50 kg/sq. m) including all fittings of superior quality (decorative type) such as door handle tower bolts hinges etc. Complete including applying a coat of lacquer as per Direction of Engineer-In-Charge duly fixed in walls with 16 x 3.15 mm lugs 10 cm long embedded in CC blocks 15 x 10 x 10 cm size in CC 1:3:6 or with wooden plugs and screws or with rawal plugs and screws or with fixing clips or bolts as required.

10.19. Unplasticized rigid PVC rain water pipes 110mm dia shall be provided and fixed on the wall face conforming to IS: 13592 type A as per approved drawing including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion single socketed pipes.

10.20. Unplasticized PVC Moulded fittings/accessories including 110mm bend and 110mm shoes shall be provided and fixed for un plasticized rigid PVC rain water pipes conforming to IS:13592 type A including jointing with seal ring conforming to IS: 5382 leaving 10mm gap for thermal expansion.

10.21. Unplasticized PVC pipe clips of approved design shall be provided and fixed to unplasticized 110mm PVC rain water pipes by means of 50x50x50mm hard wood plugs, screwed with MS screws of required length including cutting brick work and fixing in cement mortar 1 :4 (1 cement : 4 coarse sand) and making good the wall etc.

10.22. **Double action hydraulic floor spring of approved brand** and manufacture IS: 6315 marked "Hardwyn" make (Model 3000) or equivalent for doors shall be provided and fixed at the following doors including cost of cutting floors as required, embedding in floors and stainless steel cover plates with brass pivot and single piece MS sheet outer box with slide plate etc. as per the direction of Engineer-in-charge of CSPTCL with stainless steel:

10.23. 10.24 Coloured vitreous china pedestal type water closet (European type)/Orisa pan (Indian type) of **Parryware/Hindware/Jal** make with seat and lid, 40mm flush bend, 10 litre low level flushing arrangement (cistern) with specials of standard make and mosquito proof coupling of approved municipal design including painting of fittings and brackets, cutting and making good the walls and floors shall be provided for all toilets.

10.24. 10.25 Coloured vitreous china wash basin of **Parryware/Hindware/Jal** make size 630 x 450mm with C.I/M.S brackets along with single 15 mm C.P brass pillar tap, **JAL/Jaquar/Plumber make**, 32mm C.P brass waste of standard pattern, shall be provided and fixed wherever required including painting of fittings and brackets, cutting and making good the walls wherever required along with C. P brass trap and C.P brass union.

10.25. Urinals shall be coloured vitreous china flat back half stall urinal of 580x380x350mm with 10 litre PVC automatic flushing cistern, **Parryware/Hindware/Seabird/Orient** (Coral) with fittings, standard size C.P. brass flush pipe, spreaders with unions and clamps (all in C.P. brass) with waste fitting as per IS: 2556 C.I. trap with outlet grating and other couplings in C.P. brass including painting of fittings and cutting and making good the walls and floors wherever required.

10.26. Following fittings shall be provided in the toilets:

10.26.1. CP brass bib cock 15mm nominal bore of approved quality conforming to IS: 8931.

10.26.2. CP brass angle valve of 15mm nominal bore provided and fixed in position for basin and cistern points of approved quality conforming IS :8931.

10.26.3. **Best quality granite partition slab provided** and fixed in position for urinals, of size 610x1150mm, 20mm thick, polished on both sides &machine cut, exposed corners rounded etc. wherever required.

10.26.4. **6mm thick beveled edge mirror 1000x600mm** shall be provided and fixed mounted on 12mm thick water proof plywood backing and hardwood beading all-round and mirror fixed to the backing with 4 Nos. of CP cap screws & washers, including fixing the mirror to the wall with necessary screws, plugs & washers etc, with each wash basin.

10.27. GI Pipe work for Internal and External works: **All G.I. pipes shall be medium class of Jindal/TATA make only. PVC pipe of approval make & quality may also be used**.

10.27.1. All concealed GI pipes and fittings shall be ISI marked and shall be painted with anticorrosive bitumastic paint including cutting of chases and making good the wall.

10.27.2. All exposed GI pipes and fittings shall be painted with synthetic enamel paint of desired shade over a ready mixed priming coat, both of approved quality for new work.

10.27.3. Wherever GI pipes are buried the same shall be provided and laid in position including trenching sand cushion and refilling, painted with anticorrosive bitumastic paint etc.

10.27.4. Gun metal ball valve with operating levers, non-return valves conforming to IS specification shall be provided and fixed in position as per approved drawing or direction of Engineer-in-charge of CSPTCL.

10.28. Masonry chamber for sluice valve shall be 600x600mm size in plan and depth 750mm, or matching with the site condition inside with 2ndclass designation brick work in cement mortar 1:4 (1 cement : 4 sand) with CI surface box 100 mm. Top diameter, 160 mm bottom dia and 180 mm deep (inside) with chained lid and RCC top slab 1:2:4 mix (1cement : 2 coarse sand: 4 graded metal aggregate 20 mm nominal size) necessary excavation foundation concrete 1:5:10 (1 cement : 5 fine sand : 10 graded metal aggregate 40 mm nominal size) and inside plastering with cement mortar 1:3 (1 cement : 3 coarse sand) 12 mm thick finished with a floating coat of neat cement complete as per standard design with 2nd class bricks.

10.29. HDPE water storage tanks (1000 litres capacity) provided and placed on roof of control room building shall be of **ISI mark** with cover and suitable locking arrangement, **float valve** and making necessary holes for inlet, outlet and overflow pipes.

10.30. PVC floor traps of self cleansing design shall be provided & fixed in position with outlet size of 75mm diameter of approved make, including making connection with PVC soil/waste pipes using rubber gaskets, embedding the trap in 150 mm thick PCC 1:2:4, providing &fixing of top tile & strainer of CP or PVC on top of the trap etc.

10.31. Square-mouth SW gully trap grade 'A' 100x100mm size P type with 2nd class shall be provided and fixed complete with CI grating brick masonry chamber with water tight C.I. cover with frame of 300X300mm size (inside) the weight of cover to be not less than 4.5 Kg and frame to be not less than 2.70 Kg as per standard design.

10.32. PVC pipe **110 mm diameter** shall be provided laid and jointed with solvent including testing of joints etc. complete.

10.33. Cement concrete 1:3:6 (1 cement: 3 coarse sand: 6 graded metal aggregate 40 mm nominal size) shall be provided and laid around PVC pipe.

10.34. Brick masonry manhole shall be constructed in cement mortar 1:4 (1 cement : 4 coarse sand) RCC top slab with 1:2:4 mix (1 cement : 2 coarse sand : 4 graded metal aggregate 20 mm nominal size) foundation concrete 1:4:8 mix (1 cement : 4 coarse sand :8 graded metal aggregate 40 mm nominal size) inside plastering 12 mm thick with cement mortar 1:3 (1 cement : 3 coarse sand) finished with floating coat of neat cement and making channels in cement concrete 1:2:4 (1 cement: 2 coarse sand :4 graded metal aggregate 20 mm nominal size) finished with a floating coat of neat cement complete as per standard design.

10.34.1. Inside size shall be **90 x 80 cm and 60 cm** deep including CI cover with frame (light duty) 455 x 610 mm internal dimensions total weight of cover and frame shall not be less than 38 kg (weight of cover 23 kg and weight of frame 15 kg).

10.34.2. Inside size shall be **120 x 90 cm and 90 cm** or deeper including CI cover with frame (medium duty) 500mm internal diameter total weight of cover and frame to be not less than 116 kg (weight of cover 58 kg and weight of frame 58 kg).

10.35. MS foot of 20 x 20mm square rests shall be provided and fixed in manholes with 20 x 20 x 10 cm cement concrete blocks 1:3:6 (1 cement :3 coarse sand :6 graded metal aggregate 20 mm nominal size) as per standard design.

10.36. Steel glazed doors, windows and ventilators of standard rolled steel sections shall be provided and fixed wherever required, joints mitred and welded with 15 x 3 mm lugs, 10cm long, embedded in cement concrete blocks 15 x 10 x10 cm of 1:3:6 (1 cement 3 coarse sand : 6 graded metal aggregate 20mm nominal size) or with wooden plugs and screws or rawl plugs and screws or with fixing clips or with bolts and nuts as required, including providing and fixing of glass panes with glazing clips and special metal sash putty of approved make complete including applying a priming coat of approved steel primer, necessary hinges or pivots as required.

10.37. All the **internal walls** of buildings (except for cladded portion) shall be rendered smooth using water proof putty of **Birla/JK brand/Wall plast** as per direction of Engineer in charge.

10.38. The battery room shall have acid resistant ceramic tiles of Group V in approved colour and shade of reputed and standard make with acid resistant joint filler on floor and wall up to 2100 mm height. Above 2100 height acid proof paint shall be painted up to roof level.

10.39. **Anti skid tiles of reputed and approved make, quality class, pattern, color and shade** shall be provided below porch in area one metre wider than porch area on all sides as per approved drawing and direction of engineer in charge of CSPTCL.

10.40. Electrical wirings including fittings: MS conduit concealed system with 7/20 PVC **copper wire** shall be used for power circuit and 3/20 PVC copper wires for L&F circuits. **LED tube lights, LEDs**, fans exhaust fans, fixtures are to be provided .Luminaries are to be provided in excess so as to meet out minimum LUX level prescribed by CBIP even with 40% outages of light. Similarly **1200 mm sweep** size ceiling fans in adequate nos. are to be provided in Control room (15 Nos.), Back & front lobby (1 No. each), AC/DC room (4 Nos.), carrier room (2 Nos.), store room (1 No.) and AE room (2 Nos.) (Ceiling fans are not required in filter & battery room). **Exhaust fans** of standard and approved make are to be provided in Battery room, toilet, store, record room etc. and wherever required as per approved drawings. In addition to the AC Wiring as above, 2 nos. 100-Watt bulbs shall be connected in the control room from the DC Supply output through automatic change over contactor. Also concealed wiring and connection outlets for telephone & LAN points shall be provided as per direction of Engineer-in-charge of CSPTCL.

10.41. In Control Room building doors shall be of **Aluminium Sections/flush** door with teak / PVC doors etc. The windows, ventilators shall be of Aluminium Sections. The doors / windows/ventilators/ fixed opening shall be semi glazed/fully glazed/ panelled/ louvered with reflective glasses minimum 5.0 mm thick in case of doors and 4 mm thick in case of windows. All the windows, ventilators, fixed openings, exhaust fan openings etc. shall be provided with **steel grills**. In store room, 40 mm thick fully panelled grade-I "bija" wood door with grade-I "sal /sarai" wood frame (Choukhat) shall be provided. **No plywood shall be used in door panels**. All the doors, windows, ventilators, openings shall have reflective glasses. Reflective glasses shall be provided on entire front and back entrance openings upto roof height along with grill. Reflective glasses shall be provided over lintel of shutter in filter room also. All the opening shall be covered with fixed & open able reflective glasses & grill. The front and back entrance doors and entrance doors in control room shall be 2400 mm high. The front and back entrance doors shall also be provided with collapsible shutter grill gate.

10.42. All the materials such as TMT bars, MS rounds, MS angles, cement, G.I. barbed wire, G.I. wire mesh, chequered plates, bricks, etc. shall conform to relevant IS specifications. The water supply fittings, fixtures, PVC pipes, fittings, fixtures, G.I. pipes (medium class), fittings, fixtures, water tank, exhaust fans, wires, cables, electrical fixtures etc. will be ISI marked and approved by the EIC of CSPTCL. Approved quality of brick 2nd class with minimum compressive strength of 35Kg per square centimetre or Fly ash bricks having minimum compressive strength of 35 kg/Sq.cm shall be used in construction as per approval of engineer in charge of CSPTCL. The metal for **construction work** shall be crusher broken **hard stone** variety only and sand shall be clean river sand free from silt, clay organic matter etc.

10.43. **It shall be responsibility of contractor to ensure effective and efficient drainage of all rain water accumulating in substation area through drainage system up to nearest available natural outlet as per approved drawing and directions of Engineer in charge of CSPTCL. No extra payment shall be made on this account.**

10.44. Main gate shall be supported on RCC posts and **decorative lamps** shall be provided on each post.

10.45. Sub-station Glow Sign Board **1800 x 1200 mm size** on top of control room front side with GI structure supports with internal LED tube light arrangements for illumination with name of S/S.

10.46. Substation Sign Board (1800 x 1200 mm size) in front of substation with hot dip GI steel structure support with adequate illumination arrangement shall be provided.

10.47. All roof parapet wall junctions, chajja-wall junctions shall be provided with haullers of adequate dimensions as per direction of Engineer-in-charge of CSPTCL. Minimum 40 mm thick coping in 1:1.5:3 mix concrete shall be provided over parapet.

10.48. Backfilling shall be done as per direction of engineer in charge of CSPTCL using approved backfillmaterial which shall be well compacted at maximum dry density in layers not exceeding 200 mm loose thickness using proper compactor as per direction of engineer in charge of CSPTCL.

10.49. **Standard construction practices as per relevant IS codes** and as per direction of Engineer-in-charge of CSPTCL shall be followed wherever not specifically mentioned in the tender documents.

10.50. All the construction materials, fixtures, fittings etc. shall be of reputed make and shall be **got approved from Engineer-in-charge of CSPTCL prior to use.**

10.51. The septic tank and soak pit arrangement for C/R shall be provided for **50 users** with two year cleaning period.

10.52. All the FLUSH doors shall be of **NIKI/NUCOR/DURIAN/KUTTY/SUITALL** make and will have teak veneer on both sides.

10.53. All the sanitary fittings shall be of **Parryware/Hindware/Euro make**.

10.54. All the switches shall be Modular switches of **Havells/Crabtree/Salzer/Anchor** make.

10.55. All the G.I. pipes and fittings shall be of **TATA/Jindal** make.

10.56. All the ceiling fans shall be of **Havell's/Polar/Bajaj** make and shall not be less than **1200 mm sweep** size.

10.57. **All the electric wires/cables shall be of Havell's/Finolex make**.

10.58. All the exhaust fans shall be of **Khaitan/Havells's/Polar/Bajaj/Crompton** make and shall not be less than **300 mm sweep** size.

10.59. The LED tube lights shall be of **Phillips/Havells'/Bajaj** make and LED bulbs shall be of **PHILLIPS/CROMPTON/HAVELL'S** make.

10.60. All the PVC pipes & fittings shall be of **Kissan/Maharaja/Prince/Hasti** make.

10.61. All the PVC doors shall be of **Sintex/ANADOORS/Duroplast** make.

10.62. The outdoor tiles below porch of control room shall be **Ultima/Scorpio/Roopam** make.

10.63. The plastic paints, enamel paints and acrylic distempers shall be of **Asian/Burger/ICl /Nerolac** make.

10.64. The filling below plinth and ramp shall be well compacted **non expansivehard soil/stone dust/boulder** filling. The filling shall be done in compacted layers of max. 200 mm thickness. The compaction shall be done mechanically using portable plate vibrator to minimum 90% of MDD.

10.65. All the toilet fittings shall be **MARC/Jaquar/Plumber** make. The HDPE water tanks shall be of **Syntex/Sarita gold** make.

10.66. **Only TMT bars having ISI specification** shall be used as reinforcement. However, in specific areas, mild steel (Grade I) conforming to IS: 432 can also be used. Test

certificate from manufacturer shall have to be submitted to engineer in charge of CSPTCL for kind of steel being used.

10.67. In case of **B.C. soil,** the portion above NGL shall be filled with well compacted non shrinking non expansive hard soil to minimum 90% of MDD.

10.68. Chequered plates of **min. 6 mm thickness with designed supports**/stiffeners shall be provided over trenches inside control room building. The chequered plate shall be stiffened with 45x45x6 mm. MS angle provided at 300 mm C/c across the trench. The length of cover shall be max. 1200 mm.

10.69. **Bay Marshaling Room – The contractor shall be required to be construct air conditioned (with two number 2 ton split air conditioners) Bay Marshaling rooms mounting bay control units/protection/PLCC panels as per the specification and drawing. The size of the room shall be approx. 7.05 m (L) x 3.76 m (W) x 3.0 m (H). There may be variation of size of the room as per the size requirement. There shall be proper cable entry arrangement with proper water and air tight sealing of the said cable entry point. The cable entry shall be from below. The contractor shall be required to complete the work in all respect as per specifications and drawings provideed by CSPTCL.**

11. MISCELLANEOUS TECHINAL/GENERAL REQUIREMENTS:-

11.1. Dense concrete with controlled water cement ratio as per IS-code shall be used for all concrete structures such as, water retaining structures, cable and pipe trenches etc. for achieving water-tightness.

11.2. All joints including construction and expansion joints for the water retaining structures shall be made water tight by using PVC ribbed water stopper with central bulb. However, kicker type (externally placed) PVC water stopper shall be used for the base slab and in other areas where it is required to facilitate concreting. The minimum thickness of PVC water stopper shall be 5 mm and minimum width shall be 230 mm.

11.3. **All mild steel parts used in the water retaining structures shall be hot-double dip galvanized.The minimum coating of the zinc shall be 750 gm/sqm** for galvanized structures and shall comply with IS:2629 and IS:2633. Galvanizing shall be checked and tested in accordance with IS:2633. The galvanizing shall be followed by the application of an etching primer and dipping in black bitumen in accordance with BS: 3416.

11.4. **Angles 50x50x5 mm (minimum)** with lugs shall be provided for edge protection all round cut outs/openings in floor slab, edges of drains supporting, grating covers, edges of RCC cable/pipe trenches supporting covers, edges of manholes supporting covers, supporting edges of manhole precast cover and any other place where breakage of corners of concrete is expected.

11.5. **Preconstruction Anti termite chemical treatment** shall be given to column pits, wall trenches, foundations of buildings, filling below the floors etc. as per IS: 6313 and other relevant Indian Standards.

11.6. 'Kutcha Drain' of size 0.3 m wide at bottom, 1.10 m wide at top and 0.4 m deep is to be constructed around periphery of substation yard after completion of yard construction to facilitate to drain storm water to the nearest natural drain.

11.7. Turfing on slopes should be provided using approved seeds or sod including laying 15cm of good soil on the top in 7.5 cm layers, surface watering and light ramming etc.

complete as per direction of Engineer-in-charge of CSPTCL including maintenance for one year with sprinkler irrigation system for growth of grass.

11.8. **Variation in Quantities: -The quantities of equipments /foundations /items of works indicated in the schedules/Annexure are provisional and there may be variation. The contractor shall have to complete all the construction/ supply/ erection/ commissioning works in all respects as per site and field conditions and as desired by CSPTCL.**

Bidders are advised to visit the yard site prior to submission of offer.

12. STATUTORY RULES

12.1. Contractor shall comply with all the applicable statutory rules pertaining to factories act (as applicable for the State), Fire Safety Rules, Indian Electricity Act, Pollution control act etc.

12.2. The contractor shall deploy at least one degree holder in civil engineering to supervise civil works at site all the time.

12.3. Requirement of sulphate resistant cement (SRC) for sub structural works shall be decided in accordance with the Indian Standards based on the findings of the detailed soil investigation.

12.4. All building/construction materials shall conform to the best quality specifications if not mentioned in this specification.

12.5. All the tests required as per applicable relevant Indian standards/codes to ascertain quality of construction material being used /works being carried out as per specifications, shall have to be carried out at specified frequency and proper record of all these tests shall be maintained.

12.6. **Quality control lab shall be provided at site for testing of constructional material. In the lab equipments tools and plants shall be provided for compressive strength testing of bricks, concrete, fineness modulus of sand, equipments for measuring optimum density after compaction, proctor density apparatus etc and any other equipment required for measuring parameters mentioned in approved drawings, specifications and as per direction of engineer in charge of CSPTCL.**

12.7. The civil works shall conform to following standards.

(a) IS 269 Specifications for Portland cement
(b) IS 383 Specifications for coarse and fine aggregate for concrete
(c) IS 4091 Specification for tower and equipment's foundations
(d) IS 432 (Part-III) Specifications for mild steel and medium tensile steel bar concrete reinforcement
(e) IS 456 Code of practice for plain & reinforced concrete

*** * * * ***

2. TECHNICAL SPECIFICATIONS FOR SWITCHYARD & CONTROL ROOM EQUIPMENTS & OTHER MATERIAL ETC.

1. GENERAL SYSTEM PARAMETERS

1.1 PRINCIPAL PARAMETERS OF SUB-STATION:-

S. No.	PARAMETERS	220 KV	132 KV	33 KV
1	System Operating Voltage	220 KV	132 KV	33 KV
2	Maximum System Highest Voltage for which equipments are to be rated for continuous operation	245 KV	145 KV	36 KV
3	Rated Frequency	←50 Hz →		
4	No. of Phase	3	3	3
5	RATED INSULATION LEVELS			
i	Full wave impulse withstand voltage (1.2 / 50 micro-sec)	1050 KVp	650 KVp	170/ 250 KVp (Y/D)
ii	One minute power frequency – dry & wet withstand voltage (rms)	460 KV	275 KV	80 KV
6	Corona Extinction voltage	156 KV	105 KV	-
7	Minimum creepage distance	25 mm /KV (6125 mm)	25 mm /KV (3625 mm)	25 mm /KV (900 mm)
8	CLEARANCES			
i	Phase to Phase	2100 mm	1300 mm	320 mm
ii	Phase to Earth	2100 mm	1300 mm	320 mm
iii	Sectional Clearance	5000 mm	4000 mm	3000 mm
iv	Ground Clearance	5500 mm	4600 mm	3700 mm
9	System Neutral Earthind	← Solidely Earthed→		
10	Rated Short Circuit Current for 1 Second	40 KA	31.5 KA	25 KA

The specification also covers supply and erection of all G.I. steel structures, design, supply & erection of switch yard and control room equipments, conductor, cables & steel wires, their erection, testing & commissioning etc.

1.2. <u>YARD AND CONTROL ROOM EQUIPMENT:-</u>

Supply of sub station equipments and other materials include:-

a. 160 MVA, 220/132/33 KV & 63 MVA/ 40 MVA, 132/33 KV transformers with oil & other accessories.
b. 220/132/33 KV Potential Transformers (PT)/ 220 KV CVT
c. 220/132/33 KV Current Transformers (CT)
d. 220/132/33 KV Lightning Arrestors (LA)
e. 220/132/33 KV Circuit Breakers (CB)
f. 220/132/33 KV Isolators with & without Earth Switch.
g. 220/132/33 KV Post/ Polycon Insulators.
h. 220/132 KV Wave Traps

i. 33 KV PT insulation level 72.5 KV, 33 KV Isolator insulation level 72.5 KV and 39 KV LA for tertiary side of 160 MVA, 220/132/33 KV Power Transformer.

j. Complete Substation automation including hardware and software for local control stationas well as for remote control station along with associated equipments and AC bay marshalling rooms, for 220 KV, 132 KV & 33 KV bays (bay as defined in technical specification)

k. Control & Relay panels with Relays like DPR, back up O/C, E/F Differential relays, Auxiliary CTs (Universal type multi-turns) tripping relays, panel indication instruments (MW, A, V, F, Electronic Energy meters etc.) Breakers Control switch, trips supervision, annunciation, windows/ relays, mimic diagrams, semaphores, cartridge fuses, internal wiring with a grade multi standard copper insulated wires, foundation bolts etc.

l. On the 220 KV side the main bus shall be protected with bus bar protection relays for which separate panel with High speed bus bar protection relays shall be provided.

m. 220/48V Battery set with electrolyte & teak wood stands & Battery charger & its commissioning.

n. AC/ DC Boards, Bay marshalling Kiosks with standard connectors & channel etc.

o. Supply, preparation of cable schedules & laying etc.

p. Supply of 2.5/4 mm sq copper control cables of different cores including power cables laying & termination of control cables after construction of cable trenches as required.

q. Supply of Zebra ACSR conductors, earth wires, hard wares & their stringing & jumpering works including supply of suitable clamps & connectors.

r. Sub-station earthing materials, ensuring an Earth Resistance of 0.5 Ω (Ohm) or less.

s. Luminaries of Switchyard, Control Room & bay marshalling room illumination.

t. T&P safety appliances, office & control room furniture, fire fighting equipments. Testing kits & measuring instrument etc., are also to be supply by the contractor as per enclosed Annexures.

1.3 **ERECTION OF STRUCTURE & EQUIPMENTS**:-

I. The structures are required to be designed according to the requirement of equipment for proper loading of tensile, compression & cantilever forces causing due to the maximum wind pressure. The design of structures shall be got approved by the CSPTCL. The structures supplied should fully comply with all relevant standards including all clearances. ISS 7205 Indian Safety Code for structural steel works.

The contractor shall be fully responsible for following all the applicable rules, maintaining required safely clearances and other mandatory requirements. Even after approval of drawings of steel structures some discrepancy is noticed during execution, the same shall be rectified/ replaced by the contractor as agreeable by CSPTCL without any additional financial implication.

II. After the columns/supporting structures are erected respective equipment (220/132/33 KV) are to be erected carefully by suitable crane. But breaker and isolators are to be erected as 3 phase-unit basis and other item like 220/132 KV CT, PT, CC, LA & PI etc. are to be erected on I-phase unit basis and 33 KV PT insulation level 72.5 KV, 33 KV Isolator insulation level 72.5 KV & 39 KV LA for tertiary side of 160 MVA, 220/132/33 KV Power Transformer are to be erected as 3 phase – unit basis and rigidly mounted on the supporting structures to be supplied by the bidder. Simplex/ Duplex control relay panels are to be mounted inside the bay marshalling room/ control room in the same order as in the switchyard.

III. After the earth mat design is finished, the earth mats with GI Flat of 65 x 8 mm / 75 x 10 mm or any other size as approved by CSPTCL are to be put for each equipment. Then flats are to be inter connected with each other as per latest amended ISS under the supversionof EE (Sub-station)/ EE (EHT: Construction).

IV. 220/132/33 KV Bus Bars are to be strung after all the columns and beams are fitted. Both the buses should have suitable tension insulators. On approval of cable schedules various sizes of

PVC armoured control cable and power cable as required are to be laid and connected with suitable supporting devices after the various equipments, CR panels, AC/DC board, PT/CT console etc. are mounted. Before this work cable trenches are to be completed for the purpose. The contractor for approval shall submit drawing showing cable schedule and connections of both ends of control cables.

V. Control & Power cables should not run on the same tray for safety and easy maintenance.

VI. All the equipments of each 220/132/33 KV bays are to be connected by suitable jumpers and clamps with **Zebra conductor** only.

VII. All the equipments / structures will be provided by the contractor for erection.

VIII. The loading / unloading & transportation of all the materials are to be arranged by the Contractor himself for which CSPTCL will not provide any departmental vehicle.

IX. As safe custody the equipments will be under the scope of the contractor, he is advised to take a composite insurance policy for the transit-storage-cum-erection for these equipments to cover all the risk at his cost.

X. The following important points regarding the erection work of switch yards should be taken care of.

(a) As far as possible 220KV & 132KV CTs should be placed below the gantry.
(b) Proper arrangement should be made to connect transformer neutral to earth pits at two different points through 2 No. separate conductors routed through the supporting pin insulator through a small cable trench.
(c) Earth screen should be provided.
(d) Instead of conventional nut bolt type clamps, compression type / pneumatically pressed clamps should be used.
(f) PT connection from swith yard to control room should be through 4 core 10 sq mm copper cable.
(h) All breaker secondary conenctions should be stud type. No screw type connectors shall be used.
(i) All high bus and main/ auxiliary bus T- clamps should be strengthed by L shape conductor with double PG clamps.

1.4. **CLIMATIC CONDITIONS:-**

i)	Max. Temp. of air in shade	=	45°C
ii)	Minimum Temp. of air in shade	=	6°C
iii)	Max Temp. of air in sun	=	50°C
iv)	Max Humidity	=	100%
v)	Av. No. of Thunder storm days per annum	=	92 days
vi)	Average rainfall per annum	=	2000 mm
vii)	Average of dust storm days per annum	=	20 days
viii)	Minimum rainfall per annum	=	1500 mm
ix)	Max. Ambient temp. Daily average	=	45°C
x)	Wind Pressure (MAX.)	=	260 Kg/m2

1.5. CABLING/ CABLE SCHEDULE etc.:-

1. Contractor shall furnish a cable schedule for the work involved for approval of the purchaser. Each cable / termination shall be numbered to facilitate easy identification.
2. Dowel's make cable sockets viz. Copper ring tongue terminal ends or Copper ring tongue fork terminal ends for soldering-less crimping to copper / aluminium conductors shall be supplied as required by the contractor for use in control cable connection.
3. Like wise compression type aluminium fabler terminal ends for Aluminium conductors for L.T. power cables as required shall be supplied by the contractor at his own cost.
4. Power cables as required shall be supplied by the contractor at his own cost.
5. Number / Letter ferrules required for cable connections shall be supplied by the contractor.

1.6. **QUALITY ASSURANCE:-**

All design, supply, construction & erection of equipments shall conform to latest ISS. Quality of works shall be ensured. Equipments are to be supplied as per "Vendor List".

1.7. **LIGHTNING PROTECTION & EARTHING OF SUB STATION**:-

LIGHTNING PROTECTION:- The system of lightening protection of sub station witch yard equipment shall be through conventional earth wire installed at adequate height & in adequate numbers to protect the complete switch yard.

EARTH RESISTIVITY TEST:-

This test shall be conducted to determine the Electrical resistivity of soil for designing of grounding system for safe touch & step potential for the entire station area. The specifications for the equipments and other accessories required for performing electrical resistivity test, the test procedure and reporting of field observations shall conform to IS:3043. The test shall be conducted using Wagner's four electrode method as specified in IS:1892, Appendix – B2. The earth resistance test shall be witnessed by engineer-in-charge, EE (MRT) or EE (S/S) of the area. Unless otherwise specified at each test location, the test shall be conducted along two perpendicular directions parallel to the coordinate axis. On each direction a minimum of 8 to 10 readings shall be taken by changing the spacing of the electrodes from an initial small value of 0.5 in upto a distance of 10.0 m. The earth resistance test shall be repeated at multiple suitable locations to assess the average value of the earth resistivity of the switch yard area.

EARTHING OF SUB STATION:-

The contractor shall construct the following earth pits :-

i. 1 no. 2 pipe Earth pit for each 220KV,132KV & 33KV Bus PT/ CVT.

ii. 2 nos.4 pipe Earth Pits for each 40/63 MVA & 160MVA Transformer.

iii. 1 no. 2 pipes Earth Pit for 01 sets of 220KV feeder LAs (3 Nos LAs).

iv. 1 no. 2 pipes Earth Pit for 01 sets of 132KV feeder LAs (3 Nos LAs).

v. 2 nos. 2 pipes Earth Pit for Xmer LAs (independent earth pit for 220KV & 132KV 160MVA Xmer LA) in addition to Sl.No.(ii).

vi. 1 no. 2 pipes Earth Pit for Xmer LAs (independent earth pit for 132KV 40MVA Xmer LA).

vii. 1 no. 2 pipes Earth pit for 33/0.4 KV station transformer.

viii. 1 no. 2 pipes Earth Pits for 2 sets of 33KV feeder Las.

ix. 03 no. 04 pipes Earth pit of size 3.5 x 3.5 x 4 m depth.

x. For 220KV, 132KV, 33KV bus bar, gantry structure & other structures/equipments, the No. of earth pits shall be as per IS.

Apart from the above pits, there shall be a GI earth mat designed with at least 100 nos, 25mm diameter 2500mm long GI Earth Spikes &75X10 mm GI Flats. All the pits & earth mat shall be interconnected. The spacing of the GI Flats shall be at a distance of not more than 9 meters in the 220KV yard, 7 meters in the 132KV yard and 5 meters in the 33 KV yard. There shall be a Tube Well Boring with associated motor pump & water pipe lines for watering of Earth Pits.

The combined earth resistance under dry soil conditions shall be less than 0.5 ohms. The earth resistance should be taken in presence of OIC/EE (MRT) of that area. **The earth mat shall be designed as per IEEE -2000 for safe step/touch potential any where in the yard and also on the boundary for 40KA current.**

1.8 **WORK SCHEDULE:-** The work schedule for construction & commissioning of entire sub station shall be **24 (Twenty four) months** from the date of handing over of site and completion of erection and commissioning as per the approved work schedule (P.E.R.T. chart). Earlier completion may be done by utilising proper management & resources by the bidder.

1.9 **DETAILS OF STEEL STRUCTURE:**

Sl. No	Particulars	Type	Height of structure (Mtr.)	Weight of structure with foundation bolts (In MT)
A)	**220KV side structure:**			
1	Extended gantry structure having provision of 02 Nos. beams generally used for transformer bay.	AAGT	29.3 Mtr.	5.277 MT
2	Gantgry structure having provision of 1 No. beam (generally used for feeder bays)	AGT	23.3 Mtr.	3.657 MT
3	Truncated gantry structure without earth wire.	AGT4	12.7 Mtr.	1.085 MT
4	Structure of Main Bus	ABM	11.86 Mtr.	2.467 MT
5	Structure of Auxiliary bus	ABA	11.86 Mtr.	2.412 MT
6	Structure of Gantry beam	AGB	--	1.222 MT
7	Structure of Post insulator	API	4.976 Mtr.	0.283 MT
8	Structure of Isolator 1200 Amps.	AITCH	4.395 Mtr.	2.122 MT
9	Structure of Potential transformer.	APT	4.395 Mtr.	0.266 MT
10	Structure of Current transformer	ACT	4.395 Mtr.	0.266 MT
11	Structure of Lightening arrestor	ALA	3.08 Mtr.	0.127 MT
12	Structure of Coupling capacitor	ACC	2.2 Mtr.	0.239 MT

Sl. No	Particulars	Type	Height of structure from FL in mm	Width of beam in mm	Approx. Weight of each structure with Foundation bolts (in Kg)	Wt. of nut & bolts & washers (in Kg)
A)	**132KV side structure:**					
1	Gantry column	FG Lattice bolted with peak	15240	-	1242	59.5 (incl step bolts)
2	Gantry beam	FC Lattice	-	9600	570	29.3
3	Main/Aux bus 132KV Bus structure.	3BO4 Lattice bolted	8300	7000	1590	110 (incl step bolts)
4	Isolator i) with E/sw (Three phase)	EA/EAA Lattice bolted	2744	-	556	13
	i) without E/sw (Three phase)				536	

Sl. No	Particulars	Type	Height of structure from FL in mm	Width of beam in mm	Approx. Weight of each structure with Foundation bolts (in Kg)	Wt. of nut & bolts & washers (in Kg)
5	Circuit breaker	-	-	-	-	-
6	Current transformer (Single phase)	BA Lattice bolted	2600	-	142	5.0
7	Potential transformer (Single phase)	FA Lattice bolted	2300	-	128	4.5
8	Lightning arrester (Single phase)	AA Lattice bolted	3070	-	172	5.7
9	Post insulator (Single phase)	DA Lattice bolted	3178	-	175	5.2
B)	**33KV Side structure:**					
1	Gantry column	HG Lattice bolted	10650/ 8650	-	853	44 (Incl step bolt)
2	Gantry beam	HB Lattice	-	6000	352	19
3	Main/Aux bus 33 KV Bus structure.	1BO4 Lattice bolted	5490	3800	823	34 (Incl step bolts)
4	Isolator i) with E/sw (3 phase)	3ISOM Lattice bolted	2952	-	380	13
	ii) without E/sw (3 phase)				365	
5	VCB	-	-	-	-	-
6	Current transformer (T type structure for three phase)	BB Lattice bolted	2510	-	218	11
7	Potential transformer (T type structure for 3 phase)	CB Lattice bolted	2575	-	233	10
8	Lightning arrester (T type structure for 3 phase)	AB Lattice bolted	3075	-	262	9
9	Post insulator (1 phase)	DB	3142	-	166	5.2
10	D.O. Fuse Set Support Structure	Lattice bolted	4400	-	356	19.5

1.10: Validity period of type test(s) : Validity period of type tests conducted on the on major electrical equipments in power transmission system i.e. the period for which Type Test Reports (TTRs) shall remain valid and acceptable to use / utility provided no major change has been introduced in the basic design/ technology/ material/ mechanical construction/ functionalities of the equipments/ performance characteristic/ manufacturing process of the equipment, shall be as follows:

S.No.	Name of equipment	Periodicity (in years)
i	Power Transformer	5
ii	Distribution Transformers (33KV and below)	5
iii	Shunt Reactor	5
iv	OLTC	10
v	Power transformer Bushing / Reactor Bushing	7
vi	Transformer/ reactor fittings and accessories	10
vii	Circuit Breaker	10
viii	Isolator	10
ix	Lighting Arrestor	10
x	Wave Trap	10
xi	Instrument Transformers	7
xii	LV and MV Switchgear	10
xiii	GIS & Hybrid Switchgear	10
xiv	Cables & associated joints	10
xv	Capacitor	10
xvi	Relays	7
xvii	Energy Meter (including smart meters and ABT meters)	5
xviii	Battery and Battery Charger	7
xix	Conductors and earth wire	10
xx	High Temperature (HT) / High Temperature Low Sag Conductor (HTLS) conductor.	7
xxi	Insulators (Porcelain/ Glass)	10
xxii	Composite Insulator	5
xxiii	PLCC/ FO cable/ OPGW	5
xxiv	Transmission Line insulator hardware fittings and accessories for conductor & ground wire.	7

* * * * *

TECHNICAL SPECIFICATION OF 220/132/33 KV, 160 MVA POWER TRANSFORMER

3. Scope:

1.1 This specification covers design, engineering, manufacture, assembly, stage testing inspection and testing before supply and delivery of 160 MVA, 220/132/33 KV 3-phase auto power transformers complete with all fittings, accessories and associated equipment's which are required for efficient and trouble free operation.

1.2 It is not the intent to specify completely herein all detail of the design and construction of equipments. However, the equipment shall conform in all respects to standards of engineering, design and workman ship listed in clause no. 2 and shall be capable of performing in continuous commercial operation up to the bidder's guarantee in a manner acceptable to the purchaser, who will interpret the meanings of drawing and specification and shall have the power to eject any work or material which, in his judgment, is not in accordance therewith. The equipments offered shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of bidder's supply, irrespective of whether those are specifically brought out in this specification and / or in the commercial order or not.

1.3 The transformers shall conform in all respects to high standards of engineering, design, workmanship and latest revision of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which, in his judgment, is not in full accordance therewith.

1.4 Climatic Conditions:

Peak Ambient Temperature	50 Degree Celsius
Minimum Temperature in Shade	6 Deg. C
Maximum Relative Humidity	95% (sometime approaches saturation)
Average number of thunderstorm	58 days per annum.
Average number of rainy days per annum	90 days.
Average Annual Rainfall	125 cm.
Maximum Wind Pressure	150 kg/meter square.
Altitudes (Not Exceeding)	1000 metres.
Seismic Level Horizontal	g.

Standards:

2.1 The transformers and associated accessories shall conform to the latest issues of standards as given below: -

Indian Standard	Title	Internationally recognised std.
IS-2026 (part I to V)	Power Transformers	IEC-76
IS-3639	Fittings & Accessories for power transformers	
IS-335	Insulating oils for Transformers.	IEC-296, BS-148
IS-2099	Bushings for alternating Voltage above 1000 V	IEC-137, BS-223
IS-2705	Current Transformers	IEC-185
IS-325	Three phase Induction Motors	IEC-34
IS-375	Marking & arrangements for Switchgear, bus bars, Main Connections and auxiliary Wiring.	
IS-3737	Gas operated relays	
IS-1886	Code of practice for installation and maintenance of transformers	
IS-2147	Degrees of protection.	
IS-5	Colors for ready mix paints	
IS-6272	Industrial cooling fans	
IS-6600	Guide for loading of oil Immersed transformers	BSCP-0160
IS-778	Gun metal gate, globe and check valves for general purpose	
IS-3401	Silica gel.	

IS-4253	Park & Rubber	
IS-5561	Electric power connector	
IS-5578, IS-11353	Marking & arrangement for switch gear, bus bar, main connections and auxiliary wiring.	
IS-9434	Guide for sampling and analysis of dissolved gas in oil filled equipments.	
IS-12676	Oil impregnated paper insulated condenser Bushing Dimension and requirements.	
	Insulation Co-ordination	IEC-71
	Indian Electricity rule, 1956	
	CBIP publication no 275 Manual on power transformers	
DOC.ETD 16 (3487)	Draft standard by BIS for revision of IS-8468 for OLTC	
DOC.ETD 16 (3574)	Draft standard by BIS for revision of IS-3639 for fitting & accessories for transformers part-I-standardization of conservator	
DOC.ETD 16 (3575)	--- do --- part 2: dehydrating breather	
DOC.ETD 16 (3576)	--- do --- part 3: earthing terminals	
DOC.ETD 16 (3577)	--- do --- part 4: temperature indicators	
DOC.ETD 16 (3578)	--- do --- part 5: rating & diagram plate	

Equipment meeting with the requirements of other authoritative International standards which ensure equal or better performance than the standards mentioned above shall also be considered. When the equipment offered by the bidder conforms to other standards adopted and the standards salient points of difference between standards adopted and the standards specified in this specification shall be clearly brought out in the offer. Two copies of such standards with authentic translation in English shall be furnished along with the offer.

3. **Auxiliary power supply:**

Auxiliary electrical equipment shall be suitable for operation on the following supply system:-

Power Devices Like drive motors	415 V, 3 Phase 4 wire 50 Hz, neutral grounded AC supply
Lighting, space heaters and fractional kW motors	240 V, single phase, 50 Hz neutral grounded AC supply.
Alarm, control and protective devices	220 V DC, 2 wire.

Each of the foregoing supplies shall be made available by the bidder at the terminal point for each transformer for operation as accessories and auxiliary equipment. Bidders scope include supply of interconnecting cables, terminal boxes etc. the above supply voltage may very as below and all. Device shall be suitable for continuous operation over entire range of voltages.

i)	AC supply:	Voltage +10% (-) 20%, frequency + 5%
ii)	DC supply:	(-) 15% to +10%

4. **PRINCIPAL PARAMETERS (128/160 MVA TRANSFORMER):**

The transformer shall conform to the following specific parameters: -

SNo	Item	Specification of160 MVA x-mer
1.1	Rated Voltage Ratio: kV	220/132/33
1.2	Highest system voltage	245/145/36 KV
2.	No. of windings	Auto transformer with tertiary

3.	Type of cooling	ONAN/ ONAF		
4.	MVA rating corresponding to cooling system: a) ONAN Cooling b) ONAF Cooling	 80% (128/128/402.66MVA) 100%(160/160/53.33MVA)		
5.	Method of connection	HV & IV Star LV Delta		
6.	Connection Symbol (vector group)	YN a0d11		
7.	System earthing	Effectively earthed		
8.	(a) Percentage impedance's, Voltage on normal tap and MVA base corresponding to HV rating and applicable tolerances:	% Impedance	Tolerance	
	(i) HV – MV	8.35	+10%	
	(ii) HV/ LV	30	+15%	
	(iii) MV / LV	20	+15%	
	(b) Insulation resistance at an ambient temp. of 30 deg with 5 KV megger for 600 seconds duration	HV-IV/E & LV/E- 3000 M ohm HV-IV/LV - 4000 M ohm		
	(c) Polarization Index i.e. Ratio of megger values of 600 secs to that of 60 secs	>= 2		
	(d) DAR (Dielectric Absorption ratio) i.e. ratio of IR value of 60 sec. to 15 sec.	>= 1.3		
9.	Anticipated continuous loading of			
	a. HV, IV windings:	Not to exceed 110% of its rated capacity		
	b. Tertiary winding	Suitable for no load operation as well as for loading to its rated capacity with capacitive or inductive loading or combination of both (Subject to a maximum of 33% of the rated capacity of HV winding		
10.	Tap changing gear:- Type	OLTC for IV variation.		
	2) Tap range & steps	-10% to + 10%, steps 1.25%		
	3) Rated for	150 KV & 1000 A (Minimum)		
11.	Over voltage operating capability and duration	110% rated voltage Continuous 125% rated voltage for 60 secs. 140% rated voltage for 5 secs.		
12.	Minimum Air core reactance of HV windings.	20%		
13.	The voltage for which star point shall be insulated to the earth	The insulation class of the neutral end of the winding shall be graded to 95 KV.		
14.	(a) Max. Flux density in any part of core and yoke at rated MVA, frequency and normal voltage (Tesla) (b) No load current of the transformer at 105 % of rated voltage	1.6 0.5% of rated current (Maximum)		
	(c) Current density in winding	<= 3 Amp/ sq. mm (max.)		
15.	Insulation levels: For windings	HV	IV	LV
	a) 1.2/50 microsecond wave shape impulse withstand (kVp)	950	650	250

	b) Power frequency voltage withstand (kV rms.)	395	230	95
	c) Tan delta values of winding	The measured Tan delta values of winding shall not exceed 0.45% at 200C temperature. In case Tan delta of transformers during testing at works of manufacturer is measured above maximum ceiling of 0.45% at 200C temperature, then CSPTCL reserves right not to accept such of the transformer. This requirement is to be confirmed specifically by the Bidders in their offer.		
16	Type of winding insulation:- HV/IV winding LV winding	The HV/IV winding of the transformers shall have graded insulation. The insulation class of the neutral end of the winding shall be graded to 95 KV. The 33KV winding shall have full insulation for 33KV i.e. 250 KVp impulse and 95KVrms power frequency.		
17.	System short circuit level and duration for which the transformer shall be capable to withstand thermal and dynamic stresses (kA rms / sec)	If 220 KV side of transformer is connected on Infinite Bus, the transformer shall be capable to withstand terminal short circuit on 132 KV for 3 sec. duration.		
18.	Maximum partial discharge level at 1.5/sq.root 3 of rms. Phase to ground voltage.	500 pico coulombs		
19.	Noise level at rated voltage and frequency	81 Db		
20.	Permissible temperature rise: Over ambient temp. i) Of top oil measured by thermometer. ii) Of winding measured byresistance.	 400 c 450 c		
21.	Minimum clearances in air (mm):	Phase to phase	Phase to ground	
	(a) HV	2700	2400	
	(b) IV	1430	1270	
	(c) LV	700	660	
22.	Terminals:-			
	(a) HV Winding Line end (OIP condenser bushing)	245 KV		
	(b) IV Winding Line end (OIP condenser bushing)	145 KV		
	(c) HV/IV Winding Neutral	72.5 kV OIP condenser bushing		
	(d) LV Winding	72.5 kV OIP condenser bushing with center spacing of 1000 mm.		
23.	Max. Radio Interference voltage level at 1 MHz & 1.5/sq root 3 of rms phase to ground voltage for HV winding	1000 micro volts		
24.	Minimum Visual Corona extinction voltage	320 KV rms		
25.	Cooling Equipment's: Number of Banks with Adequate number of Fans.	Two Banks each 50%		
26.	Bushings:	HV	IV	LV/Neutral
	(i) Voltage rating Kvrms	245	170	72.5
	(ii) Current rating	1250	1250	1250

	(iii) Insulation level:			
	a.Lightning impulse with stand (kVp)	1050	750	325
	b. 1 Minute power frequency withstand voltage (kV rms)	460	275	140
	(iv) Creepage distance (mm)	6125	4250	1815
27.	(i) The permissible range of losses at rated voltage & frequency (without any positive tolerance)			
	a) No Load Losses (Iron losses)	31.5 KW - 35 KW		
	b) Load (Copper Losses)	184.5 KW –205 KW		
	c) Auxiliary Losses	4.5 KW - 5 KW		
	(ii) No load losses at 110% of rated voltage & rated frequency	Not more than 130% of the losses at rated voltage & frequency		
28.	Type of design of the transformer	Only Bell type tank construction is acceptable		
29.	Tank sheet thickness			
	(i) Top & bottom	Minimum 20 mm		
	(ii) Sides	Minimum 10 mm		
30.	Conservator tank sheet thickness	Minimum 8 mm		
31	There shall be two CT cores per HV, IV and N Bushing CT for REF (1-phase ring type turret mounted).	Ratio - 800/1-1A KPV- min. 800V Accuracy: PS (both cores)		
32	There shall be one CT core in middle phase of HV, IV and LV Bushings for WTI	Ratio to be specified by the Bidder		
33	33KV class CT for tertiary winding			
	(i) Type	1 phase ring type turret mounted		
	(ii) Ratio	600/1-1		
	(iii) Accuracy class	5P10/1.0		
	(iv) Quantity	1 No.		
34	Transformer oil:			
	(a) Appearance	The oil shall be clear and transparent and free from suspended matter or sediment		
	(b) Density at 27o C max.	0.89g/cm3		
	(c) Kinematic viscosity max. (i) At 27 o C (ii) Sub-zero temp	 27 cSt. Under consideration		
	(d) Interfacial tension @ 27 degree min	0.04N/m		
	(e) Flash point Penskymartn (closed) ,min.	140 degree centigrade		
	(f) Pour point max.	- 6oC		
	(g) Neutralization value (total acidity) max.	0.01mg. KOH /g		
	(h) Corrosive sulfur (in terms of classification of copper strip)	Non corrossive		
	(i) Electric strength(break-down voltage) New untreated oil b) After treatment	 40 kv (RMS) If the value is not attainted the oil shall be treated. 60 kv (RMS)		
	(j) Dielectric dissipation factor (tan delta)at 90o C max	0.002		
	(k) Specific resistance (resistivity) i) At 90 o C min. ii) At 27 o C min.	 35x1012 ohms-cm 1500x1012 ohms-cm		

	(l) Oxidation stability i) Neutralization value after oxidation (max) ii)Total sludge after oxidation(max)	 0.4 KOH/g 0.1 % by weight
	(m) Presence of oxidation inhabitor	The oil shall not contain antioxidant additives
	(n) Water content (max)	50 ppm, after treatment should be less than 10

5. GENERAL TECHNICAL REQUIREMENTS

5.1 Duty Requirements:

5.1.1 The interconnecting transformers would be used for Bi directional flow of rated power.

5.1.2 If 220 KV side of transformer is connected on Infinite Bus, the transformer shall be capable to withstand terminal short circuit on132 KV for 3 sec. duration.The transformers and all the its accessories like CTs etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuits at the terminals of any winding for a period of 3 sec. The short circuit level of the HV system to which the subject transformer will be connected is 40 KA (Sys, rms, 3 phase fault) for 220 KV and 132KV systems and 31.5KA for 33 KV systems.

5.1.3 The transformer shall be capable of being loaded in accordance with IS:6600. There shall be no limitation imposed by windings, bushings, tap changer etc. of transformer. Transformer & all its accessories shall be liberally rated to allow 10% over loading at all taps on continuous basis without exceeding the temperature limits specified in clause 4.0. The transformer shall be capable of being operated without danger on each tapping at the rated KVA with specified voltage variation corresponding to the voltage of that tapping with normal temperature rise. The design adopted to achieve this shall be indicated in detail in the Bid. Transformer shall be capable of operating under the natural cooled condition up to the specified load i.e. as ONAN rating. The forced air cooling equipment shall come into operation by pre-set contacts of winding temperature indicator and the transformer shall operate as a forced air cooled unit i.e. as ONAF. Cooling shall be so designed that during total failure of power supply to cooling fans, the transformer shall be able to operate at full load for Ten (10) minutes without the calculated winding hot spot temperature exceeding 140 deg.C. Also stopping of two cooling fans should not have any effect on the cooling system. Transformers fitted with two coolers (cooling banks) each capable of dissipating 50 per cent of the loss at continuous maximum rating shall be capable of operating for 20 minutes in the event of failure of the blowers associated with one cooler, without the calculated winding hot spot temperature exceeding 140oC at continuous maximum rating.

5.1.4 The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variation of + 10% corresponding to the voltage of that tapping. The transformers and its accessories shall be liberally rated to allow 10% overloading at all taps on continuous basis.

5.1.5 Radio interference and Noise Level:

The transformers shall be designed with particular attention to suppression of maximum harmonic voltage, especially the third and fifth so as to minimize interference with communication circuits.

The noise level, when energized at normal voltage and frequency with fans and pumps running shall not exceed, when measured under standard, conditions, the values specified in NEMA, TR-1.

5.1.6 Transformer shall be capable of operating under the natural cooled condition up-to the specified load. The forced cooling equipment shall come into operation by preset contacts of winding temperature indicator and the transformer shall operate as a forced cooled unit, at specified load. Cooling shall be so designed that during total failure of power supply to cooling fans, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 140 deg. C. Also stopping of one or two cooling fans should not have any effect on the cooling system.

5.1.7 Transformer shall be capable of withstanding thermal and mechanical stress caused by symmetrical of asymmetrical faults on any winding.

5.1.8 Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation of +/-4%, which may produce the following over fluxing condition:

i) 125% for 1 minute) for all transformer where
140% for 5 seconds) base voltage and frequency refers to rated voltage and frequency

ii) Over fluxing withstand characteristics up to 170% shall be submitted along with the bid.

PERMISSIBLE LOSSES OF 160MVA, 220/132/33 KV POWER TRANSFORMER:-

5.2.1 The losses of 160MVA, 220/132/33 KV Power Transformer should be within the range of prescribed below for respective losses (without and positive tolerance):

S.No.	Particulars	Maximum	Minimum
1.	No load loss in KW	35	31.5
2.	Load loss in KW at rated voltage, rated frequency and rated current at 75°C	205	184.5
3.	Auxiliary loss in KW	5	4.5

The bidders shall have to offer no load loss, load loss and auxiliary loss separately.In case any of the offered losses (i.e. no load loss, load loss or auxiliary loss) quoted by the bidder is more than the maximum permissible limits, the bid shall be considered as non responsive and shall be out rightly rejected without and correspondence in the matter.

In case any of the losses are below the minimum range prescribed above, the bid shall be treated as responsive. However, for price bid evaluation purpose, the minimum range of the respective loss prescribed above shall be considered.

5.2.2 **Guaranteed losses:**

The transformer losses at 75oC, rated voltage & frequency should be offered by the bidder in Schedule-I, Sl. No. 9 (a), (b) & (c). During final testing of each of the transformer, the measured losses (individually i.e. No load, load & auxiliary losses) should not exceed the guaranteed losses. In case, any of the losses exceed the guaranteed losses transformer shall not be accepted. The bidder must clearly specify that the offered losses are 'FIRM' and no tolerances shall be applicable on the offered values.

Capitalisation of losses:The capitalisation of no load loss, load & auxiliary loss for the bidder who has quoted above the minimum of the respective range of losses specified in clause 5.2.1 shall be done on the following rates (differential of quoted loss & minimum value of the range for respective loss).

a) For differential no load loss above min value : Rs. 4,01,840.00 per KW
b) For differential load loss above min value : Rs. 2,13,780.00 per KW
c) For differential auxiliary loss above min value : Rs. 1,60,700.00 per KW

In case a bidder quoted any of the losses below the min value of the range prescribed in clause 5.2.1, the value of loss shall be considered equal to min of the range specified at clause 5.2.1 for respective loss for price bid evaluation purpose. However, it should be clearly noted that during final testing of each of transformer, the major losses individualy (i.e.no load loss, load loss, auxiliary loss as applicable) should not exceed the values quoted by the bidder in the bid. In case any of the loss exceeds the quoted loss, respective transformer shall not be accepted.

The above mentioned rates for capitalization of losses have been worked out as per the formula prescribed by CBIP in publication No. 317 i.e. manual on transformers.

The contractor must clearly specify that the offered losses are "FIRM" and no tolerances as per IS shall be applicable on the offered values.

GUARANTEE PERIOD:

The contractor shall ensure that the power transformer supplied shall be guaranteed for a period of 42 months from the date of satisfactory commissioning of transformer along with all accessories. Please note that the date of commissioning of last accessory will be treated as date of commissioning of transformer. The transformer found defective/failed within the above guarantee period shall be got replaced/repaired by the contractor free of cost, within four

months from date of issue of intimation letter to the contractor by CSPTCL regarding its defect/failure.

If the contractor fails to arrange repair/replace the failed/defective transformer within four months, the contractor shall be liable to pay penalty charges for delayed repairs at the rate of 0.5% of the cost of transformer per week of delay or part thereof, subject to a maximum ceiling of 10% of the cost of the transformer. This penalty shall be in addition to the liquidated damages as per clause 14.1 of GCC for delay in completion of the contract.

If the defective/failed transformer is not lifted for replacement/repairing within 2 months from the date of intimation by CSPTCL regarding defect/ failure OR one month from date of acceptance of additional Indemnity Bond submitted by the contractor, (in case the transformer is required to be taken back to the works for repairing) whichever is later.

OR

not repaired within seven months from date of lifting of failed/ defective transformer, penal action may be taken which will include forfeiture of performance guarantee of transformer and debarring of the manufacturer from future business with CSPTCL for a period as decided by CSPTCL in addition to the other applicable penalty.

The above provisions shall be applicable for second time failure also, if any.

2. **EXTENDED GUARANTEE PERIOD POST REPAIRS**:

Further, the following extended guarantee shall be applicable, in case the transformer fails within guarantee period.

a) First time failure within guarantee period:

i) If the transformer fails within 12 months from the initial commissioning, the guarantee period shall get extended to 42 months from the date of satisfactory re-commissioning of transformer after repairs along with all accessories.

ii) If the transformer fails after 12 months within the original guarantee period, the original guarantee period shall get extended for a period equal to the time period lapsed between date of failure to date of re-commissioning after repairs i.e. the residual guarantee period or 12 months from date of re-commissioning after repairs, whichever is later.

b) Second time failure of transformer within guarantee period:

If the transformer fails again (second time) within the original/extended guarantee period, the guarantee shall automatically get extended for further period of two years from the date of re-commissioning (post repair) or from the end of the original/ previously extended period, whichever is later.

c) Third time failure of transformer within guarantee period:

If the transformer fails within guarantee /extended guarantee period for third time, this will be treated as adverse performance of contractor as well as manufacturer and in such case penal action shall be taken which will includes

Forfeiture of 10% BG submitted against performance of transformer.

(ii) Forfeiture of additional 10% performance BG furnished after satisfactory completion of guarantee period of material/equipments (except power transformer).

(iii) Debarring of the manufacture of the transformer from future business with CSPTCL for a period as decided by CSPTCL as well as deletion of their name from the vendor list of CSPTCL for forthcoming turnkey projects.

If, for the purpose of replacement/repairs, the equipment/material is required to be dispatched to manufacturer's works, all charges towards transportation / insurance/ packing / forwarding will have to be borne by contractor for to and fro dispatches.

In this connection, please note that the following additional conditions will also be applicable in case any damages/defects are noticed in the equipments or its accessories-

If the material develops defect within guarantee/extended guarantee period after installation at site or subsequent to installation after repairs (1st or 2nd time), for the purpose of replacement / repairs, the same will have to be dismantled and taken out by CSPTCL, in such cases actual cost of dismantling and replacement of the equipment / material will also be recoverable from contractor.

In case, transformer fails during guarantee / extended guarantee period, the following terms shall also be applicable (in first or second time failure both)-

An additional Indemnity Bond on stamp paper of Rs.250.00 shall be required to be submitted by the contractor, in case the transformer is required to be taken back to the works for repairing. The value of this Indemnity Bond shall be equal to the cost of transformer along with all taxes, duties, freight and testing charges. The transformer shall be handed over for repairing only after submission and acceptance of additional indemnity bond.

The transformer should be offered for inspection after completion of repairing work. The repaired Transformer shall be tested for all routine, additional routine, type and special test as per IS-2026 & as narrated in section-III-B, clause-6 under head "Tests" of technical specification of transformer.

(iii) The Transformer should be offered for inspection after repairing within four months from date of intimation of failure by CSPTCL.

(iv) The dispatch instructions shall be issued for repair transformer after its satisfactory inspection. The transformer should reach the destination (anywhere in C.G. state) within 45 days from date of issue of dispatch instruction failing which actual date of receipt of repaired transformer at site shall be treated as date of delivery of the repaired transformer for all contractual purposes.

(v) In case of failure / defect in transformer (first or second time) within guarantee / extended guarantee period, the validity of performance guarantee for transformer submitted by the contractor against the contract as per clause 12.1(i) of GCC should be extended up to expiry of extended guarantee period with additional claim period of six months. In case, contractor fails to extend the guarantee period of transformer, claim shall lodged with the issuing bank for encashment of the all performance bank guarantee for transformer.

5.3 **Clearances:**

The over all dimensions of the transformer shall allow for sufficient clearances for Installation in:

(a) 220 KV switchyard with bay width of 15000 mm & beam height of 11000 mm.

(b) 132 KV switchyard with bay width of 9600 mm & beam height of 11000 mm.

5.4 Construction Details:

The features and construction details of power transformer shall be in accordance with the requirements stated hereunder:

5.4.1 Tank and Tank Accessories:

5.4.1.1 **Tank:**

Tank shall be of welded construction and fabricated from tested quality low carbon steel of minimum thickness of 20mm. (Base & Tank cover) and 10mm for sides.

All seams and those joints not required to be opened at site shall be factory welded and whenever possible they shall be double welded. After completion of tank construction and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing member. The requirement of post weld heat treatment for tank/stress relieving parts shall be based on recommendations of BS: 5500 table 4.4.3.1

The Tank stiffeners shall be provided for general rigidity and these shall be designed to prevent retention of water.

The tanks shall be designed to withstand

(i) Mechanical shocks during transportation

(ii) Vacuum filling of oil at 10 millitorr

Continuous internal pressure of 35 kN/m2 over normal hydrostatic pressure of oil.

Short circuit forces.

Wherever possible the transformer tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets cannot be avoided, pipes shall be provided to vent the gas into the main expansion pipes.

Adequate space shall be provided at the bottom of the tank for collection of sediments. The minimum clearance of outermost winding/connection leads to tank shall not be less than 300 mm on all 4 sides to allow free movement of two persons for inspection. Suitable platforms may be provided on bottom to facilitate free movement of person all around inside the tank. The arrangement should be brought out clearly in the drawing.

The base of each tank shall be so designed that it shall be possible to move the complete unit by skidding in any direction without injury when using plates or rails.

Tank shields shall be such that no magnetic/fields shall exist outside the tank. If required impermeable shields shall be provided at the coil ends. Tank shield shall not resonate when excited at the natural frequency of the equipment. Bidder may confirm use of tank shields in the schedule of additional information.

Suitable guides shall be provided in the tank for positioning the core and coil assembly.

Each tank shall be provided with

(i) Lifting lugs suitable for lifting the equipment complete with oil

(ii) A minimum of four jacking pads in accessible position at 500 mm height to enable the transformer complete with oil, to be raised or lowered using hydraulic or screw jacks.

(iii) Suitable haulage holes shall be provided.

The transformer should be of bell tank design only. No other design is acceptable

5.4.1.2 Tank cover:

(a) The tank cover shall be sloped to prevent retention of rainwater and shall not distort when lifted.

(b) At least two adequately sized inspection openings, one at each end of the tank shall be provided for easy access to bushings and earth connections. The inspection covers shall not weigh more than 25 kg. The inspection covers shall be provided with two handles.

(c) The tank covers shall be fitted with pockets at the position of maximum oil temperature of MCR (Maximum Continuous Rating) for bulbs of oil and winding temperature indicators. It shall be possible to remove these bulbs without lowering the oil in the tank.

(d) Bushings, turrets, covers of inspection openings, thermometer, pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.

(e) All bolted connections shall be fitted with weather proof, hot oil resistant gasket in between, for complete oil tightness. If gasket is compressible metallic stops shall be provided to prevent over-compression.

5.4.2 Air cell:

The transformers should be supplied with air cell type oil preservation system. It is obligatory on the part of the bidders to clearly submit complete constructional and technical details of sealing arrangements duly supported with technical details, pamphlets and dimensional drawings.

While furnishing details for the above sealing arrangement the bidders must confirm clearly that the size and capacity of sealing arrangement is adequate for the transformer and for the quantity of transformer oil required for the transformers.

5.4.3 Axles and Wheels:

(a) The transformers are to be provided with flanged bi-directional wheels and axles. These shall be so designed as not to deflect excessively to interfere with the movement of the transformer. Wheels shall be provided with suitable bearings, which shall be rust and corrosion resistant. Fittings for lubrication shall also be provided.

(b) Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer.

(c) The wheels are required to swivel and they shall be arranged so that they can be turned through an angle of 90° when the tank is jacked up to clear of rails. Means shall be provided for locking the swivel movements in positions parallel to and at right angles to the longitudinal axis of the tank.

(d) The rail track gauge shall be 5’ – 6” (1676 mm) along longer axis as well as along shorter axis. The arrangement should be such that transformer can be installed in any direction i.e. along longer axis or along shorter axis on 2 rails with spacing of 1676 mm.

5.4.4 Anti Earthquake Clamping Device:

To prevent transformer movement during earthquake, clamping device shall be provided for fixing transformer to the foundation. The Bidder shall supply necessary bolts for embedding in the concrete foundation. The arrangements shall be such that the transformer can be fixed to or unfastened from these bolts as desired. The fixing of the transformers to the foundations shall be designed to withstand seismic, events to the extent that a static co-efficient of 0.3g, applied in the direction of least resistance to that loading will not cause the transformer or clamping devices as well as bolts to be over stressed.

The details of the device used and its adequacy shall be brought out in the additional information schedule.

5.4.5 Conservator Tank

(a) The conservator tank shall be of minimum 8mm thickness and shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to 100oC. Conservator shall be with volumetric capacity at least 7 ½ percent of a total volume of oil in the main tank of the transformer.

(b) The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.

(c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.

(d) Conservator shall be provided in such a position as not to obstruct the electrical connections to the transformer.

(e) Separate conservator tank/compartment in the main conservator shall be provided for OLTC.

5.4.6 Dehydrating Filter Breather:

Conservator shall be fitted with a dehydrating, filter breather. It shall be so designed that:

(a) Passage of air is through a dust filter and silicagal.

(b) Silicagel is isolated from atmosphere by an oil seal.

(c) Moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from a distance.

(d) Breather is mounted not more than 1400 mm above rail top level. Minimum quantity of silicagel to be 1 kG for every 3500 lts of oil in the tank.

5.4.7 Pressure relief device:

Adequate numbers of pressure relief devices (Minimum three no.) should be provided with each unit. Bidders must submit calculations to prove that the capacity of pressure relief device and location of the same in the transformer will adequately meet out requirement.

Constructional and design details of pressure relief device must be furnished and it should be proved by calculation that the size and setting of pressure relief device is adequate, considering the rating of the transformer and quantity of oil in the transformer. Furnishing of this information is a must.

Adequate No. of pressure relief devices may be provided at suitable locations which shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage to the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. One set of electrically insulated contacts shall be provided for alarm /tripping along with the recommended settings.

5.4.8 Buccholz Relay:

A double float type Buccholz relay shall be provided. All the 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 and taking gas sample. A copper or stainless steel tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling, with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

5.4.9 Temperature Indicator:

(a) Oil Temperature Indicator (OTI)

All transformers shall be provided with a 150-mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts, maximum reading pointer and resetting device mounted in the cooler control cabinet. A temperature-sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be +1.5% or better.

(b) Winding Temperature Indicator (WTI)

A device for measuring the hot spot temperature of each of the windings shall be provided (HV, IV & LV). It shall comprise of the following:

(i) Temperature sensing element.

(ii) Image coil
(iii) Auxiliary CTs,
(iv) 150 mm dia local indicating instrument with maximum reading pointer mounted in Cooler control cabinet and with two adjustable electrically independent ungrounded contacts (besides that required for control of cooling equipment), one for high winding temperature alarm and one for trip.
(v) Calibration device.
(vi) In addition to the above, the following indication equipment shall be provided for each winding.

(c) Remote winding temperature indicator
It shall be suitable for flush mounting on RTCC panel. The difference between local and remote WTI indication at any given time shall not exceed 1oC. One RWTI shall be provided for each winding in the middle phase (HV, IV & LV).

(i) Auxiliary supply if required, at Owner's panel, for RWTI, shall be 220 V DC only.
(ii) Accuracy class of WTI shall be + 1.5% or better.
(iii) Any special cables required for shielding purpose for connection between cooler control cabinet and remote winding Temperature Indicator control circuit shall be in supplier's scope or work.

5.4.10 Earthing Terminals:

(a) Two (2) earthling pads (each complete with two (2) Nos. tapped holes, M 10 bolts, plain and spring washers) suitable for connection to 110 x 12 mm copper/brass grounding flat shall be provided each at position close to the two (2) diagonally bottom corners of tank. Earthing strip shall be connected to grounding mat by the Bidder.
(b) Two earthing terminals suitable for connection to 50 x 6 mm galvanized steel flat shall also be provided on cooler, marshalling box and any other equipment mounted separately and shall be connected to grounding mat suitably.

5.4.11 Core:

(a) The core shall be constructed from high grade non aging cold rolled super grain oriented silicon steel laminations (Hi B). The core material should be of PRIME grade only. Bidder will offer the core for inspection & approval by the purchaser during manufacturing stage. Bidder call notice should be accompanied with the following documents as applicable as a proof towards use of PRIME core material.

(i) Invoice of the supplier
(ii) Mill's test certificate
(iii) Packing list
(iv) Bill of lading
(v) Bill of entry certificate by customs

(b) The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of laminations which may cause local heating.
(c) Core earthing arrangement: The manufacturer should bring out leads from core, end frame and tank to top of the transformer through insulated bushing. It may be noted that internal earthing of any nature from core and frame should not be provided. Earthing at site shall be done by taking connections from the top of the tank and this arrangement will also facilitate checking of possibility of any multiple core earthing in transformer.
(d) The insulation of core to bolts and core to clamps plates shall be able to withstand a voltage of 2 kV RMS for one minute.
(e) Core and winding shall be capable of withstanding the shock during transport, installation, service and adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.
(f) All steel sections used for supporting the core shall be thoroughly sand blasted after cutting, drilling and welding.
(g) As the transformer is of Bell tank design, suitable projecting guides shall be provided on core-assembly to facilitate removal of tank.
(h) Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.

(i) The supporting frame work of core shall be so designed as to avoid presence of pockets which would prevent complete emptying of the tank through drain valve or cause trapping of air during oil filling.

(j) The maximum flux density in any part of the core and yoke at rated MVA, voltage and frequency at any tap shall not exceed 1.6 tesla.

5.5.1 Winding:

(a) The supplier shall ensure that windings of all EHV class transformers are made in dust proof, conditioned atmosphere. He shall furnish the facilities available in this regard at his works along with the Bid.

(b) The conductors shall be of electrolytic grade copper.

(c) The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse or be catalytic and chemically active in transformer oil during service.

(d) Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.

(e) The stacks of windings shall receive adequate shrinkage treatment before and after final assembly. Adjustable devices if necessary shall be provided for taking up possible shrinkage of coils if any, in service. The provision made in this respect shall be clearly brought out in the Bid.

(f) Tertiary winding:-For 160 MVA transformer, ONAF rating of HV & IV shall be 160 MVA and that of 33 KV LV (tertiary) rating shall be 53.33MVA .The tertiary of 160 MVA transformer shall be designed for full rated MVA loading of either capacitive or inductive or mixed load. The tertiary winding shall not have taps. Tertiary winding shall be without tap changer. The tertiary winding is intended to be loaded for the specified rating as mentioned above and accordingly terminals of delta winding needs to be brought out on transformer through three bushings. One 33 Kv class CT of ratio 600/1-1 Amps having two secondary cores of rating 1Amp , one of accuracy class 5P10 and other of accuracy class 1 shall be provided in any one phase of tertiary winding before delta formation for monitoring circulating current and also to provide protection against circulating current beyond rated capacity. 1 CT core of suitable ratio shall be provided in the middle phase for monitoring WTI. For measurement of circulating current of delta winding one Ampere meter of digital /numeric type suitable for specified CT ratio shall be provided on the RTCC panel. The tertiary winding shall be designed to carry the fault current under worst fault condition.

5.5.2 Insulating oil:

(a) EHV Grade-I oil shall be used. The quality of the oil supplied with transformer shall conform to the oil parameters specified in this clause. No inhibitors shall be used in the oil. The oil samples will be drawn as follows

i) Prior to filling

ii) Before and after heat run test

iii) Before energizing.

All tests as per IS: 335 shall be conducted on all samples.

(b) The insulating oil shall be subjected to testing in the oil manufacturer's works before supply in the presence of the representative of the transformer manufacturer.

(c) Sufficient quantity of oil necessary for first filling of all tanks, coolers and radiator at the proper level along with 10% extra oil by weight for topping up shall be supplied in on-returnable containers suitable for outdoor storage.

(d) Power Transformers shall be supplied with oil.

(e) The parameter of the EHV Grade I transformer oil should confirm the values given in schedule-I Sl. No. 56.

(f) The bidder shall warrant that characteristic of oil furnished shall comply with the requirements specified in IS-335, 1993 (Fourth Revision) with latest amendment/revision and shall be suitable for EHV grade transformers.

5.6.1 Oil preservation equipment:

a) For 245 KV class transformers bidder shall offer silica gel breather type oil sealing in conservator to prevent oxidation and contamination of oil due to contact with water in this type of oil preservation system conservator shall be fitted with a dehydrating filter breather. It shall be so designed that:

i) Passage of air is through a dust filter and silicagel.
ii) Silicagel is isolated from atmosphere by an oil seal.
iii) Moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from a distance.
iv) Breather is mounted not more than 1400 mm above rail top level.

b) **On line DGA Monitoring device:** One Number 5 Gas Online DGA monitoring device + moisture should be provided on the transformer which should be capable of measuring following key gases and **moisture content** individually (Not composite) found in the transformer oil.

(i) Hydrogen (H_2)
(ii) Carbon mono oxide (CO)
(iii) Acetylene (C_2H_2)
(iv) Ethylene (C_2H_4)
(v) Methane (CH_4)

The online DGA monitor should be microprocessor based IED alongwith the required interface software in CD-ROM one with each unit. The device should have capacity to internally store minimum two years of Data. It should have non volatile memory storage to prevent loss of data.

The device should have following communication facilities:-

(i) Two separate channels for remote communications plus local USB connection and Ethernet connections.

Communications protocols supported should include MODBUS, MODBUS/ TCP, DNP3.0, IEC61850.

Modules available for connection via RS232, RS485, Ethernet, PSTN modern /GSM or CDMA wireless modems/ IEC61850 compliant latest communication module.

The make and model of on line DGA monitoring device shall be subject to approval of CSPTCL. The bidder shall submit the details of the device like make, model No., the name of gases which are detected, the location of fitting in the transformer with the schematic drawings.

5.7 TERMINAL ARRANGEMENTS:

5.7.1 Bushings:

The bushings of CSPTCL's approved make shall be manufactured tested and supplied with guaranteed particulars generally conforming to the latest issue of the following Standard Specifications:

i)	IS-2099	Bushings for alternating voltage above 1000V
ii)	IEC 60137	Bushings for alternating voltage above 1000V
iii)	IS 3347 (Part I to VIII)	Dimensions of porcelain transformer bushings for use in lightly polluted atmospheres.
iv)	IEC 60233	Tests on hollow insulators
v)	IS 2544	Specification for porcelain insulator for voltages above 1000 volts.
vi)	IS 5621	Hollow insulators

Oil impregnated paper insulated condenser type bushing shall be provided for 245 KV, 170 KV and 72.5 KV class with the following specifications.

These bushings shall be outdoor immersed self-contained draw-through lead or rod type, with oil filling. The active part of bushing shall consist of a condenser body built up around a centre tube using high quality kraft insulating paper. The paper craft shall be wound over the centre tube with pure aluminium foils inserted at pre designed locations to get optimum combination of external flashover and internal puncture strength.

The condenser body shall be enclosed in weather resistant housing consisting of a top expansion chamber, upper porcelain, a welded flange – ground sleeve assembly, lower porcelain and a bottom cap. The annular space between the condenser body and the housing shall be filled with Grade-I transformer oil. An assembly located in the top housing hold all the gasket and O ring between porcelain and metal parts thereby completely sealing the bushing. An oil site window shall be provided on the expansion chamber for observing the oil level. The space in the expansion chamber above oil shall be filled with dry Nitrogen gas.

Brown glazed porcelain insulators of high strength are used as air end and oil end insulators. Air end porcelain shall normally be provided with total nominal creepage length 25 mm/KV of the rated voltage unless otherwise specified. Oil end porcelain shall be cone shaped without shed. Air end porcelain shall be provided with long and short sheds(aerodynamic shed

profile).Porcelain used in bushing manufacture shall be homogenous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Bushings shall be manufactured from high quality porcelain.

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

Bushings hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used. The hollow column insulator shall be of reputed make and subject to the approval of CSPTCL. Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators bushings when operating at the normal rated voltage.

All iron parts shall be hot dip galvanised and all joints shall be air tight. Galvanized bolts and nuts shall be used as fasteners. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Bushing design shall be such as to ensure a uniform compressive pressure on the joints.

After assembly, the bushings shall be dried out at a very high vacuum pressure. These shall then be impregnated with transformer oil. Oil impregnation shall be carried out under pressure. The oil level in bushing shall then be adjusted and the bushings shall be sealed subsequently.

For the bushings of rated voltage 245 KV, stress relieving shield shall be provided on the lower cap. The shield shall consist of an aluminium shroud insulated in kraft paper and press board moulding. The maximum stress in oil and the surface of these shield insulation must be limited to those values normal for insulated conductors and similar components in the same transformer.

The draw lead or draw rod connecting the top terminal will be supplied along with bushing. The complete joint connector shall be provided with the draw lead and the free connector shall be suitable for brazing the lead from the connecting improvement in the case of draw rod the free end shall form the connector. For the air side connection, rod type terminal shall be provided.

The bushing shall be provided with an insulation test tap suitable for measuring bushing power factor (dissipation factor) and capacitance by ungrounded specimen test method. The cover of this tap should be removed from the tap attachment only for testing purpose. Normally the tap shall be grounded through the cover and the bushing shall not be operated with cover remove.

Tests:

Bushings shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099, IEC 60137, IS: 2544 & IS: 5621. The following type test reports of the offered bushings shall have to be submitted for approval.

Wet power frequency voltage withstand test.

Dry lighting impulse voltage withstand test.

Dry or wet switching impulse voltage withstand test.

Thermal stability test.

Temperature rise test.

Thermal short time current withstand test.

Dynamic current withstand test.

Cantilever load withstand test.

Tightness test on liquid filled and liquid insulated bushings.

The dielectric tan delta value shall not be more than 0.005.The insulation resistance of the bushing shall not be less than 20 G ohm. The partial discharge of the bushing shall not be more than 10 pC.

5.7.2 Terminal connectors:

a) Bushing terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS:5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL.

b) i) All connections with ACSR zebra conductors shall be bolted type.

ii) Connectors shall consist of two parts. The part connecting bushing stud shall be of copper and that towards conductor shall be of Aluminium. The copper part shall be electrolytic grade copper forged and silver plated/ tinned for 10 Microns.

No part of a clamp shall be less than 15 mm thick. Minimum conductor coverage on the clamp shall be 100mm. Minimum bushing terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

GI nuts, bolts and washers shall be used. Nuts and bolts shall have hexagonal head with threads as per IS and shall be fully threaded type. Also instead of spring washers check/ lock nuts shall be provided.

The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR zebra conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor. The terminal connector of 132KV side should be suitable for twin zebra conductor.

Terminal connector shall be suitable for Zebra ACSR conductors. Clamps shall be designed adequately to take care of any bimetallic effect. The temperature at the clamp shall not exceed 80°C. The bushing side of connector shall be of copper and conductor side shall be of aluminium.

The terminal connectors shall also meet the following requirements:

Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The drawing of terminal connector offered shall have to be got approved by CSPTCL

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

The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

For bimetallic connectors, copper alloy liner of minimum thickness of 4 mm shall be integral with aluminium body.

Flexible connectors shall be made from tinned copper sheets.

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

5.7.3 Bushing Current Transformer:

Current transformers shall comply with IS: 2705. Bushing current transformers of adequate ratio are to be provided in HV, IV & neutral bushings for restricted earth fault protection. Two cores (of PS class) shall be provided for each Bushing CT for REF protection.

One core each shall be provided on middle phase of HV, IV and LV Bushing for WTI. Further, 33KV CT as per clause 5.5.1(f) shall also be provided in one phase of tertiary.

It shall be possible to remove turret mounted CTs from the transformer tank without removing the tank cover. Necessary precautions shall be taken to minimize the eddy currents and local heat generated in the turret.

All secondary leads shall be brought to a terminal box near each bushing. These terminals shall be wired out to cooler Control Cabinet using separate cables for each core. The terminal shall be stud type of adequate size.

Bushing CT parameters indicated in the specification are tentative and liable to change within reasonable limits. The bidder shall obtain Purchaser's approval before proceeding with design of Bushing CTs.

5.7.4 Terminal marking:

The terminal marking and their physical position shall be in accordance with IS:2026 unless otherwise specified.

5.8 Neutral earthing arrangement:

(a) The neutral terminals of the star connected windings shall be brought to the ground level by a copper grounding bar (of adequate size) which shall be supported from the tank by porcelain insulators of highest system voltage of 36 kV.

(b) The lend of the copper bar shall be brought to the ground level, at a convenient point, for connection to ground network through two (2) Zebra conductors. The connection shall be made by using suitable clamp with necessary accessories.

(c) Suitable flexible copper strip connection of adequate size shall be provided for connecting to Neutral Bushing terminals to avoid terminal load on the Bushings.

5.9 Auxiliary power supply for OLTC, Cooler control and power circuit:

5.9.1 Auxiliary Power Supplies, shall be as indicated in clause 3.0 provided by CSPTCL at any one place for OLTC Control and Cooler Control and Cooler Control. The DC operated contactors coils & push buttons should be suitable for control voltages of 220 volt.

5.9.2 All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed any one of the local control cabinets for tap changer control and cooler circuits.

5.9.3 Design features of the transfer switch shall include the following:

i) Provision for the selection of one of the feeders as normal source and other as standby.

ii) Upon failure of the normal source, the loads shall be automatically transferred after an adjustable time delay to the standby source.

iii) Indication for failure of normal source and for transfer to stand by source and also for failure to transfer shall be provided locally as well as in remote panel.

iv) Both the transfer and the re-transfer shall be dead transfers and AC feeders shall not be paralleled at any time.

v) Necessary isolating switches, MCBs and other components for the above power supply of the bidder.

5.9.4 Tap changing equipment: TAPS IN OLTC:

In 160 MVA 3 phase transformer the OLTC is to be provided on IV winding (i.e. 132 KV) with tap range of -10% to +10% in steps of 1.25%.

(i) Tap change Switch (General Requirement):

The on load tap changer shall be provided on IV for IV variation as specified at Sr. No. 10 of clause 4.0.

OLTC gear shall be motor operated for local as well as remote operation. An external hand-wheel/handle shall be provided for local manual operation.

Arrangement shall be made for securing and padlocking the tap changer wheel in any of the working positions and it shall not be possible for setting or padlocking the wheel in any intermediate position. The arrangement shall be such that no padlock key can be inserted unless all contacts are correctly engaged and switch set in a position where no open or short circuit is possible. An indicating device shall be provided to show the tap in use.

On Load Tap Changing Gear (OLTC):

The details of the method of diversion of the load current during tap changing; the mechanical construction of the gear and the control features for OLTC gear shall be submitted with the bid. Information regarding the service experience on the gear and a list of important users shall be furnished. The tap changer shall change the effective transformation ratio without producing phase displacement.

The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer

The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.

The bidder shall indicate the safeguards in order to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under over load conditions of the transformer. Necessary tools and tackles shall be furnished for maintenance of OLTC gear.

The OLTC oil chamber shall have oil filling and drain plug, oil sampling valve, relief vent and level glass. It shall also be fitted with surge relay the outlet of which shall be connected to a separate conservator tank.

The diverter switch or arcing switch shall be so designed as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of auxiliary supplies etc.

Drive mechanism chamber shall be mounted on the tank in accessible position. It should be adequately ventilated and provided with anti-condensation metal clad heaters. All contactors, relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.

Each transformer unit shall be provided with a local control cabinet and a remote OLTC control panel. The control feature shall provide following:

Local-remote selector switch mounted in the local control cubicle shall switch control of OLTC in the following manner: When the selector switch is in LOCAL position, it shall be possible to operate the RAISE LOWER control switches specified in section (ii) below. Remote control of RAISE-LOWER functions shall be prevented.

When the selector switch is in REMOTE the local control cubicle mounted RAISE LOWER Switches specified in Section (ii) shall be inoperative. Remote control of the raise lower function shall be possible from the remote control panel. The LOCAL-REMOTE selector switch shall have at least two spare contacts per position which are closed in that position but open in the other position.

Operating mechanism for on load tap changer shall be designed to go through one step or tap change per command. Subsequent tap change shall be initiated only by a new or repeat command.

On load tap changer shall be equipped with a time delay for "INCOMPLETE STEP" in alarm consisting of a normally open contact which, closes, if the tap changer fails to make a complete tap change. The alarm shall not operate for momentary loss of auxiliary power.

The selsyn units or approved equivalents shall be installed in the local OLTC control cabinet to provide tap position indication for the transformer.

The OLTC load tap changer shall be equipped with a fixed resistor network capable of providing discrete voltage steps for input to the supervisory system.

Limit switches shall be provided to prevent overrunning of the mechanism and shall be directly connected in the circuit of the operating motor. In addition, a mechanical stop shall be provided to prevent over-running of the mechanism under any condition. Limit switches may be connected in the control circuit of the operating motor provided that a mechanical-declutching mechanism is incorporated.

Thermal device or other means shall be provided to protect the motor and control circuit. All relays, switches, MCBS etc. shall be mounted in the drive mechanism chamber and shall be clearly marked for the purpose of identification.

A permanently legible lubrication chart shall be fitted within the driving mechanism chamber.

A five digit counter shall be fitted to the tap changing equipment to indicate the number of operations completed.

All relays and operating devices shall operate correctly at any voltage between the limits specified.

It shall not be possible to operate the electric drive when the manual operating gear is in use.

It shall not be possible for any two controls to (i.e. manual, local electrical and remote) be in operation at the same time.

The equipment shall be suitable for supervisory control and indication with make before break multi-way switch, having one potential free contact for each tap position. This switch shall be provided in addition to any other switch/switches which may be required for remote tap position.

All electrical control switches and the local operating gear shall be clearly labeled in a suitable manner to indicate the direction of tap changing.

Manual control:

The cranking device for manual operation of the OLTC gear shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with the following:

(i) Mechanical tap position indicator which shall be clearly visible from near the transformer.

(ii) A mechanical operation counter.

(iii) Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.

(iv) The manual control considered as back up to the motor operated load tap changer control shall be interlocked with the motor to block motor-start-up during manual operation. The manual operating mechanism shall be labeled to show the direction of operation for raising the primary and vice-versa.

5.9.6 Electrical control:

This includes the following:

(i) Local Electrical control

(ii) Electrical remote control from remote control panel.

(iii) Remote Electrical Group Control

The OLTC control scheme offered shall have provision of remote electrical group control during parallel operation of transformers. This is in addition to independent control of OLTC.

A four position selector switch having MASTER, FOLLOWER, INDEPENDENT and OFF position shall be provided in the remote OLTC control panel for each transformer. This shall be wired to enable operator to select operation of OLTC in either Master, Follower or Independent mode.

(ii) Out of step relays with timer contacts shall also be provided to give alarm and indication in case of tap positions in all the transformers under group control being not in identical position.

(iii) Master Position - If the selector switch is in MASTER position, it shall be possible to control the OLTC units in the FOLLOWER mode by operating the controls of the MASTER unit Independent operation of the units under FOLLOWER mode shall have to be prevented. However, the units under independent mode will be controlled independently.

(iv) Follower position - If the selector switch is in FOLLOWER mode, control of OLTC shall be possible only from MASTER penal.

(v) Independent Position - In this position of Selector Switch, Control of OLTC of individual unit only shall be possible.

5.10 Cooling Equipment and its controls

5.10.1 Cooling Equipment

Cooler shall be designed using 2x50 % radiators.

Each radiator bank shall have its own cooling fans, shut off valves, lifting lugs, top and bottom oil filling valves, air release plug, a drain valve and thermometer pocket fitted with captive screw cap on the inlet and outlet.

One standby fan for each group shall also be provided and identified with each radiator bank.

Cooling fans shall not be directly mounted on radiator bank which may cause undue vibration.

The exhaust airflow from cooling fan shall not be directed towards the main tank in any case.

Cooling fans for each radiator bank shall be located so as to prevent ingress of rain water. Each fan shall be suitably protected by galvanised wire guard.

Cooling fans motors shall be suitable for operation from 415 volts, three phase 50 Hz power supply and shall conform to IS: 325.

The cooler and its accessories shall be hot painted with corrosion resistant paint.

Each cooling fan motor shall be provided with starter, thermal overload and short circuit protection.

Each radiator shall be provided with:

One shut off valve at the top (minimum 80 mm size) .

One shut-off valve at the bottom (minimum 80 mm size) .

Air release device at the top.

Main & sampling device at the bottom.

Lifting lugs.

Air release device and oil plug on oil pipe connections.

5.10.2 Cooling Equipment Control (ONAN/ONAF COOLING)

(a) Automatic operation control (switching in and out) of fans shall be provided (with temperature change) from contacts of winding temperature indicator. The bidder shall recommend the setting of WTI for automatic change over of cooler control from

ONAN to ONAF. The setting shall be such that hunting i.e. frequent start stop operations for small temperature differential do not occur.

(b) Suitable manual control facility for cooler fans with manual/ automatic selector switches and push buttons shall be provided.

5.10.3 Remote OLTC/Cooler control Panel (RTCC Panel)

The auxiliary devices for remote electrical control of the OLTC and Cooler shall be housed in a separate panel to be placed in the Control room. The panel shall be made of sheet steel of not less than 14 SWG and it shall be duly finished with stove enamel paint. The size and of the control cubicle to be supplied by the bidder shall be 750 mm depth and 2312 mm height and colour opaline green shade no. 275 of B.S.271-C: 1948, respectively. The width of the cubicle to be as per bidders' practice. Control and signal devices required to be mounted in the RTCC Panel shall comprise of the following.

1. Local - Remote selector switch for OLTC .
2. Actuating switch/push; button for electrical raise/lower control.
3. Remote tap position indicator with tap number and corresponding; rated voltage marked on the; instrument. The tap position indicators shall be digital type.
4. A four position selector switch having master follower, independent and off position.
5. Repeater dial of transformer winding temperature indicator.
6. Name plate for each component.
7. Initiating devices and contacts for alarm as well as for indications for discordance in the tap changer if any of the parallel operating transformer.
8. Cubicle lamp actuated by door, switch, space heater power sockets etc. shall be provided inside RTCC panel.
9. Annunciator (facia type) Scheme complete with accessories for the following:
   - (i) Tap changer out of step.
   - (ii) Tap changer motor trip.
   - (iii) Failure of AC supply to the OLTC local control Kiosk.
   - (iv) Fan failure of each group.
     - (i) Control supplies failure main and standby.
     - (ii) Cooler supply failure for each supply.
   - (vii) Two spare windows
   - (viii) OLTC at extreme positions i.e. lowest or highest tap.
10. Signal lamps for:
    - (i) Fan 'ON' for each group.
    - (ii) Standby fan 'ON' for each group.
    - (iii) Cooling system on manual.
    - (iv) Cooling system on automatic control.
    - (v) 415 volts cooler supply auto change over.
    - (vi) Healthy supply to control gear.
    - (vii) Tap change in progress.
11. Emergency stop push button will be provided in local control cubicle as well as on remote tap changer control cubicle panel.
12. 3 No. digital volt meter of 0.5 Accuracy Class (1 for HV , IV& LV) with selector switch should be provided. HRC cartridge fuse shall be provided for HV , IV& LV PT secondary voltage.
13. One No. Ammeter of 0.5 accuracy class for delta winding circulating current (digital).
14. Control & monitoring of RTCC shall be integrated in Sub-station Automation System. Separate Bay control Unit shall be provided for this.

5.10.4 Cooler control cabinet:

(i) Each transformer unit shall be provided with a cooler control cabinet.

(ii) The cooler control cabinet shall have all necessary devices meant for cooler control and local temp. indicators. All the contacts of various protective devices mounted on the transformer shall also be wired up to the terminal board in the cooler control cabinet. All the secondary terminals of the bushing CT's shall also be wired upto the terminal board at the cooler control cabinet.

(iii) The cooler control cabinet shall have two (2) sections. One section shall have the control equipment exclusively meant for cooler control. The other section shall house

the temperature indicators, aux. CT's and the terminal boards meant for termination of various alarm and trip contacts as well as various alarm and trip contacts as well as various bushing CT secondaries. Alternatively the two sections may be provided as two separate panels depending on the standard practices of the supplier.

The temperature indicators shall be so mounted that the dials are not more than 1600 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.
Control & monitoring of Cooler Control shall be integrated in Sub-station Automation System. Separate Bay control Unit shall be provided for this.

Nitrogen injection fire prevention system:
Each oil filled transformer shall be provided with a dedicated Nitrogen Injection system for prevention against the transformer explosion which shall use nitrogen as quenching medium. The system shall prevent transformer oil tank explosion and possible fire in case of internal / external cause.
In the event of fire by external causes such as bushing fire, OLTC fires, fire from surrounding equipment etc., it shall act as a fast and effective fire fighter. It shall accomplish its role as fire preventer and extinguisher without employing water or carbon dioxide. Fire shall be extinguished within reasonable with time (not more than 3 minutes so as not to harm the transformer) of system activation and within 30 seconds (maximum) of commencement of nitrogen injection.
Activation of the system
Mal-functioning of the Nitrogen injection system could lead to interruption in power supply. The supplier shall ensure that the probabilities of chances of malfunctioning of the Nitrogen injection system are practically zero. To achieve this objective, the supplier shall plan out scheme of activating signals which should not be too complicated to make the system inoperative in case of actual need. The system shall be provided with automatic controls to prevent the explosion of transformers. Besides automatic control, remote electrical push button control at Control box and local manual control in the cubicle shall also be provided. Simultaneous activation of the following electrical-signals shall be used for initiating the system under prevention mode/fire extinguishing mode.
Auto Mode
For prevention:
• Differential relay operation.
• Buchholz relay paralleled with pressure relief valve
• Tripping of all circuit breakers (on HV & LV/IV side) associated transformer is the pre-requisite for activation of system.
For extinguishing
• Fire Detector
• Buchholz relay paralleled with pressure relief valve
Tripping of all circuit breakers (on HV & LV/IV side) associated with transformer is the pre-requisite for activation of system.
Manual Mode (Local / Remote)
Tripping of all circuit breakers (on HV & LV / IV side) associated with transformer is the pre-requisite for activation of system.
Manual Mode (Mechanical)
• Tripping of all circuit breakers (on HV & LV / IV side) associated with transformer is the pre-requisite for activation of system.
The system shall be designed to be operated manually in case of failure of power supply to the system.
General description
Nitrogen Injection system should be a dedicated system for each oil filled transformer. It should have a Fire Extinguishing Cubicle (FEC) placed on a plinth at a distance of 5-10 m away from transformer or placed next to the firewall (if fire fighting wall exists). The FEC shall be connected to the top of transformer oil tank for depressurization of tank and to the oil pit (capacity is approximately equal to 10% of total volume of oil in transformer tank / or existing oil pit) from its bottom through oil pipes.

The FEC should house a pressurized nitrogen cylinder (s) which is connected to the oil tank of transformer oil tank at bottom. The Transformer Conservator Isolation Valve (TCIV) is fitted between the conservator tank and Buchholz relay. Cable connections are to be provided from signal box to the control box in the control room, from control box to FEC and from TCIV to signal box. Detectors placed on the top of transformer tank are to be connected in parallel to the signal box by Fire survival cables. Control box is also to be connected to relay panel in control room for receiving system activation signals.

Operation

On receipt of all activating signals, the system shall drain - pre-determined volume of hot oil from the top of tank (i.e. top oil layer), through outlet valve, to reduce tank pressure by removing top oil and simultaneously injecting nitrogen gas at high pressure for stirring the oil at pre-fixed rate and thus bringing the temperature of top oil layer down. Transformer conservator isolation valve blocks the flow of oil from conservator tank in case of tank rupture / explosion or bushing bursting. Nitrogen occupies the space created by oil drained out and acts as an insulating layer over oil in the tank and thus preventing aggravation of fire.

System components

Nitrogen Injection system shall broadly consist of the following components. However, all other components which are necessary for fast reliable and effective working of the system shall deemed to be included in the scope of supply.

MS Storage tank for storage of extracted oil

The MS storage tank of cylindrical shape should be provided for storage of extracted oil. The capacity of tank should be minimum 12% of total oil capacity of transformer.

The MS storage tank should have facility of oil filtration in side the tank. For this 2 No. flanges (one for delivery and the other for suction) should be provided. The suction flange should be connected to the bottom of the tank. The storage tank should be made of 8 mm thick plat. The inner side of the tank shall be painted with 2 coats of heat resistant, oil insoluble, insulating varnish. The outer surface shall be given a primary coat of zinc chromate, second coat of oil & weather resistant varnish of a colour distinct from primary and final two coats of glossy oil and weather resisting light grey paint in accordance with shade No. 631 of IS-5. Adequate size of inspection window should be provided so that tank can be cleaned by manual labour. A vent pipe of adequate diameter shall be provided a breather fitted on it in order to allow breathing of air.

CUBICLE (FEC)

The Cubicle Frame shall be made of CRCA sheet of 3 mm (minimum) thick complete with the base frame, painted inside and outside with post office red colour (shade 538 of IS -5). It shall have hugged / hinged split doors fitted with high quality tamper proof lock. The doors, removable covers and panels shall be gasketted all round with neoprene gaskets. The degree of protection shall be IP55. The following items shall be provided in the Cubicle.

- Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer.
- Oil drain pipe with mechanical quick drain valve.
- Electro mechanical control equipment for draining of oil of pre-determined volume and injecting regulated volume of nitrogen gas.
- Pressure monitoring switch for back-up protection for nitrogen release.
- Limit switches for monitoring of the system. Limit switch for pressure switch/sensor
- Butterfly valve with flanges on the top of panel for connecting oil drain pipe and nitrogen injection pipes for transformer.
- Panel lighting (CFL Type)
- Oil drain pipe extension of suitable sizes for connecting pipes to oil storage tank.
- Space heater.

Control box:

Control box is to be placed in the control room for monitoring system operation, automatic control and remote operation. The following alarms, indications, switches, push buttons, audio signal etc. shall be provided.

- System Oil.
- TCIV open.
- Oil drain valve closed.
- Gas inlet valve closed
- TCIV closed
- Detector trip
- Buchholz relay trip
- Oil drain valve open
- Extinction in progress
- Cylinder pressure low
- Differential relay trip
- PRV trip
- Transformer trip
- System out of service
- Fault in cable connecting fault detector
- Fault in cable connecting differential relay
- Fault in cable connecting Buchholz relay
- Fault in cable connecting PRV
- Fault in cable connecting transformer trip
- Fault in cable connecting TCIV
- Auto / Manual / Off
- Extinction release on / off
- Lamp test
- Visual / Audio alarm for AC supply fail
- Visual / Audio alarm for DC supply fail
- Nitrogen cylinder pressure indication.
- Fire in Transformer.
- Oil drain started.
- Conservator oil isolation valve closed.
- Nitrogen injection started.

As far as possible the control box should be such devised that all the transformers and or group thereof should be controlled from single spot.

The control box shall have one IEC 61850 compliant IED (BCU) of GE/Alstom/ ABB/ Siemens/SEL make, wherein operation of all the major components of NIFPS shall be logged in as time tagged events for analysis and evaluation of operation of NIFPS.

This IED shall be a separate state of art Numerical Bay Control Unit dedicated for the purpose having at least 20 % spare input and 20% spare output contacts over and above the used contacts. This IED (BCU) shall have freely configurable input and output contacts. The BCU shall also have Ethernet/RJ ports for achieving redundancy in Ethernet switch connection. The IED (BCU) shall have self monitoring feature and shall have event logger, disturbance Recorder and on initiation of event, it shall automatically be downloaded at the workstation of substation.

The IED (BCU) shall have IRIG –B port for GPS time synchronizing.

Transformer Conservator Isolation Valve:

Transformer conservator isolation valve (TCIV) to be fitted in the conservator pipe line, between conservator and buchholz relay which shall operate for isolating the conservator during abnormal flow of oil due to rupture / explosion of tank or bursting of bushing. The valve shall not isolate conservator during normal flow of oil during filtration or filling or refilling, locking plates to be provided with handle for pad locking. It shall have proximity switch for remote alarm, indication with visual position indicator. The TCIV should be of the best quality as malfunctioning of TCIV could lead to serious consequence. The closing of TCIV means stoppage of breathing of transformer. Locking plates shall be provided for pad locking.

Detectors:

The system shall be complete with minimum twenty number of detectors (quartz bulb) fitted on the top cover of the transformer oil tank. The bulbs should be provided to ensure

monitoring of all the HV, IV, LV & neutral bushings. Redundancy of detectors should be ensured & clearly brought in the drawing submitted for approval.

Signal box:

It shall be mounted away from transformer main tank, preferably near the transformer marshalling box, for terminating cable connections from TCIV & detectors and for further connection to the control box. The degree of protection shall be IP55.

Cables:

Fire survival cables (capable to withstand 750º C.) of 4 core x 1.5 sq. mm size for connection of detectors in parallel shall be used. The fire survival cable shall conform to BS 7629-1, BS 8434-1, BS 7629-1 and BS 5839-1, BS EN 50267-2-1 or relevant Indian standards.

Fire Retardant Low Smoke (FRLS) cable of adequate size shall be used for connection of signal box / marshalling box near transformer and FEC mounted near transformer with control box mounted in control room. Fire Retardant Low Smoke (FRLS) cable of 4 core x 1.5 sq. mm size shall be used for connection between control box to DC & AC supply source, FEC to AC supply source, signal box / marshalling box to transformer conservator isolation valve connection on transformer. Separate cables for AC supply & DC supply shall be used.

Pipes:

Pipes complete with connections, flanges, bends and tees etc. shall be supplied along with the system.

Other items to be supplied:

(a) Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.
(b) Flanges between Buchholz relay and conservator tank for fixing TCIV.
(c) Detector brackets on transformer tank top cover.
(d) Spare potential free contacts activating the system i.e. in differential relay, Bucholz relay. Pressure Relief Device, Circuit breaker of transformer.
(e) Pipe connections between transformer and FEC and between FEC and oil pit required for collecting top oil.
(f) Cabling for detectors mounted on transformer top cover.
(g) Inter cabling between signal box, control box and FEC.
(h) Butterfly valves / Gate valves on oil drain pipe and nitrogen injection pipe which should be able to withstand full vacuum.
(i) Supports, signal box etc. which are to be painted with enameled paint.
(j) Any other item required for satisfactory operation of system.

Power supply

For Control Box 220 V DC

For FEC Auxiliary 230 V AC

Spares for three (3) years Operation & Maintenance

The bidder apart from the below mentioned spares shall submit a list of recommendation spares for three years trouble free operation of the equipments and also furnish unit rates. The owners will scrutinize the said list and decide on the items on spares to be ordered and the quantities. These spares shall be supplied by the bidder before end of guarantee period. The owner reserves right to order the spares with twelve (12) months from the date of order for main equipments and the rate shall be kept valid till this date. The prices of these spares shall not be considered for evaluation of the bid.

Mandatory Spares

Cylinder filled with Nitrogen of required Capacity per transformer - 1 No.

Detectors per transformer 3 no.

Regulator assembly per sub-station 1 No.

Modification on the transformer

No modification on the transformer shall be allowed which affects its performance (i.e. efficiency, losses, heat dissipation ability etc.) safety, life etc. or it's any other useful parameter. This requirement shall be paramount importance and shall form the essence of the contract. However, in any case, performance of transformer should not be affected in any manner by having Nitrogen Injection Fire Prevention Cum Extinguishing System (NIFPS)

and the Bidder / Sub-vendor shall give an undertaking to this effect. All pipes should be washed / rinsed with transformer oil. If any damage is done to the transformer and / or any connected equipment during installation & commissioning full recovery therefore shall be effected from the Bidder /Sub-vendor, of NIFPS system.

It shall be solely the responsibility of bidder / Sub-vendor to install, carry out pre-commissioning tests & commission NIFPS at the mentioned Sub-Station in this specification, to the entire satisfaction of the CSPTCL.

Interlocks:

It shall be ensured that once the NIFPES gets activated manually or in automode, all the connected breakers shall not close until the system is actually put in OFF mode. Also PRV shall get closed only if all the connected breakers are open.

Tests:

Bidder has to carry out the type test as per relevant IS/IEC. Specifically IP 55 on FEC or have to produce the report from NABL approved Lab. Reports of all routine test conducted as per relevant IS/IEC standards in respect of various bought out items including test reports for degree of protection for FEC / control box / signal box shall be submitted by the supplier.

The supplier shall demonstrate all the functional test associated with the following as Factory Acceptance Tests:

- FEC, Control Box
- Fire Detector
- Transformer Conservator Isolation Valve

The performance test of the complete system shall be carried out after erection of the system with transformer at site. Detailed layout drawings, equipment drawing along with 4 sets of Operation and Maintenance manual along with soft copies (In CDs) shall be submitted by the supplier along with the consignment. The guaranteed and other technical particulars for the offered system are indicated in Section - "Guaranteed and Other Technical Particulars". Any other particulars considered necessary in addition to those listed in that Section may be furnished by the Bidder.

Terminal Block:

(i) The terminal blocks to be provided shall be fully enclosed with removable covers and made of moulded, non inflammable plastic material with block and block and barriers moulded integrally. Such block shall have washer and binding screws for external circuit wire connections, a white marking strip for circuit identification and molded plastic cove. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring.Stud type terminal connectors shall be provided.

(ii) All internal wiring to be connected to the external equipment shall terminate on terminal bocks, preferably vertically mounted on the side of each panel. The terminal blocks shall be 1100 V grade and have 10 amps continuous rating, molded piece, complete with insulated barriers, non-disconnecting stud type terminals, washers, nuts and lock nuts. Terminal block design shall include a white fiber-marking strip with clear plastic, slip-on / clip-on terminal cover. Markings on the terminal strips shall correspond to wire number and terminal numbers on the wiring diagrams.

(iii) Terminal blocks for current transformer secondary leads shall be provided with test links and isolating facilities Also current transformer secondary leads shall be provided with short-circuiting and earthing facilities.

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

(v) Unless otherwise specified, stud type terminal blocks shall be suitable for connecting the following conductors on each side.
   (a) For all circuits except current transformer circuits minimum of two nos. 2.5 mm2 copper.
   (b) For all CT circuits minimum of two nos. 4 mm2 copper.

(vi) There shall be a minimum edge to edge clearance of 250 mm between the first row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be minimum of 150 mm.

(vii) Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run parallel and in close proximity along each

side of the wiring duct to provide for convenient attachment of internal panel wiring. All adjacent terminal block shall also share this field wiring corridor. A steel strip shall be connected between adjacent terminal block rows at 450 mm intervals for support of incoming cable.

5.12 Painting:

The internal and external surfaces including oil filled chamber and structural steel work to be painted shall be shot or sand blasted to remove all rust and scale or foreign adhering matter or grease. All steel surfaces in contact with insulating oil shall be painted with two coats of heat resistant, oil insoluble, insulating varnish. All steel surfaces exposed to weather shall be given a primary coat of zinc chromate, second coat of oil and weather resistant varnish of a colour distinct from primary and final two coats of glossy oil and weather resisting Light Gary paint in accordance with shade no.631of IS-5.

All paints shall be carefully selected to withstand extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

The minimum thickness of outside painting of tank shall be 20 microns and the total thickness shall be minimum 80 microns.

Bolts and nuts:

All bolts and nuts exposed to weather shall be hot dip galvanized. Bolts and nuts below H12 (1/2 inch) size shall be stainless steel.

5.14 Wiring and cabling.

(a) Cable box/ sealing end shall be suitable for following types of cables:-

i)	415 volt Power	1100 Volt grade PVC insulated aluminum conductor cable
ii)	Control	1100 Volt grade PVC insulated 7/0.737 mm stranded copper conductor cable.

(b) Compression type cable connector shall be provided for termination of power and control cables.

(c) All controls, alarms, indicating and relaying devices provided with the transformer shall be wired up to the terminal blocks inside the Local Control Cabinets (both cooler and OLTC Control Cabinets)

(d) Not more than 2 wires shall be connected to one terminal. Each terminal shall be suitable for connecting two 7/0. 73 mm stranded copper conductors from each side.

e) All terminal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminal blocks.

(f) Engraved code identification plastic ferrules marked to correspond with schematic diagrams shall be fitted at both ends of wires. Ferrules shall fit tightly on wires and shall not fall off when the wire is disconnected from terminal block.

5.15 Marshalling box:

Some of the manufacturers have a practice to directly install winding temperature indicator and oil temperature indicator on the body of the transformer in open. It is obligatory on the part of the bidders to offer a separate marshalling box to enclose such accessories as required in the Tender specification.

5.16 Fittings:

The following fittings shall be provided with each transformer covered in this specification.

(a) Conservator for main tank, with oil filling hole and cap, isolating valves, drain valve, magnetic oil level gauge with low level alarm contacts and dehydrating breather.

(b) Conservator for OLTC with drain valve. Buchholz relay, filling hole with cap, prismatic oil level gauge and dehydrating breather.

(c) Oil preservation equipment.

(d) Pressure relief device alarm contact.

(e) i) Buchholz relay double float type with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts.

ii) Separate surge relay with above features to be provided for OLTC chamber.

(f) Air release plug

(g) Inspection openings and covers.

(h) Bushing with metal parts and gaskets to suit the termination arrangement.

(i) Winding temperature indicators for local and remote mounting. One RWTI with a four point selector switch shall be provided for all the winding (HV/LV).
(j) Oil temperature indicators.
(k) Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs.
(l) Protected type mercury or alcohol glass thermometer.
(m) Bottom and top filter valves with threaded male adapters, bottom sampling valve and drain valve.
(n) Rating and diagram plates on transformers and auxiliary apparatus.
(o) Earthing terminals.
(p) Flanged bi-directional wheels.
(q) Cooler control cabinet.
(r) On load tap changing equipment and OLTC control cabinet.
(s) Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.
(t) Bushing CTs for WTI & REF protection & circulating current in tertiary.
(u) Insulating oil.
(v) Cooling fans.
(w) Terminal marking plate.
(x) Jacking pads.
(y) Lifting bollards
(z) Haulage lugs.
(aa) Cover Lifting lugs.
(ab) Valve schedule plate
(ac) RTCC panel
(ad) Bushing terminal clamp & connector
(ae) On line DGA monitor
(af) NIFPS

Note: The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of the transformer are deemed to be included.

5.17 Limits of temperature rise:

The temperature rise on any part of equipment shall not exceed the maximum temperature rise specified below under the conditions specified in test clauses. The permissible temperature rise indicated is for a maximum ambient temperature of 50 deg. C. If the maximum ambient temperature rises, permissible values shall be reduced accordingly. For actual maximum temperature at the location of installation, refer prefect synopsis.

Sl. No.	Nature of the part or of the liquid	Maximum Value of	
		Temp.	Temp. rise at a max. ambient air temp. not exceeding 50oC
1.	Contacts in air, silver-faced copper, copper alloy or aluminum alloy [see notes (i) and (ii)]	95	40/45
	Bare copper or tinned aluminum alloy.	75	25
2.	Contacts in oil: Silver-faced copper, copper alloy or aluminum alloy (see note ii)	90	40
	Bare copper or tinned aluminum alloy.	80	30
3.	Terminals to be connected to external conductors by screws or bolts silver faced (see note iii)	105	55
4.	Metal parts acting as springs	see note iv	(see note iv)
5.	Metal parts in contract with insulation of the following classes:		
	ClassY:(for non-impregnated materials)	90	40

	Class A: (for materials immersed in oil or impregnated)	100	50
	Class E: in air in oil	100 120	70 50
	Class B: in air in oil	130 100	80 50
	Class F: in air in oil	155 100	105 50
	Enamel: oil base Synthetic, in air Synthetic, in oil	100 120 100	50 70 50
6.	Any part of metal of or insulating material in contact with oil, except contacts	100	50
7.	Oil	90	40

Notes: i) When applying the temperature rise of 40/45 deg.C. care should be taken to ensure that no damage is caused to the surrounding insulating materials.

ii) The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test. Otherwise, the contacts shall be regarded as "bare".

iii) The values of temperature and temperature rise and valid whether or not the conductor connected to the terminals is silver-faced.

iv) The temperature shall not reach a value where the elasticity of the material is impaired. For pure copper, this implies a temperature limit of 75 deg.C.

5.18 specification for control CABINETS:

Control cabinets shall be of the free standing floor mounting type.

Control cabinet of the operating mechanism shall be made out of 3mm thick sheet or 10mm thick aluminum plate or casting. Hinged door shall be provided with padlocking arrangement. Sloping rain hood shall be provided to cover all sides 15mm thick neoprene or better type of gaskets shall be provided. Colour of paint shall be olive Green in accordance with shade no 220 of IS 5.

Bus bars shall be of tinned copper of adequate cross section to carry the normal current, without exceeding the permissible temperature rise over an ambient temperature of 50 deg. C outside the cubicle. The buses shall be designed to withstand forces corresponding to short circuit current of 25 KA.

Motors rated 1 kw and above being controlled from the control cabinet would be suitable for operation on a 415 V, 3 phase 50 Hz system. Fractional kw motors would be suitable for operation on a 240 V, 1-phase, 50 Hz supply system.

Isolating switches shall be group operated units (3 pole for use on 3- phase supply systems and 2 pole for single phase supply system) quick make quick break type, capable of breaking safely and without deterioration, the rated current of the associated circuit. Switch handle shall have provision for locking in both fully open and fully closed positions.

Push button shall be rated for not less than 6 Amps, 415 V A.C or 2 Amps, 220V D.C and shall be flush mounted on the cabinet door and provided with appropriate name plates. Red, Green and Amber indicating Lamps shall be flush mounted.

For motors upto 5 KV, contactors shall be direct-on-line, air break, single throw type and shall be suitable for making and breaking the stalled current of the associated motor which shall be assumed equal to 6.5 times the full load current of the motor at 0.2 p.f. For motors above 5 KW, automatic star delta type starters shall be provided. 3 pole contactors shall be furnished for 3 phase motors and 2-pole contactors for single phase motor. Reversing contactors shall be provided with electrical interlocks between forward and reverse

contactors. If possible, mechanical interlocks shall also be provided. Contactors shall be suitable for uninterrupted duty and shall be of duty category class AC4 as defines in IS: 2959. The main contacts of the contactors shall be silver plated and the insulation class for the coils shall be class E or better. The dropout voltage of the contactors shall not exceed 70% of the rated voltage.

Contactors shall be provided with three elements positive acting, ambient temperature compensated, time lagged, hand reset type thermal overload relay with adjustable setting. Hand reset button shall be flush with the front door at the cabinet for resetting with starter compartment door closed.

Single phasing preventer relay shall be provided for 3 phase motors to provide positive protections against single phasing.

Mini starters shall be provided with no volt coils whenever required.

Power cables of 1100/650 volts grade stranded aluminum conductor. PVC insulated, PVC sheathed single steel wire armoured and PVC jacketed shall be used. All necessary cable terminating accessories such as glands, crimp type tinned copper lugs etc. for power as well as control cables shall be included in Bidder's scope of supply. Suitable brass cable glands shall be provided for cable entry.

Wiring for all control circuits shall be carried out with 1100/650 volts grade PVC insulated tinned copper stranded conductors of sizes not smaller than 2.5 mm. Atleast 20% spare terminal blocks for control wire terminations shall be provided on each connecting stand type. All terminals shall be provided with ferrules indelibly marked or numbered and these in identifications shall correspond to the designations on the relevant wiring diagrams. The terminals shall be rated for adequate capacity which shall not be less than 10 Amps.

Separate terminal blocks shall be provided for terminating circuits of various voltage classes. CT loads shall be terminated on a separate block and shall have provision for short circuiting the CT secondary terminals.

Control cabinet shall be provided with 240 V, 1 phase 50 Hz, 20 W fluorescent light fixture and a suitable rated 240 V, 1 phase, 5 Amps, 3 Pin socket for hand lamps.

Space heaters shall be provided inside each cabinet complete with thermostat (preferably differential type) to prevent moisture condensation. Heaters shall be controlled by suitably rated double-pole miniature Circuit Breakers.

Single lamps provided shall be of neon screw type with series resistors, enclosed in bakelite body. Each single lamp shall be provided with a fuse integrally mounted in the lamp body.

Electric measuring instruments shall be of moving iron type. Ammeters for measuring current upto 30 Amps shall be directly connected through suitable CTs. Ammeters shall be provided with selector switches.

Items inside the cabinet of organic material shall be coated with a fungus resistant varnish.

Please note that all DC operated push buttons/ contactors/ coils should be provided with 220 volt DC.

5.19 Motors:

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment. Motors shall conform to IS 325.

6.0 Tests:

The type test reports of the transformer (as per latest version of IS: 2026) of offered or higher rating conducted at Govt. / Govt. approved laboratory or witnessed by Govt. / Govt. approved laboratory representative should be submitted along with the bid. The type tests should not be older than five years.

Copies of all routine test reports as per latest version of IS:2026 on offered or higher rating transformer conducted within five years on due date of opening should also be submitted with the bid.

All routine and additional routine tests shall be carried out on each transformer. The type and special tests mentioned in clause 6.2 shall be carried out on one unit out of the lot. All routine & type tests shall be witnessed by representative of CSPTCL & ERDA/CPRI or any other agency authorized by CSPTCL.

The charges for conducting each type test and special tests shall be indicated separately in the relevant schedule.

6.1 Routine tests:-

All standard routine tests in accordance with IS: 2026 (with latest amendment), with dielectric tests as per IS:2026 part-III (with latest amendment) shall be carried out on each transformer. Further some additional routine tests shall also be carried out on each unit.

The list of routine and additional routine tests shall be carried out on each unit according to the methods specified in IS:2026 (Part-I):2011 and IS:2026 (Part-III):2009. The details

Sl.	Particulars
(A) Routine tests:	
1	Measurement of winding resistance
2	Measurement of voltage ratio and check of phase displacement
3	Measurement of Impedance voltage/ short circuit impedance (Principal tap) & load loss
4	Measurement of no load loss & current
5	Measurement of Insulation resistance
	Dielectric routine tests as per IS:2026 (Part-III) i.e. lightning impulse tests on all phases of HV/IV/LV windings, short duration induced AC withstand voltage tests, separate source AC withstand voltage tests
7	Tests on load tap changers
(B) Addl. Routine Tests:	
1	Dimensional checks as per approved drawing & specification
2	Magnetic circuit test. After assembly ,core shall be tested for 1 minute for 2000 volts AC between all bolts, side plates & structures steel works
3	Polarisation index – IR value for 15 sec, 60 sec & 600 sec duration shall be recorded and PI for 600/60 sec and DAR i.e. ratio of IR values of 60/15 seconds shall be recorded. The PI value (600/60 sec) should be >=2 and DAR value (60/15 sec) should be >=1.3. These values should be recorded both before and after HV tests.
4	Tank oil leakage test – the complete transformer assly filled with oil shall be subjected to nitrogen pressure of 0.35 Kg/cm2 above the normal oil head for a period of 12 Hrs to ensure that there is no oil leakage.
5	Capacitance and tan delta measurement to determine capacitance between winding and earth. This test should be carried out before and after series of dielectric tests.
6	Tan delta & capacitance Test on bushings (Before and after HV tests)
7	Checking of recording of IR values
	(a) Between core & coil frame
	(b) Between core & tank
	(c) Between coil frame & main tank The measured IR values should be more than 1000 M Ohms.
8	Magnetic balance test (Before and after HV tests)
	Magnetising Current Tests on all three windings with LT voltage (Before and after HV tests)
9	Tests of PRDs for successful operation
10	Oil BDV test before & after HV tests
11	Sweep Frequency response analysis (SFRA) - SFRA shall be carried out at manufacturer's works with his own SFRA test set. The test shall be repeated at site with same test set.
12	Measurement of DEW point prior to dispatch of the unit filled with N2 gas prior to dispatch - This test shall be carried out by manufacturer and results shall be submitted to CSPTCL for reference.
13	Cooler Control and RTCC Functional checks
14	Functional checks on Air cell
15	Ratio and polarity tests on Bushing Turret CTs
16	Functional checks on Buchholz Relay

Note: All testing equipments viz. CT,PT, ampere-meter, volt-meter, watt meter, frequency meter, power analyzer, Insulation resistance test kit, winding resistance test kit, winding turns ratio test kit, tan delta & capacitance measurement test kit, potential divider, temperature sensors, etc. shall be of appropriate class of accuracy and shall havevalid calibration certificates from NABL accredited labs.

6.2 Type/ special tests to be carried out on one transformer out of lot:

Following tests shall be conducted on one transformer of each lot.

6.2.1 Temperature Rise Test:

This test as per cl. 16.8 of IS:2026 (Part-I) and IS:2026 (Part-II) shall be conducted at the lowest voltage tap having maximum current with 10% over load condition. The supplier before carrying out such tests, shall submit detailed calculations showing the alternatives possible, on various taps and for different ratings (ONAN/ONAF), of the transformer and shall recommend the combination that results in highest temperature rise, for the test. Since 160 MVA transformer is an auto transformer, the temperature rise test shall be conducted for the condition of simultaneous loading of all three windings for their respective ONAF rating i.e.220KV and 132 KV winding corresponding to current of 160 MVA, and 33 KV winding for 53.33 MVA. Loading on two windings for 160 MVA transformer for the measured losses will not be accepted. Gas chromatographic analysis of oil shall be conducted before and after heat run test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC-567. For the evaluation of the gas analysis in temperature rise test, a method will be proposed which is based on the rate of increase of particular gases and the permissible limits of minimum detectable value of gases and the maximum limit will be mutually discussed and agreed upon between the Purchaser and Supplier. This shall be treated as reference during maintenance of transformer in future.

The calibration of OTI and WTI shall be done by Transformer Manufacturer and these calibrated OTI, WTI shall be used during testing of transformer. The Sr.No.of WTI,OTI shall be recorded during testing of transformer and these indicators only shall be supplied with the transformer. During test the manufacturer selects suitable tap from CT based on gradient between the reading of WTI & OTI. This tap position is to be clearly recorded on test report so that selection of correct tap could be done at site to avoid discrepancy in temperature gradient recorded during factory test and the value recorded at site.

6.2.2 Tank vacuum test as per details given this clause subsequently.

6.2.3 Tank pressure test as per details given in this clause subsequently.

6.2. Pressure Relief Device Test:

The pressure relief device of each size shall be subjected to increase in oil pressure. It shall operate before reaching the test pressure specified in 'tank Tests' subsequently in this clause device shall seal off after the excess pressure has been relieved.

6.2.5 Following special tests other than above mentioned tests shall also be carried out as per "IS: 2026 part-I and part-III (with latest amendment) as applicable on one unit out of the ordered lot.

(i) Measurement of zero Seq. Reactance.
(ii) Measurement of acoustic noise level.
(iii) Measurement of power taken by fans.
(iv) Measurement of harmonic level in no load current.
(v) Lighting impulse with chop on tail on all 3 phase of HV and LV terminals.
(vi) One cooler cabinet and OLTC cabinet of the transformers (preferably for thefirst unit of the lot) shall be tested for IP:55 protection in accordance with IS: 2147. In case facility for this test is not available with the manufacturer or their vendor; the test has to be carried out at the laboratory of either CPRI or ERDA in presence of CSPTCL's representative and test report should be furnished.

6.2.6 Tests on Assembled Transformer:

a) Check completed transformer against approved out line drawing, provision for all fittings, finish level etc.
b) Jacking test on the assembled Transformer.

6.3 Tank Tests

6.3.1 Routine Tests: Oil leakage test:

This test will be conducted on each transformer. All tanks and oil filled compartments shall be tested for oil tightness by completely filling with air or oil of a viscosity not greater than that of insulating oil conforming to IS: 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/sq m measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours for oil and one hour or air during which time no leak shall occur.

6.3.2 Tests to be conducted on one tank out of lot:

(i) Vacuum Test

One transformer tank out of the whole lot shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m 2 absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below.

orizontal length of flat plate (in mm)	Permanent Deflection (in mm)
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

(ii) Pressure Test

One transformer tank of each size together with its radiator, conservator, vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m 2 whichever is lower, measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released, should be within the limits specified in the table given at (i) above.

6.4 TESTS AT SITE: After erection at site, the transformer shall be subject to the following tests, in presence of manufacturer's engineer.

6.4.1 Tests on reaching at site:

(i) Immediately upon receipt of transformer at site and before unloading of transformer from trailor, core earthing, end frame earthing and tank earthing shall be checked. Only after satisfactory verification that there is not multiple core earthing in transformer, unloading of transformer shall be undertaken.

(ii) After receipt of transformer at site physical inspections shall be done for checking any physical damage to transformer tank and accessories. Further, data of impact recorder shall be analyzed for any changes before unloading of transformer.

6.4.2 Pre commissioning tests at site:

(i) Insulation resistance test and polarization index.
(ii) Ratio and polarity test
(iii) DGA of oil and di-electric, tan delta and moisture content test of oil.
(iv) OLTC operational test at each tap for lower and raise operation of tap changer.
(v) Magnetic balance tests and measurement of magnetizing current.
(vi) Vector group test
(vii) Short circuit current measurement at low voltage and at all taps
(viii) Measurement of winding resistance at all taps
(ix) Tangent delta and capacitance of Transformer
(x) Tangent delta, capacitance and insulation resistance tests of bushings
(xi) Leakage current between core & tank, core & end frame, end frame and tank and between short circuited links and neutral in grounded and ungrounded conditions.
(xii) Dew point measurement and recording of pressure of nitrogen gas.
(xiii) SFRA test.

The SFRA test and Dew point measurement shall be carried out in presence of manufacturer's representative. The test kits shall be same as used for carrying out these tests in the factory and shall be brought by manufacturer's representative.

6.4.3 Pre commissioning checks at site:

a) Check the colour of silica gel breather.
b) Check the oil level in the breather housing, conservator tank, cooling system, condenser housing etc.
c) Check the bushings for conformity of connection to the line etc.
d) Check for correct operation of all protection and alarms.

i) Buchholz relay
ii) PRV
ii) Excessive winding temperature
iii) Excessive oil temperature

e) Low oil level indication
f) Check for adequate protection on electric circuit supplying the accessories.
g) Check for cleanliness of the Transformer and the surroundings

6.5 Test reports

6.5.1 Copies of certified test reports and oscillograms shall be submitted for approval prior to dispatch of the equipment. The equipment shall be dispatched only when all the required type and routine tests have been carried out and test reports have been approved by the purchaser.

6.5.2 Copies of the test reports for the tests carried out on the ancillary apparatus shall be furnished to the purchaser for approval prior to dispatch.

6.5.3 All auxiliary equipment shall be tested as per the relevant standard. Test certificate shall be submitted for bought out items.

6.6 Apart from rejection due to failure of the transformer to meet the specified test requirements the transformer shall be liable for rejection on any one of the following reasons.
No load loss exceeds the values mentioned in schedule-I
Load loss/Auxiliary exceeds the specified values mentioned in schedule-I
Impedance voltage value exceeds the guaranteed value plus tolerance.

7.0 INSPECTION AND TESTING:

7.1 Inspection:

7.1.1 The Purchaser shall have access at all times to the works and all other places of manufacture where the transformers are being manufactured and the bidder shall provide all facilities for unrestricted inspection of the bidders works, raw materials, manufacture of all the accessories and for conducting necessary tests as detailed herein.

7.1.2 The successful bidder shall keep the purchaser informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages, so that arrangements could be made for inspection.

7.1.3 No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

7.1.4 The acceptance of any quantity of transformer & its accessories shall in no way relieve the successful bidder of his responsibility for ;meeting all the requirement of this specification and shall not prevent subsequent rejection if such equipments are later found to be defective.

7.1.5 Acceptance of condition regarding stage inspection at various stages, which will be intimated to successful bidders, shall be an essence of the contract to be placed against this tender.

7.2 Inspection programme:

7.2.1 The bidder shall chalk out a detailed inspection and testing programme for manufacturing activities for the various components. An indicative programme of inspection as envisaged by the CSPTCL is given in Annexure-VII. Stage inspection of core & winding and final inspection of the transformer shall be carried out at manufacturer's works in presence of CSPTCL's representative and representative of a third party i.e. CPRI/ ERDA or any other agency authorized by CSPTCL. The expenses on witness of tests by third party shall be borne by CSPTCL.

7.2.2 The routine tests on each transformer is to be carried out free of cost by the bidder. The rates for type & special tests for one transformer should be separately offered and the same shall be payable by CSPTCL.

7.3 Stage inspection:

7.3.1 The manufacturer shall indicate the inspections and checks carried out at various stages of the manufacture of the transformers. A complete record of stage inspection would be kept by the manufacturer and thus record should be made available for inspection by the representative of CSPTCL. The manufacturer should indicate the manufacturing programme and CSPTCL will have a right to depute its inspecting officers during the manufacture. Some of the inspecting stages are coil winding and core building, assembly of coil on core, the condition of the coil and core after the treatment in vacuum chamber, assembly within the transformer tank together with application of tap changer.

7.3.2 It may be noted that stage inspection for all the units at CSPTCL's discretion shall be done at manufacturer's works in presence of CSPTCL's representative and representative of third party authorized by CSPTCL at the following stages.

(a) Fabrication stage of tank: After fabrication, tank shall be inspected for measurement of its dimensions, thickness of sheets used and leakage test by applying requisite pressure/ vacuum.

(b) Building up of core: After the core is built but before its clamping, our representative will inspect the core to take complete weight of the core and also to measure approximate core loss. If necessary, a small strip of core shall also be taken for testing at CPRI/ ERDA or at any other testing laboratory of repute.

(c) Preparation of winding: Once the coils are prepared but before the same are fitted on to the core, stage inspection shall be done to take various measurements and also for weighment of total weight of coil of each voltage class. Measurement of resistance shall be taken and for this purpose, a small piece of conductor for each type of winding shall be made available by the manufacture. The magnetic balance test shall also be carried out during this stage inspection.

(d) Core Coil Assembly.

Apart from the above, CSPTCL also reserves the right to carry out stage inspections at other stages also, for which advance intimation shall be given and all necessary cooperation shall be rendered by the manufacturer.

7.4 Final inspection and testing:

7.4.1 All the routine, additional routine, type and special tests as mentioned in clause 6 shall be carried out as per IS:2026 (Part-I & III) at manufacturer's works in presence of CSPTCL's representative and representative of third party authorized by CSPTCL. In other transformers, routine & additional routine tests shall be carried out as per clause-6 shall be carried out as per IS:2026 (Part-I & III) at manufacturer's works in presence of CSPTCL's representative and representative of third party authorized by CSPTCL. At the time of final inspection, the supplier shall identify each and every item/ accessories of the particular transformer under testing. Unless all the items are identified, the manufacture will not be treated as complete. Serial number of bushings, serial number of tap changer and other details shall be entered into the test report to ensure that these items are not being applied to the subsequent transformer units while testing. Various tests stipulated in IS shall be performed in the presence of our engineers or when the inspection waiver has been given, in such a case, the testing shall be done at the manufacturer's works as per IS stipulations and same should be confirmed by documentary evidence by way of Test Certificate which shall be got approved by us.

7.4.2 The WTI & OTI shall be calibrated during testing of transformer and serial Nos. of these instruments; shall be recorded in test reports. The WTI & OTI used during testing shall be dispatched with the transformer so that installation of same OTI & WTI on transformer is done which are utilized during testing of transformer at supplier's works. The Bushings and Radiators on Transformer (if heat run test is conducted) during testing of transformer at manufacturers works are required to be supplied with the same transformer to avoid any mismatch / misalignment etc. during assembly of transformer. This should be noted for strict compliance and confirmed specifically.

7.4.3 Whenever inspection call for a particular transformer is given, the letter of inspection call will accompany the following:

(a) List of various fittings and accessories, which are ready at the works and will be offered for inspection. The Inspecting Officer will carry the list and check the items declared to have been offered for inspection.

(b) It is expected that before a transformer is finally offered for inspection, internal testing of the transformer for various important parameters like winding resistance, transformer losses, IR values etc. are already done. CSPTCL may ask for Routine test report for such tests before conducting the inspection.

(c) List of testing equipments and instruments which will be used during the inspection of the transformer with their makes, sl. No. and date of calibration, agency who conducted calibration and validity of calibration certificate should also be furnished along with the inspection call.

8. Quality Assurance Plan:

8.1 The Bidder shall invariably furnish following information along with his offer, failing which the offer shall be liable for rejection.

(i) Statement giving list of important raw materials, names of sub-suppliers for the raw material, list of standards according to which the raw material are tested, list of tests normally carried out on raw material in the presence of Bidder's representative, copies of test certificates.

(ii) Information and copies of test certificates as in (i) above in respect of bought out items.

(iii) List of manufacturing facilities available.

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

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

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

(vii) List of testing equipment available with the Bidder for final testing of equipment specified and test. Plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in "schedule of Deviations". The bidder should have power analyzer for testing & all other routine & acceptance tests facilities as per latest amendments of IEC.

9. Design control: The supplier shall furnish the checks exercise in design calculations particularly in respect of short circuit forces and method of clamping end coil to show the healthiness of the design. The salient features of design together with the certificates of design engineers will have to be made available to the CSPTCL.

10. Engineering documents: The supplier shall give complete information regarding copper conductor, insulating paper, core materials, tap changer, gaskets etc. bringing out the detailed description and specification of these items with explanation as to how our requirements are being met in this respect.

11. Procurement document control & purchased material & services: The supplier shall indicate the various sources from whom the items namely copper conductor, insulating paper, core material, tap changer and other items such as gaskets etc. are being procured. The type of check, quantum of check and acceptance norms shall be intimated and random test and check results should be made available for inspection whenever so desired. The vendor list as per Annexure-VI is only acceptable to us & in case any change in vendor list is required, same shall be subject to approval of CSPTCL.

12. Documentation:

12.1 All drawings shall confirm to relevant international standards Organization (ISO) specification. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

12.2 The Bidder shall furnish along with the bid dimensional drawings of transformer, and all other accessories. These drawings shall include the following information.

(i) Dimensions.

(ii) Tolerances on dimensions.

(iii) Material designation used for different components with reference to standards.

(iv) Fabrication details such as welds, finishes and coatings.

(v) Catalogue or part numbers for each component and the total assembly with bill of materials.

(vi) Identification marking.

(vii) Weight of individual components and total assembled weight.

(viii) Foundation drawing.

(ix) G.A. drawings of cooler control cabinet and RTCC panels.

(x) Schematics drawings of OLTC, RTCC and cooler control.

12.3 The bidder shall also furnish four copies per unit of transformer to the owner bound manuals covering erection, commissioning, operation and maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices. Marked erection drawings shall identify the component parts of the equipment as shipped to enable purchaser to carryout erection with his own personnel. Each manual shall also contain

one set of acceptance reports of the corresponding consignment dispatched. These manuals shall be invariably furnished to the purchaser before dispatch of transformer.
The manufacturing of the equipment shall be strictly in accordance with approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the bidder's risk.

13. Packing and forwarding:

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

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

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

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

14. Storage, handling & shipping:

When the transformer is declared ready, the manufacturer has to identify each and every item associated with this unit and a complete packing list shall be prepared in advance. The equipments shall be stored and handling properly in shipping depot, while the same is under process of dispatch. The manufacturer should ensure dispatch of all the related items and accessories with a particular unit of transformer along with tank.
Tap changer, bushing, radiators and other accessories of the transformer should not be withheld for use subsequently on; units for testing purposes. If there are any items procured from sub-vendor which are to be directly installed like instrumentation, panels, control gear etc. test and inspection report for the same will be kept separately and made available to our inspecting officers.
It may be noted that "No change in any accessory or associated equipments after passing all the test successfully shall be allowed and if this is subsequently defected it shall be binding on the bidder to replace with the same item with which the initial test were conducted at his part failing which the entire test shall become null and void. The CSPTCL at its discretion may consider for rejection of the units thus supplied. The entire cost, for replacement of such rejected units thus supplied and for repeating acceptance test, shall be borne by the bidder.

Transportation:

The bidder shall include charges for fitting one Electronic impact recorder (on returnable basis) during transportation of transformers to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the manufacturer during detailed engineering. The recording shall commence in the factory before dispatch and must continue till the unit is installed in its foundation. The data of electronic impact recorder(s) shall be down-loaded at site and a soft copy of it shall be handed over to engineer-in-charge. Further, within three weeks the manufacturer shall communicate the interpretation of the data. In the unlikely event of impact recorder output not available at site, the equipment shall be thoroughly internally inspected by the manufacturer's representative before erection at site to ensure healthiness of the equipment.

(A). In order to conduct low voltage field testing on power transformers before unloading/ commissioning at site to determine the internal condition, the transformer shall be transported with:

(a) Small bushing (12 KV) may be installed on the bushing cover plate to represent the actual bushing.

(b) Winding leads may be routed, secured and electrically isolated from the tank walls and active part.

(c) Temporarily tests leads may be used to connect the winding leads by the small bushings (which will be removed before erection of the main bushings).

(B). Further, the manufacturer shall mount vehicle tracking system (GPRS/ GPS/ GSM based) to track the exact position of the vehicle on which the power transformer is being loaded for transportation and during detailed engineering take approval for the equipment installed.

The details of arrangement for transport configuration of power transformer (which shall be adopted by manufacturer) shall be submitted by the manufacturer to CSPTCL for approval. The price quoted by the bidder should take into account this requirement.

15. Completeness of equipment and bought out items:

The bidders must furnish the following information's along with technical bid.

15.1 A list of all the accessories which will be supplied with the transformer should be furnished. This should be as per Annexure-II & III. While furnishing the list of accessories in schedule-VII items, which will be manufactured by the bidder and balance items, which will be procured from sub-suppliers should be clearly identified and stipulated in the tender.

15.2 It is obligatory on the part of bidder to ensure that supply of all accessories as per Clause 13.1 are made along with Main Tank or prior to delivery of Main Tank so that erection and commissioning work of Transformer can be completed properly and uninterruptedly. The date of supply of last accessory will be treated as date of delivery of transformer and penalty shall be imposed up to a maximum of 10% for delay in supply and supply bills will be processed accordingly.

15.3 The responsibility for obtaining timely supplies of bought out items will rest on the bidder and only on this basis, delivery period will be offered in the tender.

15.4 It may be noted that in case of damages/ shortages due to improper packing or any other negligence, replenishment shall be arranged within one month's time. If this is not done, date of delivery of such accessory will be treated as date of delivery of main equipment and full penalty shall be recoverable from the bidder on total cost of the equipment. This should be confirmed.

For bought out items, responsibility for guarantee and obtaining immediate replacement in case any defects are noticed and in case defective supply of any item is reported, will rest on the tenderer.

15.5 In case for attending to defect in any accessory or inspection/replacement of the accessory, which may be bought out item for the tenderers services of engineer of original manufacturer is required, the same will be organized on immediate basis by the tenderer at his cost.

16. Calculations/ design data required to be submitted with the tender for power transformer:

All the important data of the transformer i.e. net weight of bare copper in each winding, weight of core without clamping fixtures, weight of core and windings, Cross section of the core, Flux density calculations, Calculations for short circuit current and its duration, Current density during short circuit, Calculations showing withstand capability of windings for thermal & mechanical stresses during short circuit conditions, Mechanical design of transformer tank etc should be invariably submitted by the Bidder. After placement of detailed contract the final design calculations shall be submitted for our verification and records.

16.1 Short circuit withstands capability:

In order to ensure capability of transformer to withstand short circuit forces due to most severe fault in our inter connected net work the transformer should be designed on the basis that winding are connected to an infinite bus and fault current is limited by transformer impedance alone, ignoring system impedance. The calculations to prove dynamic and thermal short circuit withstand capability of transformer shall be submitted considering the above for

transformer. The design of winding assembly which is to be furnished in the drawing should be commensurate with these calculations.

16.2 Design of tank:

Complete mechanical design of transformer tank including details of stiffeners shall be submitted. The tank shall be designed to withstand the following without permanent distortion.

(i) Mechanical shocks during transportation.
(ii) Vacuum filling of oil at 10 milli torr in transformer with all fittings.
(iii) Continuous internal pressure of 35 kN/m2 over normal hydrostatic pressure of oil.
(iv) Short circuit forces
(v) Under seismic condition /events both horizontal/vertical .

The calculations for tank stiffeners shall be submitted to prove no. &size of stiffeners are adequate to withstand full vacuum & pressure. Drawing of tank shall be submitted indicating stiffeners.

16.3 Design of static end rings (SER) and Magnetic shunts:

Details of Static End Rings (SER) and magnetic shunts, if provided, shall be submitted with calculations. A drawing indicating locations, size, material of SER and magnetic shunts shall be submitted.

16.4 Overfluxing capability:

A curve to prove suitability of transformer to withstand various Overfluxing conditions for the duration indicated in relevant clause without core saturation shall be furnished.

16.5 Cooling calculations:

Calculations of tank surface for heat dissipation, details of radiators, fans for ONAN & ONAF cooling shall be provided.

16.6 Design Data:

On the basis of offered flux density and current density, the Bidder shall furnish following design calculations & data. :

16.6.1 Core Data:

Details of core material i.e Name of manufacturer, manufacturer's type designation for core , thickness of core, curve for Loss Vs Flux density, No of steps of Core & No of limbs, gross core area, stacking factor, Net core area, height & width of core window, center to center distance of limb, voltage per turn, wt. of core material, working flux density , core loss in watts per kg marked on graph for grade of core material & selected flux density, building factor and calculated no load loss in watts, guaranteed no load loss.

Design data for core shall be submitted. A drawing indicating details of core i.e. limbed construction, step width & thickness, core belting, top & bottom yoke plate etc shall be submitted.

16.6.2 Winding Data:

Wt. of copper for windings i.e. for HV, LV, tap, cross sectional area, current density, type of coil, ID/OD/mean dia of coils, size of winding conductor including parallels, no. of turns per phase, no of spacers, length of mean turn, weight of copper without paper covering, resistance per phase of winding at 75oC, I2R loss at 75oC & normal tap, eddy current & stray loss at 75oC, total copper loss at 75oC, guaranteed transformer losses at 75oC. Complete details of Insulation components i.e. Top & Bottom clamping rings, washers, Pressboard blocks & cylinders, Pressboard spacers & Phase barriers, Pressboard segments etc shall be submitted indicating qty , thickness in mm, width & height, wt. Design data for winding as per clause 31.2.2 shall be submitted. Dimensioned drawings indicating details of winding, ducts, insulation, take off arrangement, clamping ring, pressure points etc shall be submitted.

16.6.3 Quantity of oil:

Complete calculations of oil quantity to be utilized in transformer for first filling shall be submitted. The calculations shall indicate

(i) Volume of tank including turrets, conservator main & OLTC, volume of headers & Radiators, oil quantity in OLTC.
(ii) Oil displacement by Active parts i.e. core - coil assembly,

16.7 Capacity of conservator & size of air cell :

While furnishing details of conservator & air cell type sealing arrangement, the Bidder shall submit details & calculations for adequacy of size and capacity of air cell for the rating of the

power transformer and also for the quantity of oil required. Catalogue of AIR CELL should be enclosed clearly marking type designation of selected size of Air cell. A drawing indicating complete details of conservator with Air cell shall be submitted.

16.8 Capacity of pressure relief device:

Our specification calls for supply of pressure relief device for all power transformers. Bidders must submit calculation to prove that the capacity/ rating of pressure relief device and locations of the same for the transformer will adequately meet our requirement. Constructional and design details of pressure relief device must be furnished and it should be proved by calculation that the size and setting of pressure relief device is adequate considering the rating of the transformer and quantity of oil in the transformer.

A drawing indicating complete details of PRDs & their locations on tank shall be submitted.

16.09 Capacity of Silica gel breather:

The Bidder shall submit details & calculations for adequacy of size and capacity of silica gel breather for the oil quantity in the power transformer.

16.10 Rating of on load tap changer (OLTC):

It has been our experience that due to inadequate rating of OLTC elements, the failure of OLTC components or pitting of contacts have been observed before the claimed period for maintenance. To verify the adequacy and suitability of the OLTC components, it is necessary to furnish the calculations for selecting the proper rating of transition resistance as well as the normal current rating of OLTC. The calculations shall include the temperature rise of the OLTC diverter switch and also the short circuit current considered for calculation of temperature rise.

Calculations shall be submitted to prove that the current rating of OLTC is adequate for the rating of the transformer winding taking in to account the over loading capability as per IS 6600. The basis for selection of transition resistance and its current carrying capacity shall also be submitted. In this regard the circulating current in tap winding during tap change operation through transition resistance shall be taken in to consideration. Adequacy of insulation provided in the OLTC between various parts needs to be established with specific reference to the voltage between two taps. Confirmation shall be given that the OLTC is suitable for bidirectional flow of current. The through current capacity shall be adequate to handle on continuous basis the winding current including over loading as per IS 6600. The through current rating and the rating of transition resistance shall take in to account the short time current rating of the winding. Capability to handle short circuit current to be established by calculations and also by test reports. The above Calculations for OLTC shall be submitted.

16.11 Capacity of Nitrogen /dry air Cylinder, pressure in Nitrogen / dry air Cylinder to be used during transportation of transformer shall be submitted.

16.12 The manufacturer shall carry out optimization of Dielectric design of insulation including electromagnetic design; overload & short circuit withstand capabilities. During design, transformer modeling shall be done & finite element software (FEM) may be used.

It is assured that these data will be kept strictly confidential by CSPTCL.

SCHEDULE-I

GUARANTEED TECHNICAL PARTICULARS

01.	Name of the Manufacturers		
02.	Normal continuous rating of (MVA)		
	(a). With ONAN cooling		
	(b). With ONAF cooling		
03.	Normal ratio of transformation		
04.	Phase connection:		
	a) HV winding		
	b) IV winding		
	c) LV winding		
	d) Vector group reference no. & symbol		
05.	Current at rated no load and on principal taps (Amps) - HV		
	- IV		
	- LV		
06.	Maximum temperature rise:		
	i) of oil by thermometer a) at full ONAN rating b) at full ONAF rating		
	ii) of winding by resistance a) at full ONAN rating b) at full ONAF rating c) by hot spot temperature indicator d) Ambient tep. Adopted		
07.	Temperature gradient between oil and winding		
08.	Voltage to earth for which the star point will be insulated		
09.	LOSSES:		
(a)	No Load Losses :		
	i) Guaranteed no load losses at normal ratio, rated voltage rated out put, rated frequency at 75oC average winding temp. (KW) (no positive tolerance is permissible)		
	ii) No load losses at 110% of rated voltage		
(b)	Load losses:		
	Guaranteed load losses at normal ratio, rated voltage rated out put rated frequency at 75oC average winding temp. at rated output (KW) (no positive tolerance is permissible)		
(c)	Auxiliary losses:		
	Auxiliary losses at rated output (no positive tolerance is permissible)		
10.	Guaranteed total losses at 75oC temp. (i.e. 9 (a)(i) + 9 (b)+9(c)		
11.	Efficiencies at normal ratio, rated voltage, rated frequency and average winding temp. for 75oC average winding temp. for outputs of	At UPF	0.8 PF Lagging
	(i) full load		
	(ii) ¾ full load		
	(iii) ½ full load		
	(iv) ¼ full load		
	(v) Maximum efficiency with load		
12.	Resistance per phase at normal tap of		

	(a) HV winding			
	(b) IV winding			
	(c) LV winding			
13.	Reactance per phase of (at normal tap of (in ohms.)			
	(a) HV winding			
	(b) IV winding			
	(c) LV winding			
	(d) Reactance at rated MVA base			
14.	Resistance voltage drop at 75 degree centigrade average winding temp. expressed as percent of rated voltage			
15.	Reactance voltage drop expressed as percent of rated voltage on rated winding MVA			
16.	Positive sequence Impedance on rated MVA base at rated current & freq. At 75 degree centigrade. Winding temp. between	Normal Tap	Highest Tap	Lowest Tap
	(a) HV – IV			
	(b) HV – LV			
	(c) IV – LV			
17.	Zero sequence Impedance at 75 degree Centigrade & at principle tap.			
18.	Impedence voltage at normal & 75 degree centigrade average winding temp. expressed as percentage of rated voltage.			
	(a) between HV & IV winding			
	(b) between IV & LV winding			
	(c) between LV & HV winding			
	(d) Positive sequence, HV			
	(e) Positive sequence, IV			
	(f) Positive sequence, LV			
19.	Regulation at full load and 75 degree centigrade Unity power factor b. 0.8 power factor (lagging)			
20.	Type of transformer (core or shell)			
21.	Width of track gauge.			
22.	Time in minutes for which transformer can be run at full load without exceeding maximum possible temp. above ambient temp. when:			
	(a) Supply to fan group 1 is cutoff			
	(b) When supply to both groups of fans are cutoff.			
23.	Permissible over loading			
	(a) HV winding			
	(b) IV winding			
	(c) LV winding			
24.	Terminal arrangement for			
	(a) HV winding			
	(b) IV winding			
	(c) LV winding			
25.	Insulation level:			
	(a). L.I. withstand (Kvp)			
	(b). P.f. withstand for one minute (dry and wet.)			
	(c) Switching impulse withstand (KVp)			
26.	Partial discharge level at 1.5xUm/ square root 3 KV RMS in pico coulomb.			

27.	Noise level when energised at normal voltage & frequency without load (db)	
28.	External short circuit withstand capacity (KA) and duration (secs),	220KV– KA for ----- - seconds 132KV – KA for ------ seconds 33 KV – KA for ------ seconds
29.	Over fluxing capability of transformer at over fluxing factor.	
	(a). 1.7	
	(b). 1.4	
	(c). 1.25	
	(d). 1.10	
30.	Details of core:	
(a)	Type of core construction of no. of limbs in frame.	
(b)	Type of core joins.	
(c)	Flux density at rated voltage and frequency and at principle tap Tesla)	
(d)	Flux density at principal tap and at 10% over Voltage (Tesla)	
(e)	Magnetizing current at normal ratio and frequency.	
	(i) 85% of rated voltage	
	(ii) 100% of rated voltage	
	(iii) 105% of rated voltage	
(f)	Power factor of magnetizing current at normal voltage ratio and frequency.	
(g)	Core lamination:	
	(i) Material and grade	
	(ii) Thickness	
	(iii) Voltage per turn	
	(iv) dia of circumscribing circle of core	
	(v) No. of steps in core	
	(vi) Dimensions of core	
	(vii) Net iron area	
	(viii) Specific Iron Loss in watts/Kg of core material at working flux density.	
	(ix) Total Iron loss, KW	
(h)	Details of core Belting:-	
	(i) Material, grade, type	
	(ii) Width	
	(iii) Thickness	
	(iv) Fixing method	
(i)	Core clamping plate (YOKE):-	
	(i) Material	
	(ii) Thickness	
	(iii) Insulation	
	(iv) Depth & height of Yoke	
	(v) Net Yoke area	
	(vi) Flux density in Yoke	
	(vii) Weight of Yoke	
(j)	Describe Location/ method of core grounding	
(k)	Details of oil ducts in core	
31.	Details of windings:	
(a)	Type of winding	
(b)	Material of the winding conductor	

(c)	Maximum current density of windings (at rated current and conductor area)	
	(i) Conductor Area (sq. cm)	
	(ii) Current density (A/sq. cm.)	
(d)	Whether HV windings are interleaved	
(e)	Whether winding are preshrunk	
(f)	Whether adjustable coil clamps are provided for HV, IV and LV windings	
(g)	Whether steel rings used for the windings, If so, whether they are split.	
(h)	Whether electro-static shields are provided to obtain uniform voltage. Distribution in the HV windings	
(i)	Insulating material used for:	
	(a) HV winding	
	(b) IV winding	
	(c) LV winding	
(j)	Insulating material used between	
	(a) HV and IV winding	
	(b) IV and LV winding	
	(c) LV winding and core	
	(d) Regulating winding and earth	
(k)	Type of axial coil supports	
	(a) HV winding	
	(b) IV winding	
	(c) LV winding	
(l)	Type of Radial coil supports	
	(a) HV winding	
	(b) IV winding	
	(c) LV winding	
(m)	(i) Maximum allowable torque on coil clamping bolts:-	
	(ii) clamping ring details	
	- Thickness of ring	
	- Dia of ring	
	- No.& size of pressure screw	
(n)	Power frequency Test voltage for 1 minute withstand test on	
	(a) HV winding	
	(b) IV winding	
	(c) LV winding	
(o)	Impulse test on windings 1.2/50 micro sec. Full wave withstand.	
	(a) HV	
	(b) IV	
	(c) LV	
(p)	Switching surge test	
	(a) HV	
	(b) IV	
	(c) LV	
32	BUSHINGS	
(a)	Type & make	
(b)	Rated voltage class & rated current	
(c)	Dry & Wet flashover voltage	
(d)	Power frequency withstand test voltage for 1	

	minute for wet & Dry (KV rms)	
(e)	Visible corona discharge voltage (KV rms)	
(f)	Partial discharge level	
(g)	Under oil flashover of puncture withstand test voltage (1.2/50 micro sec. Wave.)	
(h)	Full wave impulse withstand test voltage (1.2/50 micro sec.wave.)	
	(i) Positive	
	(ii) Negative	
(i)	Switching withstand test voltage (KV peal)	
(j)	Creepage distance in air (mm)	
(k)	Protected Creepage distance (mm)	
(l)	Recommended gap setting.	
(m)	Weight of assembled bushing, kg.	
(n)	Qty.of oil in ltrs.	
(o)	Whether test tap is provided.	
(p)	Cantilever & Torsional force withstand values.	
(q)	Type of connection lead arrangement & length of condenser portion.	
(r)	Bottom PCD & Details of bolts.	
(s)	Details of bushing current transformers:	
	(i) Quantity	
	(ii) No. of cores	
	(iii) Ratio	
	(iv) V.A. burden	
	(v) Accuracy	
	(vi) Knee point voltage	
	(vii) Magnetizing current at Knee point voltage	
	(viii) Secondary resistance.	
	(ix) Free space required at top for removal of bushing (mm)	
33.	Minimum clearance (mm)	
	(a) HV	
	(b) IV	
	(c) LV	
34.	Approx. weight of following :	
(a)	Core excluding clamping	
(b)	Core with clamping	
(c)	Coil with insulation	
(d)	Wt. of steel	
(e)	Core and winding	
(f)	Fittings and parts	
(g)	Oil required for first filling including 10% extra.	
(h)	(i) Transportation wt. excluding accessories.	
	(ii) Shipping details:	
	- Approx. wt. Of heaviest package	
	- Approx. dimension of largest package	
(i)	Un-tanking weight	
(j)	Total weight of transformer with oil and fittings	
35.	Details of Tank	
(a)	Type of tank	
(b)	Approx. thickness of sheet	
	(i) Sides	
	(ii) Bottom	
	(iii) Cover	

	(iv) Details of stiffener & under carriage	
(c)	Vacuum recommended for hot oil circulation (torr.)	
(d)	Vacuum to be maintained during oil filling in transformer tank (torr.)	
(e)	Vacuum to which the tank can be subjected without distortion (torr.)	
(f)	No. of bi-directional wheels provided	
(g)	Please note that only bell tank design is acceptable. Please confirm that offered transformers are of bell tank design.	
36.	Conservator:	
	(a) Thickness of sheet	
	(b) Size	
	(c) Total volume (Liters)	
	(d) Volume between the highest and lowest visible oil levels (Ltrs)	
	(e) Power required by heaters (if provided) (KW)	
37.	Details of oil preserving equipment offered (Air Cell) please indicate type, make & size.	
38.	Radiator:	
	(a) overall dimensions, 1xbxh (mm)	
	(b) Total weight with oil (Kg)	
	(c) Total weight without oil (Kg)	
	(d) Thickness of Radiator tube (mm)	
	(e) Types of mounting	
	(f) Vacuum withstand capability	
39.	Cooling System	
	(a) Make and type	
	(b) No. of connected units	
	(c) No. of standby units	
	(d) Rated power input	
	(e) Capacity (cu. M/min or litres/min	
	(f) Rated voltage (volts)	
	(g) Locked motor current	
	(h) Efficiency of motor at full load (percent)	
	(i) Temperature rise of motor at full load (degree centigrade)	
	(j) BHP of driven equipment	
	(k) Temperature range over which control is adjustable	
	(l) Whether the fan suitable for continuous operation at 85% of their rated voltage	
	(m) Estimated time constant in hours for i) Natural cooling ii) Forced air cooling	
	(n) Period of continuous working at full load with out fans (in min.)	
	(o) Continuous MVA rating without fans, MVA	
40.	Gas and oil operated relay (make, type, rang of setting etc.)	
41.	Temperature indicator	
	(a) Make and type	
	(b) Permissible setting rang for alarm & trip	
	(c) Number of contacts	

	(d) Current rating of each contact	
	(e) Whether remote indicators provided. If so whether equipment required at purchaser's control room's included	
42.	Approximate over all dimension of transformer in mm.	
	(i) Length	
	(ii) Breadth	
	(iii) Height	
43.	Minimum clearance height for lifting core and winding from tank	
44.	Minimum clearance height for lifting core and winding from tank	
45.	Please confirm transformer will be transported with oil/nitrogen gas	
46.	Lifting jacks	
	(i) Governing standard	
	(ii) No. of jacks on one set	
	(iii) Type and make	
	(iv) Capacity (tonnes)	
	(v) Pitch (mm)	
	(vi) Lift (mm)	
	(vii) Height in closed position (mm)	
	(viii) Mean diameter of thread (mm)	
47.	Marshalling kiosk	
	(i) Make and type	
	(ii) Details of apparatus proposed to be housed in the kiosk	
48.	Details of anti earthquake device provided, if any	
49.	Tap changing equipment (these details refer to the basic rating of OLTC. As guaranteed by manufacturer)	
	(i) Make	
	(ii) Type	
	(iii) Power flow direction /bi-directional / restricted bi- directional	
	(iv) Rated voltage to earth (kv)	
	(v) Rated current (amps.)	
	(vi) Step voltage (volt)	
	(vii) Number of steps	
	(viii) Control manual /Local electrical /remote electrical	
	(ix) Voltage control automatic /non automatic	
	(x) Line drop compensation provided /not provided	
	(xi) Parallel operation	
	(xii) Protective devices	
	(xiii) Auxiliary supply detail	
	(xiv) Time for complete tap change (one step) in sec.	
	(xv) Divertor selector switch transient time (cycles)	
	(xvi) Value of maximum short circuit current (amps)	
	(xvii) Maximum impulse withstand test voltage	

	with 1.2/50 micro-seconds full wave between switch assembly and ground (kv peak)	
	(xviii) Maximum impulse frequency test voltage between switch assembly land earth (kv rms)	
	(xix) Maximum impulse withstand test voltage with 1.2/50 microseconds across the tapping range (kv peak)	
	(xx) Approximate overall dimensions of tap changer (hxwxd)	
	(xxi) Approx. overall weight (kg)	
	(xxii) Approx. mass of oil (kg)	
	(xxiii) Particulars of the O.L.T.C. control cubicle	
50.	Driving mechanism box (a) Make and type (b) Details of apparatus proposed to be housed in the box.	
51.	Please enclose list of accessories and fittings being provided on transformer. Please confirm these are as stipulated in tender.	
52.	Whether the transformer covered have been fully type tested and if so, whether copies of type test certificates enclosed with tender.	
53.	Valves: indicate details of valves, their type, sizes and no. required/ fitted	
54.	a) type and make of pressure relief devices	
	(b) No. of each type pf devices per transformer	
	(c) Minimum pressure at which device operates.	
55.	Please give details of PRV like make, rating etc.	
56.	Characteristics of Insulating oil to be used	
(a)	Density in gms/cu. Cm	
(b)	Kinetic viscosity in cst	
(c)	Interfacial Tension at 27oC in N/M	
(d)	Flash point in oC	
(e)	Pour point in oC	
(f)	Acidity (Neutralization/Value)	
(g)	Corrosive Sulphur in %	
(h)	Electric strength Breakdown	
	a) As received Voltage (KV rms)	
	b) After treatment (KV rms)	
(i)	Dielectric dissipation factor (tan delta) at 90 oC	
(j)	Saponification value in mg of KOH/gm	
(k)	Water content in ppm	
(l)	Specific resistance	
	(i) at 90 oC ohm/cm	
	(ii) at 27 oC ohm/cm	
(m)	N-dm Analysis CA % CM % CP %	
(n)	Oxidation stability	
	(i) Neutralization value after oxidation	
	(ii) Total sludge after oxidation.	
(o)	Aging characteristic as per Border 140 h/110 oC	
(p)	Saponification value in mg of KOH/gm	
(q)	Dielectric loss after 90 oC	
(r)	Aging characteristics as per NEMA 164 H/110 oC	

(s)	Neutralization value in mg of KOH/gm	
(t)	Sludge content weight %	
(u)	Pemitivity at 60 oC	
(v)	Specific heat at 60 oC	
(w)	Thermal conductivity at 60 oC	
(x)	Mean coefficient of expansion	
57.	Details of online DGA monitoring device:	
	(i) Make	
	(ii) Name of gases which will be monitored	
	(iii) Please confirm that necessary soft wares has been provided	
58.	Details of nitrogen injection fire protection system device	
	(a) Make & model	
	(b) Auxiliary supply required	
	(c) size & capacity of storage tank proposed to be provided	

SIGNATURE OF BIDDER

Date
Place

NAME
DESIGNATION
(SEAL)

ANNEXURE-II

LIST OF FITTINGS AND ACCESSORIES TO BE PROVIDED WITH POWER TRANSFORMER.

Each transformer shall be provided with the following accessories.

(i) Dial type Thermometers for oil: - A dial type indicating thermometer with repeater of robust pattern mounted on the side of the transformer at a convenient height to read the temperature in the hottest part of the oil and fitted with alarm and trip contacts. Remote oil temperature indicator shall also be mounted on RTCC panel.

(ii) 3 no. Winding temperature indicator for HV , IV& LV winding:- It shall be indicating type with repeater responsible to the combination of top oil temperature and winding current, calibrated to follow the hottest spot temperature of the transformer winding,. The winding temperature indicator shall operate a remote alarm before the hottest spot temperature approaches a dangerous value and it shall automatically actuate the cooling fan Motors.

(iii) a) Remote winding temperature indicator is to be installed in the indoor control panel i.e. fan control cubicle with its repeater on remote tap charger control cubicle.

b) In addition to the winding temperature indication device another device for measurement of hot spot in transformer winding using fibre optic sensors should also be provided. The probes shall be directly installed in each phase of power transformer to measure the winding hot spot temperature. The fibre optic cables should be brought out of the main tank to tank wall penetrator feed through a plate. The feed through plate should be welded on the tank. The external fibre optic extension cable shall then be run to the control cabinet. Separate temperature indicator should be provided for hot spot measurement through this device. The fibre optic sensor display shall be brought to the RTCC panel also.

(iv) a. One magnetic type oil level gauge with low level alarm contacts and dial showing minimum, maximum and normal oil levels. The gauge shall be readable from the gauge transformer base level.

b. One plain oil level gauge of over lapped type on other side of conservator.

(v) Minimum 3 no. pressure relief valves : The quantity of these valves should commensurate with the quantity of oil in the transformer and also location of valves should be properly designed to adequately release the excessive pressure.

(vi) A set of air release valves on the top and on the radiators and also at appropriate place

(vii) A safety valve of the chimney type with an equalizer pipe interconnecting the top of the conservator and upper most part of the safety valve should be provided to prevent rise of oil in the safety valve pipe. Any other substitute arrangement shall also be acceptable.

(viii) One thermometer pocket for mercury in glass type thermometer.

(ix) The safety valve pipe shall preferably take off from the side of the transformer tank near to the tank cover and not from the top of the tank cover. The requirements shall be met as specified in 'CBIP' specification.

(x) One double float gas detector relay (Buchholz relay) with alarm and tripping contacts to detect accumulation of gas and sudden changes of oil pressure, complete with shutoff valves and flanges couplings to permit easy removal without lowering oil level in the main tank, a blend valve for gas venting, and test valve. Make of buchholz relay shall be as per our approved list of vendors.

(xi) Heat exchangers or radiators complete with shut of valves and with facility for oil draining arrangement.

(xii)a/ Two oil conservator, with required accessories, one for main tankand other for OLTC.

b/ Air cell type breathing arrangement with oil preserving equipment complete in all respects.

(xiii) Eye bolts and lugs on all parts for easy handling.

(xiv) Two grounding earth terminals at diagonally opposite corner of tank.

(xv) One rating and diagram plate.

(xvi) A set of minimum 4 nos. flanged bi-directional wheels for rail mounting (for 1676mm rail gauge).

(xvii) A set of fans required for ONAF cooling of the transformer with following information.

a. Number of Radiator Banks.

b. No. of cooling fans of adequate voltage & rpm) provided in each bank to ensure 100% ONAF rating of the transformer. As per our specification, for each bank one additional cooling fan is to be included which will be duly wired-up.

(xviii) Suitable jacking lugs and haulage holes.

(xix) Thermosyphone filter assembly with complete details.

(xx) Inspection window & main holes with bolted cover as per Annexure-IV.

(xxi) Lifting arrangement for the complete transformer, core coil assembly and also tank.

(xxii) One foldable ladder on main tank.

(xxiii) For the purpose of taking earthing connection from the neutral bushing, adequate number of brackets with small support insulators shall be provided on the body of the tank so that earthing could be arranged by us near the earthing pit of transformer itself.

(xxiv) A separate weather proof FCC (Fan/Cooler control) cubicle shall be mounted on the transformer containing dial type thermometer and winding temperature indicator and terminals of dial, type thermometer, winding temperature indicator, buchholz relay, MDG, control of fans etc.

Please note provision of separate Fan Control Cubicle (FCC) is a must. FCC shall be suitably dimensioned to accommodate following:-

(a) The wiring from RTCC shall be brought to marshalling box and for terminating the same adequate number of suitably rated terminal connectors shall be provided.

(b) Necessary cable glands shall be included in the scope of supply.

(c) Arrangement for terminating the connecting leads of OTI, WTI, buchholz, magnetic oil level gauge etc. shall be made in the marshalling box. It should be possible to read OTI and ETI readings without opening the box through suitable glass window. All trip alarm and repeater signals will be transferred to control room for which arrangement will have to be made.

(d) Starters for cooling fans shall be housed in marshalling box and necessary switches for local operation of fans shall be provided.

(e) Local remote control switch for OLTC shall be provided.

(f) Space heater with switch, cubicle illumination lamp, fuses, links overload protection arrangement for motors and other accessories shall be included in the scope of supply.

(xxv) One set of indoor RTCC (Remote tap changer control) cubicle complete with provision for remote operation of OLTC, as independent or master/follower scheme, with oil and winding temperature repeater, tap position indicator with annunciation for fan group ON/OFF and cooler supply fail indicator and Tap changer in progress.

(xxvi) One set of erection manual/relevant drawing/leaflets should be secured permanently inside the RTCC cubicle as a guideline for site erection and commissioning.

(xxvii) Three separate connection i.e. connection from core, connection from end frame and connection from tank shall be brought out on to a terminal box with cover. Arrangement for inter connecting these terminals in the terminal box shall also be provided. This arrangement shall facilitate verification of core, end frame and tank insulation.

(xxviii) Mounting of radiators on the IV bushing should be avoided. In no case, the radiators should be projected above the main tank height.

(xxix) All transformers shall be supplied with a full outfit of tools, spanners, jacks, special tools for assembly and all spanners shall be single ended and of very good quality of "Gedore" or "Ttaparia" make.

2. The equipments and accessories furnished with the transformer shall be suitably mounted on the transformer for ease of operation, inspection and maintenance and the mounting details shall be subject to the approval of the purchaser. All valves shall be provided either with blind companion flanges or with pipe plugs for protection.

3. Indication, alarm and relay equipment shall have contacts suitable for operation with 220V/110V DC supply. Any other accessories or appliances recommended by the manufacturer for the satisfactory operation of the transformer shall also have 110 DC as input.

4. (a) OLTC and its controls shall be as per Clause 5.10 Section-II of specification.

(b) All cabinets & panels shall be conforming to stipulations under Clause-5.18 of specifications.

(c) All 220/132KV and neutral bushings shall be of OIP condenser type and as per Clause 5.7.1 Section-II of specifications.

5. NIFP system as per clause 5.10.5.
6. On line DGA Monitoring device as per clause 5.6.1(b).

Accessories, which are not included in the above schedule but details of which are given in tender specification and which are necessary for satisfactory operation of Transformer shall be deemed to have been included in the accepted price without any extra cost to the CSPTCL.

* * * * *

ANNEXURE-III

LIST OF TRANSFORMER ACCESSORIES AND TEST CERTIFICATES REQUIRED FOR THEM

S.No	Accessory	Test-certificates required
	Condenser Bushing	Appearance, construction and dimensional check. Test for leakage of internal filling at a pressure of 1.0 Kg/cm for 12 hours. Insulation resistance measurement with 2000V megger. Dry/wet power frequency voltage withstand test. Dry/wet power frequency voltage withstand test for test tap insulation Partial discharge measurement upto 1.5 UN 3Kv. Measurement of tangent delta and capacitance.
	Pressure Gauges/ Differential Pressure Gauges	Appearance, construction and dimensional check. Calibration test. Alarm contact setting test.
	OLTC.	Oil tightness test for the diverter switch oil chamber at an oil pressure of 0.5 Kg/cm2 at 100 degree centigrade for 1 hour. Mechanical operation test. Operation sequence measurement Insulation resistance measurement using 2000V megger. Power frequency voltage withstand test on diverter switch to earth and between even and odd contacts. Power frequency voltage withstand test on tap selector- between stationary contacts, between max. and min. taps, between phases and supporting frames, between phases. Operation test of complete tap changer. Operation and dielectric test of driving mechanism.
	Winding & Oil Temperature Indicator	Calibration test. Dielectric test at 2 KV for one minute. Accuracy test for indication and switch setting scales. Test for adjustability of switch setting. Test for switch rating. Measurement of temperature rise with respect to the heater coil current.
	PRV	Functional test with Compressed air to check bursting pressure, indicating flag operation and switch operation. Dielectric test at 2 Kv for one minute. Switch contact test at 5A, 240 Volt AC.
	Cooling fans	Insulation resistance measurement. Dielectric test at 2 KV between winding and body for one minute. Operation check. Appearance, construction and dimensional check.
	Buchholz relay	Leak test with transformer oil at a pressure of 3 Kg/cm2 for 30 minutes at ambient temperature for relay casing. Insulation resistance measurement with 500V megger. Dielectric test at 2KV for 1 minute. Elements test at 1.75 Kg/cm2 for 15 minutes using transformer oil at ambient temperature. Loss of oil and surge test. Gas volume test. Mechanical strength test. Velocity calibration test. Appearance construction and dimensional check.

	Oil level indictor	Test for oil levels. Switch operation for low level alarm. Switch contact test at 5A 240V AC. Dielectric test at 2 KV for 1 minute. Appearance, construction and dimensional check.
	Pressed steel radiators	Air pressure test at 2 kg/cm2 under water for 15 minutes. Appearance, construction and dimensional check.
	OLTC control cubicle/ cooler control cabinet	Appearance, construction and dimensional check. Electric operation. Insulation resistance measurement using 500V megger at ambient temperature. Dielectric test at 2 KV for 1 minute.
	Bushing current transformer	Appearance, construction and dimensional check. Polarity check. Measurement of insulation resistance. High voltage power frequency test. Determination of ratio error and phase angle of measuring and protection BCTs. Determination of Turns ratio error for PS class BCT. Determination of composite error for protective class BCT. Interturn insulation withstand test. Exciting current characteristic test. Secondary winding resistance measurement. Knee-Point voltage, measurement for PS class BCT.

Date
Place

SIGNATURE OF BIDDER
NAME
DESIGNATION
(SEAL)

LIST OF VENDERS FOR MAJOR ITEMS OF TRANSFORMER

S. No.	Name of Item	Supplier/manufacturer
1.	CRGO	M/s. Nippon steel corporation, Japan M/s. Kawasaki Corp., Japan (M/s JFE, Japan) M/s. Armco, USA, M/s. Covefi, France M/s. Salzgittar, Germany M/s. S Usinor, France M/s Transfer, France M/s Mitsubishi, Japan. M/s AST Terni, Italy M/s. EBG India Pvt Limited, (Indian Agent) for M/s GELSE NKIRCHEN, Germany M/s British Steel Corporation , UK M/s Thyseen Krupp Group of Companies M/s. POSCO, Korea M/s A.K.Steel USA
2. (a)	Winding conductor	M/s Invex Filli Isolati Speciali s.p.a. Italy M/s. Asta M/s. Smit Draad, Holland M/s. Incab Industries, Jamshedpur M/s. Sterlite Industries, Mumbai M/s. Bhandari Conductor, Mumbai/ Mandideep. M/s. Shakti Insulated Wires, Mumbai M/s KSH International Pvt Limited, Taloja M/s Delta-Trans Conductor, Mumbai M/s Vijay Electricals, Hyderabad M/s RIMA Transformers & Conductors (P) Ltd, Bangalore. M/s Lacroix and Kress (GMBH) Germany M/s Pirellicavi Italy M/s Shree Cable & Conductors M/s. Hindalco M/s. Chandra Metals M/s. BCPL Conductors
(b)	CTC Conductor	M/s Sam Dong Korea M/s Invex Filli Isolati Speciali s.p.a. Italy M/s Loc Roix AND KRESS – Germany M/s. KSH International (P) Ltd. M/s. Chandra Metals
3.	Precompressed press Board & press Board components	M/s. H. Weidmann, Switzerland M/s. Fige Holms Brruk, Swedan M/s. Senapathy Whiteley, Banglore M/s. Raman Board, Mysore

4.	Insulating Material	M/s. Dupont, USA M/s. Senapathy Whiteley, Banglore M/s. H. Weidmann, Switzerland M/s. Munksio M/s Amotfors, Sweden M/s Krammerer
5.	Air Cell	M/s PRONL, France, M/s. Swastik M/s. Unirub M/s. Rubber Products M/s Sukrut Udyog M/s Nu-cork Products (P) Ltd., Bhiwadi (Raj.)
6.	Gaskets	M/s. Talbros, Faridabad M/s. Cortica, Chennai M/s. Packing & Jointing, Chennai M/s Indian Rubber Products, Haridwar M/s Bombay Oil Seal Mfg. Mumbai M/s MGM Rubber Kolkata M/s Bharat Corrub Industries, Vadodara. M/s Indian work Industries M/s Works Product Pvt Ltd M/s Nu-cork Products (P) Ltd., Bhiwadi (Raj.)
7.	OIP Condensor bushing	M/s. BHEL M/s. CGL M/s. TELK M/s ASEA-MICAFIL M/s. Trench M/s. Alstom (earlier M/s. Areva) M/s. Vijai Electricals Ltd. M/s ABB
8.	Terminal Connector	M/s. Best & Crompton, Chennai M/s. PeeVee Engg., Bangalore M/s. Milind Engg., Mumbai M/s. Nootan, Baroda M/s Utsav, Baroda M/s Vinayak and Co., Mumbai M/s Megha Engg. Enterprises, Chennai M/s Klemmen Engg. Corporation , Chennai
9.	OTI/WTI with repeater	M/s. Accurate Control,UK M/s. AKM, Swedan M/s. Perfect Control, Chennai, India M/s. Preci Measure, Banglore M/s Radix Electrosystems Pvt. Ltd/ Radix Pyrotech India
10.	Magnetic oil gauge	M/s. Sukrut Udyog, Pune M/s. Yogya, Jhansi
11.	Buchholz Relay	M/s. Fukuda Instrument, Japan M/s. Atvus,Calcutta M/s. English Electric, Chennai M/s. Prayog; M/s BHEL M/s Instrument and Control, Vadodara
12.	Pressure Relief Device	M/s. Qualtrol, USA M/s. GE, USA; M/s. Sukrut Udyog, Pune
13.	Fan & Motor	M/s. Alstom (earlier Areva) M/s. CGL, Mumbai M/s. Khaitan, Calcutta.

		M/s EPC, Calcutta M/s Marathan
14.	Un-impregnated Densified laminated wood	M/s. Permali Wallace Bhopal M/s. Kit ply Assam M/s. Mysore Polymers Banglore M/s Narmada Forest Ind. Pvt. Ltd. Bhopal. M/s Western India Plywood , Kerala M/s Rochling Detonite
15.	Valves	M/s. Leader M/s. Bombay Metal & Alloys M/s. Audco M/s. Petson M/s. Manixon M/s. Creseant M/s Precision Engg. Kottayam, M/s Eapen Joseph, Kottayam M/s Apex Piping Systems, Jalandhar M/s Liberty Engg., Mumbai M/s Niton Valves, Mumbai M/s Eapen Joseph & Co., Coimbatore M/s Oswal Agra M/s Neo Engg. Ahamedabad M/s CG Valve Udaipur
16.	MCB	M/s. Sieman M/s. MDS M/s. S&S M/s. Havell's
17.	Fuse	M/s. Siemens/ S&S / Areva / Havell's
18.	Tank Steel	M/s. SAIL/Jindal/Essar steel
19.	OLTC Complete	M/s. BHEL M/s. CTR M/s. TELK M/s Easun, Madras
20.	Terminal Blocks	M/s. ELMEX M/s. Technoplast, M/s. Tosha
21.	Silica gel Breather	M/s. Yogya Enterprises, Jhansi. M/s. Anusen Industries, Pune. M/s Instruments & Controls , Vadodara, India
22.	Transformer oil	M/s Apar Limited, Mumbai M/s Savita Oil Technologies M/s. Raj Petrochemicals
23.	Radiator	M/s CTR Manufacturing Industries, Pune M/s Thermal Transformer Product, Bangalore M/s Exotherm, Bangalore. M/s P.E. Engg. Hyderanad. M/s Hitech Switchgear, Mumbai M/s Mahindra Electrical works M/s Triveni Electroplast
24.	On line DGA monitor	M/s. GE Kelman- Transfix DGA500 M/s. Morgan Schaffer Calisto-5 M/s. A-EBerley Hydrocol-1005
25.	NIFP System	M/s. CTR M/s Easun Reyrolle

Note: The contractor should submit their offer considering the above mentioned vendors.

DRAWINGS AND DATA TO BE FURNISHED BY THE CONTRACTOR.

The following drawings and data are to be submitted by the contractor for approval:

(a) Outline dimensional drawings of transformer and its accessories including conservator complete with Bill of material and details of all parts, their quantity, rating & name of Vendors indicating clearances of transformer body from live terminals i.e. HV, IV, LV.
(b) Drawing of transformer tank with location of inspection windows, thickness of side/bottom/top of tank, details of stiffener.
(c) Drawing indicating limbed core construction with complete details of no., width and wt. of core laminations with size of steps; thickness of core laminations ; dimension of window; size of limbs; Gross and net core ; wt. of complete core.
(d) Drawing indicating core belting arrangement with details of belting, belting material etc.
(e) Large scale dimensioned drawings for HV , IV& LV windings of the transformer; size and no. of parallel of HV, LV and IV of cooling ducts, coil clamping arrangement, no./size & location of pressure screws, clamping ring; top yoke arrangement etc. The details should commensurate with the short circuit calculations submitted by you for each rating of transformer
(f) Detailed drawing of transformer tank with complete core and winding indicating clearances inside transformer tank as also passage and space for free movement of at least two persons for inspection of active parts etc .
(g) Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding. Longitudinal and cross-sectional views showing the duct sizes, cooling pipes etc. for the transformers/radiators drawn to scale .
(h) Drawings giving the weights for foundations.
(i) Combined Rating and diagram plate including tap changing, which should also include details of guaranteed and measured no load and load losses as also winding resistances and percentage impedances at all taps.
(j) Schematic control and wiring diagram for all auxiliary equipment and control cubicle.
(k) Drawing showing constructional details, dimensions, mechanical & technical particulars of bushings. Arrangement of terminals and details of connection of bushing shall also be indicated in drawing with their technical particulars.
(l) Transportation drawing of transformer.
(m) Details of fittings and cable box.
(n) Drawing showing arrangement and details of tap changing gear including selector switch, diverter switch and drive mechanism.
(o) Valve Schedule plate.
(p) Oil filling instruction plate for conservator fitted with Air cell breather arrangement including equalizing arrangement if any required at the time of taking full Vacuum at site.
(q) Drawing and instruction for fitting ofAir Cell.
(r) Drawing of conservator indicating internal details of air cell MOG, oil level gauge and silica gel breather pipe fitting arrangement.
(s) Drawings of all HV IV & LV bushings with complete details meeting TS requirement.
(t) Drawings of HV,IV,LV& neutral terminal connectors indicating plate thickness, no. of nut bolts with size and other details.
(u) Drawing of foldable& detachable ladder with its complete details and fitting arrangement on transformer/ conservator tank.
(v) Drawing for HV/IV/LV neutral earthing arrangement indicating voltage rating of insulators and its fitting arrangements, size of copper strips, terminal connectors etc.
(w) Detailed drawing indicating two views of all valves provided in the transformer tank.
(x) Detailed internal drawing of transformer indicating transportation locking arrangement provided to avoid shifting of core assembly.
(y) Drawing showing weights of transformers, cooling fan structures, FCC structures with distance from central line of transformer for casting of civil foundation for transformer and associated equipments.
(aa) Drawing of Earthing terminal box showing earthing arrangement for core, end frame, tank giving details of voltage class and current rating of terminal bushings.
(ab) Drawing indicating insulation thickness details and other arrangement provided between core assembly and bottom yoke and base of bottom of tank.

(ac) Drawing indicating details of 'O' ring gasketting arrangement provided in transformer tank covers.
(ad) Detailed Drawing of jacks.
(ae) Drawing of stiffeners provided on top, each faces/sides of tank with their number and size.
(af) Drawing indicating number, location, size of shields/ magnetic shunts and its material provided inside the tank as per clause 11.1 (g).
(ag) Drawing indicating internal details of transformer giving complete details of clearances from live parts.
(ah) Drawing of internal LV winding termination arrangement indicating minimum clearance between core and LV take off lead.
(ai) Drawing for Lead termination to bottom of HV IV& LV Neutral Bushings
(aj) Drawing for Lead termination to bottom of HV IV& LV bushings.
(ak) Internal drawing & design of Core & Winding indicating all attachment with identification numbers, description including take-off arrangement of lead connection for Core & End frame and related Bill of Material
(al) Locking arrangement drawing for tank top cover, core & winding with complete dimension & details.
(am) Plan view of the bottom of Bell Tank for complete details of core coil resting arrangement, indicating clearly dimensional details, material of insulation, clamping arrangement with details of nuts/ bolts,clearance from all sides provided at bottom.
(an) Drawing indicating complete details, dimension & mounting arrangement of OLTC inside the tank with respect to End frame.
(ao) Drawing indicating complete details, dimensions & fixing arrangement of static end rings if used.
(ap) Other relevant drawings.

The manufacturer shall supply four (4) copies of the drawings as listed out above, which will describe the equipment in details for approval.Three sets of instruction books, operation and maintenance manuals and spare part bulletin, shall be supplied. In addition to above two sets of manuals and drawings with test certificates for each unit to be despatched as per despatch instructions.

It will be obligatory on the part of the manufacturer to ensure that the weight of core lamination, weight of copper ,weight of steel , weight of transformer tank along with fitting and accessories, quantity of oil for first filling including wastage and 10 % extra of that quantity, total weight of core plus winding after assembly, total weight of transformer and other dimension of transformer are worked out carefully. It may be noted that at the time of submission of final drawings, variation in these weights beyond the limits of (+) 5% shall not be permitted.

DETAILS OF INSPECTION PROGRAMME

(A). Inspections to be performed at manufacturer's works in presence of CSPTCL's representative and/ or a representative of NABL accredited third party.

1.0 Stage Inspection:

It may be noted that stage inspection for all the units at CSPTCL's discretion shall be done at manufacturer's works in presence of CSPTCL's representative and representative of third party authorized by CSPTCL at the following stages.

After the core is built but before its clamping, CSPTCL's representative will inspect the core to take complete weight of the core and also to measure approximate core loss. If necessary, a small strip of core shall also be taken for testing at ERDA/ CPRI at our discretion.

Once the coils are prepared and are fitted on to the core, stage inspection of the core coil assembly shall be done to take measurements of HV/ LV windings. A small piece of conductor for each type of winding shall be made available by the manufacture. The magnetic balance test shall also be carried out during this stage inspection.

Apart from the above, the CSPTCL also reserves the right to carry out stage inspections at other stages also, for which advance intimation shall be given and all necessary cooperation shall be rendered by the manufacturer.

2.0 Final inspection:

After satisfactory stage inspections, ovening of core coil assembly and tanking thereafter shall be carried out by the manufacturer. Call for final inspection of the transformer shall be given after readiness of transformer in all respects. During the final inspection, all routine and additional routine tests shall be carried out on each unit according to the methods specified in IS:2026 (Part-I):2011 and IS:2026 (Part-III):2009. These tests shall be witnessed by CSPTCL's representative and representative of third party authorized by CSPTCL The details of the tests to be carried out are as given here under:

Sl.	Particulars
(A) Routine tests:	
1	Measurement of winding resistance
2	Measurement of voltage ratio and check of phase displacement
3	Measurement of Impedance voltage/ short circuit impedance (Principal tap) & load loss
4	Measurement of no load loss at 90%, 100% & 110% of rated voltage and no load current
5	Measurement of Insulation resistance
6	Dielectric routine tests as per IS:2026 (Part-III) i.e. lightning impulse tests on all phases of HV/LV windings, short duration induced AC withstand voltage tests, separate source AC withstand voltage tests
7	Tests on load tap changers
(B) Addl. Routine Tests:	
1	Dimensional checks as per approved drawing & specification
2	Magnetic circuit test. After assembly ,core shall be tested for 1 minute for 2000 volts AC between all bolts, side plates & structures steel works
3	Polarisation index – IR value for 15 sec, 60 sec & 600 sec duration shall be recorded and PI for 600/60 sec and DAR i.e. ratio of IR values of 60/15 seconds shall be recorded. The PI value (600/60 sec) should be ≥2 and DAR value (60/15 sec) should be ≥1.3. These values should be recorded both before and after HV tests.
4	Tank oil leakage test – the complete transformer assly filled with oil shall be subjected to nitrogen pressure of 0.35 Kg/cm2 above the normal oil head for a period of 12 Hrs to ensure that there is no oil leakage.
5	Capacitance and tan delta measurement to determine capacitance between wingding and earth. This test should be carried out before and after series of dielectric tests by ANSI II method.
6	Test on bushings and tan delta capacitance and IR values
7	Checking of recording of IR values
	(a) Between core & coil frame
	(b) Between core & tank
	(c) Between coil frame & main tank The measured IR values should be more than 1000 M Ohms.
8	Magnetic balance and magnetizing current (3 phase & 1 phase at normal tape) test
9	Tests of PRDs for successful operation
10	Oil BDV test before & after HV tests
11	Sweep Frequency response analysis (FRA)- SFRA shall be carried out at manufacturer's works with his own SFRA test set. The test shall be repeated at site with same test set.

Further, following type & special tests as per clause 6.2, Section-II of tender specifications shall be carried out on one unit out of the lot.

Temperature rise test as per IS:2026 (part-I) & clause 4 of IS:2026 (part-II) on both ONAN/ONAF ratings.
Tank vacuum test and tank pressure test
Test on pressure relief devices

i) Measurement of zero Seq. Reactance.
ii) Measurement of acoustic noise level.
iii) Measurement of power taken by fans.
iv) Measurement of harmonic level in no load current.
v) Lighting impulse with chop on tail on all 3 phase of HV and LV terminals.
vi) One cooler cabinet and OLTC cabinet of the transformers (preferably for the first unit of the lot) shall be tested for IP:55 protection in accordance with IS: 2147. In case facility for this test is not available with the manufacturer, the test has to be carried out at the laboratory of either CPRI or ERDA in presence of CSPTCL's representative and test report should be furnished.

Tests on Assembled Transformer:

a) Check completed transformer against approved out line drawing, provision for all fittings, finish level etc.
b) Jacking test on the assembled Transformer.

3.0 Tests to be conducted at destination site of CSPTCL:
On delivery / receipt, after erection at site, the transformer shall be subject to the following tests, in presence of supplier's engineer.

3.1 Tests on reaching at site:

(i) Immediately upon receipt of transformer at site and before unloading of transformer from trailor, core earthing, end frame earthing and tank earthing shall be checked. Only after satisfactory verification that there is not multiple core earthing in transformer, unloading of transformer shall be undertaken.
(ii) After receipt of transformer at site physical inspections shall be done for checking any physical damage to transformer tank and accessories. Further, data of impact recorder shall be analyzed for any changes before unloading of transformer.

3.2 Pre commissioning tests:

(i) Insulation resistance test and polarization index.
(ii) Ratio and polarity test
(iii) DGA of oil and di-electric, tan delta, resistivity & moisture content test of oil.
(iv) OLTC operational test at each tap for lower and raise operation of tap changer.
(v) Magnetic balance tests and measurement of magnetizing current.
(vi) Vector group test
(vii) Percentage impedance test at all taps
(viii) Short circuit current measurement at low voltage and at all taps
(ix) Measurement of winding resistance at all taps
(x) Tangent delta, capacitance and insulation resistance tests of bushings
(xi) Measurement of IR values between core & coil frame, core & tank end coil frame and tank.
(xii) Dew point measurement and recording of pressure of nitrogen gas.
(xiii) SFRA test.

The SFRA test and Dew point measurement shall be carried out in presence of manufacturer's representative. The test kits shall be same as used for carrying out these tests in the factory and shall be brought by manufacturer's representative.

(B). Checks to be performed by the manufacturer during various stages of manufacturer of transformer. The in house test reports may be reviewed by CSPTCL's representative during stage / final inspection.
Tank and conservator:
Certification of chemical analysis and material tests of plates.
Welder's qualification and weld procedure.
Testing of electrodes for quality of base materials and coatings.

Inspection of major weld preparation and joint.
Crack detection of major strength weld seams by 'dye penetration test'.
Measurement of film thickness of:
Oil insoluble varnish.
Zinc chromate paint.
Finished coat.
Check correct dimensions between wheels, demonstrate turning of wheels through 90 degrees and further dimensional check.
Check for physical properties of materials for lifting lugs, jacking pads etc. All load bearing welds including lifting lug welds shall be subjected to NDT.
Tank vacuum & Tank pressure tests as per CBIP manual on transformer & as per this specification.
Leakage test of the conservator and tank.
Measurement of thickness of tank plates i.e. top, Bottom & Sides.
All double welds shall be tested for leaks with dry nitrogen, at the pressure not less than 7 kg/sq.cms. (atm)
All tanks, single welds, cooling coils, radiators valve and other parts necessary for complete transformer shall be tested for leaks and strength by applying pressure not less than 0.7 atm for a period of 24 hrs or not less than 1 atm for a period of 06 hours. If leaks occur, the tests shall be conducted after all leaks have been stopped.
Certification of all test results.

2. Core:

Sample testing of core material for checking thickness of lamination, special loss, bend properties, magnetization characteristics (B-H Curve) and Epstein curve.
Check on the quality of varnish, if used on the stampings.
Measurement of thickness and hardness of varnish on stampings.
Solvent resistance test to check that varnish does not react in hot oil.
Check overall quality of varnish by sampling to ensure uniform shining colour, no bare spot, no over burnt varnish layer and not bubbles on varnished surface.
Check on the amount of burrs.
Bow check on stampings.
Check for the over lapping of stampings, Corners of the sheets are to be apart.
Visual and dimensional check during assembly stage.
Check on completed core for measurement of iron loss characteristic and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.
Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps. Weightment of core with belting after building up.
High voltage test of 2KV for one minute between core and clamps.
Certification of all test results.

3. Insulating material:

Sample check for physical properties of materials.
Check for dielectric strength, .
Visual and dimensional checks.
Check for the reaction of hot oil on insulating materials.
Dimensional stability test at high temperature for insulating material.
Tracking resistance test on insulating material.
Certification of all test results.

4. Winding:

Sample check on winding conductor for mechanical properties and electrical conductivity.
Check insulating distance between high voltage/low voltage connection, cable and earth and other live parts.
Check for proper cleanliness and absence of dust.
Visual dimensional checks on conductor for scratches, dent marks etc.
Sample check on insulating paper for PH values bursting strength and electric strength.

Check for bonding of insulating paper on conductor and absence of short circuit between parallel strands.
Check for brazed joints wherever applicable.
Measurement of voltage, when yoke/core is completely restocked and all connection are ready.
Measurement of no. of turns in each winding and cross sectional area of windings. Weightment of windings.
Certification of all test results.

5. Checks before drying process:
Weight of complete core, winding and insulation.
Check condition of insulation of the conductor and between windings, Insulation gap between HV connection, cables, earth and other live parts. Similarly check for HV/LV connections.
Insulation of core shall be tested at 2KV /min between core to bolts and core to clamp plates.
Check for proper cleanliness and absence of dust etc.
Certification of all test results.

6. Checks after drying process:
Record measurement of temperature, vacuum and drying time during vacuum treatment.
Check for completeness of drying by measuring IR values and Tan Delta.
DP test shall be carried out after jacking test.

7. Pre shipment check at manufacturer's works:
Check for inter changeability of components of similar transformers for mounting dimensions.
Check for proper packing and preservation of accessories like radiators, bushings, explosion vent, dehydrating breather, rollers, buchholz relay, fans, control cubicle, connecting pipes, conservator etc.
Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
Gas tightness test to conform tightness.
Derivation of leakage rate and ensure adequate reserve gas capacity.

Note:

(i). Further tests:
The Purchaser reserves the right to having other reasonable, tests carried out at his own expenses either before shipment or at site to ensure that the transformer complies with the requirements of this specifications.

(ii). Test reports:
After all tests have been completed seven certified copies of each test report shall be furnished. Each report shall supply the following information:

(i) Complete identification data including serial number of the transformer.
(ii) Method application, where applied duration and interpretation of results for each test.
(iii) Temperature data corrected to 75 degree centigrade including ambient temperature.

LIST OF HAND TOOLS & JACKS TO BE SUPPLIED ALONG WITH THE POWER TRANSFORMER

One tool box consisting of the following hand tools of reputed make shall be supplied.

No.	Spanners of different sizes	
1	a) Open jaw double ended	08 No.
	b) Cranked ring double ended	03 No.
	c) Tubular Box double ended	01 No.

2	Tommy Bar (for Tabular Box spanner)	
3	Adjustable wrenches	02 No.
4	Pipe wrench	01 No.
5	Screw Drivers of different sizes	05 No.
6	Flat Nose, Round Nose, Side Cutting Pliers	03 No.
7	Gasket punches	10 No.
8	Filkeswith Handles	02 No.
9	Hammers with Handles	02 No.
10	Knife with Handles	02 No.
11	Adjustable Hacksaw	01 No.
12	Cold Chisel	01 No

ROUTINE AND ADDITIONAL ROUTINE TESTS

Sl. No.	Particulars	Remarks (mention specific comments regarding tests results as per standards or not)
(A) Routine tests:		
1	Measurement of winding resistance – The resistance of HV, IV & LV windings should be carried out at different taps and values at the ambient temperature & converted values at 75 deg C should be recorded in a separate sheet.	
2	Measurement of voltage ratio and check of voltage vector relationship – The measurement of HV to LV ratio at all taps should be recorded and ratio error should be mentioned in a separate sheet. The voltage vector relationship should also be recorded to ensure the vector group of the transformer.	
3	Measurement of Impedance voltage/ short circuit impedance (Principal tap) & load loss – Tests to be carried out at normal, highest & lowest tap	
4	Measurement of no load loss & current – The values of no load loss and no load current at normal tap at 90%, 100% & 110% of rated voltage should be recorded before and after dielectric test.	
5	Measurement of Insulation resistance – The insulation resistance between HV/tank, LV/tank & HV/LV should be recorded with 5KV megger for 15 seconds, 60 seconds & 600 seconds. The values and PI of 60th / 15th& 600th / 60th should be mentioned in a separate sheet. The values should be recorded before & after HV tests.	
6	Dielectric tests – Separate sources voltage withstand tests, induced over voltage withstand test and lighting impulse withstand tests on all phases of HV & LV as per IS: 2026 should be carried out in following sequence: (i) One reduced full wave impulse (ii) Three 100% full impulse (iii) 650KV p for HV and 170KV p for LV winding. Results should be indicated in separate sheet with Oscillograms output should be enclosed.	
7	Tests on load tap changers - The testing of OLTC should be	

	done as per clause 16.9.1 of IS:2026 part-I. After the tap changer is assembled on the transformer, the following tests should be performed at 100% of rated auxiliary supply voltage. (i) Eight complete operating cycles with transformer not energized. (ii) One complete operating cycle with transformer not energized with 85% of rated auxiliary supply voltage. (iii) One complete operating cycle with the transformer energized at rated voltage and frequency at no load loss. (iv) Ten tap change operations with +/- two steps on either side of the normal tap with as far as possible rated current of the transformer with one winding short circuited.	
(B)	Addl Routine Tests:	
1	Dimensional checks as per approved drawings & specifications – All dimensions as per approved drawing should be checked.	
2	Magnetic circuit test. After assembly ,core shall be tested for 1 minute for 2000 volts AC between all bolts, side plates & structures steel works	
3	Tank oil leakage test – the complete transformer assly filled with oil shall be subjected to nitrogen pressure of 0.35 Kg/cm2 above the normal oil head for a period of 12 Hrs to ensure that there is no oil leakage.	
4	Capacitance and tan delta measurement to determine capacitance between wingding and earth. This test should be carried out before and after series of dielectric tests.	
5	Test on bushings: All tests on bushings including capacitance, creepage distance & tan delta measurement as per IS	
6	Checking of recording of	
(A)	IR values	
	(a) Between core & coil frame	
	(b) Between core & tank	
	(c) Between coil frame & main tank The measured IR values should be more than 1000 M Ohms.	
(B)	Measurement & recording of currents with application of 400V 3 phase AC supply on HV side & LV side shorted	
	(a) Between core & coil frame	
	(b) Between core & tank	
	(c) Between coil frame & main tank	
7	Magnetizing current measured with LT supply (before and after HV tests)	
	Particulars: With three/single phase supply	
	Volts | Amp	
8	Magnetic balance test (before and after HV tests)	
9	Tests of PRDs for successful operation	
10	Oil BDV test before & after HV tests	
11	Frequency Response Analysis (FRA)	

TYPE AND SPECIAL TESTS

The following type tests shall be performed:

(i) Temperature rise tests as per clause 4 of IS: 2026 part-II. – The temperature rise of oil & winding should not be more than the limits specified in the tender specifications.

(ii) Tank vacuum tests:

One transformer tank out of the whole lot shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m 2 absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been releases shall not exceed the values specified below.

Horizontal length of flat plate (in mm)	Permanent Deflection (in mm)
Up to and including 750 751 to 1250	5.0 6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

(iii) Tank Pressure Test

Transformer tank together with its radiator, conservator, vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m 2 whichever is lower, measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released after conducting vacuum test should not be more than the values specified above.

(iv) Measurement of zero sequence reactance as per clause 16.10 of IS:2026 part-I.

(v) Measurement of acoustic noise level as per clause 16.12 of IS:2026 part-I.

(v) Measurement of harmonics of the no load current as per clause 16.13 IS:2026 part-I.

(v) Measurement of power taken by the fans as per clause 16.14 of IS:2026 part-I.

(vii) Lightning impulse tests with chop on tail as per clause 14 of the IE:60076. The sequence to be followed for routine lightning impulse tests and chopped lightning impulse tests for this particular unit shall be as mentioned here under:

One reduced level full impulse;
One full level full impulse;
One or more reduced level chopped impulse(s);
Two full level chopped impulses;
Two full level full impulses.

(viii) One cooler cabinet and one OLTC cabinet of the transformer shall be tested for IP:55 protection in accordance with IS:2147. This test may be conducted either at manufacturer's works or any other Govt. approved laboratory.

Sequence of tests

The sequence of routine tests, type tests, special tests (whenever applicable) and routine tests required to be conducted on the transformer is as mentioned hereunder:

Sl.No.	DESCRIPTION
1	Dimensional checks as per approved drawings & specifications
2	Pressure relief device test.
3	Degree of protection IP 55 for OLTC & cooling control cabinets.
4	Magnetic circuit insulation test 2 KV- 1 Min. core to Yoke clamp, core to fixing plate, core bolt to Yoke.

Sl.No.	DESCRIPTION
5	Checking of IR values (a) Between core & coil frame (b) Between core & tank (c) Between coil frame & main tank The measured IR values should be more than 1000 M Ohms.
6	Magnetic balance test at normal and extreme taps.
7	Magnetizing current measured with LT supply (both single phase and three phase)
8	Voltage ratio at all taps & polarity/phase displacement at normal tap.
9	IR value at 15, 60, 600 sec (before & after HV & Heat Run tests). PI value should not be less than 2
10	Capacitance and tan delta (before & after HV & TR tests) at 5 KV & 10 KV, LV + TANK, HV + LV to TANK under grounded, ungrounded and guarded specimen modes.
11	Winding resistance measurement at all taps.
12	Oil DGA test (before and after HV & TR tests)
13	Oil BDV test (before and after HV & TR tests)
14	No load loss and current (before & after HV & TR Routine Tests) at 90%, 100% and 110% of rated voltage with 3Watt meter, 3A and 3V meters methods.
15	Separate source voltage withstand test
16	Induced over voltage withstand test
17	Harmonic analysis of no load current at 90%, 100%, 110% of rated voltage
18	Zero sequence impedance test at 10%, 20%, 60%, 80%, 100% of test current at extreme taps and normal taps.
19	Impulse test as per specifications on all phases.
20	Load loss at extreme taps & normal tap & impedance all taps by digital power analyser.
21	Temperature rise test at ONAN & ONAF ratings & quoted max. losses.
22	Measurement of power consumption by fans
23	Max. static head of oil measured at the base for 12 hrs.
24	Tests on OLTC: Circuit insulation test 2 KV- 1Min.
25	Operations tests: 8 Cy, 1 Cy at 85% V 1 Cy at no-load and Rated V, 10 Cy + / - 2 steps from normal tap and rated current.
26	Cooler control test: Circuit insulation test 2 KV- 1 Min. Operation test.
27	Bushing current transformer ratio & polarity tests.
28	Acoustic noise level test.
29	Frequency Response Analysis (FRA)
30	Tests of PRDs for successful operation

***

4. TECHNICAL SPECIFICATION OF 132/33 KV, 63 MVA POWER TRANSFORMER

Scope:

1.1 This specification covers design, engineering, manufacture, assembly, stage testing inspection and testing before supply and delivery of 02 (Two) No. 63 MVA, 132/33 KV 3-phase two winding transformers complete with all fittings, accessories and associated equipment's which are required for efficient and trouble free operation.

1.2 It is not the intent to specify completely herein all detail of the design and construction of equipments. However, the equipment shall conform in all respects to standards of engineering, design and workman ship listed in clause no. 2 and shall be capable of performing in continuous commercial operation up to the contractor's guarantee in a manner acceptable to the purchaser, who will interpret the meanings of drawing and specification and shall have the power to eject any work or material which, in his judgment, is not in accordance therewith. The equipments offered shall be complete with all components necessary for their effective and trouble free operation. Such components shall be deemed to be within the scope of contractor's supply, irrespective of whether those are specifically brought out in this specification and / or in the work order or not.

1.3 The transformers shall conform in all respects to high standards of engineering, design, workmanship and latest revision of relevant standards at the time of offer and purchaser shall have the power to reject any work or material which, in his judgment, is not in full accordance therewith.

1.4 Climatic Conditions:

Peak Ambient Temperature	50 Degree Celsius
Minimum Temperature in Shade	6 Deg. C
Maximum Relative Humidity	95% (sometime approaches saturation)
Average number of thunderstorm	58 days per annum.
Average number of rainy days per annum	90 days.
Average Annual Rainfall	125 cm.
Maximum Wind Pressure	150 kg/meter square.
Altitudes (Not Exceeding)	1000 metres.
Seismic Level Horizontal	g.

Standards:

2.1 The transformers and associated accessories shall conform to the latest issues of standards as given below:

Indian Standard	Title	Internationally recognised std.
IS-2026 (part I to V)	Power Transformers	IEC-76
IS-3639	Fittings & Accessories for power transformers	
IS-335	Insulating oils for Transformers.	IEC-296, BS-148
IS-2099	Bushings for alternating Voltage above 1000 V	IEC-137, BS-223
IS-2705	Current Transformers	IEC-185
IS-325	Three phase Induction Motors	IEC-34
IS-375	Marking & arrangements for Switchgear, bus bars, Main Connections and auxiliary Wiring.	
IS-3737	Gas operated relays	
IS-1886	Code of practice for installation and maintenance of transformers	
IS-2147	Degrees of protection.	
IS-5	Colors for ready mix paints	
IS-6272	Industrial cooling fans	
IS-6600	Guide for loading of oil Immersed transformers	BSCP-0160
IS-778	Gun metal gate, globe and check valves for general	

	purpose	
IS-3401	Silica gel.	
IS-4253	Park & Rubber	
IS-5561	Electric power connector	
IS-5578, IS-11353	Marking & arrangement for switch gear, bus bar, main connections and auxiliary wiring.	
IS-9434	Guide for sampling and analysis of dissolved gas in oil filled equipments.	
IS-12676	Oil impregnated paper insulated condenser Bushing Dimension and requirements.	
	Insulation Co-ordination	IEC-71
	Indian Electricity rule, 1956	
	CBIP publication No. 275 Manual on power transformers	
DOC.ETD 16 (3487)	Draft standard by BIS for revision of IS-8468 for OLTC	
DOC.ETD 16 (3574)	Draft standard by BIS for revision of IS-3639 for fitting & accessories for transformers part-I-standardization of conservator	
DOC.ETD 16 (3575)	--- do --- part 2: dehydrating breather	
DOC.ETD 16 (3576)	--- do --- part 3: earthing terminals	
DOC.ETD 16 (3577)	--- do --- part 4: temperature indicators	
DOC.ETD 16 (3578)	--- do --- part 5: rating & diagram plate	

Equipment meeting with the requirements of other authoritative International standards which ensure equal or better performance than the standards mentioned above shall also be considered. When the equipment offered by the bidder conforms to other standards adopted and the standards salient points of difference between standards adopted and the standards specified in this specification shall be clearly brought out in the offer. Two copies of such standards with authentic translation in English shall be furnished along with the offer.

3. Auxiliary power supply:

Auxiliary electrical equipment shall be suitable for operation on the following supply system:-

Power Devices Like drive motors	415 V, 3 Phase 4 wire 50 Hz, neutral grounded AC supply
Lighting, space heaters and fractional kW motors	240 V, single phase, 50 Hz neutral grounded AC supply.
Alarm, control and protective devices	220 V/110 V DC, 2 wire with facility for selection of either 220 volt or 110 volt.

Each of the foregoing supplies shall be made available by the bidder at the terminal point for each transformer for operation as accessories and auxiliary equipment. Bidders scope include supply of interconnecting cables, terminal boxes etc. the above supply voltage may very as below and all. Device shall be suitable for continuous operation over entire range of voltages.

i)	AC supply:	Voltage +10% (-) 20%, frequency + 5%
ii)	DC supply:	(-) 15% to +10%

4. PRINCIPAL PARAMETERS (63 MVA TRANSFORMERS):

The transformer shall conform to the following specific parameters: -

Sl. No.	Item	Specification of 63 MVA x-mer	
1.1	Rated Voltage Ratio: kV	132/33	
1.2	Highest system voltage	145/36 KV	
2.0	No. of windings	Two winding transformer	
3.0	Type of cooling	ONAN/ ONAF	
4.0	MVA rating corresponding to cooling system: a) ONAN Cooling b) ONAF Cooling	 80% (50 MVA) 100%(63 MVA)	
5.0	Method of connection	HV & LV Star LV delta	
6.0	Connection Symbol (vector group)	YN yn0	
7.0	System earthing	Solidly/ Effectively earthed	
8.0	(a) Percentage Impedance's (HV-LV), Voltage on normal tap and MVA base Corresponding to HV rating and applicable tolerances:	% Impedance 10	Tolerance +-10%
	(b) Insulation resistance at an ambient temp. of 30 deg with 5 KV megger for 600 seconds duration	HV/LV- Min. 4000 M.Ohms, HV/E, LV/E- Min 3000 M. Ohms	
	(c) Polarisation Index i.e. Ratio of megger values of 600 secs to that of 60 secs	>= 2	
	(d) DAR (Dielectric Absorption ratio) i.e. ratio of IR value of 60 sec. to 15 sec.	>= 1.3	
9.0	Anticipated continuous loading of windings: a) HV and LV	 110% of its rated capacity.	
10.0	Tap changing gear:- Type	 OLTC for HV neutral end.	
	2) Tap range & steps	-15% to + 5%, steps 1.25%	
	3) Rated for	132 KV (neutral end) & 500 A (Min.)	
11.0	Over voltage operating capability and duration	110% rated voltage Continuous 125% rated voltage for 60 secs. 140% rated voltage for 5 secs.	
12.0	Minimum Air core reactance of HV windings.	20%	
13.0	The voltage for which star point shall be insulated to the earth	The insulation class of the neutral end of the winding shall be graded to 95 KV.	
14.0	(a) Max. Flux density in any part of core and yoke at rated MVA, frequency and normal voltage (Tesla) (b) No load current of the transformer at 105 % of rated voltage	1.6 0.5% of rated current (Maximum)	
	(c) Current density in winding	<= 3 Amp/ sq. mm (max.)	
15.0	Insulation levels: For windings	HV	LV
15.1	1.2/50 microsecond wave shape impulse withstand (kVp)	650	170
15.2	Power frequency voltage withstand (kV rms.)	230	95

15.3	Tan delta values of winding	The measured Tan delta values of winding shall not exceed 0.45% at 200C temperature. In case Tan delta of transformers during testing at works of manufacturer is measured above maximum ceiling of 0.45% at 200C temperature, then CSPTCL reserves right not to accept such of the transformer. This requirement is to be confirmed specifically by the Bidders in their offer.	
16.0	Type of winding insulation:- HV/IV winding LV winding	 graded full	
17.0	System short circuit level and duration for which the transformer shall be capable to withstand thermal and dynamic stresses (kA rms / sec)	132KV side of transformer shall be connected on a infinite bus & 33KV shall be capable to withstand terminal short circuit for 3 sec. duration.	
18.0	Maximum partial discharge level at 1.5/sq.root 3 of rms. Phase to ground voltage.	500 pico coulombs	
19.0	Noise level at rated voltage and frequency	81 Db	
20.0	Permissible temperature rise: Over ambient temp.		
20.1	Of top oil measured by thermometer.	400 c	
20.2	Of winding measured byresistance.	450 c	
20.3	Gradient between oil & winding temp	160 c (max)	
21.0	Minimum clearances in air (mm):	Phase to phase	Phase to ground
21.1	HV	1430	1270
21.2	LV	700	660
22.0	Terminals:-		
22.1	HV Winding Line end (OIP condenser bushing)	170 KV	
22.2	HV/LV Winding Neutral	72.5 kV OIP condenser bushing	
22.3	LV Winding	72.5 kV OIP condenser bushing with center spacing of 1000 mm.	
23.0	Max. Radio Interference voltage level at 1 MHz & 1.5/sq root 3 of rms phase to ground voltage for HV winding	1000 micro volts	
24.0	Minimum Visual Corona extinction voltage	320 KV rms	
25.0	Cooling Equipment's: Number of Banks with Adequate number of Fans.	Two Banks each 50%	
26.0	Bushings:	HV	LV
26.1	Voltage rating Kvrms	170	72.5
26.2	Current rating	1250	1250
26.3	Insulation level:		
	a.Lightning impulse with stand (kVp)	750	250
	b. 1 Minute power frequency withstand voltage (kV rms)	275	140
26.4	Creepage distance (mm)	3625(132 KV)	1813(33 KV)
27.1	Maximum permissible losses at rated voltage & frequency (without any positive tolerance)		
	a) No Load Losses (Iron losses)	22.5 - 25 KW	
	b) Load (Copper Losses) +Aux. Losses	133– 147.5 KW	
	c) Auxiliary losses	2.3 – 2.5 KW	

27.2	No load losses at 110% of rated voltage & rated frequency	Not more than 130% of the losses at rated voltage & frequency
28.	Type of design of the transformer	Only Bell type tank construction is acceptable
29.	Tank sheet thickness	
	(i) Top & bottom	Minimum 20 mm
	(ii) Sides	Minimum 10 mm
30.	Conservator tank sheet thickness	Minimum 8 mm
31.	There shall be two CT cores per HV, LV and HVN/LVN Bushing CT for REF (1-phase ring type turret mounted).	Ratio for HV & HVN bushings - 400/1-1A KPV- min. 800V Accuracy: PS (both cores) Ratio for LV & LVN bushings - 1200/1-1A KPV- min. 1200V Accuracy: PS (both cores)
32.	There shall be one CT core in middle phase of HV and LV Bushings for WTI	Ratio to be specified by the Bidder
33.	Transformer oil:	
	(a) Appearance	The oil shall be clear and transparent and free from suspended matter or sediment
	(b) Density at 27o C max.	0.89g/cm3
	(c) Kinematic viscosity max. (i) At 27 o C (ii) Sub-zero temp	 27 cSt. Under consideration
	(d) Interfacial tension @ 27 deg min	0.04N/m
	(e) Flash point Penskymartn (closed) min.	140 degree centigrade
	(f) Pour point max.	- 6oC
	(g) Neutralization value (total acidity) max.	0.01mg. KOH /g
	(h) Corrosive sulfur (in terms of classification of copper strip)	Non corrossive
	(i) Electric strength(break-down voltage) New untreated oil b) After treatment	 40 kv (RMS) If the value is not attainted the oil shall be treated. 70 kv (RMS)
	(j) Dielectric dissipation factor (tan delta)at 90o C max	0.002
	(k) Specific resistance (resistivity) i) At 90 o C min. ii) At 27 o C min.	 35x1012 ohms-cm 1500x1012 ohms-cm
	(l) Oxidation stability i) Neutralization value after oxidation (max) ii)Total sludge after oxidation (max)	 0.4 KOH/g 0.1 % by weight
	(m) Presence of oxidation inhabitor	The oil shall not contain antioxidant additives
	(n) Water content (max)	50 ppm, after treatment should be less than 10
34.	Oil sample taken from the transformer after the completion of site processing and tested in approved manner shall have the following values before commissioning of the transformer. Break down strength Moisture content Resistivity at 90oc minimum Interfacial Tension at 27oc v. Dielectric dissipation factor at 90 oC	 Minimum 70 KV withstand Maximum of 10 ppm 35x1012 ohm.cm (min) 0.04 N/M (min) 0.002 (max.)

5. GENERAL TECHNICAL REQUIREMENTS

5.1 Duty Requirements:

5.1.1 The interconnecting transformers would be used for Bi directional flow of rated power.

5.1.2 The transformers and all the its accessories like CTs etc. shall be designed to withstand without injury, the thermal and mechanical effects of any external short circuits at the terminals of any winding for a period of 3 sec. If 132KV side of transformer is connected on a infinite bus, 33KV shall be capable to withstand terminal short circuit for 3 sec. duration.

5.1.3 The transformer shall be capable of being loaded in accordance with IS:6600. There shall be no limitation imposed by windings, bushings, tap changer etc. of transformer. Transformer & all its accessories shall be liberally rated to allow 10% over loading at all taps on continuous basis without exceeding the temperature limits specified in clause 4.0. The transformer shall be capable of being operated without danger on each tapping at the rated KVA with specified voltage variation corresponding to the voltage of that tapping with normal temperature rise. The design adopted to achieve this shall be indicated in detail in the Bid. Transformer shall be capable of operating under the natural cooled condition up to the specified load i.e. as ONAN rating. The forced air cooling equipment shall come into operation by pre-set contacts of winding temperature indicator and the transformer shall operate as a forced air cooled unit i.e. as ONAF. Cooling shall be so designed that during total failure of power supply to cooling fans, the transformer shall be able to operate at full load for Ten (10) minutes without the calculated winding hot spot temperature exceeding 140 deg.C. Also stopping of two cooling fans should not have any effect on the cooling system. Transformers fitted with two coolers (cooling banks) each capable of dissipating 50 per cent of the loss at continuous maximum rating shall be capable of operating for 20 minutes in the event of failure of the blowers associated with one cooler, without the calculated winding hot spot temperature exceeding 140 deg C at continuous maximum rating.

5.1.4 The transformer shall be capable of being operated without danger on any tapping at the rated KVA with voltage variation of + 10% corresponding to the voltage of that tapping. The transformers and its accessories shall be liberally rated to allow 10% overloading at all taps on continuous basis.

5.1.5 Radio interference and Noise Level:

The transformers shall be designed with particular attention to suppression of maximum harmonic voltage, especially the third and fifth so as to minimize interference with communication circuits.

The noise level, when energized at normal voltage and frequency with fans and pumps running shall not exceed, when measured under standard, conditions, the values specified in NEMA, TR-1

5.1.6 Transformer shall be capable of operating under the natural cooled condition up-to the specified load. The forced cooling equipment shall come into operation by preset contacts of winding temperature indicator and the transformer shall operate as a forced cooled unit, at specified load. Cooling shall be so designed that during total failure of power supply to cooling fans, the transformer shall be able to operate at full load for at least ten (10) minutes without the calculated winding hot spot temperature exceeding 140 deg. C. Also stopping of one or two cooling fans should not have any effect on the cooling system.

5.1.7 Transformer shall be capable of withstanding thermal and mechanical stress caused by symmetrical of asymmetrical faults on any winding.

5.1.8 Transformer shall accept, without injurious heating, combined voltage and frequency fluctuation of +/-4%, which may produce the following over fluxing condition:

(i)	125% for 1 minute 140% for 5 seconds	for all transformer where base voltage and frequency refers to rated voltage and frequency
(ii)	Over fluxing withstand characteristics up to 170% shall be submitted along with the bid.	

GUARANTEED LOSSES AND MAXIMUM PERMISSIBLE LOSSES:-

Maximum permissible losses:

While the contrsctor may offer their own design, it may be noted that the transformer losses at 75oC rated voltage and rated frequency should not exceed the following maximum limits (Without any positive tolerance):

Sl. No.	Particulars	Maximum	Minimum
1	No Load losses in KW	25	22.5
2	Load loss in KW at rated voltage, rated frequency and rated current at 75oC in KW	147.5	133
3	Auxiliary Loss in KW	2.5	2.3

The bidders shall have to offer no load loss, load loss and auxiliary loss separately. In case any of the offered losses (i.e. no load loss, load loss and auxiliary loss) quoted by the bidder is more than the maximum permissible limits , the bid shall be considered as non responsive and shall be out rightly rejected without any correspondence in the matter.

In case any of these losses are below the minimum range prescribed above, the bid shall be treated as responsive. However, for price bid evaluation purpose, the minimum range of the respective loss prescribed above shall be considered.

5.2.2 Guaranteed losses:

The transformer losses at 75oC, rated voltage & frequency should be offered by the contractor. During final testing of each of the transformer, the measured losses (individually i.e. No load, load & auxiliary losses) should not exceed the guaranteed losses. In case, any of the losses exceed the guaranteed losses transformer shall not be accepted. The contractor must clearly specify that the offered losses are 'FIRM' and no tolerances shall be applicable on the offered values.

5.2.3 Capitalisation of losses:

The capitalisation of no load loss, load loss and auxiliary loss for the bidder who has quoted above the minimum of the respective range of losses specified in pre clause-5.2.1 shall be done on following rates (differential of quoted loss and minimum value of the range for respective loss).

For differential no load loss above Min value:		Rs.4,01,840.00 per KW
For differential load loss above Min value	:	Rs.2,13,780.00 per KW
For differential auxiliary loss above Min value		Rs.1,60,700.00 Per KW

In case a bidder quotes any of the losses below the minimum value of the range prescribed in pre clause-5.2.1, the value of loss shall be considered equal to minimum of the range specified at clause-5.2.1 for respective loss for price bid evaluation purpose. However, it should be clearly noted that during final testing of each of transformer, the measured losses individually (i.e. no load loss, load loss & auxiliary loss as applicable) should not exceed the values quoted by the bidder in the bid. In case any of the loss exceeds the quoted loss, respective transformer shall not be accepted.

The above mentioned rates for capitalization of losses have been worked out as per the formula prescribed by CBIP publication No. 317 i.e. manual on Transformers.

5.2.4 GUARANTEE PERIOD:

The contractor shall ensure that the power transformer supplied shall be guaranteed for a period of 42 months from the date of satisfactory commissioning of transformer along with all accessories. Please note that the date of commissioning of last accessory will be treated as date of commissioning of transformer. The transformer found defective/ failed within the above guarantee period shall be got replaced/ repaired by the contractor free of cost, within four months from date of issue of intimation letter to the contractor by CSPTCL regarding its defect/failure.

If the contractor fails to arrange repair/replace the failed/defective transformer within four months, the contractor shall be liable to pay penalty charges for delayed repairs at the rate of

0.5% of the cost of transformer per week of delay or part thereof, subject to a maximum ceiling of 10% of the cost of the transformer. This penalty shall be in addition to the liquidated damages as per clause 14.1 of GCC for delay in completion of the contract.

If the defective/failed transformer is not lifted for replacement/repairing within 2 months from the date of intimation by CSPTCL regarding defect/ failure OR one month from date of acceptance of additional Indemnity Bond submitted by the contractor, (in case the transformer is required to be taken back to the works for repairing) whichever is later.

OR

not repaired within seven months from date of lifting of failed/ defective transformer, penal action may be taken which will include forfeiture of performance guarantee of transformer and debarring of the turnkey contractor in addition to the other applicable penalty.

The above provisions shall be applicable for second time failure also, if any.

EXTENDED GUARANTEE PERIOD POST REPAIRS:
Further, the following extended guarantee shall be applicable, in case the transformer fails within guarantee period.

a) First time failure within guarantee period:
   i) If the transformer fails within 12 months from the initial commissioning, the guarantee period shall get extended to 42 months from the date of satisfactory re-commissioning of transformer after repairs along with all accessories.
   ii) If the transformer fails after 12 months within the original guarantee period, the original guarantee period shall get extended for a period equal to the time period lapsed between date of failure to date of re-commissioning after repairs i.e. the residual guarantee period or 12 months from date of re-commissioning after repairs, whichever is later.

b) Second time failure of transformer within guarantee period:
If the transformer fails again (second time) within the original/extended guarantee period, the guarantee shall automatically get extended for further period of two years from the date of re-commissioning (post repair) or from the end of the original/ previously extended period, whichever is later. Further the contractor shall be required to submit an additional performance bank Guarantee equivalent to 10 % of the FOR destination price of Power Transformer with validity up to expiry of extended guaranteed period plus six months additional claim period. This performance bank Guarantee shall be in addition to 10% performance guarantee submitted as per clause No. 12.1 (i).

c) Third time failure of transformer within guarantee period:
If the transformer fails within guarantee /extended guarantee period for third time, this will be treated as adverse performance of contractor as well as manufacturer and in such case penal action shall be taken which will includes
Forfeiture of 10% BG submitted against Performance of transformer.
Forfeiture of additional 10% performance BG of transformer furnished subsequent to second time failure.
The contractor shall be debarred from future business with CSPTCL and other Chhatishgarh state power companies for a period as decided by management.
The name of the transformer manufacture shall be deleted from the vendor list of CSPTCL for power transformer of the capacity supplied for the instant case and higher capacities for forthcoming turnkey project and shall not be considered for procurement cases of CSPTCL as well as other Chhattisgarh state power companies for a period as decided by management.

If, for the purpose of replacement/repairs, the equipment/material is required to be dispatched to manufacturer's works, all charges towards transportation / insurance/ packing / forwarding will have to be borne by contractor for to and fro dispatches.

In this connection, please note that the following additional conditions will also be applicable in case any damages/defects are noticed in the equipments or its accessories-

If the material develops defect within guarantee/extended guarantee period after installation at site or subsequent to installation after repairs (1st or 2nd time), for the purpose of replacement / repairs, the same will have to be dismantled and taken out by CSPTCL, in such cases actual cost of dismantling and replacement of the equipment / material will also be recoverable from contractor.

In case, transformer fails during guarantee / extended guarantee period, the following terms shall also be applicable (in first or second time failure both)-

An additional Indemnity Bond on stamp paper of Rs.250.00 shall be required to be submitted by the contractor, in case the transformer is required to be taken back to the works for repairing. The value of this Indemnity Bond shall be equal to the cost of transformer along with all taxes, duties, freight and testing charges. The transformer shall be handed over for repairing only after submission and acceptance of additional indemnity bond.

The transformer should be offered for inspection after completion of repairing work. The repaired Transformer shall be tested for all routine, additional routine, type and special test as per IS-2026 & as narrated in section-III-B, clause-6 under head "Tests" of technical specification of transformer.

(iii) The Transformer should be offered for inspection after repairing within four months from date of intimation of failure by CSPTCL.

(iv) The dispatch instructions shall be issued for repair transformer after its satisfactory inspection. The transformer should reach the destination (anywhere in C.G. state) within 45 days from date of issue of dispatch instruction failing which actual date of receipt of repaired transformer at site shall be treated as date of delivery of the repaired transformer for all contractual purposes.

(v) In case of failure / defect in transformer (first or second time) within guarantee / extended guarantee period, the validity of performance guarantee for transformer submitted by the contractor against the contract as per clause 12.1(i) of GCC should be extended up to expiry of extended guarantee period with additional claim period of six months. In case, contractor fails to extend the guarantee period of transformer, claim shall lodged with the issuing bank for encashment of the all performance bank guarantee for transformer.

5.3 CLEARANCES

The over all dimensions of the transformer shall allow for sufficient clearances for installation in:-

132KV switchyard with bay width of 9600 mm and beam height of 11000 mm.

5.4 CONSTRUCTION DETAILS

The features and construction details of power transformer shall be in accordance with the requirements stated hereunder:

5.4.1 Tank and Tank Accessories:

5.4.1.1 Tank:

Tank shall be of welded construction and fabricated from tested quality low carbon steel of minimum thickness of 20 mm. (Base & Tank cover) and 10mm for sides.

All seams and those joints not required to be opened at site shall be factory welded and whenever possible they shall be double welded. After completion of tank construction and before painting, dye penetration test shall be carried out on welded parts of jacking bosses, lifting lugs and all load bearing member. The requirement of post weld heat treatment for tank/ stress relieving parts shall be based on recommendations of BS: 5500 table 4.4.3.1.

The Tank stiffeners shall be provided for general rigidity and these shall be designed to prevent retention of water.

The tanks shall be designed to withstand

(i) Mechanical shocks during transportation

(ii) Vacuum filling of oil at 10 milli torr

(iii) Continuous internal pressure of 35 kN/m2 over normal hydrostatic pressure of oil.

Short circuit forces.

Wherever possible the transformer tank and its accessories shall be designed without pockets wherein gas may collect. Where pockets cannot be avoided, pipes shall be provided to vent the gas into the main expansion pipes.

Adequate space shall be provided at the bottom of the tank for collection of sediments. The minimum clearance of outermost winding/connection leads to tank shall not be less than 300 mm on all 4 sides to allow free movement of two persons for inspection. Suitable platforms may be provided on bottom to facilitate free movement of person all around inside the tank. The arrangement should be brought out clearly in the drawing.

The base of each tank shall be so designed that it shall be possible to move the complete unit by skidding in any direction without injury when using plates or rails.

Tank shields shall be such that no magnetic/fields shall exist outside the tank. If required impermeable shields shall be provided at the coil ends. Tank shield shall not resonate when excited at the natural frequency of the equipment.Manufacturer may confirm use of tank shields in the schedule of additional information.

Suitable guides shall be provided in the tank for positioning the core and coil assembly.

Each tank shall be provided with

(i) Lifting lugs suitable for lifting the equipment complete with oil

(ii) A minimum of four jacking pads in accessible position at 500 mm height to enable the transformer complete with oil, to be raised or lowered using hydraulic or screw jacks.

(iii) Suitable haulage holes shall be provided.

One detachable bolted type mild steel (MS) ladder with anti-climbing arrangement shall be provided. Ladder for climbing up to & over top cover of power transformer shall be mechanically sturdy enough to bear the load of healthy maintenance staff without any shake/jerks. The arrangement shall not be detached after erection and commissioning of the unit, hence shall be provided with padlock locking arrangement for anti-climbing device. On the upper top of the ladder, provision for support shall be provided. However, the arrangement of the ladder shall be approved by CSPTCL. Collapsible ladder shall not be acceptable.

The transformer should be of bell tank design only. No other design is acceptable.

5.4.1.2 Tank cover:

(a) The tank cover shall be sloped to prevent retention of rainwater and shall not distort when lifted.

(b) At least two adequately sized inspection openings, one at each end of the tank shall be provided for easy access to bushings and earth connections. The inspection covers shall not weigh more than 25 kg. The inspection covers shall be provided with two handles.

(c) The tank covers shall be fitted with pockets at the position of maximum oil temperature of MCR (Maximum Continuous Rating) for bulbs of oil and winding temperature indicators. It shall be possible to remove these bulbs without lowering the oil in the tank.

(d) Bushings, turrets, covers of inspection openings, thermometer, pockets etc. shall be designed to prevent ingress of water into or leakage of oil from the tank.

(e) All bolted connections shall be fitted with weather proof, hot oil resistant gasket in between, for complete oil tightness. If gasket is compressible metallic stops shall be provided to prevent over-compression.

5.4.2 Air cell:

The transformers should be supplied with air cell type oil preservation system. It is obligatory on the part of the bidders to clearly submit complete constructional and technical details of sealing arrangements duly supported with technical details, pamphlets and dimensional drawings.

While furnishing details for the above sealing arrangement the bidders must confirm clearly that the size and capacity of sealing arrangement is adequate for the transformer and for the quantity of transformer oil required for the transformers.

5.4.3 Axles and Wheels:

(a) The transformers are to be provided with flanged bi-directional wheels and axles. These shall be so designed as not to deflect excessively to interfere with the movement of the transformer. Wheels shall be provided with suitable bearings, which shall be rust and corrosion resistant. Fittings for lubrication shall also be provided.

(b) Suitable locking arrangement along with foundation bolts shall be provided for the wheels to prevent accidental movement of transformer.

(c) The wheels are required to swivel and they shall be arranged so that they can be turned through an angle of 90° when the tank is jacked up to clear of rails. Means shall be provided for locking the swivel movements in positions parallel to and at right angles to the longitudinal axis of the tank.

(d) The rail track gauge shall be 5' – 6" (1676 mm) along longer axis as well as along shorter axis. The arrangement should be such that transformer can be installed in any direction i.e. along longer axis or along shorter axis on 2 rails with spacing of 1676 mm.

(e) Pulling eyes shall be provided to facilitate movement/ pulling of transformers and these shall be suitably braced in a vertical direction so that bending does not occur when the pull has in vertical component.

5.4.4 Anti Earthquake Clamping Device:

To prevent transformer movement during earthquake, clamping device shall be provided for fixing transformer to the foundation. The Bidder shall supply necessary bolts for embedding in the concrete foundation. The arrangements shall be such that the transformer can be fixed to or unfastened from these bolts as desired. The fixing of the transformers to the foundations shall be designed to withstand seismic, events to the extent that a static co-efficient of 0.3g, applied in the direction of least resistance to that loading will not cause the transformer or clamping devices as well as bolts to be over stressed.

The details of the device used and its adequacy shall be brought out in the additional information schedule.

5.4.5 Conservator Tank

(a) The conservator tank shall be of minimum 8 mm thickness and shall have adequate capacity between highest and lowest visible levels to meet the requirement of expansion of the total cold oil volume in the transformer and cooling equipment from minimum ambient temperature to 100oC. Conservator shall be with volumetric capacity at least 7 ½ percent of a total volume of oil in the main tank of the transformer.

(b) The conservator tank shall be bolted into position so that it can be removed for cleaning purposes.

(c) The conservator shall be fitted with magnetic oil level gauge with low level electrically insulated alarm contact.

(d) Conservator shall be provided in such a position as not to obstruct the electrical connections to the transformer.

(e) Separate conservator tank/compartment in the main conservator shall be provided for OLTC.

(f) Conservator shall be provided with air cell to avoid direct contact of atmospheric air with transformer oil.

5.4.6 Dehydrating Filter Breather:

Conservator shall be fitted with a dehydrating, filter breather. It shall be so designed that:

(a) Passage of air is through a dust filter and silicagal.

(b) Silicagel is isolated from atmosphere by an oil seal.

(c) Moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from a distance.

(d) Breather is mounted not more than 1400 mm above rail top level. Minimum quantity of silicagel to be 1 kG for every 3500 lts of oil in the tank.

(e) Minimum quantity of silicagel to be 1 Kg for every 3500 lts of oil in the tank.

5.4.7 Pressure relief device:

Adequate numbers of pressure relief devices (Minimum three no.) should be provided with each unit. Bidders must submit calculations to prove that the capacity of pressure relief device and location of the same in the transformer will adequately meet out requirement.

Constructional and design details of pressure relief device must be furnished and it should be proved by calculation that the size and setting of pressure relief device is adequate, considering the rating of the transformer and quantity of oil in the transformer. Furnishing of this information is a must.Adequate No. of pressure relief devices may be provided at suitable locations which shall be of sufficient size for rapid release of any pressure that may be generated in the tank and which may result in damage to the equipment. The device shall operate at a static pressure of less than the hydraulic test pressure of transformer tank. It shall be mounted direct on the tank. One set of electrically insulated contacts shall be provided for alarm /tripping along with the recommended settings.

5.4.8 Buccholz Relay:

A double float type Buccholz relay shall be provided. All the 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 and taking gas sample. A copper or stainless steel tube shall be connected from the gas collector to a valve located about 1200 mm above ground level to facilitate sampling, with the transformer in service. The device shall be provided with two electrically independent ungrounded contacts, one for alarm on gas accumulation and the other for tripping on sudden rise of pressure.

Note: The manufacturer shall ensure that the compartments housing of relay contacts of Pressure Relief Valve and Buchholz Relay are made water and vermin proof. The compartment housing contacts of PRV and Buchholz Relay shall be tested for water proofing at the time of inspection and effectiveness of water proofing shall be demonstrated at the time of inspection.

5.4.9 Temperature Indicator:

(a) Oil Temperature Indicator (OTI)

All transformers shall be provided with a 150-mm dial type thermometer for top oil temperature indication. The thermometer shall have adjustable, electrically independent ungrounded alarm and trip contacts, maximum reading pointer and resetting device mounted in the cooler control cabinet. A temperature-sensing element suitably located in a pocket on top oil shall be furnished. This shall be connected to the OTI by means of capillary tubing. Accuracy class of OTI shall be +1.5% or better.

(b) Winding Temperature Indicator (WTI)

A device for measuring the hot spot temperature of each of the HV &LV windings shall be provided. It shall comprise of the following:

Temperature sensing element.

(ii) Image coil

(iii) Auxiliary CTs,

(iv) 150 mm dia local indicating instrument with maximum reading pointer mounted in Cooler control cabinet and with two adjustable electrically independent ungrounded

contacts (besides that required for control of cooling equipment), one for high winding temperature alarm and one for trip.

(v) Calibration device.

(vi) In addition to the above, the following indication equipment shall be provided for each winding.

(c) Remote winding temperature indicator

It shall be suitable for flush mounting on RTCC panel. The difference between local and remote WTI indication at any given time shall not exceed 1deg C. One RWTI shall be provided for each winding in the middle phase (HV & LV).

(i) Auxiliary supply if required, at Owner's panel, for RWTI, shall be 110/220 V DC only.

(ii) Accuracy class of WTI shall be + 1.5% or better.

(iii) Any special cables required for shielding purpose for connection between cooler control cabinet and remote winding Temperature Indicator control circuit shall be in supplier's scope or work.

5.4.10 Earthing Terminals:

(a) Two (2) earthling pads (each complete with two (2) Nos. tapped holes, M 10 bolts, plain and spring washers) suitable for connection to 110 x 12 mm copper/brass grounding flat shall be provided each at position close to the two (2) diagonally bottom corners of tank. Earthing strip shall be connected to grounding mat by the Bidder.

(b) Two earthing terminals suitable for connection to 50 x 6 mm galvanized steel flat shall also be provided on cooler, marshalling box and any other equipment mounted separately and shall be connected to grounding mat suitably.

5.4.11 Core:

(a) The core shall be constructed from high grade non aging cold rolled super grain oriented silicon steel laminations (Hi B). The core material should be of PRIME grade only. Bidder will offer the core for inspection & approval by the purchaser during manufacturing stage. Bidder call notice should be accompanied with the following documents as applicable as a proof towards use of PRIME core material.

(i) Invoice of the supplier

(ii) Mill's test certificate

(iii) Packing list

(iv) Bill of lading

(v) Bill of entry certificate by customs

(b) The design of the magnetic circuit shall be such as to avoid static discharges, development of short circuit paths within itself or to the earthed clamping structure and production of flux component at right angles to the plane of laminations which may cause local heating.

(c) Core earthing arrangement: The manufacturer should bring out leads from core, end frame and tank to top of the transformer through insulated bushing. It may be noted that internal earthing of any nature from core and frame should not be provided. Earthing at site shall be done by taking connections from the top of the tank and this arrangement will also facilitate checking of possibility of any multiple core earthing in transformer.

(d) The insulation of core to bolts and core to clamps plates shall be able to withstand a voltage of 2 kV RMS for one minute.

(e) Core and winding shall be capable of withstanding the shock during transport, installation, service and adequate provision shall be made to prevent movement of core and winding relative to tank during these conditions.

(f) All steel sections used for supporting the core shall be thoroughly sand blasted after cutting, drilling and welding.

(g) As the transformer is of Bell tank design, suitable projecting guides shall be provided on core-assembly to facilitate removal of tank.

(h) Each core lamination shall be insulated with a material that will not deteriorate due to pressure and hot oil.

(i) The supporting frame work of core shall be so designed as to avoid presence of pockets which would prevent complete emptying of the tank through drain valve or cause trapping of air during oil filling.

(j) The maximum flux density in any part of the core and yoke at rated MVA, voltage and frequency at any tap shall not exceed 1.6 tesla.

5.5.1 Winding:

(a) The supplier shall ensure that windings of all EHV class transformers are made in dust proof, conditioned atmosphere. He shall furnish the facilities available in this regard at his works along with the Bid.

(b) The conductors shall be of electrolytic grade copper.

(c) The insulation of transformer windings and connections shall be free from insulating compounds which are liable to soften, ooze out, shrink or collapse or be catalytic and chemically active in transformer oil during service.

(d) Coil assembly and insulating spacers shall be so arranged as to ensure free circulation of oil and to reduce the hot spot of the winding.

(e) The stacks of windings shall receive adequate shrinkage treatment before and after final assembly. Adjustable devices if necessary shall be provided for taking up possible shrinkage of coils if any, in service. The provision made in this respect shall be clearly brought out in the Bid.

5.5.2 Insulating oil:

(a) EHV Grade-I oil shall be used. The quality of the oil supplied with transformer shall conform to the oil parameters specified in this clause. No inhibitors shall be used in the oil. The oil samples will be drawn as follows

i) Prior to filling

ii) Before and after heat run test

iii) Before energizing.

All tests as per IS: 335 shall be conducted on all samples.

(b) The insulating oil shall be subjected to testing in the oil manufacturer's works before supply in the presence of the representative of the transformer manufacturer.

(c) Sufficient quantity of oil necessary for first filling of all tanks, coolers and radiator at the proper level along with 10% extra oil by weight for topping up shall be supplied in on-returnable containers suitable for outdoor storage.

(d) Power Transformers shall be supplied with oil.

(e) The parameter of the EHV Grade I transformer oil should confirm the values given in schedule-I Sl. No. 28.

(f) The bidder shall warrant that characteristic of oil furnished shall comply with the requirements specified in IS-335, 1993 (Fourth Revision) with latest amendment/revision and shall be suitable for EHV grade transformers.

5.6.1 Oil preservation equipment:

a) The manufacturer shall offer silica gel breather type oil sealing in conservator to prevent oxidation and contamination of oil due to contact with water in this type of oil preservation system conservator shall be fitted with a dehydrating filter breather. It shall be so designed that:

i) Passage of air is through a dust filter and silica gel.

ii) Silica gel is isolated from atmosphere by an oil seal.

iii) Moisture absorption indicated by a change in colour of the tinted crystals can be easily observed from a distance.

iv) Breather is mounted not more than 1400 mm above rail top level.

b) On line DGA Monitoring device:

One Number 5 Gas Online DGA monitoring device + moisture should be provided on the transformer which should be capable of measuring following key gases and moisture content individually (Not composite) found in the transformer oil.

(i) Hydrogen (H2) (iv) Ethylene (C2H4)

(ii) Carbon mono oxide (CO) (v) Methane (CH4)
(iii) Acetylene (C2H2)

The online DGA monitor should be microprocessor based IED alongwith the required interface software in CD-ROM one with each unit. The device should have capacity to internally store minimum two years of Data. It should have non volatile memory storage to prevent loss of data.

The device should have following communication facilities:-
Two separate channels for remote communications plus local USB connection and Ethernet connections.
Communications protocols supported should include MODBUS, MODBUS/ TCP, DNP3.0, IEC61850.
Modules available for connection via RS232, RS485, Ethernet, PSTN modern /GSM or CDMA wireless modems/ IEC61850 compliant latest communication module.

The make and model of on line DGA monitoring device shall be subject to approval of CSPTCL. The contractor shall submit the details of the manufacturer's device like make, model No., the name of gases which are detected, the location of fitting in the transformer with the schematic drawings. The on line DGA monitor of only approved vendors as per the vendor list given in "List of Vendors for Major items of Transformer" shall only be acceptable.

5.7 TERMINAL ARRANGEMENTS:

5.7.1 Bushings:

The bushings of CSPTCL's approved make shall be manufactured tested and supplied with guaranteed particulars generally conforming to the latest issue of the following Standard Specifications:

i)	IS-2099	Bushings for alternating voltage above 1000V
ii)	IEC 60137	Bushings for alternating voltage above 1000V
iii)	IS 3347 (Part I to VIII)	Dimensions of porcelain transformer bushings for use in lightly polluted atmospheres.
iv)	IEC 60233	Tests on hollow insulators
v)	IS 2544	Specification for porcelain insulator for voltages above 1000 volts.
vi)	IS 5621	Hollow insulators

Oil impregnated paper insulated condenser type bushing shall be provided for 170 KV, 72.5 KV class with the following specifications.
These bushings shall be outdoor immersed self-contained draw-through lead or rod type, with oil filling. The active part of bushing shall consist of a condenser body built up around a centre tube using high quality kraft insulating paper. The paper craft shall be wound over the centre tube with pure aluminium foils inserted at pre designed locations to get optimum combination of external flashover and internal puncture strength.
The condenser body shall be enclosed in weather resistant housing consisting of a top expansion chamber, upper porcelain, a welded flange – ground sleeve assembly, lower porcelain and a bottom cap. The annular space between the condenser body and the housing shall be filled with Grade-I transformer oil. An assembly located in the top housing hold all the gasket and O ring between porcelain and metal parts thereby completely sealing the bushing. An oil site window shall be provided on the expansion chamber for observing the oil level. The space in the expansion chamber above oil shall be filled with dry Nitrogen gas.
Brown glazed porcelain insulators of high strength are used as air end and oil end insulators. Air end porcelain shall normally be provided with total nominal creepage length 25 mm/KV of the rated voltage unless otherwise specified. Oil end porcelain shall be cone shaped without shed. Air end porcelain shall be provided with long and short sheds(aerodynamic shed profile).Porcelain used in bushing manufacture shall be homogenous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. Bushings shall be

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

Bushings hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used. The hollow column insulator shall be of reputed make and subject to the approval of CSPTCL. Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators bushings when operating at the normal rated voltage.

All iron parts shall be hot dip galvanised and all joints shall be air tight. Galvanized bolts and nuts shall be used as fasteners. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Bushing design shall be such as to ensure a uniform compressive pressure on the joints.

After assembly, the bushings shall be dried out at a very high vacuum pressure. These shall then be impregnated with transformer oil. Oil impregnation shall be carried out under pressure. The oil level in bushing shall then be adjusted and the bushings shall be sealed subsequently.

For the bushings of rated voltage 170 KV, stress relieving shield shall be provided on the lower cap. The shield shall consist of an aluminium shroud insulated in kraft paper and press board moulding. The maximum stress in oil and the surface of these shield insulation must be limited to those values normal for insulated conductors and similar components in the same transformer.

The draw lead or draw rod connecting the top terminal will be supplied along with bushing. The complete joint connector shall be provided with the draw lead and the free connector shall be suitable for brazing the lead from the connecting improvement in the case of draw rod the free end shall form the connector. For the air side connection, rod type terminal shall be provided.

The bushing shall be provided with an insulation test tap suitable for measuring bushing power factor (dissipation factor) and capacitance by ungrounded specimen test method. The cover of this tap should be removed from the tap attachment only for testing purpose. Normally the tap shall be grounded through the cover and the bushing shall not be operated with cover remove.

Tests:

Bushings shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099, IEC 60137, IS: 2544 & IS: 5621. The following type test reports of the offered bushings shall have to be submitted for approval.

Wet power frequency voltage withstand test.
Dry lighting impulse voltage withstand test.
Dry or wet switching impulse voltage withstand test.
Thermal stability test.
Temperature rise test.
Thermal short time current withstand test.
Dynamic current withstand test.
Cantilever load withstand test.
Tightness test on liquid filled and liquid insulated bushings.

The dielectric tan delta value shall not be more than 0.005.The insulation resistance of the bushing shall not be less than 20 G ohm. The partial discharge of the bushing shall not be more than 10 pC.

5.7.2 Terminal connectors:

a) Bushing terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS:5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL.

b) i) All connections with ACSR zebra conductors shall be bolted type.
ii) Connectors shall be electrolytic grade copper forged and silver plated/ tinned for 10 Microns.

No part of a clamp shall be less than 15 mm thick. Minimum conductor coverage on the clamp shall be 100mm. Minimum bushing terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

GI nuts, bolts and washers shall be used. Nuts and bolts shall have hexagonal head with threads as per IS and shall be fully threaded type. Also instead of spring washers check/ lock nuts shall be provided.

The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR zebra conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor. The terminal connector of 33KV side should be suitable for twin zebra conductor.

Terminal connector shall be suitable for Zebra ACSR conductors. Clamps shall be designed adequately to take care of any bimetallic effect. The temperature at the clamp shall not exceed 80°C. The bushing side of connector shall be of copper and conductor side shall be of aluminium.

The terminal connectors shall also meet the following requirements:

Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The drawing of terminal connector offered shall have to be got approved by CSPTCL

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

Minimum conductor coverage on the clamp shall be 100mm. Minimum bushing terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

For bimetallic connectors, copper alloy liner of minimum thickness of 4 mm shall be integral with aluminium body.

Flexible connectors shall be made from tinned copper sheets.

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

5.7.3 Bushing Current Transformer:

Current transformers shall comply with IS: 2705. Bushing current transformers of adequate ratio are to be provided in HV, LV & HV/LV neutral bushings for restricted earth fault protection. Two cores (of PS class) shall be provided for each Bushing CT for REF protection.

One core each shall be provided on middle phase of HV, LV and neutral Bushing for WTI.

It shall be possible to remove turret mounted CTs from the transformer tank without removing the tank cover. Necessary precautions shall be taken to minimize the eddy currents and local heat generated in the turret.

All secondary leads shall be brought to a terminal box near each bushing. These terminals shall be wired out to cooler Control Cabinet using separate cables for each core. The terminal shall be stud type of adequate size.

Bushing CT parameters indicated in the specification are tentative and liable to change within reasonable limits. The bidder shall obtain Purchaser's approval before proceeding with design of Bushing CTs.

5.7.4 Terminal marking:

The terminal marking and their physical position shall be in accordance with IS:2026 unless otherwise specified.

5.8 Neutral earthing arrangement:

(a) The neutral terminals of the star connected windings shall be brought to the ground level by a copper grounding bar (of adequate size) which shall be supported from the tank by porcelain insulators of highest system voltage of 36 kV.

(b) The end of the copper bar shall be brought to the ground level, at a convenient point, for connection to ground network through two (2) Zebra conductors. The connection shall be made by using suitable clamp with necessary accessories.

(c) Suitable flexible copper strip connection of adequate size shall be provided for connecting to Neutral Bushing terminals to avoid terminal load on the Bushings.

5.9 Auxiliary power supply for OLTC, Cooler control and power circuit:

5.9.1 Auxiliary Power Supplies, shall be as indicated in clause 3.0 provided by CSPTCL at any one place for OLTC Control and Cooler Control and Cooler Control. The DC operated contactors coils & push buttons should be suitable for control voltages of either 220 volt or 110 volt.

5.9.2 All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed any one of the local control cabinets for tap changer control and cooler circuits.

5.9.3 Design features of the transfer switch shall include the following:

i) Provision for the selection of one of the feeders as normal source and other as standby.

ii) Upon failure of the normal source, the loads shall be automatically transferred after an adjustable time delay to the standby source.

iii) Indication for failure of normal source and for transfer to stand by source and also for failure to transfer shall be provided locally as well as in remote panel.

iv) Both the transfer and the re-transfer shall be dead transfers and AC feeders shall not be paralleled at any time.

v) Necessary isolating switches, MCBs and other components for the above power supply of the bidder.

5.9.4 Tap changing equipment: TAPS IN OLTC:
with tap range of -15% to +5% in steps of 1.25 %.

(i) Tap changer Switch (General Requirement):
The on load tap changer shall be provided on HV for HV variation as specified at Sr. No. 10 of clause 4.0.

OLTC gear shall be motor operated for local as well as remote operation. An external hand-wheel/handle shall be provided for local manual operation.

Arrangement shall be made for securing and padlocking the tap changer wheel in any of the working positions and it shall not be possible for setting or padlocking the wheel in any intermediate position. The arrangement shall be such that no padlock key can be inserted unless all contacts are correctly engaged and switch set in a position where no open or short circuit is possible. An indicating device shall be provided to show the tap in use.

On Load Tap Changing Gear (OLTC):

The details of the method of diversion of the load current during tap changing; the mechanical construction of the gear and the control features for OLTC gear shall be submitted with the bid. Information regarding the service experience on the gear and a list of important users shall be furnished. The tap changer shall change the effective transformation ratio without producing phase displacement.

The current diverting contacts shall be housed in a separate oil chamber not communicating with the oil in main tank of the transformer

The contacts shall be accessible for inspection without lowering oil level in the main tank and the contact tips shall be replaceable.

The bidder shall indicate the safeguards in order to avoid harmful arcing at the current diverting contacts in the event of operation of the OLTC gear under over load conditions of the transformer. Necessary tools and tackles shall be furnished for maintenance of OLTC gear.

The OLTC oil chamber shall have oil filling and drain plug, oil sampling valve, relief vent and level glass. It shall also be fitted with surge relay the outlet of which shall be connected to a separate conservator tank.

The diverter switch or arcing switch shall be so designed as to ensure that its operation once commenced shall be completed independently of the control relays or switches, failure of auxiliary supplies etc.

Drive mechanism chamber shall be mounted on the tank in accessible position. It should be adequately ventilated and provided with anti-condensation metal clad heaters. All contactors, relay coils and other parts shall be protected against corrosion, deterioration due to condensation, fungi etc.

Each transformer unit shall be provided with a local control cabinet and a remote OLTC control panel. The control feature shall provide following:

Local-remote selector switch mounted in the local control cubicle shall switch control of OLTC in the following manner: When the selector switch is in LOCAL position, it shall be possible to operate the RAISE LOWER control switches specified in section (ii) below. Remote control of RAISE-LOWER functions shall be prevented.

When the selector switch is in REMOTE the local control cubicle mounted RAISE LOWER Switches specified in Section (ii) shall be inoperative. Remote control of the raise lower function shall be possible from the remote control panel. The LOCAL-REMOTE selector switch shall have at least two spare contacts per position which are closed in that position but open in the other position.

Operating mechanism for on load tap changer shall be designed to go through one step or tap change per command. Subsequent tap change shall be initiated only by a new or repeat command.

On load tap changer shall be equipped with a time delay for "INCOMPLETE STEP" in alarm consisting of a normally open contact which, closes, if the tap changer fails to make a complete tap change. The alarm shall not operate for momentary loss of auxiliary power.

The selsyn units or approved equivalents shall be installed in the local OLTC control cabinet to provide tap position indication for the transformer.

The OLTC load tap changer shall be equipped with a fixed resistor network capable of providing discrete voltage steps for input to the supervisory system.

Limit switches shall be provided to prevent overrunning of the mechanism and shall be directly connected in the circuit of the operating motor. In addition, a mechanical stop shall be provided to prevent over-running of the mechanism under any condition. Limit switches may be connected in the control circuit of the operating motor provided that a mechanical-declutching mechanism is incorporated.

Thermal device or other means shall be provided to protect the motor and control circuit. All relays, switches, MCBS etc. shall be mounted in the drive mechanism chamber and shall be clearly marked for the purpose of identification.

A permanently legible lubrication chart shall be fitted within the driving mechanism chamber.

A five digit counter shall be fitted to the tap changing equipment to indicate the number of operations completed.

All relays and operating devices shall operate correctly at any voltage between the limits specified.

It shall not be possible to operate the electric drive when the manual operating gear is in use.

It shall not be possible for any two controls to (i.e. manual, local electrical and remote) be in operation at the same time.

The equipment shall be suitable for supervisory control and indication with make before break multi-way switch, having one potential free contact for each tap position. This switch shall be provided in addition to any other switch/switches which may be required for remote tap position.

All electrical control switches and the local operating gear shall be clearly labeled in a suitable manner to indicate the direction of tap changing.

Manual control:

The cranking device for manual operation of the OLTC gear shall be removable and suitable for operation by a man standing on ground level. The mechanism shall be complete with the following:

(i) Mechanical tap position indicator which shall be clearly visible from near the transformer.

(ii) A mechanical operation counter.

(iii) Mechanical stops to prevent over-cranking of the mechanism beyond the extreme tap positions.

(iv) The manual control considered as back up to the motor operated load tap changer control shall be interlocked with the motor to block motor-start-up during manual operation. The manual operating mechanism shall be labeled to show the direction of operation for raising the primary and vice-versa.

Electrical control:
This includes the following:
Local Electrical control
Electrical remote control from remote control panel.

(v) Remote Electrical Group Control

The OLTC control scheme offered shall have provision of remote electrical group control during parallel operation of transformers. This is in addition to independent control of OLTC.

A four position selector switch having MASTER, FOLLOWER, INDEPENDENT and OFF position shall be provided in the remote OLTC control panel for each transformer. This shall be wired to enable operator to select operation of OLTC in either Master, Follower or Independent mode.

(vi) Out of step relays with timer contacts shall also be provided to give alarm and indication in case of tap positions in all the transformers under group control being not in identical position.

(vii) Master Position: If the selector switch is in MASTER position, it shall be possible to control the OLTC units in the FOLLOWER mode by operating the controls of the MASTER unit Independent operation of the units under FOLLOWER mode shall have to be prevented. However, the units under independent mode will be controlled independently.

(viii) Follower position: If the selector switch is in FOLLOWER mode, control of OLTC shall be possible only from MASTER penal.

(ix) Independent Position: In this position of Selector Switch, Control of OLTC of individual unit only shall be possible.

5.10 Cooling Equipment and its controls:

5.10.1 Cooling Equipment

Cooler shall be designed using 2x50 % radiators.

Each radiator bank shall have its own cooling fans, shut off valves, lifting lugs, top and bottom oil filling valves, air release plug, a drain valve and thermometer pocket fitted with captive screw cap on the inlet and outlet.

One standby fan for each group shall also be provided and identified with each radiator bank.

Cooling fans shall not be directly mounted on radiator bank which may cause undue vibration.

The exhaust airflow from cooling fan shall not be directed towards the main tank in any case.

Cooling fans for each radiator bank shall be located so as to prevent ingress of rain water.

Each fan shall be suitably protected by galvanised wire guard.

Cooling fans motors shall be suitable for operation from 415 volts, three phase 50 Hz power supply and shall conform to IS: 325.

The cooler and its accessories shall be hot painted with corrosion resistant paint.

Each cooling fan motor shall be provided with starter, thermal overload and short circuit protection.

Each radiator shall be provided with:

One shut off valve at the top (minimum 80 mm size).
One shut-off valve at the bottom (minimum 80 mm size).
Air release device at the top.
Main & sampling device at the bottom.
Lifting lugs.
Air release device and oil plug on oil pipe connections.

5.10.2 Cooling Equipment Control (ONAN/ONAF COOLING)

(a) Automatic operation control (switching in and out) of fans shall be provided (with temperature change) from contacts of winding temperature indicator. The bidder shall recommend the setting of WTI for automatic change over of cooler control from ONAN to ONAF. The setting shall be such that hunting i.e. frequent start stop operations for small temperature differential do not occur.

(b) Suitable manual control facility for cooler fans with manual/ automatic selector switches and push buttons shall be provided.

5.10.3 Remote OLTC/Cooler control Panel (RTCC Panel)

The auxiliary devices for remote electrical control of the OLTC and Cooler shall be housed in a separate panel to be placed in the Control room. The panel shall be made of sheet steel of not less than 14 SWG and it shall be duly finished with stove enamel paint. The size and of the control cubicle to be supplied by the bidder shall be 750 mm depth and 2312 mm height and colour opaline green shade no. 275 of B.S.271-C: 1948, respectively. The width of the cubicle to be as per bidders' practice. Control and signal devices required to be mounted in the RTCC Panel shall comprise of the following.

1. Local - Remote selector switch for OLTC .
2. Actuating switch/push; button for electrical raise/lower control.
3. Remote tap position indicator with tap number and corresponding; rated voltage marked on the; instrument. The tap position indicators shall be digital type.
4. A four position selector switch having master follower, independent and off position.
5. Repeater dial of transformer winding temperature indicator.
6. Name plate for each component.
7. Initiating devices and contacts for alarm as well as for indications for discordance in the tap changer if any of the parallel operating transformer.
8. Cubicle lamp actuated by door, switch, space heater power sockets etc. shall be provided inside RTCC panel.
9. Annunciator (facia type) Scheme complete with accessories for the following:
   (i) Tap changer out of step.
   (ii) Tap changer motor trip.
   (iii) Failure of AC supply to the OLTC local control Kiosk.
   (iv) Fan failure of each group.
   (v) Control supplies failure main and standby.
   (vi) Cooler supply failure for each supply.
   (vii) Two spare windows
   (viii) OLTC at extreme positions i.e. lowest or highest tap.
10. Signal lamps for:
    (i) Fan 'ON' for each group.
    (ii) Standby fan 'ON' for each group.
    (iii) Cooling system on manual.
    (iv) Cooling system on automatic control.
    (v) 415 volts cooler supply auto change over.
    (vi) Healthy supply to control gear.
    (vii) Tap change in progress.
11. Emergency stop push button will be provided in local control cubicle as well as on remote tap changer control cubicle panel.
12. 2 No. digital volt meter of 0.5 Accuracy Class (1 for HV & other for LV) with selector switch should be provided. HRC cartridge fuse shall be provided for HV and LV PT secondary voltage.

5.10.4 Cooler control cabinet:

(i) Each transformer unit shall be provided with a cooler control cabinet.

(ii) The cooler control cabinet shall have all necessary devices meant for cooler control and local temp. indicators. All the contacts of various protective devices mounted on the transformer shall also be wired up to the terminal board in the

cooler control cabinet. All the secondary terminals of the bushing CT's shall also be wired upto the terminal board at the cooler control cabinet.

(iii) The cooler control cabinet shall have two (2) sections. One section shall have the control equipment exclusively meant for cooler control. The other section shall house the temperature indicators, aux. CT's and the terminal boards meant for termination of various alarm and trip contacts as well as various alarm and trip contacts as well as various bushing CT secondaries. Alternatively the two sections may be provided as two separate panels depending on the standard practices of the supplier.

The temperature indicators shall be so mounted that the dials are not more than 1600 mm from ground level. Glazed door of suitable size shall be provided for convenience of reading.

Nitrogen injection fire prevention system:

Each oil filled transformer shall be provided with a dedicated Nitrogen Injection system for prevention against the transformer explosion which shall use nitrogen as quenching medium. The system shall prevent transformer oil tank explosion and possible fire in case of internal / external cause.

In the event of fire by external causes such as bushing fire, OLTC fires, fire from surrounding equipment etc., it shall act as a fast and effective fire fighter. It shall accomplish its role as fire preventer and extinguisher without employing water or carbon dioxide. Fire shall be extinguished within reasonable with time (not more than 3 minutes so as not to harm the transformer) of system activation and within 30 seconds (maximum) of commencement of nitrogen injection.

Activation of the system

Mal-functioning of the Nitrogen injection system could lead to interruption in power supply. The supplier shall ensure that the probabilities of chances of malfunctioning of the Nitrogen injection system are practically zero. To achieve this objective, the supplier shall plan out scheme of activating signals which should not be too complicated to make the system inoperative in case of actual need. The system shall be provided with automatic controls to prevent the explosion of transformers. Besides automatic control, remote electrical push button control at Control box and local manual control in the cubicle shall also be provided. Simultaneous activation of the following electrical-signals shall be used for initiating the system under prevention mode/fire extinguishing mode.

Auto Mode

For prevention:

- Differential relay operation.
- Buchholz relay paralleled with pressure relief valve
- Tripping of all circuit breakers (on HV & LV side) associated transformer is the pre-requisite for activation of system.

For extinguishing

- Fire Detector
- Buchholz relay paralleled with pressure relief valve

Tripping of all circuit breakers (on HV & LV side) associated with transformer is the pre-requisite for activation of system.

Manual Mode (Local / Remote)

Tripping of all circuit breakers (on HV & LV side) associated with transformer is the pre-requisite for activation of system.

Manual Mode (Mechanical)

- Tripping of all circuit breakers (on HV & LV side) associated with transformer is the pre-requisite for activation of system.

The system shall be designed to be operated manually in case of failure of power supply to the system.

General description

Nitrogen Injection system should be a dedicated system for each oil filled transformer. It should have a Fire Extinguishing Cubicle (FEC) placed on a plinth at a distance of 5-

10 m away from transformer or placed next to the firewall (if fire fighting wall exists). The FEC shall be connected to the top of transformer oil tank for depressurization of tank and to the oil pit (capacity is approximately equal to 10% of total volume of oil in transformer tank / or existing oil pit) from its bottom through oil pipes.

The FEC should house a pressurized nitrogen cylinder (s) which is connected to the oil tank of transformer oil tank at bottom. The Transformer Conservator Isolation Valve (TCIV) is fitted between the conservator tank and Buchholz relay. Cable connections are to be provided from signal box to the control box in the control room, from control box to FEC and from TCIV to signal box. Detectors placed on the top of transformer tank are to be connected in parallel to the signal box by Fire survival cables. Control box is also to be connected to relay panel in control room for receiving system activation signals.

Operation

On receipt of all activating signals, the system shall drain - pre-determined volume of hot oil from the top of tank (i.e. top oil layer), through outlet valve, to reduce tank pressure by removing top oil and simultaneously injecting nitrogen gas at high pressure for stirring the oil at pre-fixed rate and thus bringing the temperature of top oil layer down. Transformer conservator isolation valve blocks the flow of oil from conservator tank in case of tank rupture / explosion or bushing bursting. Nitrogen occupies the space created by oil drained out and acts as an insulating layer over oil in the tank and thus preventing aggravation of fire.

System components

Nitrogen Injection system shall broadly consist of the following components. However, all other components which are necessary for fast reliable and effective working of the system shall deemed to be included in the scope of supply.

MS Storage tank for storage of extracted oil

The MS storage tank of cylindrical shape should be provided for storage of extracted oil. The capacity of tank should be minimum 12% of total oil capacity of transformer.

The MS storage tank should have facility of oil filtration in side the tank. For this 2 No. flanges (one for delivery and the other for suction) should be provided. The suction flange should be connected to the bottom of the tank. The storage tank should be made of 8 mm thick plate .The inner side of the tank shall be painted with 2 coats of heat resistant, oil insoluble, insulating varnish. The outer surface shall be given a primary coat of zinc chromate, second coat of oil & weather resistant varnish of a colour distinct from primary and final two coats of glossy oil and weather resisting light grey paint in accordance with shade No. 631 of IS-5. Adequate size of inspection window should be provided so that tank can be cleaned by manual labour. A vent pipe of adequate diameter shall be provided a breather fitted on it in order to allow breathing of air.

CUBICLE (FEC)

The Cubicle Frame shall be made of CRCA sheet of 3 mm (minimum) thick complete with the base frame, painted inside and outside with post office red colour (shade 538 of IS -5). It shall have hugged / hinged split doors fitted with high quality tamper proof lock. The doors, removable covers and panels shall be gasketted all round with neoprene gaskets. The degree of protection shall be IP55. The following items shall be provided in the Cubicle.

- Nitrogen gas cylinder with regulator and falling pressure electrical contact manometer.
- Oil drain pipe with mechanical quick drain valve.
- Electro mechanical control equipment for draining of oil of pre-determined volume and injecting regulated volume of nitrogen gas.
- Pressure monitoring switch for back-up protection for nitrogen release.
- Limit switches for monitoring of the system. Limit switch for pressure switch/sensor
- Butterfly valve with flanges on the top of panel for connecting oil drain pipe and nitrogen injection pipes for transformer.
- Panel lighting (CFL Type)
- Oil drain pipe extension of suitable sizes for connecting pipes to oil storage tank.

- Space heater.

Control box:

Control box is to be placed in the control room for monitoring system operation, automatic control and remote operation. The following alarms, indications, switches, push buttons, audio signal etc. shall be provided.

- System Oil.
- TCIV open.
- Oil drain valve closed.
- Gas inlet valve closed
- TCIV closed
- Detector trip
- Buchholz relay trip
- Oil drain valve open
- Extinction in progress
- Cylinder pressure low
- Differential relay trip
- PRV trip
- Transformer trip
- System out of service
- Fault in cable connecting fault detector
- Fault in cable connecting differential relay
- Fault in cable connecting Buchholz relay
- Fault in cable connecting PRV
- Fault in cable connecting transformer trip
- Fault in cable connecting TCIV
- Auto / Manual / Off
- Extinction release on / off
- Lamp test
- Visual / Audio alarm for AC supply fail
- Visual / Audio alarm for DC supply fail
- Nitrogen cylinder pressure indication.
- Fire in Transformer.
- Oil drain started.
- Conservator oil isolation valve closed.
- Nitrogen injection started.

As far as possible the control box should be such devised that all the transformers and or group thereof should be controlled from single spot.

The control box shall have one IEC 61850 compliant IED (BCU) of GE/Alstom/ ABB/ Siemens/SEL make, wherein operation of all the major components of NIFPS shall be logged in as time tagged events for analysis and evaluation of operation of NIFPS.

This IED shall be a separate state of art Numerical Bay Control Unit dedicated for this purpose. It shall have 20 % spare input and output contacts over what has been utilised in the scheme. This IED (BCU) shall have freely configurable input and output contacts. The BCU shall also have Ethernet/RJ ports for achieving redundancy in Ethernet switch connection. The IED (BCU) shall have self monitoring feature and shall have event logger, disturbance Recorder and on initiation of event, it shall automatically be downloaded at the workstation of substation.

The IED (BCU) shall have IRIG –B port for GPS time synchronizing.

Transformer Conservator Isolation Valve:

Transformer conservator isolation valve (TCIV) to be fitted in the conservator pipe line, between conservator and buchholz relay which shall operate for isolating the conservator during abnormal flow of oil due to rupture / explosion of tank or bursting of bushing. The valve shall not isolate conservator during normal flow of oil during filtration or filling or refilling, locking plates to be provided with handle for pad locking. It shall have proximity switch for remote alarm, indication with visual position indicator. The TCIV should be of the best quality as malfunctioning of TCIV could lead to serious consequence. The closing of TCIV means stoppage of breathing of transformer. Locking plates shall be provided for pad locking.

Detectors:
The system shall be complete with adequate number of detectors (quartz bulb) fitted on the top cover of the transformer oil tank. The bulbs should be provided to ensure monitoring of all the HV, IV, LV & neutral bushings. Redundancy of detectors should be ensured & clearly brought in the drawing submitted for approval.
Signal box:
It shall be mounted away from transformer main tank, preferably near the transformer marshalling box, for terminating cable connections from TCIV & detectors and for further connection to the control box. The degree of protection shall be IP55.
Cables:
Fire survival cables (capable to withstand 750º C.) of 4 core x 1.5 sq. mm size for connection of detectors in parallel shall be used. The fire survival cable shall conform to BS 7629-1, BS 8434-1, BS 7629-1 and BS 5839-1, BS EN 50267-2-1 or relevant Indian standards.
Fire Retardant Low Smoke (FRLS) cable of adequate size shall be used for connection of signal box / marshalling box near transformer and FEC mounted near transformer with control box mounted in control room. Fire Retardant Low Smoke (FRLS) cable of 4 core x 1.5 sq. mm size shall be used for connection between control box to DC & AC supply source, FEC to AC supply source, signal box / marshalling box to transformer conservator isolation valve connection on transformer. Separate cables for AC supply & DC supply shall be used.
Pipes:
Pipes complete with connections, flanges, bends and tees etc. shall be supplied along with the system.
Other items to be supplied:

(a) Oil drain and nitrogen injection openings with gate valves on transformer tank at suitable locations.
(b) Flanges between Buchholz relay and conservator tank for fixing TCIV.
(c) Detector brackets on transformer tank top cover.
(d) Spare potential free contacts activating the system i.e. in differential relay, Bucholz relay. Pressure Relief Device, Circuit breaker of transformer.
(e) Pipe connections between transformer and FEC and between FEC and oil pit required for collecting top oil.
(f) Cabling for detectors mounted on transformer top cover.
(g) Inter cabling between signal box, control box and FEC.
(h) Butterfly valves / Gate valves on oil drain pipe and nitrogen injection pipe which should be able to withstand full vacuum.
(i) Supports, signal box etc. which are to be painted with enameled paint.
(j) Any other item required for satisfactory operation of system.

Power supply
For Control Box 220 V / 110 V DC
For FEC Auxiliary 230 V AC
Spares for three (3) years Operation & Maintenance
The bidder apart from the below mentioned spares shall submit a list of recommendation spares for three years trouble free operation of the equipments and also furnish unit rates. The owners will scrutinize the said list and decide on the items on spares to be ordered and the quantities. These spares shall be supplied by the bidder before end of guarantee period. The owner reserves right to order the spares with twelve (12) months from the date of order for main equipments and the rate shall be kept valid till this date. The prices of these spares shall not be considered for evaluation of the bid.
Mandatory Spares
Cylinder filled with Nitrogen of required Capacity per transformer - 1 No.
Detectors per transformer 3 no.
Regulator assembly per sub-station 1 No.

Modification on the transformer
No modification on the transformer shall be allowed which affects its performance (i.e. efficiency, losses, heat dissipation ability etc.) safety, life etc. or it's any other useful parameter. This requirement shall be paramount importance and shall form the essence of the contract. However, in any case, performance of transformer should not be affected in any manner by having Nitrogen Injection Fire

Prevention Cum Extinguishing System (NIFPES) and the Bidder / Sub-vendor shall give an undertaking to this effect. All pipes should be washed / rinsed with transformer oil. If any damage is done to the transformer and / or any connected equipment during installation & commissioning full recovery therefore shall be effected from the Bidder /Sub-vendor, of NIFPES system.
It shall be solely the responsibility of bidder / Sub-vendor to install, carry out pre-commissioning tests & commission NIFPES at the mentioned Sub-Station in this specification, to the entire satisfaction of the CSPTCL.

Interlocks:
It shall be ensured that once the NIFPES gets activated manually or in automode, all the connected breakers shall not close until the system is actually put in OFF mode. Also PRV shall get closed only if all the connected breakers are open.
Tests:
Bidder has to carry out the type test as per relevant IS/IEC. Specifically IP 55 on FEC or have to produce the report from NABL approved Lab. Reports of all routine test conducted as per relevant IS/IEC standards in respect of various bought out items including test reports for degree of protection for FEC / control box / signal box shall be submitted by the supplier.
The supplier shall demonstrate all the functional test associated with the following as Factory Acceptance Tests:
• FEC, Control Box
• Fire Detector
• Transformer Conservator Isolation Valve
The performance test of the complete system shall be carried out after erection of the system with transformer at site. Detailed layout drawings, equipment drawing along with 4 sets of Operation and Maintenance manual along with soft copies (In CDs) shall be submitted by the supplier along with the consignment. The guaranteed and other technical particulars for the offered system are indicated in Section - "Guaranteed and Other Technical Particulars". Any other particulars considered necessary in addition to those listed in that Section may be furnished by the Bidder.
Terminal Block:

(i) The terminal blocks to be provided shall be fully enclosed with removable covers and made of moulded, non inflammable plastic material with block and block and barriers moulded integrally. Such block shall have washer and binding screws for external circuit wire connections, a white marking strip for circuit identification and molded plastic cove. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring.

(ii) All internal wiring to be connected to the external equipment shall terminate on terminal bocks, preferably vertically mounted on the side of each panel. The terminal blocks shall be 1100 V grade and have 10 amps continuous rating, molded piece, complete with insulated barriers, non-disconnecting stud type terminals, washers, nuts and lock nuts. Terminal block design shall include a white fiber-marking strip with clear plastic, slip-on / clip-on terminal cover. Markings on the terminal strips shall correspond to wire number and terminal numbers on the wiring diagrams.

(iii) Terminal blocks for current transformer secondary leads shall be provided with test links and isolating facilities Also current transformer secondary leads shall be provided with short-circuiting and earthing facilities.

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

(v) Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side.
   (a) For all circuits except current transformer circuits minimum of two nos. 2.5 mm2 copper.
   (b) For all CT circuits minimum of two nos. 4 mm2 copper.

(vi) There shall be a minimum edge to edge clearance of 250 mm between the first row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be minimum of 150 mm.

(vii) Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run parallel and in close proximity along each

side of the wiring duct to provide for convenient attachment of internal panel wiring. All adjacent terminal block shall also share this field wiring corridor. A steel strip shall be connected between adjacent terminal block rows at 450 mm intervals for support of incoming cable.

5.12 Painting:

The internal and external surfaces including oil filled chamber and structural steel work to be painted shall be shot or sand blasted to remove all rust and scale or foreign adhering matter or grease. All steel surfaces in contact with insulating oil shall be painted with two coats of heat resistant, oil insoluble, insulating varnish. All steel surfaces exposed to weather shall be given a primary coat of zinc chromate, second coat of oil and weather resistant varnish of a colour distinct from primary and final two coats of glossy oil and weather resisting Light Grey paint in accordance with shade no.631of IS-5.

All paints shall be carefully selected to withstand extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

The minimum thickness of outside painting of tank shall be 20 microns and the total thickness shall be minimum 80 microns.

5.13. Bolts and nuts:

All bolts and nuts exposed to weather shall be hot dip galvanized. Bolts and nuts below H12 (1/2 inch) size shall be stainless steel.

5.14 Wiring and cabling.

(a) Cable box/ sealing end shall be suitable for following types of cables:-

i)	415 volt Power	1100 Volt grade PVC insulated aluminum conductor cable
ii)	Control	1100 Volt grade PVC insulated 7/0.737 mm stranded copper conductor cable.

(b) Compression type cable connector shall be provided for termination of power and control cables.

(c) All controls, alarms, indicating and relaying devices provided with the transformer shall be wired up to the terminal blocks inside the Local Control Cabinets (both cooler and OLTC Control Cabinets)

(d) Not more than 2 wires shall be connected to one terminal. Each terminal shall be suitable for connecting two 7/0. 73 mm stranded copper conductors from each side.

(e) All terminal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminal blocks.

(f) Engraved code identification plastic ferrules marked to correspond with schematic diagrams shall be fitted at both ends of wires. Ferrules shall fit tightly on wires and shall not fall off when the wire is disconnected from terminal block.

5.15 Marshalling box:

Some of the manufacturers have a practice to directly install winding temperature indicator and oil temperature indicator on the body of the transformer in open. It is obligatory on the part of the bidders to offer a separate marshalling box to enclose such accessories as required in the Tender specification.

5.16 Fittings:

The following fittings shall be provided with each transformer covered in this specification.

(a) Conservator for main tank, with oil filling hole and cap, isolating valves, drain valve, magnetic oil level gauge with low level alarm contacts and dehydrating breather.

(b) Conservator for OLTC with drain valve. Buchholz relay, filling hole with cap, prismatic oil level gauge and dehydrating breather.

(c) Oil preservation equipment.

(d) Pressure relief device alarm contact.

(e) i) Buchholz relay double float type with isolating valves on both sides, bleeding pipe with pet cock at the end to collect gases and alarm and trip contacts.
ii) Separate surge relay with above features to be provided for OLTC chamber.

(f) Air release plug

(g) Inspection openings and covers.

(h) Bushing with metal parts and gaskets to suit the termination arrangement.
(i) Winding temperature indicators for local and remote mounting. One RWTI with a four point selector switch shall be provided for all the winding (HV/LV).
(j) Oil temperature indicators.
(k) Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs.
(l) Protected type mercury or alcohol glass thermometer.
(m) Bottom and top filter valves with threaded male adapters, bottom sampling valve and drain valve.
(n) Rating and diagram plates on transformers and auxiliary apparatus.
(o) Earthing terminals.
(p) Flanged bi-directional wheels.
(q) Cooler control cabinet.
(r) On load tap changing equipment and OLTC control cabinet.
(s) Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.
(t) Bushing CTs for WTI & REF protection (u) Insulating oil.
(v) Cooling fans.
(w) Terminal marking plate.
(x) Jacking pads.
(y) Lifting bollards
(z) Haulage lugs.
(aa) Cover Lifting lugs.
(ab) Valve schedule plate
(ac) RTCC panel
(ad) Bushing terminal clamp & connector
(ae) On line DGA monitor
(af) Insulating Oil
(ag) NIFPS along with all accessories

Note: The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of the transformer are deemed to be included.

5.17 Limits of temperature rise:

The temperature rise on any part of equipment shall not exceed the maximum temperature rise specified below under the conditions specified in test clauses. The permissible temperature rise indicated is for a maximum ambient temperature of 50 deg. C. If the maximum ambient temperature rises, permissible values shall be reduced accordingly. For actual maximum temperature at the location of installation, refer prefect synopsis.

Sl. No.	Nature of the part or of the liquid	Maximum Value of	
		Temp.	Temp. rise at a max. ambient air temp. not exceeding 50oC
1.	Contacts in air, silver-faced copper, copper alloy or aluminum alloy [see notes (i) and (ii)]	95	40/45
	Bare copper or tinned aluminum alloy.	75	25
2.	Contacts in oil: Silver-faced copper, copper alloy or aluminum alloy (see note ii)	90	40
	Bare copper or tinned aluminum alloy.	80	30
3.	Terminals to be connected to external conductors by screws or bolts silver faced (see note iii)	105	55
4.	Metal parts acting as springs	see note iv	(see note iv)
5.	Metal parts in contract with insulation of the following classes:		
	ClassY☹for non-impregnated materials)	90	40

	Class A: (for materials immersed in oil or impregnated)	100	50
	Class E: in air in oil	120 100	70 50
	Class B: in air in oil	130 100	80 50
	Class F: in air in oil	155 100	105 50
	Enamel: oil base Synthetic, in air Synthetic, in oil	100 120 100	50 70 50
6.	Any part of metal of or insulating material in contact with oil, except contacts	100	50
7.	Oil	90	40

Notes: i) When applying the temperature rise of 40/45 deg.C. care should be taken to ensure that no damage is caused to the surrounding insulating materials.

ii) The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test. Otherwise, the contacts shall be regarded as "bare".

The values of temperature and temperature rise and valid whether or not the conductor connected to the terminals is silver-faced.

The temperature shall not reach a value where the elasticity of the material is impaired. For pure copper, this implies a temperature limit of 75 deg.C.

5.18 Specification for control CABINETS:

Control cabinets shall be of the free standing floor mounting type.

Control cabinet of the operating mechanism shall be made out of 3mm thick sheet or 10mm thick 133odelling plate or casting. Hinged door shall be provided with padlocking arrangement. Sloping rain hood shall be provided to cover all sides 15mm thick neoprene or better type of gaskets shall be provided. Colour of paint shall be olive Green in accordance with shade no 220 of IS 5.

Bus bars shall be of tinned copper of adequate cross section to carry the normal current, without exceeding the permissible temperature rise over an ambient temperature of 50 deg. C outside the cubicle. The buses shall be designed to withstand forces corresponding to short circuit current of 25 KA.

Motors rated 1 KW and above being controlled from the control cabinet would be suitable for operation on a 415 V, 3 phase 50 Hz system. Fractional KW motors would be suitable for operation on a 240 V, 1-phase, 50 Hz supply system.

Isolating switches shall be group operated units (3 pole for use on 3- phase supply systems and 2 pole for single phase supply system) quick make quick break type, capable of breaking safely and without deterioration, the rated current of the associated circuit. Switch handle shall have provision for locking in both fully open and fully closed positions.

Push button shall be rated for not less than 6 Amps, 415 V A.C or 2 Amps, 220V/110V D.C and shall be flush mounted on the cabinet door and provided with appropriate name plates. Red, Green and Amber indicating Lamps shall be flush mounted.

For motors upto 5 KW, contactors shall be direct-on-line, air break, single throw type and shall be suitable for making and breaking the stalled current of the associated motor which shall be assumed equal to 6.5 times the full load current of the motor at 0.2 p.f. For motors above 5 KW, automatic star delta type starters shall be provided. 3 pole contactors shall be furnished for 3 phase motors and 2-pole contactors for single phase motor. Reversing contactors shall be provided with electrical interlocks between forward and reverse contactors. If possible, mechanical interlocks shall also be provided. Contactors shall be suitable for uninterrupted duty and shall be of duty category class AC4 as defines in IS: 2959. The main contacts of the contactors shall be silver plated and the insulation class for the coils shall be class E or better. The dropout voltage of the contactors shall not exceed 70% of the rated voltage.

Contactors shall be provided with three elements positive acting, ambient temperature compensated, time lagged, hand reset type thermal overload relay with adjustable setting. Hand reset button shall be flush with the front door at the cabinet for resetting with starter compartment door closed.

Single phasing preventer relay shall be provided for 3 phase motors to provide positive protections against single phasing.

Mini starters shall be provided with no volt coils whenever required.

Power cables of 1100/650 volts grade stranded 134odelling conductor. PVC insulated, PVC sheathed single steel wire armoured and PVC jacketed shall be used. All necessary cable terminating accessories such as glands, crimp type tinned copper lugs etc. for power as well as control cables shall be included in Bidder's scope of supply. Suitable brass cable glands shall be provided for cable entry.

Wiring for all control circuits shall be carried out with 1100/650 volts grade PVC insulated tinned copper stranded conductors of sizes not smaller than 2.5 mm. Atleast 20% spare terminal blocks for control wire terminations shall be provided on each connecting stand type. All terminals shall be provided with ferrules indelibly marked or numbered and these in identifications shall correspond to the designations on the relevant wiring diagrams. The terminals shall be rated for adequate capacity which shall not be less than 10 Amps.

Separate terminal blocks shall be provided for terminating circuits of various voltage classes. CT loads shall be terminated on a separate block and shall have provision for short circuiting the CT secondary terminals.

Control cabinet shall be provided with 240 V, 1 phase 50 Hz, 20 W fluorescent light fixture and a suitable rated 240 V, 1 phase, 5 Amps, 3 Pin socket for hand lamps.

Space heaters shall be provided inside each cabinet complete with thermostat (preferably differential type) to prevent moisture condensation. Heaters shall be controlled by suitably rated double-pole miniature Circuit Breakers.

Single lamps provided shall be of neon screw type with series resistors, enclosed in 134odellin body. Each single lamp shall be provided with a fuse integrally mounted in the lamp body.

Electric measuring instruments shall be of moving iron type. Ammeters for measuring current upto 30 Amps shall be directly connected through suitable CTs. Ammeters shall be provided with selector switches.

Items inside the cabinet of organic material shall be coated with a fungus resistant varnish.

Please note that all DC operated push buttons/ contactors/ coils should be provided such that they have selection for operation with either 220 volt or 110 volt DC.

5.19 Motors:

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment.

Motors shall conform to IS 325.

6.0 Tests:

The type test reports of the transformer (as per latest version of IS: 2026) of offered or higher rating conducted at Govt. / Govt. approved laboratory or witnessed by Govt. / Govt. approved laboratory representative should be submitted along with the bid. The type tests should not be older than five years.

Copies of all routine test reports as per latest version of IS:2026 on offered or higher rating transformer conducted within five years on due date of opening should also be submitted with the bid.

All routine and additional routine tests shall be carried out on each transformer. The type and special tests mentioned in clause 6.2 shall be carried out on one unit out of the lot. All routine & type tests shall be witnessed by representative of CSPTCL & ERDA/CPRI or any other agency authorized by CSPTCL.

The charges for conducting each type test and special tests shall be indicated separately in the relevant schedule.

6.1 All standard routine tests in accordance with IS: 2026 (with latest amendment), with dielectric tests as per IS:2026 part-III (with latest amendment) shall be carried out on the transformer. Further some additional routine tests shall also be carried out.

The list of routine and additional routine tests shall be carried out on transformer according to the methods specified in IS:2026 (Part-I):2011 and IS:2026 (Part-III):2009.

THE DETAILS OF THE TESTS TO BE CARRIED OUT ARE AS GIVEN HERE UNDER:-

Sl.No.	Particulars
(A) Routine tests:	
1	Measurement of winding resistance
2	Measurement of voltage ratio and check of phase displacement
3	Measurement of Impedance voltage/ short circuit impedance (Principal tap) & load loss
4	Measurement of 'No load loss & No load current" (Measured with suitable CT. The CT should be calibrated on the measuring current)
5	Measurement of Insulation resistance
6	Dielectric routine tests as per IS:2026 (Part-III) i.e. lightning impulse tests on all phases of HV/ LV windings, short duration induced AC withstand voltage tests, separate source AC withstand voltage tests
7	Tests on load tap changers
(B) Addl. Routine Tests:	
1	Dimensional checks as per approved drawing & specification
2	Magnetic circuit test. After assembly ,core shall be tested for 1 minute for 2000 volts AC between all bolts, side plates & structures steel works
3	Polarisation index – IR value for 15 sec, 60 sec & 600 sec duration shall be recorded and PI for 600/60 sec and DAR i.e. ratio of IR values of 60/15 seconds shall be recorded. The PI value (600/60 sec) should be >=2 and DAR value (60/15 sec) should be >=1.3. These values should be recorded both before and after HV tests.
4	Tank oil leakage test – the complete transformer assly filled with oil shall be subjected to nitrogen pressure of 0.35 Kg/cm2 above the normal oil head for a period of 12 Hrs to ensure that there is no oil leakage.
5	Capacitance and tan delta measurement to determine capacitance between winding and earth. This test should be carried out before and after series of dielectric tests.
6	Tan delta & capacitance Test on bushings (Before and after HV tests)
7	Checking of recording of IR values
	(a) Between core & coil frame
	(b) Between core & tank
	Between coil frame & main tank The measured IR values should be more than 1000 M Ohms.
8	Magnetic balance test (Before and after HV tests)
	Magnetising Current Tests on all three windings with LT voltage (Before and after HV tests)
9	Tests of PRDs for successful operation
10	Oil BDV test before & after HV tests
11	Sweep Frequency response analysis (SFRA) – SFRA shall be carried out at manufacturer's works with his own SFRA test set. The test shall be repeated at site with same test set.
12	Measurement of DEW point prior to dispatch of the unit filled with N2 gas prior to dispatch – This test shall be carried out by manufacturer and results shall be submitted to CSPTCL for reference.
13	Cooler Control and RTCC Functional checks
14	Functional checks on Air cell
15	Ratio and polarity tests on Bushing Turret CTs
16	Functional checks on Buchholz Relay

Note: All testing equipments viz., CT, PT, ampere-meter, volt-meter, watt meter, frequency meter, power analyzer, Insulation resistance test kit, winding resistance test kit, winding turns ratio test kit, tan delta & capacitance measurement test kit, potential divider, temperature sensors, etc. shall be of appropriate class of accuracy and shall havevalid calibration certificates from NABL accredited labs. Minimum CTR and accuracy class required for CT with valid calibration certificate for 1-120% rated current shall be used for measuring of 'No load loss & no load current'.

6.2 Type/Special Tests to be carried out on the Power Transformer:

Following tests shall be conducted on power transformer:-

6.2.1 Temperature Rise Test:
This test as per cl. 16.8 of IS:2026 (Part-I) and IS:2026 (Part-II) shall be conducted at the lowest voltage tap having maximum current with 10% over load condition. The manufacturer before carrying out such tests, shall submit detailed calculations showing the alternatives possible, on various taps and for different ratings (ONAN/ONAF), of the transformer and shall recommend the combination that results in highest temperature rise, for the test. Gas chromatographic analysis of oil shall be conducted before and after heat run test and the values shall be recorded in the test report. The sampling shall be in accordance with IEC-567. For the evaluation of the gas analysis in temperature rise test, a method will be proposed which is based on the rate of increase of particular gases and the permissible limits of minimum detectable value of gases and the maximum limit will be mutually discussed and agreed upon between the CSPTCL and manufacturer. This shall be treated as reference during maintenance of transformer in future.

The calibration of OTI and WTI shall be done by Transformer Manufacturer and these calibrated OTI, WTI shall be used during testing of transformer. The Sl.No.of WTI, OTI shall be recorded during testing of transformer and these indicators only shall be supplied with the transformer. During test the manufacturer selects suitable tap from CT based on gradient between the readings of WTI & OTI. This tap position is to be clearly recorded on test report so that selection of correct tap could be done at site to avoid discrepancy in temperature gradient recorded during factory test and the value recorded at site.

6.2.2 Tank vacuum test as per details given in this clause subsequently.

6.2.3 Tank pressure test as per details given in this clause subsequently.

6.2.4 Pressure Relief Device Test:
The pressure relief device of each size shall operate in case of increase in oil pressure inside the tank. It shall operate before reaching the test pressure specified in 'tank Tests' subsequently in this clause. Device shall seal off after the excess pressure has been relieved.

6.2.5 Following special tests other than above mentioned tests shall also be carried out as per "IS: 2026 part-I and part-III (with latest amendment) as applicable on one unit out of the lot.

(i) Measurement of zero Seq. Reactance.
(ii) Measurement of acoustic noise level.
(iii) Measurement of power taken by fans.
(iv) Measurement of harmonic level in no load current.
(v) Lighting impulse with chop on tail on all 3 phase of HV and LV terminals.
(vi) One cooler cabinet and OLTC cabinet of the transformer shall be tested for IP:55 protection in accordance with IS: 2147. In case facility for this test is not available with the manufacturer or their vendor; the test has to be carried out at the laboratory of either CPRI or ERDA in presence of CSPTCL's representative and test report should be furnished.

6.2.6 Tests on Assembled Transformer:

a) Check completed transformer against approved out line drawing, provision for all f ittings, finish level etc.
b) Jacking test on the assembled Transformer.

6.3 TANK TESTS

6.3.1 Routine Tests: Oil leakage test:

This test will be conducted on power transformer. All tanks and oil filled compartments shall be tested for oil tightness by completely filling with air or oil of a viscosity not greater than that of insulating oil conforming to IS: 335 at the ambient temperature and applying a pressure equal to the normal pressure plus 35 KN/sq m measured at the base of the tank. The pressure shall be maintained for a period of not less than 12 hours for oil and one hour on air during which time no leak shall occur.

6.3.2 Tests to be conducted on tank:

(i) Vacuum Test

The transformer tank shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m² absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been released shall not exceed the values specified below.

Horizontal length of flat plate (in mm)	Permanent Deflection (in mm)
Up to and including 750	5.0
751 to 1250	6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

Pressure Test

The transformer tank together with its radiator, conservator, vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m 2 whichever is lower, measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released, should be within the limits specified in the table given at (i) above.

6.4 TESTS AT SITE: After erection at site, the transformer shall be subject to the following tests, in presence of manufacturer's engineer.

6.4.1 Tests on reaching at site:

(i) Immediately upon receipt of transformer at site and before unloading of transformer from trailor, core earthing, end frame earthing and tank earthing shall be checked. Only after satisfactory verification that there is no multiple core earthing in transformer, unloading of transformer shall be undertaken.
(ii) After receipt of transformer at site, physical inspections shall be done for checking any physical damage to transformer tank and accessories. Further, data of impact recorder shall be 137odellin for any changes before unloading of transformer.

6.4.2 Pre-commissioning tests at site:

(i) Insulation resistance test and polarization index.
(ii) Ratio and polarity test
(iii) DGA of oil and di-electric, tan delta and moisture content test of oil.
(iv) OLTC operational test at each tap for lower and raise operation of tap changer.
(v) Magnetic balance tests and measurement of magnetizing current.
(vi) Vector group test

(vii) Short circuit current measurement at low voltage and at all taps
(viii) Measurement of winding resistance at all taps
(ix) Tangent delta and capacitance of Transformer
(x) Tangent delta, capacitance and insulation resistance tests of bushings
(xi) Leakage current between core & tank, core & end frame, end frame and tank and between short circuited links and neutral in grounded and ungrounded conditions.
(xii) Dew point measurement & recording of pressure of nitrogen gas (if applicable)
(xiii) SFRA test.

The SFRA test and Dew point measurement shall be carried out in presence of manufacturer's representative. The test kits shall be same as used for carrying out these tests in the factory and shall be brought by manufacturer's representative.

6.4.3 Pre-commissioning checks at site:

a) Check the colour of silica gel breather.
b) Check the oil level in the breather housing, conservator tank, cooling system, condenser housing etc.
c) Check the bushings for conformity of connection to the line etc.
d) Check for correct operation of all protection and alarms.
 i) Buchholz relay
 ii) PRV
 ii) Excessive winding temperature
 iii) Excessive oil temperature
e) Low oil level indication
f) Check for adequate protection on electric circuit supplying the accessories.
g) Check for cleanliness of the Transformer and the surroundings

6.5 Test reports

6.5.1 Copies of certified test reports and oscillograms shall be submitted for approval prior to dispatch of the equipment.The equipment shall be dispatched only when all the required type and routine tests have been carried out and test reports are approved by the CSPTCL.

6.5.2 Copies of the test reports for the tests carried out on the ancillary apparatus shall be furnished to the CSPTCL for approval prior to dispatch.

6.5.3 All auxiliary equipment shall be tested as per the relevant standard. Test certificate shall be submitted for bought out items.

6.6 Apart from rejection due to failure of the transformer to meet the specified test requirements the transformer shall be liable for rejection on any one of the following reasons.
No load loss exceeds the values mentioned in GTP
Load loss/Auxiliary exceeds the specified values mentioned in GTP
Impedance voltage value exceeds the guaranteed value plus tolerance.

7.0 INSPECTION AND TESTING:

7.1 Inspection:

7.1.1 CSPTCL shall have access at all times to the works and all other places of manufacture where the transformer is being manufactured and the manufacturer shall provide all facilities for unrestricted inspection of the manufacturer works, raw materials, manufacture of all the accessories and for conducting necessary tests as detailed herein.

7.1.2 The contractor shall keep CSPTCL informed in advance of the time of starting and of the progress of manufacture of equipment in its various stages, so that arrangements could be made for inspection.

7.1.3 No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

7.1.4 The acceptance of transformer & its accessories shall in no way relieve the contractor of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection if such equipments are later found to be defective.

7.1.5 Acceptance of condition regarding stage inspection at various stages, which will be intimated to contractor, shall be an essence of this contract.

7.2 Inspection programme:

7.2.1 The contractor shall chalk out a detailed inspection and testing programme for manufacturing activities for the various components. An indicative programme of inspection as envisaged by CSPTCL is given in technical specification of transformer. Stage inspection of core & winding and final inspection of the transformer shall be carried out at manufacturer's works in presence of CSPTCL's representative and representative of a third party i.e. CPRI/ERDA or any other agency authorized by CSPTCL. The expenses on witness of tests by third party shall be borne by CSPTCL.

7.2.2 The routine tests on transformer shall be carried out free of cost. The rates for type & special tests shall be included in the cost of transformer and the same shall not be payable by CSPTCL.

7.3 Stage inspection:

7.3.1 The manufacturer shall indicate the inspections and checks carried out at various stages of the manufacture of the transformers. A complete record of stage inspection would be kept by the manufacturer and thus record should be made available for inspection by the representative of CSPTCL. The manufacturer should indicate the manufacturing programme and CSPTCL will have a right to depute its inspecting officers during the manufacture. Some of the inspecting stages are coil winding and core building, assembly of coil on core, the condition of the coil and core after the treatment in vacuum chamber, assembly within the transformer tank together with application of tap changer.

7.3.2 It may be noted that stage inspection for transformer at CSPTCL's discretion shall be done at manufacturer's works in presence of CSPTCL's representative and representative of third party authorized by CSPTCL at the following stages.

(a) Fabrication stage of tank: After fabrication, tank shall be inspected for measurement of its dimensions, thickness of sheets used and leakage test by applying requisite pressure/ vacuum.

(b) Building up of core: After the core is built but before its clamping, our representative will inspect the core to take complete weight of the core and also to measure approximate core loss. If necessary, a small strip of core shall also be taken for testing at CPRI/ ERDA or at any other testing laboratory of repute.

(c) Preparation of winding: Once the coils are prepared but before the same are fitted on to the core, stage inspection shall be done to take various measurements and also for weighment of total weight of coil of each voltage class. Measurement of resistance shall be taken and for this purpose, a small piece of conductor for each type of winding shall be made available by the manufacture.

(d) Core Coil Assembly: Apart from the above, CSPTCL also reserves the right to carry out stage inspections at other stages also, for which advance intimation shall be given and all necessary cooperation shall be rendered by the manufacturer.

7.4 FINAL INSPECTION AND TESTING:

7.4.1 All the routine, additional routine, type and special tests as mentioned in clause 6 shall be carried out as per IS:2026 (Part-I & III) at manufacturer's works in presence of CSPTCL's representative and representative of third party authorized by CSPTCL. At the time of final inspection, the supplier shall identify each and every item/ accessories of the transformer under testing. Unless all the items are identified, the manufacture will not be treated as complete. Serial number of bushings, serial number of tap changer and other details shall be entered into the test report to ensure that these items are not being applied to the subsequent transformer units while testing. Various tests stipulated in IS shall be performed in the

presence of our engineers or when the inspection waiver has been given, in such a case, the testing shall be done at the manufacturer's works as per IS stipulations and same should be confirmed by documentary evidence by way of Test Certificate which shall be got approved by us.

7.4.2 The WTI & OTI shall be calibrated during testing of transformer and serial Nos. of these instruments; shall be recorded in test reports. The WTI & OTI used during testing shall be dispatched with the transformer so that installation of same OTI & WTI on transformer is done which are utilized during testing of transformer at manufacturer's works. The Bushings and Radiators on Transformer during testing of transformer at manufacturers' works are required to be supplied with the same transformer to avoid any mismatch/misalignment etc. during assembly of transformer. This should be noted for strict compliance and confirmed specifically.

7.4.3 When inspection call for transformer is given, the letter of inspection call will accompany the following:

List of various fittings and accessories, which are ready at the works and will be offered for inspection. The Inspecting Officer will carry the list and check the items declared to have been offered for inspection.

It is expected that before a transformer is finally offered for inspection, internal testing of the transformer for various important parameters like winding resistance, transformer losses, IR values etc. are already done. CSPTCL may ask for routine test report for such tests before conducting the inspection.

List of testing equipments and instruments which will be used during the inspection of the transformer with their makes, Sl. No. and date of calibration, agency who conducted calibration and validity of calibration certificate should also be furnished along with the inspection call.

7.4.4 Testing at an independent test laboratory:

CSPTCL at its discretion may get the transformer tested at a Govt. approved laboratory like CPRI/ ERDA for all the routine and type tests at the expenses of CSPTCL. In case, the test results are found to be deviating from the results during the inspection at manufacturer's works or the test results are found to be beyond the permissible limits as per the tender specifications and concerned standards, the transformer shall be liable for rejection.

8. Quality Assurance Plan:

8.1 The contractor shall invariably furnish following information at the time of detailed engineering:-

(i) Statement giving list of important raw materials, names of sub-suppliers for the raw material, list of standards according to which the raw material are tested, list of tests normally carried out on raw material in the presence of manufacturer's representative, copies of test certificates.

(ii) Information and copies of test certificates as in (i) above in respect of bought out items.

(iii) List of manufacturing facilities available.

(iv) Level of automation achieved and list of areas where manual processing exists. List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

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

(vi) List of testing equipment available with the manufacturer for final testing of equipment specified and test. Plant limitation, if any, vis-à-vis the type, special, acceptance and routine tests specified in the relevant standards. The manufacturer should have power analyzer for testing & all other routine & acceptance tests facilities as per latest amendments of IEC.

8.2 The manufacturer shall submit the following information to the CSPTCL-

Name of the raw material as well as bought out accessories and the names of sub-suppliers selected from those furnished in the "list of vendors for major items of transformer" attached with technical specification for power transformer.

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

Quality Assurance Plan (QAP) with hold points for CSPTCL's inspection. The QAP and hold points shall be discussed between the CSPTCL and the contractor before the QAP is finalized.

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

9. Customers Specifications and Contract review: The quality assurance and failure prevention starts with careful study and scrutiny of our technical specifications and requirements. The manufacturer shall carefully study all the technical parameters and other particulars & the contractor shall categorically give his confirmation that these requirements shall be met in a satisfactory manner.

10. Design Control: The manufacturer shall furnish the checks exercise in design calculations particularly in respect of short circuit forces and method of clamping end coil to show the healthiness of the design. The salient features of design together with the certificates of design engineers will have to be made available to the CSPTCL.

11. Engineering Documents: The manufacturer shall give complete information regarding copper conductor, insulating paper, core materials, tap changer, gaskets etc. bringing out the detailed description and specification of these items with explanation as to how our requirements are being met in this respect.

12. Procurement document control & purchased material & services: The manufacturer shall indicate the various sources from whom the items namely copper conductor, insulating paper, core material, tap changer and other items such as gaskets etc. are being procured. The type of check, quantum of check and acceptance norms shall be intimated and random test and check results should be made available for inspection whenever so desired. The vendor list enclosed with transformer specifications is only acceptable to us & in case any change in vendor list is required, same shall be subject to approval of CSPTCL.

13. Programme chart: Based on above QAP and offered delivery schedule a tentative programme chart indicating period for various manufacturing/ testing activities shall be submitted along with QAP. The programme chart should specify periods for various activities i.e. design, ordering of new materials, assembly, testing etc.

14. Documentation:

14.1 All drawings shall confirm to relevant international standards Organization (ISO) specification. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

14.2 The Contractor shall furnish dimensional drawings of transformer and all other accessories as indicated in specification. These drawings shall include the following information.

(i) Dimensions.
(ii) Tolerances on dimensions.
(iii) Material designation used for different components with reference to standards.
(iv) Fabrication details such as welds, finishes and coatings.
(v) Catalogue or part numbers for each component and the total assembly with bill of materials.
(vi) Identification marking.
(vii) Weight of individual components and total assembled weight.
(viii) Foundation drawing.
(ix) G.A. drawings of cooler control cabinet and RTCC panels.
(x) Schematics drawings of OLTC, RTCC and cooler control.

14.3 The contractor shall submit four sets of final version of all the above drawings for CSPTCL's approval. CSPTCL shall communicate its comments/approval on the drawings to the contractor within reasonable period.

The contractor shall, if necessary modify the drawings and resubmit four copies of the modified drawings for CSPTCL's approval within two weeks from the date of comments. After receipt of CSPTCL's approval, the contractor shall, within three weeks, submit three prints and one good quality reproducible of the approved drawings for each location separately for CSPTCL's use.

14.4 The contractor shall also furnish four copies of transformer to CSPTCL bound manuals covering erection, commissioning, operation and maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices. Marked erection drawings shall identify the component parts of the equipment as shipped to enable CSPTCL to carryout erection with his own personnel. Each manual shall also contain one set of acceptance reports of the corresponding consignment dispatched. These manuals shall be invariably furnished to CSPTCL before dispatch of transformer.

The manufacturing of transformer shall be strictly in accordance with approved drawings and no deviation shall be permitted without the written approval of CSPTCL.

15. Packing and forwarding:

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

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

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

16.1 Storage, Handling & Shipping:

When the transformer is declared ready, the manufacturer has to identify each and every item associated with this unit and a complete packing list shall be prepared in advance. The transformer shall be stored and handled properly in shipping depot, while the same is under process of dispatch. The manufacturer should ensure dispatch of all the related items and accessories with transformer along with tank.

Tap changer, bushing, radiators and other accessories of the transformer should not be withheld for use subsequently on units for testing purposes. If there are any items procured from sub-vendor which are to be directly installed like instrumentation, panels, control gear etc. test and inspection report for the same will be kept separately and made available to our inspecting officers.

It may be noted that no change in any accessories or associated equipments after passing all the test successfully shall be allowed and if this is subsequently detected it shall be binding on the manufacturer & contractor to replace with the same item with which the initial test were conducted at his part failing which the entire test shall become null and void. CSPTCL at its discretion may consider for rejection of the unit thus supplied. The entire cost, for

replacement of such rejected units thus supplied and for repeating acceptance test, shall be borne by the contractor.

16.2 Transportation:

The contractor shall include charges for fitting one Electronic impact recorder (on returnable basis) during transportation of transformers to measure the magnitude and duration of the impact in all three directions. The acceptance criteria and limits of impact in all three directions which can be withstood by the equipment during transportation and handling shall be submitted by the contractor during detailed engineering. The recording shall commence in the factory before dispatch and must continue till the unit is installed in its foundation. The data of electronic impact recorder(s) shall be down-loaded at site and a soft copy of it shall be handed over to engineer-in-charge. Further, within three weeks, the contractor/manufacturer shall communicate the interpretation of the data. In the unlikely event of impact recorder output not available at site, the equipment shall be thoroughly internally inspected by the manufacturer's representative before erection at site to ensure healthiness of the equipment.

(A) In order to conduct low voltage field testing on power transformers before unloading/commissioning at site to determine the internal condition, the transformer shall be transported with:
   (a) Small bushing (12 KV) may be installed on the bushing cover plate to represent the actual bushing.
   (b) Winding leads may be routed, secured and electrically isolated from the tank walls and active part.
   (c) Temporarily tests leads may be used to connect the winding leads by the small bushings (which will be removed before erection of the main bushings).

(B) Further, the contractor shall mount vehicle tracking system (GPRS/GPS/GSM based) to track the exact position of the vehicle on which the power transformer is being loaded for transportation and during detailed engineering take approval for the equipment installed.
The details of arrangement for transport configuration of power transformer (which shall be adopted by contractor) shall be submitted by the contractor to CSPTCL for approval. The price quoted by the contractor should take into account this requirement.

17 Completeness of Equipment and bought out items:

The contractor must furnish the following informations:-

17.1 A list of all the accessories which will be supplied with the transformer should be furnished during detailed engineering. This should be as per "List of fittings and accessories to be provided with power transformer" and "List of transformer accessories and test certificates" enclosed with this tender specification. While furnishing this list, items which will be manufactured by the manufacturer and balance items which will be procured from sub-manufacturers, should be clearly identified as stipulated in the tender.

17.2 It is obligatory on the part of contractor to ensure that supply of all accessories as per tender specification are made along with Main Tank or prior to delivery of Main Tank so that erection and commissioning work of Transformer can be completed properly and uninterruptedly. The date of supply of last accessory will be treated as date of delivery of transformer.

17.3 The responsibility for obtaining timely supplies of bought out items will rest on the contractor.

17.4 It may be noted that in case of damages/ shortages due to improper packing or any other negligence, replenishment shall be arranged within one month's time. If this is not done, date of delivery of such accessory will be treated as date of delivery of main equipment.
For bought out items, responsibility for guarantee and obtaining immediate replacement in case any defects are noticed and in case defective supply of any item is reported will rest on the contractor.

17.5 In case for attending to defect in any accessory or inspection/replacement of the accessory, which may be bought out item for the contractor services of engineer of original manufacturer is required, the same will be organized on immediate basis by the contractor at his cost.

18. Calculations/ design data required to be submitted for power Transformer:
All the important data of the transformer i.e. Net weight of bare copper in each winding, Weight of core without clamping fixtures, Weight of core and windings, Cross section of the core, Flux density calculations, Calculations for short circuit current and its duration, Current density during short circuit, Calculations showing withstand capability of windings for thermal & mechanical stresses during short circuit conditions, Mechanical Design of transformer tank, final design calculations etc should be submitted by the contractor during detailed engineering for our verification and records.

18.1 Short circuit withstands capability:

In order to ensure capability of transformer to withstand short circuit forces due to most severe fault in our inter connected network the transformer should be designed on the basis that winding are connected to an infinite bus and fault current is limited by transformer impedance alone, ignoring system impedance. The calculations to prove dynamic and thermal short circuit withstand capability of transformer shall be submitted considering the above for transformer. The design of winding assembly which is to be furnished in the drawing should be in commensuration with these calculations.

18.2 Design of Tank:
Complete mechanical design of transformer tank including details of stiffeners shall be submitted. The tank shall be designed to withstand the following without permanent distortion.

(i) Mechanical shocks during transportation.
(ii) Vacuum filling of oil at 10 milli torr in transformer with all fittings.

Continuous internal pressure of 35 kN/m2 over normal hydrostatic pressure of oil.
Short circuit forces &
Under seismic condition /events both horizontal/vertical.

The calculations for tank stiffeners shall be submitted to prove no. & sizes of stiffeners are adequate to withstand full vacuum & pressure. Drawing of tank shall be submitted indicating stiffeners.

18.3 Design of Static End Rings (SER) and magnetic shunts:
Details of Static End Rings (SER) and magnetic shunts, if provided, shall be submitted with calculations. A drawing indicating locations, size, material of SER and magnetic shunts shall be submitted.

18.4 Overfluxing Capability:
A curve to prove suitability of transformer to withstand various Overfluxing conditions for the duration indicated in relevant clause without core saturation shall be furnished.

18.5 Cooling calculations:
Calculations of tank surface for heat dissipation, details of radiators, and fans for ONAN & ONAF cooling shall be provided.

18.6 Design Data :
On the basis of offered flux density and current density, the manufacturer shall furnish following design calculations &data :-

18.6.1 Core Data:
Details of core material i.e Name of Manufacturer, Manufacturer's type designation for core , thickness of core, curve for Loss Vs Flux density, No of steps of Core & No of limbs, gross

core area , stacking factor, Net core area, height & width of core window, center to center distance of limb, voltage per turn, wt. of core material, working flux density , core loss in watts per kg marked on graph for grade of core material & selected flux density, building factor & calculated no load loss in watts, guaranteed no load loss.

Design data for core shall be submitted. A drawing indicating details of core i.e. limbed construction, step width & thickness, core belting, top & bottom yoke plate etc shall be submitted.

18.6.2 Winding Data:

Weight of copper for windings ie,. For HV, LV, tap, cross sectional area ,current density, type of coil, ID/OD/mean dia of coils, size of winding conductor including parallels, number of turns per phase, number of spacers, length of mean turn, weight of copper without paper covering, resistance per phase of winding at 75°C, I2R loss at 75°C & normal tap, eddy current & stray loss at 75°C , total copper loss at 75°C , guaranteed transformer losses at 75 °C.

Complete details of Insulation components i.e. Top & Bottom clamping rings, washers, Pressboard blocks & cylinders, Pressboard spacers & Phase barriers, Pressboard segments etc shall be submitted indicating qty, thickness in mm, width & height, weight design data for winding shall be submitted.

Dimensioned drawings indicating details of winding, ducts, insulation, take off arrangement, clamping ring, pressure points etc shall be submitted.

18.6.3 Quantity of Oil :

Complete calculations of oil quantity to be utilized in transformer for first filling shall be submitted. The calculations shall indicate-

Volume of tank including turrets, conservator main & OLTC, volume of headers & Radiators, oil quantity in OLTC.

Oil displacement by Active parts i.e. core – coil assembly.

18.7 Capacity of Conservator & Size of Air Cell:

While furnishing details of conservator & air cell type sealing arrangement, the manufacturer shall submit details & calculations for adequacy of size and capacity of air cell for the rating of the power transformer and also for the quantity of oil required. Catalogue of AIR CELL as per vendor list should be submitted clearly marking type designation of selected size of Air cell. A drawing indicating complete details of conservator with Air cell shall be submitted.

18.8 Capacityof Pressure Relief Device:

Manufacturer shall furnish calculation to prove that the capacity/rating of pressure relief device and locations of the same for the transformer will adequately meet CSPTCL's requirement. Constructional and design details of pressure relief device must be furnished and it should be proved by calculation that the size and setting of pressure relief device is adequate considering the rating of the transformer and quantity of oil in the transformer.

A drawing indicating complete details of PRDs & their locations on tank shall be submitted.

18.9 Limitsof Temperature rise & hot spot winding temperature:

The limits of temperature rise for windings, oil and hot spot have been specified. Temperature rise calculations at rated full load, 110% load and 125% load considering 100% cooler banks, 50% cooler banks and without coolers shall be furnished as indicated below:

a	100 % Loading	20 minutes duration	100 % cooler bank
			50 % cooler bank
			without cooler bank
		10 minutes duration	100 % cooler bank
			50 % cooler bank

			without cooler bank
b	110 % Loading	20 minutes duration	100 % cooler bank
			50 % cooler bank
			without cooler bank
		10 minutes duration	100 % cooler bank
			50 % cooler bank
			without cooler bank
c	125 % Loading	20 minutes duration	100 % cooler bank
			50 % cooler bank
			without cooler bank
		10 minutes duration	100 % cooler bank
			50 % cooler bank
			without cooler bank

The calculations shall indicate temperature gradient (for all windings i.e. HV,LV,tap), load losses at lowest tap for all windings , Eddy current & stray losses, thermal Constant Value & calculations with parameters affecting the values for above conditions for top oil temperature & winding hot spot temperature.
The Calculations for Hot Spot winding Temperature and Calculations for Temperature Rise shall also be submitted.

18.10 Capacity of Silica Gel Breather:
The manufacturer shall submit details & calculations for adequacy of size and capacity of silica gel breather for the oil quantity in the power transformer.

18.11 Rating of Onload Tap changer (OLTC):
It has been our experience that due to inadequate rating of OLTC elements, the failure of OLTC components or pitting of contacts has been observed before the claimed period for maintenance. To verify the adequacy and suitability of the OLTC components, it is necessary to furnish the calculations for selecting the proper rating of transition resistance as well as normal current rating of OLTC. The calculations shall include the temperature rise of the OLTC diverter switch and also the short circuit current considered for calculation of temperature rise.

Calculations shall be submitted to prove that the current rating of OLTC is adequate for the rating of the transformer winding taking in to account the over loading capability as per IS 6600. The basis for selection of transition resistance and its current carrying capacity shall also be submitted. In this regard the circulating current in tap winding during tap change operation through transition resistance shall be taken in to consideration. Adequacy of insulation provided in the OLTC between various parts needs to be established with specific reference to the voltage between two taps. Confirmation shall be given that the OLTC is suitable for bidirectional flow of current. The through current capacity shall be adequate to handle on continuous basis the winding current including over loading as per IS 6600. The through current rating and the rating of transition resistance shall take in to account the short time current rating of the winding. Capability to handle short circuit current to be established by calculations and also by test reports. The above Calculations for OLTC shall be submitted.

18.12 The manufacturer shall carry out optimization of Dielectric design of insulation including electromagnetic design, overload & short circuit withstand capabilities. During design, transformer modelling shall be done & finite element software (FEM) may be used.It is assured that these data will be kept strictly confidential by CSPTCL.

GUARANTEED TECHNICAL PARTICULARS

01.	Name of the Manufacturers	
02.	Normal continuous rating of (MVA)	

	(a). With ONAN cooling		
	(b). With ONAF cooling		
03.	Normal ratio of transformation		
04.	Phase connection:		
	a) HV winding		
	b) LV winding		
	c) Vector group reference no. & symbol		
05.	Current at rated no load and on principal taps (Amps) - HV		
	- LV		
06.	Maximum temperature rise:		
	i) of oil by thermometer a) at full ONAN rating b) at full ONAF rating		
	ii) of winding by resistance a) at full ONAN rating b) at full ONAF rating c) by hot spot temperature indicator d) Ambient tep. Adopted		
07.	Temperature gradient between oil and winding		
08.	Voltage to earth for which the star point will be insulated		
09.	LOSSES:		
(a)	No Load Losses :		
	i) Guaranteed no load losses at normal ratio, rated voltage rated out put, rated frequency at 75oC average winding temp. (KW) (no positive tolerance is permissible)		
	ii) No load losses at 110% of rated voltage		
(b)	Load losses:		
	Guaranteed load losses at normal ratio, rated voltage rated out put rated frequency at 75oC average winding temp. at rated output (KW) (no positive tolerance is permissible)		
I	Auxiliary losses:		
	Auxiliary losses at rated output (no positive tolerance is permissible)		
10.	Guaranteed total losses at 75oC temp. (i.e. 9 (a)(i) + 9 (b)+9(c)		
11.	Efficiencies at normal ratio, rated voltage, rated frequency and average winding temp. for 75oC average winding temp. for outputs of	At UPF	0.8 PF Lagging
	(i) full load		
	(ii) ¾ full load		
	(iii) ½ full load		
	(iv) ¼ full load		
	(v) Maximum efficiency with load		
12.	Resistance per phase at normal tap of		
	(a) HV winding		
	(b) LV winding		
13.	Reactance per phase of (at normal tap of (in ohms.)		
	(a) HV winding		
	(b) LV winding		
	(c) Reactance at rated MVA base		
14.	Resistance voltage drop at 75 degree centigrade average winding temp. expressed as percent of rated		

	voltage			
15.	Reactance voltage drop expressed as percent of rated voltage on rated winding MVA			
16.	Positive sequence Impedance on rated MVA base at rated current & freq. At 75 degree centigrade. Winding temp. between	Normal Tap	Highest Tap	Lowest Tap
	(a) HV – LV			
17.	Zero sequence Impedance at 75 degree Centigrade & at principle tap.			
18.	Impedence voltage at normal & 75 degree centigrade average winding temp. expressed as percentage of rated voltage.			
	(a) between HV & LV winding			
	(b) Positive sequence, HV			
	(c) Positive sequence, LV			
19.	Regulation at full load and 75 degree centigrade Unity power factor b. 0.8 power factor (lagging)			
20.	Type of transformer (core or shell)			
21.	Width of track gauge.			
22.	Time in minutes for which transformer can be run at full load without exceeding maximum possible temp. above ambient temp. when:			
	(a) Supply to fan group 1 is cutoff			
	(b) When supply to both groups of fans are cutoff.			
23.	Permissible over loading			
	(a) HV winding			
	(b) LV winding			
24.	Terminal arrangement for			
	(a) HV winding			
	(b) LV winding			
25.	Insulation level:			
	(a). L.I. withstand (Kvp)			
	(b). P.f. withstand for one minute (dry and wet.)			
26.	Partial discharge level at 1.5xUm/ square root 3 KV RMS in pico coulomb.			
27.	Noise level when energised at normal voltage & frequency without load (db)			
28.	External short circuit withstand capacity (KA) and duration (secs),	132KV – KA for ------ seconds 33 KV – KA for ------ seconds		
29.	Over fluxing capability of transformer at over fluxing factor.			
	(a). 1.7			
	(b). 1.4			
	(c). 1.25			
	(d). 1.10			
30.	Details of core:			
(a)	Type of core construction of no. of limbs in frame.			
(b)	Type of core joins.			
(c)	Flux density at rated voltage and frequency and at principle tap Tesla)			
(d)	Flux density at principal tap and at 10% over Voltage (Tesla)			
(e)	Magnetizing current at normal ratio and frequency.			
	(i) 85% of rated voltage			

	(ii) 100% of rated voltage	
	(iii) 105% of rated voltage	
(f)	Power factor of magnetizing current at normal voltage ratio and frequency.	
(g)	Core lamination:	
	(i) Material and grade	
	(ii) Thickness	
	(iii) Voltage per turn	
	(iv) dia of circumscribing circle of core	
	(v) No. of steps in core	
	(vi) Dimensions of core	
	(vii) Net iron area	
	(viii) Specific Iron Loss in watts/Kg of core material at working flux density.	
	(ix) Total Iron loss, KW	
(h)	Details of core Belting:-	
	(i) Material, grade, type	
	(ii) Width	
	(iii) Thickness	
	(iv) Fixing method	
(i)	Core clamping plate (YOKE):-	
	(i) Material	
	(ii) Thickness	
	(iii) Insulation	
	(iv) Depth & height of Yoke	
	(v) Net Yoke area	
	(vi) Flux density in Yoke	
	(vii) Weight of Yoke	
(j)	Describe Location/ method of core grounding	
(k)	Details of oil ducts in core	
31.	Details of windings:	
(a)	Type of winding	
(b)	Material of the winding conductor	
(c)	Maximum current density of windings (at rated current and conductor area)	
	(i) Conductor Area (sq. cm)	
	(ii) Current density (A/sq. cm.)	
(d)	Whether HV windings are interleaved	
(e)	Whether winding are preshrunk	
(f)	Whether adjustable coil clamps are provided for HV and LV windings	
(g)	Whether steel rings used for the windings, If so, whether they are split.	
(h)	Whether electro-static shields are provided to obtain uniform voltage. Distribution in the HV windings	
(i)	Insulating material used for:	
	(a) HV winding	
	(b) LV winding	
(j)	Insulating material used between	
	(a) HV winding	
	(b) LV winding and core	
	(c) Regulating winding and earth	
(k)	Type of axial coil supports	
	(a) HV winding	
	(b) LV winding	

(l)	Type of Radial coil supports	
	(a) HV winding	
	(b) LV winding	
(m)	(i) Maximum allowable torque on coil clamping bolts:-	
	(ii) clamping ring details	
	- Thickness of ring	
	- Dia of ring	
	- No.& size of pressure screw	
(n)	Power frequency Test voltage for 1 minute withstand test on	
	(a) HV winding	
	(b) LV winding	
(o)	Impulse test on windings 1.2/50 micro sec. Full wave withstand.	
	(a) HV	
	(b) LV	
(p)	Switching surge test	
	(a) HV	
	(b) LV	
32	BUSHINGS	
(a)	Type & make	
(b)	Rated voltage class & rated current	
(c)	Dry & Wet flashover voltage	
(d)	Power frequency withstand test voltage for 1 minute for wet & Dry (KV rms)	
(e)	Visible corona discharge voltage (KV rms)	
(f)	Partial discharge level	
(g)	Under oil flashover of puncture withstand test voltage (1.2/50 micro sec. Wave.)	
(h)	Full wave impulse withstand test voltage (1.2/50 micro sec.wave.)	
	(i) Positive	
	(ii) Negative	
(i)	Switching withstand test voltage (KV peal)	
(j)	Creepage distance in air (mm)	
(k)	Protected Creepage distance (mm)	
(l)	Recommended gap setting.	
(m)	Weight of assembled bushing, kg.	
(n)	Qty.of oil in ltrs.	
(o)	Whether test tap is provided.	
(p)	Cantilever & Torsional force withstand values.	
(q)	Type of connection lead arrangement & length of condenser portion.	
(r)	Bottom PCD & Details of bolts.	
(s)	Details of bushing current transformers:	
	(i) Quantity	
	(ii) No. of cores	
	(iii) Ratio	
	(iv) V.A. burden	
	(v) Accuracy	
	(vi) Knee point voltage	
	(vii) Magnetizing current at Knee point voltage	
	(viii) Secondary resistance.	
	(ix) Free space required at top for removal of	

	bushing (mm)	
33.	Minimum clearance (mm)	
	(a) HV	
	(b) LV	
34.	Approx. weight of following :	
(a)	Core excluding clamping	
(b)	Core with clamping	
(c)	Coil with insulation	
(d)	Wt. of steel	
(e)	Core and winding	
(f)	Fittings and parts	
(g)	Oil required for first filling including 10% extra.	
(h)	(i) Transportation wt. excluding accessories.	
	(ii) Shipping details:	
	- Approx. wt. Of heaviest package	
	- Approx. dimension of largest package	
(i)	Un-tanking weight	
(j)	Total weight of transformer with oil and fittings	
35.	Details of Tank	
(a)	Type of tank	
(b)	Approx. thickness of sheet	
	(i) Sides	
	(ii) Bottom	
	(iii) Cover	
	(iv) Details of stiffener & under carriage	
(c)	Vacuum recommended for hot oil circulation (torr.)	
(d)	Vacuum to be maintained during oil filling in transformer tank (torr.)	
(e)	Vacuum to which the tank can be subjected without distortion (torr.)	
(f)	No. of bi-directional wheels provided	
(g)	Please note that only bell tank design is acceptable. Please confirm that offered transformers are of bell tank design.	
36.	Conservator:	
	(a) Thickness of sheet	
	(b) Size	
	(c) Total volume (Liters)	
	(d) Volume between the highest and lowest visible oil levels (Ltrs)	
	(e)Power required by heaters (if provided) (KW)	
37.	Details of oil preserving equipment offered (Air Cell) please indicate type, make & size.	
38.	Radiator:	
	(a) overall dimensions, 1xbxh (mm)	
	(b) Total weight with oil (Kg)	
	(c) Total weight without oil (Kg)	
	(d) Thickness of Radiator tube (mm)	
	(e) Types of mounting	
	(f) Vacuum withstand capability	
39.	Cooling System	
	(a) Make and type	
	(b) No. of connected units	
	(c)No. of standby units	
	(d) Rated power input	

	(e) Capacity (cu. M/min or litres/min	
	(f) Rated voltage (volts)	
	(g) Locked motor current	
	(h) Efficiency of motor at full load (percent)	
	(i) Temperature rise of motor at full load (degree centigrade)	
	(j) BHP of driven equipment	
	(k) Temperature range over which control is adjustable	
	(l) Whether the fan suitable for continuous operation at 85% of their rated voltage	
	(m) Estimated time constant in hours for i) Natural cooling ii) Forced air cooling	
	(n) Period of continuous working at full load with out fans (in min.)	
	(o) Continuous MVA rating without fans, MVA	
40.	Gas and oil operated relay (make, type, rang of setting etc.)	
41.	Temperature indicator	
	(a) Make and type	
	(b) Permissible setting rang for alarm & trip	
	(c) Number of contacts	
	(d) Current rating of each contact	
	(e) Whether remote indicators provided. If so whether equipment required at purchaser's control room's included	
42.	Approximate over all dimension of transformer in mm.	
	(i) Length	
	(ii) Breadth	
	(iii) Height	
43.	Minimum clearance height for lifting core and winding from tank	
44.	Minimum clearance height for lifting core and winding from tank	
45.	Please confirm transformer will be transported with oil/nitrogen gas	
46.	Lifting jacks	
	(i) Governing standard	
	(ii) No. of jacks on one set	
	(iii) Type and make	
	(iv) Capacity (tonnes)	
	(v) Pitch (mm)	
	(vi) Lift (mm)	
	(vii) Height in closed position (mm)	
	(viii) Mean diameter of thread (mm)	
47.	Marshalling kiosk	
	(i) Make and type	
	(ii) Details of apparatus proposed to be housed in the kiosk	
48.	Details of anti earthquake device provided, if any	
49.	Tap changing equipment (these details refer to the basic rating of OLTC. As guaranteed by manufacturer)	

	(i) Make	
	(ii) Type	
	(iii) Power flow direction /bi-directional / restricted bi- directional	
	(iv) Rated voltage to earth (kv)	
	(v) Rated current (amps.)	
	(vi) Step voltage (volt)	
	(vii) Number of steps	
	(viii) Control manual /Local electrical /remote electrical	
	(ix) Voltage control automatic /non automatic	
	(x) Line drop compensation provided /not provided	
	(xi) Parallel operation	
	(xii) Protective devices	
	(xiii) Auxiliary supply detail	
	(xiv) Time for complete tap change (one step) in sec.	
	(xv) Divertor selector switch transient time (cycles)	
	(xvi) Value of maximum short circuit current (amps)	
	(xvii) Maximum impulse withstand test voltage with 1.2/50 micro-seconds full wave between switch assembly and ground (kv peak)	
	(xviii) Maximum impulse frequency test voltage between switch assembly land earth (kv rms)	
	(xix) Maximum impulse withstand test voltage with 1.2/50 microseconds across the tapping range (kv peak)	
	(xx) Approximate overall dimensions of tap changer (hxwxd)	
	(xxi) Approx. overall weight (kg)	
	(xxii) Approx. mass of oil (kg)	
	(xxiii) Particulars of the O.L.T.C. control cubicle	
50.	Driving mechanism box (a) Make and type (b) Details of apparatus proposed to be housed in the box.	
51.	Please enclose list of accessories and fittings being provided on transformer. Please confirm these are as stipulated in tender.	
52.	Whether the transformer covered have been fully type tested and if so, whether copies of type test certificates enclosed with tender.	
53.	Valves: indicate details of valves, their type, sizes and no. required/ fitted	
54.	a) type and make of pressure relief devices	
	b) No. of each type pf devices per transformer	
	c) Minimum pressure at which device operates.	
55.	Please give details of PRV like make, rating etc.	
56.	Characteristics of Insulating oil to be used	
(a)	Density in gms/cu. Cm	
(b)	Kinetic viscosity in cst	
(c)	Interfacial Tension at 27oC in N/M	
(d)	Flash point in oC	
(e)	Pour point in oC	

(f)	Acidity (Neutralization/Value)	
(g)	Corrosive Sulphur in %	
(h)	Electric strength Breakdown	
	a) As received Voltage (KV rms)	
	b) After treatment (KV rms)	
(i)	Dielectric dissipation factor (tan delta) at 90 oC	
(j)	Saponification value in mg of KOH/gm	
(k)	Water content in ppm	
(l)	Specific resistance	
	(i) at 90 oC ohm/cm	
	(ii) at 27 oC ohm/cm	
(m)	N-dm Analysis CA % CM % CP %	
(n)	Oxidation stability	
	(i) Neutralization value after oxidation	
	(ii) Total sludge after oxidation.	
(o)	Aging characteristic as per Border 140 h/110 oC	
(p)	Saponification value in mg of KOH/gm	
(q)	Dielectric loss after 90 oC	
(r)	Aging characteristics as per NEMA 164 H/110 oC	
(s)	Neutralization value in mg of KOH/gm	
(t)	Sludge content weight %	
(u)	Pemitivity at 60 oC	
(v)	Specific heat at 60 oC	
(w)	Thermal conductivity at 60 oC	
(x)	Mean coefficient of expansion	
57.	Details of online DGA monitoring device:	
	(i) Make	
	(ii) Name of gases which will be monitored	
	(iii) Please confirm that necessary soft wares has been provided	
58.	Details of nitrogen injection fire protection system device	
	(a) Make & model	
	(b) Auxiliary supply required	
	(c) size & capacity of storage tank proposed to be provided	

SIGNATURE OF BIDDER

Date
Place

NAME
DESIGNATION
(SEAL)

LIST OF FITTINGS AND ACCESSORIES TO BE PROVIDED WITH EACH POWER TRANSFORMER

(1) Each transformer shall be provided with the following accessories.

(i) Dial type Thermometers for oil: - A dial type indicating thermometer with repeater of robust pattern mounted on the side of the transformer at a convenient height to read the temperature in the hottest part of the oil and fitted with alarm and trip contacts. Remote oil temperature indicator shall also be mounted on RTCC panel.

(ii) 3 no. Winding temperature indicator for HV , IV& LV winding:- It shall be indicating type with repeater responsible to the combination of top oil temperature and winding current, calibrated to follow the hottest spot temperature of the transformer winding,. The winding temperature indicator shall operate a remote alarm before the hottest spot temperature approaches a dangerous value and it shall automatically actuate the cooling fan Motors.

(iii) a) Remote winding temperature indicator is to be installed in the indoor control panel i.e. fan control cubicle with its repeater on remote tap charger control cubicle.

b) In addition to the winding temperature indication device another device for measurement of hot spot in transformer winding using fibre optic sensors should also be provided. The probes shall be directly installed in each phase of power transformer to measure the winding hot spot temperature. The fibre optic cables should be brought out of the main tank to tank wall penetrator feed through a plate. The feed through plate should be welded on the tank. The external fibre optic extension cable shall then be run to the control cabinet. Separate temperature indicator should be provided for hot spot measurement through this device. The fibre optic sensor display shall be brought to the RTCC panel also.

(iv) a. One magnetic type oil level gauge with low level alarm contacts and dial showing minimum, maximum and normal oil levels. The gauge shall be readable from the gauge transformer base level.

b. One plain oil level gauge of over lapped type on other side of conservator.

(v) Minimum 3 no. pressure relief valves : The quantity of these valves should commensurate with the quantity of oil in the transformer and also location of valves should be properly designed to adequately release the excessive pressure.

(vi) A set of air release valves on the top and on the radiators and also at appropriate place

(vii) A safety valve of the chimney type with an equalizer pipe interconnecting the top of the conservator and upper most part of the safety valve should be provided to prevent rise of oil in the safety valve pipe. Any other substitute arrangement shall also be acceptable.

(viii) One thermometer pocket for mercury in glass type thermometer.

(ix) The safety valve pipe shall preferably take off from the side of the transformer tank near to the tank cover and not from the top of the tank cover. The requirements shall be met as specified in 'CBIP' specification.

(x) One double float gas detector relay (Buchholz relay) with alarm and tripping contacts to detect accumulation of gas and sudden changes of oil pressure, complete with shutoff valves and flanges couplings to permit easy removal without lowering oil level in the main tank, a blend valve for gas venting, and test valve. Make of buchholz relay shall be as per our approved list of vendors.

(xi) Heat exchangers or radiators complete with shut of valves and with facility for oil draining arrangement.

(xii)a/ Two oil conservator, with required accessories, one for main tankand other for OLTC.

b/ Air cell type breathing arrangement with oil preserving equipment complete in all respects.

(xiii) Eye bolts and lugs on all parts for easy handling.

(xiv) Two grounding earth terminals at diagonally opposite corner of tank.

(xv) One rating and diagram plate.

(xvi) A set of minimum 4 nos. flanged bi-directional wheels for rail mounting (for 1676mm rail gauge).

(xvii) A set of fans required for ONAF cooling of the transformer with following information.

a. Number of Radiator Banks.

b. No. of cooling fans of adequate voltage & rpm) provided in each bank to ensure 100% ONAF rating of the transformer. As per our specification, for each bank one additional cooling fan is to be included which will be duly wired-up.

(xviii) Suitable jacking lugs and haulage holes.

(xix) Thermosyphone filter assembly with complete details.

(xx) Inspection window & main holes with bolted cover as per Annexure-IV.

(xxi) Lifting arrangement for the complete transformer, core coil assembly and also tank.

(xxii) One foldable ladder on main tank.

(xxiii) For the purpose of taking earthing connection from the neutral bushing, adequate number of brackets with small support insulators shall be provided on the body of the tank so that earthing could be arranged by us near the earthing pit of transformer itself.

(xxiv) A separate weather proof FCC (Fan/Cooler control) cubicle shall be mounted on the transformer containing dial type thermometer and winding temperature indicator and terminals of dial, type thermometer, winding temperature indicator, buchholz relay, MDG, control of fans etc.

Please note provision of separate Fan Control Cubicle (FCC) is a must. FCC shall be suitably dimensioned to accommodate following:-

(a) The wiring from RTCC shall be brought to marshalling box and for terminating the same adequate number of suitably rated terminal connectors shall be provided.

(b) Necessary cable glands shall be included in the scope of supply.

(c) Arrangement for terminating the connecting leads of OTI, WTI, buchholz, magnetic oil level gauge etc. shall be made in the marshalling box. It should be possible to read OTI and ETI readings without opening the box through suitable glass window. All trip alarm and repeater signals will be transferred to control room for which arrangement will have to be made.

(d) Starters for cooling fans shall be housed in marshalling box and necessary switches for local operation of fans shall be provided.

(e) Local remote control switch for OLTC shall be provided.

(f) Space heater with switch, cubicle illumination lamp, fuses, links overload protection arrangement for motors and other accessories shall be included in the scope of supply.

(xxv) One set of indoor RTCC (Remote tap changer control) cubicle complete with provision for remote operation of OLTC, as independent or master/follower scheme, with oil and winding temperature repeater, tap position indicator with annunciation for fan group ON/OFF and cooler supply fail indicator and Tap changer in progress.

(xxvi) One set of erection manual/relevant drawing/leaflets should be secured permanently inside the RTCC cubicle as a guideline for site erection and commissioning.

(xxvii) Three separate connection i.e. connection from core, connection from end frame and connection from tank shall be brought out on to a terminal box with cover. Arrangement for inter connecting these terminals in the terminal box shall also be provided. This arrangement shall facilitate verification of core, end frame and tank insulation.

(xxviii) Mounting of radiators on the IV bushing should be avoided. In no case, the radiators should be projected above the main tank height.

(xxix) All transformers shall be supplied with a full outfit of tools, spanners, jacks, special tools for assembly and all spanners shall be single ended and of very good quality of "Gedore" or "Ttaparia" make.

2. The equipments and accessories furnished with the transformer shall be suitably mounted on the transformer for ease of operation, inspection and maintenance and the mounting details shall be subject to the approval of the purchaser. All valves shall be provided either with blind companion flanges or with pipe plugs for protection.

3. Indication, alarm and relay equipment shall have contacts suitable for operation with 220V/110V DC supply. Any other accessories or appliances recommended by the manufacturer for the satisfactory operation of the transformer shall also have 110 DC as input.

4. (a) OLTC and its controls shall be as per Clause 5.10 Section-II of specification.

(b) All cabinets & panels shall be conforming to stipulations under Clause-5.18 of specifications.

(c) All 220/132KV and neutral bushings shall be of OIP condenser type and as per Clause 5.7.1 Section-II of specifications.

5. NIFP system as per clause 5.10.5.

6. On line DGA Monitoring device as per clause 5.6.1(b).

Accessories, which are not included in the above schedule but details of which are given in tender specification and which are necessary for satisfactory operation of Transformer shall be deemed to have been included in the accepted price without any extra cost to the CSPTCL.

* * * * *

LIST OF TRANSFORMER ACCESSORIES AND TEST CERTIFICATES REQUIRED

S.No	Accessory	Test-certificates required
	Condenser Bushing	Appearance, construction and dimensional check. Test for leakage of internal filling at a pressure of 1.0 Kg/cm for 12 hours. Insulation resistance measurement with 2000V megger. Dry/wet power frequency voltage withstand test. Dry/wet power frequency voltage withstand test for test tap insulation Partial discharge measurement upto 1.5 UN 3Kv. Measurement of tangent delta and capacitance.
	Pressure Gauges/ Differential Pressure Gauges	Appearance, construction and dimensional check. Calibration test. 3. Alarm contact setting test.
	OLTC.	Oil tightness test for the diverter switch oil chamber at an oil pressure of 0.5 Kg/cm2 at 100 degree centigrade for 1 hour. Mechanical operation test. Operation sequence measurement Insulation resistance measurement using 2000V megger. Power frequency voltage withstand test on diverter switch to earth and between even and odd contacts. Power frequency voltage withstand test on tap selector- between stationary contacts, between max. and min. taps, between phases and supporting frames, between phases. Operation test of complete tap changer. Operation and dielectric test of driving mechanism.
	Winding & Oil Temperature Indicator	Calibration test. Dielectric test at 2 KV for one minute. Accuracy test for indication and switch setting scales. Test for adjustability of switch setting. Test for switch rating. Measurement of temperature rise with respect to the heater coil current.
	PRV	Functional test with Compressed air to check bursting pressure, indicating flag operation and switch operation. Dielectric test at 2 KV for one minute. Switch contact test at 5A, 240 Volt AC.
	Cooling fans	Insulation resistance measurement. Dielectric test at 2 KV between winding and body for one minute. Operation check. Appearance, construction and dimensional check.
	Buchholz relay	Leak test with transformer oil at a pressure of 3 Kg/cm2 for 30 minutes at ambient temperature for relay casing. Insulation resistance measurement with 500V megger. Dielectric test at 2KV for 1 minute. Elements test at 1.75 Kg/cm2 for 15 minutes using transformer oil at ambient temperature. Loss of oil and surge test. Gas volume test. Mechanical strength test. Velocity calibration test. Appearance construction and dimensional check.
	Oil level indictor	Test for oil levels. Switch operation for low level alarm. Switch contact test at 5A 240V AC. Dielectric test at 2 KV for 1 minute. Appearance, construction and dimensional check.

	Pressed steel radiators	Air pressure test at 2 kg/cm2 under water for 15 minutes. Appearance, construction and dimensional check.
	OLTC control cubicle/ cooler control cabinet	Appearance, construction and dimensional check. Electric operation. Insulation resistance measurement using 500V megger at ambient temperature. Dielectric test at 2 KV for 1 minute.
	Bushing current transformer	Appearance, construction and dimensional check. Polarity check. Measurement of insulation resistance. High voltage power frequency test. Determination of ratio error and phase angle of measuring and protection BCTs. Determination of Turns ratio error for PS class BCT. Determination of composite error for protective class BCT. Interturn insulation withstand test. Exciting current characteristic test. Secondary winding resistance measurement. Knee-Point voltage, measurement for PS class BCT.

SCHEDULE OF INSPECTION WINDOW

Sl. No.	Particulars	Qty (in no.)
01.	Main hole	01
02	Inspection cover to facilitate full inspection and tightening of all connections of diverter switch of OLTC fitted in position. This inspection window can also be used as main hole at S.No. 1 above.	01
03.	Inspection cover for facilitating inspection/ connections of R, Y & B phase HV bushings.	02
04.	Inspection cover to facilitate inspection and connection of R, Y & B phase LV bushings.	02
05.	Inspection cover to facilitate inspection and connection of HVN & LVN bushings.	02
06.	Inspection cover to facilitate inspection and connection of delta formation.	01
07.	Inspection cover considered necessary for inspection of active parts/ connections etc. as per manufacturer's design.	Qty. as per requirement

LIST OF VENDERS FOR MAJOR ITEMS OF TRANSFORMER

S. No.	Name of Item	Supplier/manufacturer
1.	CRGO	M/s. Nippon steel corporation, Japan M/s. Kawasaki Corp., Japan (M/s JFE, Japan) M/s. Armco, USA, M/s. Covefi, France M/s. Salzgittar, Germany M/s. S Usinor, France M/s Transfer, France M/s Mitsubishi, Japan. M/s AST Terni, Italy M/s. EBG India Pvt Limited, (Indian Agent) for M/s GELSE NKIRCHEN, Germany M/s British Steel Corporation , UK M/s Thyseen Krupp Group of Companies M/s. POSCO, Korea M/s A.K.Steel USA
2. (a)	Winding conductor	M/s Invex Filli Isolati Speciali s.p.a. Italy M/s. Asta M/s. Smit Draad, Holland M/s. Incab Industries, Jamshedpur M/s. Sterlite Industries, Mumbai M/s. Bhandari Conductor, Mumbai/ Mandideep. M/s. Shakti Insulated Wires, Mumbai M/s KSH International Pvt Limited, Taloja M/s Delta-Trans Conductor, Mumbai M/s Vijay Electricals, Hyderabad

		M/s RIMA Transformers & Conductors (P) Ltd, Bangalore. M/s Lacroix and Kress (GMBH) Germany M/s Pirellicavi Italy M/s Shree Cable & Conductors M/s. Hindalco M/s. Chandra Metals M/s. BCPL Conductors
(b)	CTC Conductor	M/s Sam Dong Korea M/s Invex Filli Isolati Speciali s.p.a. Italy M/s Loc Roix AND KRESS – Germany M/s. KSH International (P) Ltd. M/s. Chandra Metals
3.	Precompressed press Board & press Board components	M/s. H. Weidmann, Switzerland M/s. Fige Holms Brruk, Swedan M/s. Senapathy Whiteley, Banglore M/s. Raman Board, Mysore
4.	Insulating Material	M/s. Dupont, USA M/s. Senapathy Whiteley, Banglore M/s. H. Weidmann, Switzerland M/s. Munksio M/s Amotfors, Sweden M/s Krammerer
5.	Air Cell	M/s PRONL, France, M/s. Swastik M/s. Unirub M/s. Rubber Products M/s Sukrut Udyog M/s Nu-cork Products (P) Ltd., Bhiwadi (Raj.)
6.	Gaskets	M/s. Talbros, Faridabad M/s. Cortica, Chennai M/s. Packing & Jointing, Chennai M/s Indian Rubber Products, Haridwar M/s Bombay Oil Seal Mfg. Mumbai M/s MGM Rubber Kolkata M/s Bharat Corrub Industries, Vadodara. M/s Indian work Industries M/s Works Product Pvt Ltd M/s Nu-cork Products (P) Ltd., Bhiwadi (Raj.)
7.	OIP Condensor bushing	M/s. BHEL M/s. CGL M/s. TELK M/s ASEA-MICAFIL M/s. Trench M/s. Alstom (earlier M/s. Areva) M/s. Vijai Electricals Ltd. M/s ABB
8.	Terminal Connector	M/s. Best & Crompton, Chennai M/s. PeeVee Engg., Bangalore M/s. Milind Engg., Mumbai M/s. Nootan, Baroda M/s Utsav, Baroda M/s Vinayak and Co., Mumbai

		M/s Megha Engg. Enterprises, Chennai M/s Klemmen Engg. Corporation , Chennai
9.	OTI/WTI with repeater	M/s. Accurate Control,UK M/s. AKM, Swedan M/s. Perfect Control, Chennai, India M/s. Preci Measure, Banglore M/s Radix Electrosystems Pvt. Ltd/ Radix Pyrotech India
10.	Magnetic oil gauge	M/s. Sukrut Udyog, Pune M/s. Yogya, Jhansi
11.	Buchholz Relay	M/s. Fukuda Instrument, Japan M/s. Atvus,Calcutta M/s. English Electric, Chennai M/s. Prayog; M/s BHEL M/s Instrument and Control, Vadodara
12.	Pressure Relief Device	M/s. Qualtrol, USA M/s. GE, USA; M/s. Sukrut Udyog, Pune
13.	Fan & Motor	M/s. Alstom (earlier Areva) M/s. CGL, Mumbai M/s. Khaitan, Calcutta. M/s EPC, Calcutta M/s Marathan
14.	Un-impregnated Densified laminated wood	M/s. Permali Wallace Bhopal M/s. Kit ply Assam M/s. Mysore Polymers Banglore M/s Narmada Forest Ind. Pvt. Ltd. Bhopal. M/s Western India Plywood , Kerala M/s Rochling Detonite
15.	Valves	M/s. Leader M/s. Bombay Metal & Alloys M/s. Audco M/s. Petson M/s. Manixon M/s. Creseant M/s Precision Engg. Kottayam, M/s Eapen Joseph, Kottayam M/s Apex Piping Systems, Jalandhar M/s Liberty Engg., Mumbai M/s Niton Valves, Mumbai M/s Eapen Joseph & Co., Coimbatore M/s Oswal Agra M/s Neo Engg. Ahamedabad M/s CG Valve Udaipur
16.	MCB	M/s. Sieman M/s. MDS M/s. S&S M/s. Havell's
17.	Fuse	M/s. Siemens/ S&S / Areva / Havell's

18.	Tank Steel	M/s. SAIL/Jindal/Essar steel
19.	OLTC Complete	M/s. BHEL M/s. CTR M/s. TELK M/s Easun, Madras
20.	Terminal Blocks	M/s. ELMEX M/s. Technoplast, M/s. Tosha
21.	Silica gel Breather	M/s. Yogya Enterprises, Jhansi. M/s. Anusen Industries, Pune. M/s Instruments & Controls , Vadodara, India
22.	Transformer oil	M/s Apar Limited, Mumbai M/s Savita Oil Technologies M/s. Raj Petrochemicals
23.	Radiator	M/s CTR Manufacturing Industries, Pune M/s Thermal Transformer Product, Bangalore M/s Exotherm, Bangalore. M/s P.E. Engg. Hyderanad. M/s Hitech Switchgear, Mumbai M/s Mahindra Electrical works M/s Triveni Electroplast
24.	On line DGA monitor	M/s. GE Kelman- Transfix DGA500 M/s. Morgan Schaffer Calisto-5 M/s. A-Eberley Hydrocol-1005
25.	NIFP System	M/s. CTR M/s Easun Reyrolle

Note: The contractor should submit their offer considering the above mentioned vendors.

DRAWINGS AND DATA TO BE FURNISHED BY THE CONTRACTOR
****

The following drawings and data are to be submitted by the contractor for approval:

(a) Outline dimensional drawings of transformer and its accessories including conservator complete with Bill of material and details of all parts, their quantity, rating & name of Vendors indicating clearances of transformer body from live terminals i.e. HV,LV.

(b) Drawing of transformer tank with location of inspection windows, thickness of side/bottom/top of tank, details of stiffener.

(c) Drawing indicating limbed core construction with complete details of no., width and wt. of core laminations with size of steps; thickness of core laminations ; dimension of window; size of limbs; Gross and net core ; wt. of complete core.

(d) Drawing indicating core belting arrangement with details of belting, belting material etc.

(e) Large scale dimensioned drawings for HV & LV windings of the transformer; size and no. of parallel of HV, LV and of cooling ducts, coil clamping arrangement, no./size & location of pressure screws, clamping ring; top yoke arrangement etc. The details should commensurate with the short circuit calculations submitted by you for each rating of transformer

(f) Detailed drawing of transformer tank with complete core and winding indicating clearances inside transformer tank as also passage and space for free movement of at least two persons for inspection of active parts etc .

(g) Schematic diagram showing the flow of oil in the cooling system as well as each limb and winding. Longitudinal and cross-sectional views showing the duct sizes, cooling pipes etc. for the transformers/radiators drawn to scale .

(h) Drawings giving the weights for foundations.

(i) Combined Rating and diagram plate including tap changing, which should also include details of guaranteed and measured no load and load losses as also winding resistances and percentage impedances at all taps.

(j) Schematic control and wiring diagram for all auxiliary equipment and control cubicle.

(k) Drawing showing constructional details, dimensions, mechanical & technical particulars of bushings. Arrangement of terminals and details of connection of bushing shall also be indicated in drawing with their technical particulars.

(l) Transportation drawing of transformer.

(m) Details of fittings and cable box.

(n) Drawing showing arrangement and details of tap changing gear including selector switch, diverter switch and drive mechanism.

(o) Valve Schedule plate.

(p) Oil filling instruction plate for conservator fitted with Air cell breather arrangement including equalizing arrangement if any required at the time of taking full Vacuum at site.

(q) Drawing and instruction for fitting ofAir Cell.

(r) Drawing of conservator indicating internal details of air cell MOG, oil level gauge and silica gel breather pipe fitting arrangement.

(s) Drawings of all HV & LV bushings with complete details meeting TS requirement.

(t) Drawings of HV, LV& neutral terminal connectors indicating plate thickness, no. of nut bolts with size and other details.

(u) Drawing of foldable & detachable ladder with its complete details and fitting arrangement on transformer/ conservator tank.

(v) Drawing for HV/LV neutral earthing arrangement indicating voltage rating of insulators and its fitting arrangements, size of copper strips, terminal connectors etc.

(w) Detailed drawing indicating two views of all valves provided in the transformer tank.

(x) Detailed internal drawing of transformer indicating transportation locking arrangement provided to avoid shifting of core assembly.

(y) Drawing showing weights of transformers, cooling fan structures, FCC structures with distance from central line of transformer for casting of civil foundation for transformer and associated equipments.

Drawing of Earthing terminal box showing earthing arrangement for core, end frame, tank giving details of voltage class and current rating of terminal bushings.

Drawing indicating insulation thickness details and other arrangement provided between core assembly and bottom yoke and base of bottom of tank.

Drawing indicating details of 'O' ring gasketting arrangement provided in transformer tank covers.
Detailed Drawing of jacks.
Drawing of stiffeners provided on top, each faces/sides of tank with their number and size.

Drawing indicating number, location, size of shields/ magnetic shunts and its material provided inside the tank as per clause 11.1 (g).

Drawing indicating internal details of transformer giving complete details of clearances from live parts.

Drawing of internal LV winding termination arrangement indicating minimum clearance between core and LV take off lead.

Drawing for Lead termination to bottom of HV & LV Neutral Bushings

Drawing for Lead termination to bottom of HV & LV bushings.

Internal drawing & design of Core & Winding indicating all attachment with identification numbers, description including take-off arrangement of lead connection for Core & End frame and related Bill of Material

Locking arrangement drawing for tank top cover, core & winding with complete dimension & details.

Plan view of the bottom of Bell Tank for complete details of core coil resting arrangement, indicating clearly dimensional details, material of insulation, clamping arrangement with details of nuts/ bolts, clearance from all sides provided at bottom.

Drawing indicating complete details, dimension & mounting arrangement of OLTC inside the tank with respect to End frame.

Drawing indicating complete details, dimensions & fixing arrangement of static end rings if used.

Other relevant drawings.

The manufacturer shall supply four (4) copies of the drawings as listed out above, which will describe the equipment in details for approval.Three sets of instruction books, operation and maintenance manuals and spare part bulletin, shall be supplied. In addition to above two sets of manuals and drawings with test certificates for each unit to be despatched as per despatch instructions. It will be obligatory on the part of the manufacturer to ensure that the weight of core lamination, weight of copper, weight of steel, weight of transformer tank along with fitting and accessories, quantity of oil for first filling including wastage and 10 % extra of that quantity, total weight of core plus winding after assembly, total weight of transformer and other dimension of transformer are worked out carefully. It may be noted that at the time of submission of final drawings, variation in these weights beyond the limits of (+) 5% shall not be permitted.

***

DETAILS OF INSPECTION PROGRAMME

***

(A). Inspections to be performed at manufacturer's works in presence of CSPTCL's representative and/ or a representative of NABL accredited third party.

Stage Inspection:
It may be noted that stage inspection for all the units at CSPTCL's discretion shall be done at manufacturer's works in presence of CSPTCL's representative and representative of third party authorized by CSPTCL at the following stages.

After the core is built but before its clamping, CSPTCL's representative will inspect the core to take complete weight of the core and also to measure approximate core loss. If necessary, a small strip of core shall also be taken for testing at ERDA/ CPRI at our discretion.

Once the coils are prepared and are fitted on to the core, stage inspection of the core coil assembly shall be done to take measurements of HV/ LV windings. A small piece of conductor for each type of winding shall be made available by the manufacture. The magnetic balance test shall also be carried out during this stage inspection.

Apart from the above, the CSPTCL also reserves the right to carry out stage inspections at other stages also, for which advance intimation shall be given and all necessary cooperation shall be rendered by the manufacturer.

Final inspection:
After satisfactory stage inspections, ovening of core coil assembly and tanking thereafter shall be carried out by the manufacturer. Call for final inspection of the transformer shall be given after readiness of transformer in all respects. During the final inspection, all routine and additional routine tests shall be carried out on each unit according to the methods specified in IS:2026 (Part-I):2011 and IS:2026 (Part-III):2009. These tests shall be witnessed by CSPTCL's representative and representative of third party authorized by CSPTCL The details of the tests to be carried out are as given here under:

Sl.	Particulars
(A) Routine tests:	
1	Measurement of winding resistance
2	Measurement of voltage ratio and check of phase displacement
3	Measurement of Impedance voltage/ short circuit impedance (Principal tap) & load loss
4	Measurement of no load loss at 90%, 100% & 110% of rated voltage and no load current
5	Measurement of Insulation resistance
6	Dielectric routine tests as per IS:2026 (Part-III) i.e. lightning impulse tests on all phases of HV/LV windings, short duration induced AC withstand voltage tests, separate source AC withstand voltage tests
7	Tests on load tap changers
(B) Addl. Routine Tests:	
1	Dimensional checks as per approved drawing & specification
2	Magnetic circuit test. After assembly ,core shall be tested for 1 minute for 2000 volts AC between all bolts, side plates & structures steel works
3	Polarisation index – IR value for 15 sec, 60 sec & 600 sec duration shall be recorded and PI for 600/60 sec and DAR i.e. ratio of IR values of 60/15 seconds shall be recorded. The PI value (600/60 sec) should be ≥2 and DAR value (60/15 sec) should be ≥1.3. These values should be recorded both before and after HV tests.
4	Tank oil leakage test – the complete transformer assly filled with oil shall be subjected to nitrogen pressure of 0.35 Kg/cm2 above the normal oil head for a period of 12 Hrs to ensure that there is no oil leakage.

5	Capacitance and tan delta measurement to determine capacitance between wingding and earth. This test should be carried out before and after series of dielectric tests by ANSI II method.
6	Test on bushings and tan delta capacitance and IR values
7	Checking of recording of IR values
	(a) Between core & coil frame
	(b) Between core & tank
	(c) Between coil frame & main tank The measured IR values should be more than 1000 M Ohms.
8	Magnetic balance and magnetizing current (3 ph.& 1 ph. at normal tape) test
9	Tests of PRDs for successful operation
10	Oil BDV test before & after HV tests
11	Sweep Frequency response analysis (FRA)- SFRA shall be carried out at manufacturer's works with his own SFRA test set. The test shall be repeated at site with same test set.

Further, following type & special tests as per clause 6.2, Section-II of tender specifications shall be carried out on one unit out of the lot.

(i) Temperature rise test as per IS:2026 (part-I) & clause 4 of IS:2026 (part-II) on both ONAN/ONAF ratings.
(ii) Tank vacuum test and tank pressure test
(iii) Test on pressure relief devices
(iv) Measurement of zero Seq. Reactance.
(v) Measurement of acoustic noise level.
(vi) Measurement of power taken by fans.
(vii) Measurement of harmonic level in no load current.
(viii) Lighting impulse with chop on tail on all 3 phase of HV and LV terminals.
(ix) One cooler cabinet and OLTC cabinet of the transformers (preferably for the first unit of the lot) shall be tested for IP:55 protection in accordance with IS: 2147. In case facility for this test is not available with the manufacturer, the test has to be carried out at the laboratory of either CPRI or ERDA in presence of CSPTCL's representative and test report should be furnished.

Tests on Assembled Transformer:

a) Check completed transformer against approved out line drawing, provision for all fittings, finish level etc.
b) Jacking test on the assembled Transformer.

Tests to be conducted at destination site of CSPTCL:

On delivery / receipt, after erection at site, the transformer shall be subject to the following tests, in presence of supplier's engineer.

3.1 Tests on reaching at site:

(i) Immediately upon receipt of transformer at site and before unloading of transformer from trailor, core earthing, end frame earthing and tank earthing shall be checked. Only after satisfactory verification that there is not multiple core earthing in transformer, unloading of transformer shall be undertaken.
(ii) After receipt of transformer at site physical inspections shall be done for checking any physical damage to transformer tank and accessories. Further, data of impact recorder shall be analyzed for any changes before unloading of transformer.

3.2 Pre commissioning tests:

(i) Insulation resistance test and polarization index.
(ii) Ratio and polarity test
(iii) DGA of oil and di-electric, tan delta, resistivity & moisture content test of oil.
(iv) OLTC operational test at each tap for lower and raise operation of tap changer.
(v) Magnetic balance tests and measurement of magnetizing current.

(vi) Vector group test
(vii) Percentage impedance test at all taps
(viii) Short circuit current measurement at low voltage and at all taps
(ix) Measurement of winding resistance at all taps
(x) Tangent delta, capacitance and insulation resistance tests of bushings
(xi) Measurement of IR values between core & coil frame, core & tank end coil frame and tank.
(xii) Dew point measurement and recording of pressure of nitrogen gas.
(xiii) SFRA test.

The SFRA test and Dew point measurement shall be carried out in presence of manufacturer's representative. The test kits shall be same as used for carrying out these tests in the factory and shall be brought by manufacturer's representative.

(B). Checks to be performed by the manufacturer during various stages of manufacturer of transformer. The in house test reports may be reviewed by CSPTCL's representative during stage / final inspection.

Tank and conservator:
Certification of chemical analysis and material tests of plates.
Welder's qualification and weld procedure.
Testing of electrodes for quality of base materials and coatings.
Inspection of major weld preparation and joint.
Crack detection of major strength weld seams by 'dye penetration test'.
Measurement of film thickness of:
Oil insoluble varnish.
Zinc chromate paint.
Finished coat.
Check correct dimensions between wheels, demonstrate turning of wheels through 90 degrees and further dimensional check.
Check for physical properties of materials for lifting lugs, jacking pads etc. All load bearing welds including lifting lug welds shall be subjected to NDT.
Tank vacuum & Tank pressure tests as per CBIP manual on transformer & as per this specification.
Leakage test of the conservator and tank.
Measurement of thickness of tank plates i.e. top, Bottom & Sides.
All double welds shall be tested for leaks with dry nitrogen, at the pressure not less than 7 kg/sq.cms. (atm)
All tanks, single welds, cooling coils, radiators valve and other parts necessary for complete transformer shall be tested for leaks and strength by applying pressure not less than 0.7 atm for a period of 24 hrs or not less than 1 atm for a period of 06 hours. If leaks occur, the tests shall be conducted after all leaks have been stopped.
Certification of all test results.

2. Core:
Sample testing of core material for checking thickness of lamination, special loss, bend properties, magnetization characteristics (B-H Curve) and Epstein curve.
Check on the quality of varnish, if used on the stampings.
Measurement of thickness and hardness of varnish on stampings.
Solvent resistance test to check that varnish does not react in hot oil.
Check overall quality of varnish by sampling to ensure uniform shining colour, no bare spot, no over burnt varnish layer and not bubbles on varnished surface.
Check on the amount of burrs.
Bow check on stampings.
Check for the over lapping of stampings, Corners of the sheets are to be apart.
Visual and dimensional check during assembly stage.

Check on completed core for measurement of iron loss characteristic and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.
Visual and dimensional checks for straightness and roundness of core, thickness of limbs and suitability of clamps. Weightment of core with belting after building up.
High voltage test of 2KV for one minute between core and clamps.
Certification of all test results.

3. Insulating material:
Sample check for physical properties of materials.
Check for dielectric strength,
Visual and dimensional checks.
Check for the reaction of hot oil on insulating materials.
Dimensional stability test at high temperature for insulating material.
Tracking resistance test on insulating material.
Certification of all test results.

4. Winding:
Sample check on winding conductor for mechanical properties and electrical conductivity.
Check insulating distance between high voltage/low voltage connection, cable and earth and other live parts.
Check for proper cleanliness and absence of dust.
Visual dimensional checks on conductor for scratches, dent marks etc.
Sample check on insulating paper for PH values bursting strength and electric strength.
Check for bonding of insulating paper on conductor and absence of short circuit between parallel strands.
Check for brazed joints wherever applicable.
Measurement of voltage, when yoke/core is completely restocked and all connection are ready.
Measurement of no. of turns in each winding and cross sectional area of windings. Weightment of windings.
Certification of all test results.

5. Checks before drying process:
Weight of complete core, winding and insulation.
Check condition of insulation of the conductor and between windings, Insulation gap between HV connection, cables, earth and other live parts. Similarly check for HV/LV connections.
Insulation of core shall be tested at 2KV /min between core to bolts and core to clamp plates.
Check for proper cleanliness and absence of dust etc.
Certification of all test results.

6. Checks after drying process:
Record measurement of temperature, vacuum and drying time during vacuum treatment.
Check for completeness of drying by measuring IR values and Tan Delta.
DP test shall be carried out after jacking test.

7. Pre shipment check at manufacturer's works:
Check for inter changeability of components of similar transformers for mounting dimensions.
Check for proper packing and preservation of accessories like radiators, bushings, explosion vent, dehydrating breather, rollers, buchholz relay, fans, control cubicle, connecting pipes, conservator etc.
Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.
Gas tightness test to conform tightness.
Derivation of leakage rate and ensure adequate reserve gas capacity.
Note:
(i) Further tests:

The Purchaser reserves the right to having other reasonable, tests carried out at his own expenses either before shipment or at site to ensure that the transformer complies with the requirements of this specifications.

(ii) Test reports:

After all tests have been completed seven certified copies of each test report shall be furnished. Each report shall supply the following information:

(i) Complete identification data including serial number of the transformer.
(ii) Method application, where applied duration and interpretation of results for each test.
(iii) Temperature data corrected to 75 degree centigrade including ambient temperature.

LIST OF HAND TOOLS & JACKS TO BE SUPPLIED ALONG WITH THE POWER TRANSFORMER

No.	Spanners of different sizes	
A.	One tool box consisting of the following hand tools of reputed make shall be supplied	
1	a) Open jaw double ended (Tapadia)	08 No.
	b) Cranked ring double ended	03 No.
	c) Tubular Box double ended	01 No.
2	Tommy Bar (for Tabular Box spanner)	
3	Adjustable wrenches	02 No.
4	Pipe wrench	01 No.
5	Screw Drivers of different sizes (Set of 12)	1 Set.
6	Flat Nose, Round Nose, Side Cutting Pliers	01 No. Each
7	Gasket punches of different size	1 Set
8	Filkes with Handles	02 Nos.
9	Hammers with Handles	02 Nos.
10	Knife with Handles 6" & 8"	02 Nos.
11	Adjustable Hacksaw	02 Nos.
12	Cold Chisel	02 Nos

ROUTINE AND ADDITIONAL ROUTINE TESTS

Sl. No.	Particulars	Remarks (mention specific comments regarding tests results as per standards or not)
(A) Routine tests:		
1	**Measurement of winding resistance** – The resistance of HV, IV & LV windings should be carried out at different taps and values at the ambient temperature & converted values at 75 deg C should be recorded in a separate sheet.	
2	**Measurement of voltage ratio and check of voltage vector relationship** – The measurement of HV to LV ratio at all taps should be recorded and ratio error should be mentioned in a separate sheet. The voltage vector relationship should also be recorded to ensure the vector group of the transformer.	
3	**Measurement of Impedance voltage/ short circuit impedance (Principal tap) & load loss** – Tests to be carried out at normal, highest & lowest tap	
4	**Measurement of no load loss & current** – The values of no load loss and no load current at normal tap at 90%, 100% & 110% of rated voltage should be recorded before and after dielectric test.	
5	**Measurement of Insulation resistance** – The insulation resistance between HV/tank, LV/tank & HV/LV should be recorded with 5KV megger for 15 seconds, 60 seconds & 600 seconds. The values and PI of 60th / 15th& 600th / 60th should be mentioned in a separate sheet. The values should be recorded before & after HV tests.	
6	**Dielectric tests** – Separate sources voltage withstand tests, induced over voltage withstand test and lighting impulse withstand tests on all phases of HV & LV as per IS: 2026 should be carried out in following sequence: (i) One reduced full wave impulse (ii) Three 100% full impulse (iii) 650KV p for HV and 170KV p for LV winding. Results should be indicated in separate sheet with Oscillograms output should be enclosed.	
7	**Tests on load tap changers** - The testing of OLTC should be done as per clause 16.9.1 of IS:2026 part-I. After the tap changer is assembled on the transformer, the following tests should be performed at 100% of rated auxiliary supply voltage. (i) Eight complete operating cycles with transformer not energized. (ii) One complete operating cycle with transformer not energized with 85% of rated auxiliary supply voltage. (iii) One complete operating cycle with the transformer energized at rated voltage and frequency at no load loss. (iv) Ten tap change operations with +/- two steps on either side of the normal tap with as far as possible rated current of the transformer with one winding short circuited.	
(B)	**Addl Routine Tests:**	
1	**Dimensional checks as per approved drawings & specifications** – All dimensions as per approved drawing should be checked.	
2	Magnetic circuit test. After assembly ,core shall be tested for	

	1 minute for 2000 volts AC between all bolts, side plates & structures steel works		
3	Tank oil leakage test – the complete transformer assly filled with oil shall be subjected to nitrogen pressure of 0.35 Kg/cm2 above the normal oil head for a period of 12 Hrs to ensure that there is no oil leakage.		
4	Capacitance and tan delta measurement to determine capacitance between wingding and earth. This test should be carried out before and after series of dielectric tests.		
5	Test on bushings: All tests on bushings including capacitance, creepage distance & tan delta measurement as per IS		
6	Checking of recording of		
(A)	IR values		
	(a) Between core & coil frame		
	(b) Between core & tank		
	(c) Between coil frame & main tank The measured IR values should be more than 1000 M Ohms.		
(B)	Measurement & recording of currents with application of 400V 3 phase AC supply on HV side & LV side shorted		
	(a) Between core & coil frame		
	(b) Between core & tank		
	(c) Between coil frame & main tank		
7	Magnetizing current measured with LT supply (before and after HV tests)		
	Particulars	With three/single phase supply	
		Volts	Amp
8	Magnetic balance test (before and after HV tests)		
9	Tests of PRDs for successful operation		
10	Oil BDV test before & after HV tests		
11	Frequency Response Analysis (FRA)		

TYPE AND SPECIAL TESTS
(TO BE PERFORMED ON ONE UNIT OUT OF THE LOT)

The following type tests shall be performed:

(i) Temperature rise tests as per clause-4 of IS: 2026 part-II. – The temperature rise of oil & winding should not be more than the limits specified in the tender specifications.

(ii) Tank vacuum tests:
One transformer tank out of the whole lot shall be subjected to the specified vacuum. The tank designed for full vacuum shall be tested at an internal pressure of 3.33 KN/m 2 absolute (25 torr) for one hour. The permanent deflection of flat plate after the vacuum has been releases shall not exceed the values specified below.

Horizontal length of flat plate (in mm)	Permanent Deflection (in mm)
Up to and including 750 751 to 1250	5.0 6.5
1251 to 1750	8.0
1751 to 2000	9.5
2001 to 2250	11.0
2251 to 2500	12.5
2501 to 3000	16.0
Above 3000	19.0

(iii) Tank Pressure Test
Transformer tank together with its radiator, conservator, vessel and other fittings shall be subjected to a pressure corresponding to twice the normal head of oil or to the normal pressure plus 35 KN/m 2 whichever is lower, measured at the base of the tank and maintained for one hour. The permanent deflection of flat plates after the excess pressure has been released after conducting vacuum test should not be more than the values specified above.

(iv) Measurement of zero sequence reactance as per clause 16.10 of IS:2026 part-I.

(v) Measurement of acoustic noise level as per clause 16.12 of IS:2026 part-I.

(v) Measurement of harmonics of the no load current as per clause 16.13 IS:2026 part-I.

(v) Measurement of power taken by the fans as per clause 16.14 of IS:2026 part-I.

(vii) Lightning impulse tests with chop on tail as per clause 14 of the IE:60076. The sequence to be followed for routine lightning impulse tests and chopped lightning impulse tests for this particular unit shall be as mentioned here under:
One reduced level full impulse;
One full level full impulse;
One or more reduced level chopped impulse(s);
Two full level chopped impulses;
Two full level full impulses.

(viii) One cooler cabinet and one OLTC cabinet of the transformer shall be tested for IP:55 protection in accordance with IS:2147. This test may be conducted either at manufacturer's works or any other Govt. approved laboratory.

Sequence of tests

The sequence of routine tests, type tests, special tests (whenever applicable) and routine tests required to be conducted on the transformer is as mentioned hereunder:

Sl.No.	DESCRIPTION
1	Dimensional checks as per approved drawings & specifications
2	Pressure relief device test.
3	Degree of protection IP 55 for OLTC & cooling control cabinets.
4	Magnetic circuit insulation test 2 KV- 1 Min. core to Yoke clamp, core to fixing plate, core bolt to Yoke.

Sl.No.	DESCRIPTION
5	Checking of IR values (a) Between core & coil frame (b) Between core & tank (c) Between coil frame & main tank The measured IR values should be more than 1000 M Ohms.
6	Magnetic balance test at normal and extreme taps.
7	Magnetizing current measured with LT supply (both single phase and three phase)
8	Voltage ratio at all taps & polarity/phase displacement at normal tap.
9	IR value at 15, 60, 600 sec (before & after HV & Heat Run tests). PI value should not be less than 2
10	Capacitance and tan delta (before & after HV & TR tests) at 5 KV & 10 KV, LV + TANK, HV + LV to TANK under grounded, ungrounded and guarded specimen modes.
11	Winding resistance measurement at all taps.
12	Oil DGA test (before and after HV & TR tests)
13	Oil BDV test (before and after HV & TR tests)
14	No load loss and current (before & after HV & TR Routine Tests) at 90%, 100% and 110% of rated voltage with 3Watt meter, 3A and 3V meters methods.
15	Separate source voltage withstand test
16	Induced over voltage withstand test
17	Harmonic analysis of no load current at 90%, 100%, 110% of rated voltage
18	Zero sequence impedance test at 10%, 20%, 60%, 80%, 100% of test current at extreme taps and normal taps.
19	Impulse test as per specifications on all phases.
20	Load loss at extreme taps & normal tap & impedance all taps by digital power analyser.
21	Temperature rise test at ONAN & ONAF ratings & quoted max. losses.
22	Measurement of power consumption by fans
23	Max. static head of oil measured at the base for 12 hrs.
24	Tests on OLTC: Circuit insulation test 2 KV- 1Min.
25	Operations tests: 8 Cy, 1 Cy at 85% V 1 Cy at no-load and Rated V, 10 Cy + / - 2 steps from normal tap and rated current.
26	Cooler control test: Circuit insulation test 2 KV- 1 Min.Operation test.
27	Bushing current transformer ratio & polarity tests.
28	Acoustic noise level test.
29	Frequency Response Analysis (FRA)
30	Tests of PRDs for successful operation

5. TECHNICAL SPECIFICATION FOR 220 KV CIRCUIT BREAKERS

1.0 **SCOPE**:

This specification covers design, engineering, manufacture, assembly, inspection & testing before supply, packing & delivery of 245 KV class outdoor SF_6 Normal Duty/Single pole reclosing , circuit breakers along with support structures, terminal connectors, all accessories and auxiliary equipments required for their satisfactory operation in various EHV grid substations of Chhattisgarh State.

1.1 It is not the intent to specify completely here all the details of design and construction of the circuit breakers. However the, breaker shall conform in all respects to the high standard of engineering design and workmanship and shall be capable of performing in continuous operation up to the Bidder's guarantee in a manner acceptable to the owner who will interpret the meanings of drawings and specifications and shall have power to reject any **work or material** which in his judgment is not in accordance therewith. The circuit breakers offered shall be complete with all components necessary for their effective and trouble free operation up to the end of guarantee period, to the entire satisfaction of purchaser or his representative. Such components shall deemed to be included within the scope of supply of the Bidder irrespective of whether these are specifically brought out in this specification and/or in the commercial order or not.

2.0 **STANDARDS :**

2.1 The offered circuit breakers shall conform to meet the requirement of the latest revisions of relevant standards of international Electro-Technical commission or equivalent national standards of the country with amendments of relevant standards, rules and codes, available at the time of testing at the manufacturer's work. Some of the standards & codes are listed herein for ready reference.

2.2 Equipment meeting with the requirements of any other authoritative standards, which ensures equal or better quality than the standard mentioned below shall also be acceptable. If the equipment offered by the Bidder conforms to any other standards, salient points of comparison between the standards adopted and the specific standards shall be clearly brought out in relevant schedule of technical deviation.

Copies of such standards with authentic English Translations shall be furnished along with the offer.

SN.	STANDARD	TITLE
1.	IEC-56/ IS-13118	Specification for alternating current circuit breakers.
2.	IEC-376	Specification and acceptance of new supply of sulphur hexafluoride
3.	IS-375	Marking and arrangement for switchgear, busbar, main connections & auxiliary wirings.
4.	IS-2147	Degree of protection provided for enclosures for low voltage switchgear and control gear.
5.	IS-325	Specification for three phase induction motors.
6.	IS-2629	Recommended practice for hot dip galvanizing of iron and steel.
7.	IS-5	Color for ready mix paints.
8.	IS-2099	High voltage porcelain bushings.
9.	IS:5561	Electric Power connectors.

3.0 SERVICE CONDITIONS:

3.1 Climatic Conditions:

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

i)	Location	Outdoor
ii)	Max. ambient air temperature (˚C)	50 ˚C

iii)	Min. ambient air temperature (°C)	1 °C
iv)	Average daily ambient air temperature	30 °C
v)	Max. Relative Humidity (%)	95%(sometimes approaches saturation)
vi)	Max. altitude above mean sea level (meters)	1000 m
vii)	Average annul rainfall	1250 mm
viii)	Max. wind Pressure	150 kg/m^2
ix)	Seismic level (Horizontal acceleration.)	0.3

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

3.2 AUXILIARY POWER SUPPLY:

3.3 Auxiliary electrical equipment shall be suitable for operation on the following supply system:-

a.	Power device (like dry motor)	400 V 3 - ϕ , 4 wire 50 Hz, neutral grounded A.C. supply
b.	D.C. alarm, control and protective device	220 D.C., 2 wire substation wise exact details shall be furnished to the successful bidder.

Each of the foregoing supplies shall be made available by the Owner at the terminal point for each circuit breaker for operation of accessories and auxiliary equipment. Bidder's scope include supply of interconnecting cables, terminal boxes etc. The supply voltage may vary as shown below and all devices shall be suitable for continuous operation over entire range of voltage variations :-

S.No.	Type of Supply	Range Variation
1	AC supply voltage	+10% to (-) 25%
2	AC supply frequency	frequency (±) 5%
3	D.C. Supply	(-)15% to +10%.

4.0 **TYPE & RATING:**

The offered circuit breakers shall be of Sulphur Hexa-Fluoride (SF6) gas type suitable for outdoor operation under all climatic conditions specified above without any additional protection from the sun, dust and rain.

As far as 220 KV network of CG system is concerned, studies carried out show that system stability is ensured with total fault clearing time of 80 milli seconds which also includes a small margin for the relay operating time over the guaranteed performance to allow for fault locations under varying system conditions. The purchaser has come to the conclusion that the circuit breaker shall have a total break time not exceeding 50 milli seconds for the range of fault levels likely to be experienced in the CG system. It is therefore desired that total break time of any 245 kV class breaker shall not exceed 50 milli seconds (not more than 2.5 cycles) which should be guaranteed for interrupting ratings from 30% to 100% of the specified interrupting capacity.

5.0 **PRINCIPAL PARAMETERS:**

The breakers shall conform to the specific technical requirements specified hereunder:

SNo	Items	Requirement of 245 KV SF_6 Circuit Breaker
1.	Nominal System Voltage	220 KV
2.	Highest System Voltage	245 KV
3.	Rated Frequency	50 Hz.

4.	Rated Normal Current (A_{rms}) At 50°C Ambient Temperature	2000 Amperes
5.	Type	Outdoor SF_6
6.	Mounting Structural Details	Hot dip galvanised lattice steel support structure to be supplied by the bidder for all breakers. One platform with suitable steps should be provided of such a height that operator can easily operate the breaker climbing this platform.
7.	System Neutral Earthing	Effectively earthed
8.	Number of Poles	3
9.	Type of Operation (i) For transformers (ii) For Feeders	 (i) Normal Duty (Mechanically gang operated) (ii) Suitable for single pole reclosing.
10.	Phase to phase spacing in the switch yard i.e. interpole spacing for breaker (mm) SPR Duty/ ND	4500mm(SPR)/2300 m.m.(ND)
11.	Required ground clearance from the lowest live terminal to structure base place to be erected on Concrete Plinth in m.m.	5500 m.m
12.	Height of Concrete Plinth to be provided by the purchaser	300 m.m.
13.	Operating Mechanism	Spring operated by electrical & mechanical control individually for each breaker with anti pumping & trip free facility.
14.	Auto Reclosing Duty (i) For feeders (ii) For transformers	 (i) Single phase - SPR duty (ii) Three phase
15.	Rated Operating Sequence	0-0.3 sec CO -3 min-CO
16.	"First Pole to Clear" Factor (Type of Tripping)	1.3 Trip free
17.	Maximum closing time not exceeding in millisecond	150
18.	Maximum Total Break Time (For any Current Up to the rated breaking current) at limiting conditions of operating coil Voltage & Quenching Media Pressure in Milliseconds	50
19.	a. Rated insulating level 1.2/ 50 Micro Second Lightning impulse withstand Voltage : (Kvp) b. 250/ 2500 Micro Second Switching Impulse Withstand Voltage (Kvp)	1050 -
20.	1 Minute Power frequency withstand Voltage KV rms	460
21.	Maximum Radio Interference Voltage	1000 at 266 kVrms line to ground voltage (both in closed & open condition)

22.	Minimum corona extinction voltage (kVrms)	-
23.	Rated breaking current capacity i) Line charging at rated voltage at 90° Degree leading power factor (Arms) ii) Rated small inductive current iii) rated short circuit breaking current in KA a. A.C. Component b. % D.C. Component c. Asymmetrical breaking current including DC Component	 280 Amperes (rms) (this should be possible with temporary over voltage as high as 2.3 p.u. without re-strike. 0 - 10 without switching over voltage exceeding 2.3 p.u. 40 K.A. Corresponding to minimum opening time as per IEC -56. To be confirmed by the bidder in accordance with IEC 56.
24.	Transient recovery voltage for terminal fault	As per IEC 56-2, 1971 Clause no. 7.
25.	Rated characteristics for short line faults	As per IEC 56-2, 1971 Clause no. 8.
26.	Rated out of phase making current	Breaking 25% of the rated fault current of twice rated voltage under out of phase conditions as per IEC publication no. 267
27.	Reactor loaded transformer interrupting capacity	To be specified by the bidder.
28.	Rated short circuit making current capacity	100 KA
29.	Permissible limits of temperature rise	As per the table given under clause8.27
30.	Maximum acceptable difference in the instants of closing / opening of contacts i) within a pole (milli second) ii) between poles (milli second)	 5 10 The above timings will be at rated controlled voltage & rated operating & quenching media pressure.
31.	Total creepage distance of support insulator in m.m.	6,125 m.m.
32.	Type of tripping	The bidder should specifically mention whether the breaker is trip free or fixed trip according to IEC 56-1.
33.	Short time current carrying capacity for three seconds (kilo amperes) KA	50 KA.
34.	Breaking capacity of auxiliary contacts	10 A D.C. with the circuit time constant not less than 20 milli second.
35.	Noise level at base and upto 50 metres.	140 dB.
36.	Seismic acceleration	0.3 g (horizontal)
NOTE :**-With ref. to point No.-18 above, at 220V DC operating voltage the current in tripping coil of breaker should not exceed 6Amp at the time of tripping of breaker. The tripping coilresistance may be designed accordingly**.		

6.0 **SPECIAL DUTY REQUIREMENT :-**

6.1 DUTY CYCLES :

a. Terminal faults (C-1 min-O-CO-2 min-C-1 min-O-CO)

b. Reclosing against trapped charge: Same but with first, third and fourth closing being on de-energised line and second closing against trapped charge of 1.2 p.u. of opposite polarity.

c. Out of phase closing one closing operation under phase opposition i.e. with twice the normal voltage across the terminals.
The bidder shall highlight the design features provided to effectively deal with the followings Charging of long lines open at other end.

d) Auto reclosing of line i.e. closing the breaker on trapped charge.
Details of gears, linkage etc., involved in ensuring the required time of insertion of resistor shall be indicated.
Damping resistors when provided shall be of ceramic type hermetically sealed in porcelain bushings.

6.2 TRANSFORMER/ REACTOR CHARGING CURRENT BREAKING CAPACITY:
The offered 245 kV class circuit breakers shall be capable of interrupting small inductive current, such as those occurring while switching off unloaded transformers of rating 500 MVA, for 220 KV breakers with/ without reactor/capacitor loaded transformers under all conditions, including those of high dynamic or temporary over voltages without giving rise to undue over voltage and without restrikes. The maximum over voltage value which will not be exceeded under such conditions shall also be stated in the bid.

6.3 SHUNT CAPACITOR SWITCHING CAPACITY:
The maximum rating of 3 phase single bank of shunt capacitors which can be switched safely by 220 KV circuit breakers without restriking shall be stated in the bid along with over voltage occurring during such switching. It should be confirmed that offered breakers will safely switch 3 Phase shunt capacitor single bank of 80 MVAR rating minimum.

6.4 DYNAMIC OVER VOLTAGES:
The circuit breaker shall be capable of satisfactorily performing all their duties including, but not limited to, clearing of faults and interrupting the line charging and transformer charging currents without causing undue over voltage and showing signs of undue strain while operating under conditions of high temporary (Power frequency) over voltage of the order of 1.5 p.u.
The stability of circuit breakers for working satisfactorily under such conditions should be explicitly guaranteed by the bidder and it should be supported with clear technical elaborations and details in the bid.

6.5. PROTECTION SCHEMES:
Two independent trip coils shall be provided on the breakers for segregation of two main relaying schemes. The local breaker back-up protection is also being provided and the breaker shall be suitable for its operation. Two separate DC sources shall be available one for each trip coil.

6.6. DEVELOPING FAULTS:
The circuit breakers shall be capable to withstand the high stresses imposed on them during fault clearing, developing faults, load rejection and re-energisation of line, with trapped charges within the full rating of the breaker. The breaker shall also withstand the voltage specified in clause "Principal Parameters of this specification"

6.7 TRIP FREE OPERATION:

The circuit breakers mechanism shall be suitable for trip-free operation.

6.8 SMALL FAULT-CURRENT INTERRUPTING CAPACITY:

The circuit breakers shall be capable of interrupting Small fault Currents of magnitude between 0.5 KA to 10 KA along with the usual short circuit current interrupting capacity in the range of 2 KA to 50 KA without causing any restrikes or causing un-permissible over-voltage on the system in which these are to be installed. The over-voltage shall not exceed 2.3 pu.

The test certificates in support of this capacity of circuit breaker must be submitted along with the bid.

6.9 RECOVERY VOLTAGE AND POWER FACTOR:

Each circuit breaker shall be capable of interrupting rated short circuit breaking current under the condition of recovery voltage corresponding to highest system voltage and to power factor not exceeding 0.15.

6.10 The circuit breakers shall be capable of satisfactory operation even under conditions of phase opposition that may arise due to faulty synchronising or otherwise. The maximum power in accordance with relevant IEC Specification which the circuit breaker can satisfactorily interrupt under-phase opposition shall be stated in the bid.

6.11 RESTRIKING VOLTAGE:

The rated transient recovery voltage for terminal faults shall be as already specified in clause No. 5 "Principal Parameters". The measures adopted for ensuring proper operation at high rate of rise of restriking voltage and for limiting the actual values across the breakers shall be described in the tender. No opening resistors shall be necessary for ensuring conformity with the duty cycle.

6.12 LINE CHARGING CURRENT INTERRUPTING CAPACITY

Circuit breaker shall be designed so as to be capable of interrupting line charging currents as given in clause no. 5.0 "Principal Parameters" of this specification under the conditions of high dynamic over voltages of the order of 1.5 pu without showing signs of undue strain. The successful bidder shall have to carry out adequate acceptance tests with proper representation of actual system conditions, including correct simultation of natural frequency of bus bars so as to properly reproduce the initial part of the recovery voltage, to prove the charging current interrupting capability of the breaker. The bidder shall furnish in the bid complete details of procedure in respect of this acceptance test. The bid found deficient in respect of requirements as mentioned in this clause may be rejected.

The guaranteed over voltage, if any, which will not be exceeded while interrupting line charging current as given in clause '5' "Principal parameters" shall be stated in the tender.

"' The over voltage caused while interrupting the line charging current shall not exceed the limits of switching surges and dynamic over voltages as given here in above at clause 6.1 & 6.4. The result of the test conducted along with copies of the oscillographs to prove the capability of the circuit breakers to interrupt these and lower line charging current values shall be furnished along with the tender."

6.13. INSULATING SUPPORTS

The basic impulse insulation level of the external insulator supports bushing & interrupting insulator bushing shall match with that of the SF_6 circuit breakers and shall be specified and suitable for insulation in the contaminated atmosphere. Insulating supports shall be designed to have ample insulation and adequate mechanical strength and rigidity for satisfactory operation under various operating conditions detailed in this specification.

All hollow insulator & interrupter housing of identical rating shall be interchangeable. The puncture strength of the hollow insulator & interrupter housing shall be greater than the flash over value.

6.14. BREAKING CAPACITY FOR KILOMETRIC FAULTS:

All circuit breakers shall have high capacity for breaking short line (kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified. The interrupting capacity of the circuit breakers for kilometric faults (short line faults) should be equal to its interrupting capacity and shall be stated in the bid. The details of tests conducted to guarantee the capability of the circuit breaker operation under kilometric fault condition shall be furnished in the bid.

6.15 AUTOMATIC RAPID RECLOSING:

220 KV circuit breakers shall be suitable for single pole automatic rapid reclosing as per requirement.

'The dead time corresponding to automatic rapid reclosing of the circuit breakers shall be adjustable at least within limits of 15 cycles (0.3 sec) to 35 cycles and actual limits of adjustment provided in the offered circuit breaker shall be stated in the bid. The relay or timer required for adjustment of the dead time shall form a part of the scope of supply. The breaking capacity of the circuit breakers shall be guaranteed for second and third interruptions.

6.16 TEMPERATURE RISE:

The temperature rise and the maximum temperature attained by any part of the equipment when in service at site under continuous full load conditions and exposed continuously to the direct rays of the sun shall not exceed the permissible limits as per limits given. The permissible temperature rise indicated is for a maximum ambient temperature of 50° deg. centigrade. If the maximum ambient temperature is higher, the temperature rise permissible limit shall be reduced accordingly.

6.18. INSULATION OF CIRCUIT BREAKERS:

The insulation to ground, insulation between open contacts and the insulation between phases of the completely assembled circuit breaker (including closing resistors etc.,) shall be capable of withstanding satisfactorily dielectric test voltage corresponding to the stipulations made in para 5 of "Principal parameters". The exposed live parts shall be placed high enough above ground to meet the requirements of local safety codes.

7.0 ADDITIONAL REQUIREMENTS:

a) The circuit breakers shall be single pressure type, the design and construction of the circuit beaker shall be such that there is minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF_6 gas on the internal insulating surface of the circuit breaker.

b) All gasketed surfaces shall be smooth, straight and reinforced, if necessary to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF_6 media) shall have adequate seals, Double"O" ring seals and test holes for leakage test of the internal seal shall be provided on each static joint.

c) In the interrupter assembly there shall be an absorbing product box to eliminate SF_6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be fully compatible with SF_6 gas.

d) Each pole shall form an enclosure filled with SF_6 gas independent of two other poles. The SF_6 gas density of each pole in 220 KV Circuit breaker shall be monitored and regulated by individual pressure switches which are required for SPR duty.

e) The SF_6 gas density monitor shall be adequately temperature compensated. The density monitor shall meet the following requirements:

   i) It shall be possible to dismantle the density monitor for checking/ replacement without draining the SF_6 gas by using suitable interlocked non-return couplings.

   ii) It shall damp the pressure pulsation while filling the gas in service so that the flickering of the pressure switch contacts does not take place.

iii) Air & gas pressure indicator shall also be supplied. The pressure indicator shall have uniform graduated dial.

f) Means for pressure relief shall be provided in the gas chamber of circuit breaker to avoid the damages or distortion during occurrence of abnormal pressure increase or shock waves generated by internal electric fault / arcs. The position of vents, diaphragms and pressure relief devices shall be arranged so as to minimize danger to the operators in the event of gas or vapour escaping under pressure.

g) Facility shall also be provided to reduce the gas pressure within the breaker to a value not exceeding 8 milli-bars within 4 hours or less. Each circuit breaker shall be capable of withstanding this degree of vacuum without distortion or failure of any part.

h) Sufficient SF_6 gas shall be provided to fill all the circuit breakers installed. In addition to this 20% of the total gas requirement shall be supplied in separate cylinders as spare requirement. This quantity of gas should be inclusive in the quoted rates of Breakers.

i) In addition to the gas required for first filling, spare cylinder of 20 kg capacity (one per breaker) has been asked in price schedule for which separate rates should be quoted.

j) Provisions shall be made for attaching an operation analyser after installation at site to record contact travel, speed and making measurement of operation timings, pre-insertion timing of closing resistor, synchronisation of contacts in one pole.

k) Portable SF_6 gas leakage detector to be supplied along with each SF_6 breaker.

8.0 GENERAL TECHNICAL REQUIREMENTS:

8.1 Circuit breaker offered shall be Sulphur hexa-flouride (SF_6) type only suitable for outdoor installation. Circuit breaker shall be designed to withstand seismic acceleration equivalent to 0.3g. If construction of the breaker is of wheel mounted type suitable locking clamps shall be provided designed to sustain above seismic acceleration.

8.2 Exposed live parts shall be placed high enough above ground to meet the requirement of local safety codes.

8.3 Any part of the breaker, especially the removable ones, shall be freely inter-changeable without the necessity of any modification at site.

8.4 Circuit-breaker shall comprise of three identical single pole units which should be linked together electrically. Each breaker pole shall have, its associated mechanism box. Common operating shaft for all the three poles is not acceptable for 220 KV class circuit breakers.

8.5 Complete circuit breaker with all the necessary items for successful operation shall be supplied, including but not limited to the following:

8.5.1 Breaker assemblies with bases, support -structure for circuit breaker as well as for control cabinet, central control cabinet and foundation bolts for main structure as well as control cabinet and central control cabinet (except concrete foundations), terminals and operating mechanisms.

8.5.2 Compressed SF_6 gas, pneumatic systems complete including compressors, tanks, pipings, fittings, valves and controls and necessary supports for interpole pipings for pneumatic systems.

8.5.3 One central control cabinet for each breaker and one control box for each pole with all the required electrical devices mounted therein and the necessary terminal blocks for termination of inter-pole wiring. The necessary intepole cables shall be in the scope of supplier and cabling at site shall be done by the Owner based on the schematic wiring diagram and termination schedule to be supplied by the Bidder.

8.5.4 Instruments, gauges and leakage detector for SF_6 gas pressures pneumatic pressure supervision.

8.5.5 All necessary parts to provide a complete and operatable circuit breaker installation such as main equipment, terminal connectors, control parts, cable connectors, pipe lines and other devices, whether specifically called for herein or not.

8.5.6 Circuit breaker shall be suitable for hot line washing.

8.5.7 All breakers shall be supplied with terminal connectors. Details of terminal connector required with each circuit breaker is enclosed and the bidders are required to confirm that the offered prices, are inclusive of terminal connectors.

8.8 The current density adopted for the design of the terminal pads shall in no case exceed the following values. For copper pads 1.6 A/sq.mm. and others - 1.0 A/sq. mm.

8.9 CONTACTS:

8.9.1 Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise which may cause pitting or welding. Contacts shall be adjustable to allow for wear, easily replaceable and shall have a minimum of moveable parts and adjustments to accomplish these results.

8.9.2 All making and breaking contacts shall be sealed free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacements due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

8.9.3 Main contacts shall be first to open and the last to close so that there will be little contact burning and wear.

8.9.4 If arcing contacts are used they shall be first to close and the last to open. These shall be easily accessible for inspection and replacement. If there are no separately mounted arcing contacts the main contacts shall be easily accessible for inspection and replacements. Tips of arcing contacts and main contacts shall be silver plated or have tungsten alloy tips.

8.9.5 Any device provided for voltage grading to damp oscillations or to prevent re-strike prior to the complete interruption of the circuit or to limit over voltages on closing shall have a life expectancy comparable to that of the breaker as a whole.

8.9.6 Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life or the material used. The temperature shall not exceed that indicated in IEC-56 under specified ambient conditions.

8.9.7 Contacts shall be kept permanently under pressure of SF_6 gas. The gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage continuously at zero gauge pressure of SF_6 gas due to its leakage.

8.9.8 If multi-break interrupters are used these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished along with the bid. The thermal and voltage withstands of the grading elements shall be adequate for the service conditions and duty specified.

8.10 PORCELAIN HOUSING:

8.10.1. The porcelain housing shall be of single piece construction without any joint or coupling, it shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect high, mechanical, and dielectric strength and shall be thoroughly vitrified, tough and impervious to moisture.

8.10.2. Glazing of porcelain shall be uniform brown or dark brown colour, free from blisters, burns and similar other defects with a smooth surface arranged to shed away rain water or, condensed water particles (fog).

8.10.3. Housings shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation for the conditions under which they will be used. All housings of identical ratings shall be interchangeable.

8.10.4. Puncture strength of housings shall be greater than the dry flash-over value. When operating at normal rated voltage there shall be no electric discharge between the conductors and housing which would cause corrosion or injury to conductors, insulators or supports by the

formation of substance produced by chemical action. No radio disturbance shall be caused by the housing when operating at the normal rated voltage.

8.10.5. All iron parts shall be hot dip galvanized and all joints shall be air-tight. Surfaces of the joint shall be made burr free, porcelain parts by grinding and metal parts by machining. Bushing design shall be such as to ensure a uniform compressive pressure on the joints.

8.10.6 All current carrying contact surfaces shall be silver plated.

8.10.7. Bushings shall satisfactorily withstand the insulation level specified in the IEC Specification.

8.11 SULPHUR HEXA FLUORIDE GAS (SF_6 GAS)

a. The SF_6 gas shall comply with IEC 376, 376A &376 B and be suitable in all respects for use in the switch gear under the worst operating conditions,

b. The high pressure cylinders in which the SF_6 gas is shipped and stored at site shall comply with requirement of the following standards and regulations:
   i) IS : 4379 Identifications for the contents of industrial gas cylinder.
   ii) IS : 7311 Seamless high carbon steel cylinders for permanent and high pressure liquifiable gases.
   iii) The cylinders shall also meet Indian boiler regulations.

c. Test : SF_6 gas shall be shall be tested for purity, dew point, break down voltage, water contents as per IEC 376, 376A 7 376B and test certificates shall be furnished to owner indicating all the tests as per IEC 376 for each lot of SF_6 gas.

8.12 **AUXILIARY CONTACTS:-**

The auxiliary switches (contacts) required for satisfactory operation of the circuit breaker including automatic reclosing (single shot single and three phases) ON/ OFF indicators both in control room and switch yard semaphore indicators in the mimic diagram in the control room and anti pumping in the mimic diagram in the control room and anti pumping features shall be provided on each circuit breaker and shall be clearly indicated in the bid and all these auxiliary switches shall be included in the scope of supply. In addition to the auxiliary switches mentioned above, the bidder shall provide as spares 10 auxiliary contacts each of the "normally open" and "normally closed" types which shall be used to operate the closing or opening of each of the three poles of circuit breakers. These spare switches shall be utilised for safety interlocking and other monitoring devices by the purchaser. Special contacts for use with the trip coils and single shot reclosing operations which permit the relative adjustment with respect to the travel of the circuit breaker shall also be provided. All auxiliary switches shall be placed in a weather proof galvanised casing and current rating of the switches shall be mentioned in the bid. There shall be provision to add more auxiliary switches at a later date and to convert the "normally open" contacts to the "normally closed" type and vice versa.

Arrangement proposed for connecting control cables to the auxiliary switches shall be clearly stated. Provision shall be made for suitable cable glands for receiving control cable for terminating connections in the auxiliary switches.Auxiliary switch terminal contacts shall be of stud type suitable for ring type lugs.

8.13 TOTAL BREAK TIME:

8.13.1 The "Total Break Time" as specified in clause 5.0, "Principal Parameters" of this section shall not be exceeded under any of the following duties:

i) Test duties 1,2,3,4,5 (with TRV as per IEC)
ii) Short line fault L90, L75 (with TRV as per IEC-56).

8.13.2 The Bidder may please note that there is only one specified break time of the breaker which shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, (70-110%) and arc extinguishing medium pressure etc. while furnishing the proof for the total break time of complete circuit breaker, the Bidder may specifically bring out the effect of non-simultaneity between contracts within a pole or between poles and show how it is covered in the guaranteed total break time.

8.13.3 The values guaranteed shall be supported with the type test reports.

8.14 OPERATING MECHANISM AND ASSOCIATED EQUIPMENTS:

8.14.1 Each circuit breaker shall be designed for remote control from the control room in addition there shall be provision for local tripping & closing operations both by electrical control. Mechanical arrangement should also be provided to facilitate manual tripping of circuit breaker for emergency trip when DC is not available OR tripping coil is burnt OR trip lever mechanism becomes defective etc., under healthy arc quenching medium condition.

8.14.2 The operating mechanism shall be spring type, operated by electrical & mechanical control under every method of tripping/ closing. The mechanism shall be adequately designed & capable of performing satisfactorily the specified tripping and re-closing duty indicated above within the time specified. The entire operating mechanism control circuitry including electrical controls & monitoring devices and all other accessories, individual breaker compressor unit, pump, etc., as required, shall be housed in an outdoor type, hot dip galvanised steel enclosure. This enclosure shall conform to the degree of protection IP-55 of BIS 2147. The enclosure shall be invariably mounted on a separate concrete plinth of 300 mm height. However in case due to IP-55 protection limitations, if operating mechanism is mounted below the pole housing, in that case it should be possible for operating personnel to charge the spring from ground level including making ON/OFF operation without using any stool or plateform.

8.14.3 All working parts in the mechanism shall be of corrosion resistant material. All bearings which require greasing, shall be equipped with pressure grease fittings. Bearing pins, bolts, nuts and other parts shall be adequately pinned or blocked to prevent loosening or charging adjustment with repeated operation of the breaker.

8.14.4 The design of the operating mechanism shall be such that it shall be practically maintenance free. The guaranteed years of maintenance free operation, the number of full load and full rated short circuit current breaking/operation without requiring any maintenance or overhauling, shall be clearly stated in the bid. As far as possible the need for lubricating the operating mechanism shall be kept to the minimum and eliminated altogether if possible.

8.14.5 The operating mechanism shall be suitable for high speed single phase reclosing. It shall be non-pumping and trip free electrically and mechanically under every method of closing. A latch checking switch shall be provided on mechanically trip free mechanism to prevent reclosing before the breaker latches have reset. There shall be no objectionable rebounds in the mechanism and it shall not require any critical adjustments at site. It shall be string, rigid, positive and fast in operation. Mechanism shall be such that the failure of any auxiliary spring will not cause tripping or closing. Operation of the power operated closing device, when the circuit breaker is already closed, shall not cause damage to the circuit beaker or endanger the operator life. Provision shall be made for attaching an operation analyser similar to concinnatic operation analyser to facilitate speed test after installation of the breaker at site. ON-OFF indicating lamps shall be provided on the mechanism box.

8.14.6 A mechanical indicator shall be provided to show open and close position of the breaker in addition to facilitate remote electrical indication. An operation counter shall also be provided in the central control cabinet. The mechanical indicator and operation counter shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed.

8.14.7 Should the settings of the three breaker piles not be the same (e.g. failure of an operating or closing coil) all three poles shall trip simultaneously on appropriate electrical pneumatic command. An out of step relay shall be supplied with each breaker to give a remote trip discrepancy alarm.

8.14.8 Should the most unlikely situation occur in SF_6 breakers where there is a substantial pressure loss in a pole already open, the main interrupting chamber column should be blocked off (by a non return value) so that the main interrupting chambers remain pressurised and can retain their full insulating capacity for several more hours.

8.14.9 Circuit breaker operating mechanism shall incorporate an electrically achieved positive acting anti-pumping feature to prevent the circuit breaker from reclosing after an automatic opening when the initiating closing device is maintained in the position for closing. Necessary anti-pumping relay shall be included in the scope of supply.

8.14.10 The Bidder shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit beaker.

8.14.11 All material for making connection between the circuit breaker and its local control cabinet shall be included in the scope of supply.

8.14.12 All the similar contacts of 3 pole circuit breakers shall be designed to touch or open essentially simultaneously & in any case shall close or open within a period of half a cycle or less. The auxiliary circuit through resistors shall be closed in sufficient time before the main contacts closes to ensure that the over-voltage will be held to guaranteed value under most favorable sequence of contact closing.

8.15 MOTOR COMPRESSED SPRING CHARGING MECHANISM:

Spring operated mechanism shall be complete with motor, opening & closing spring with Visual indication for spring charged / discharged condition and all necessary accessories to make the mechanism a complete operating unit. Each mechanism shall be so designed as to enable a continuous sequence of circuit breaker opening and closing operations to be obtained by the control switch as long as power is available to the motor and at least one circuit breaker opening and closing after failure of power supply to the motor. Breaker operation shall be independent of the motor which shall be used solely for the purpose of compressing the closing spring. Motor rating shall be such that it required only about 30 seconds for fully charging the closing spring. Closing action of the circuit breaker shall compress the opening spring ready for tripping. Motors for spring charging mechanism shall operate satisfactorily at all supply voltages between 85% and 110% of the rated voltage. Spring charging motor shall be AC motor (Single or 3 phase 230/400 volts). DC Motors are not acceptable. The mechanism shall be capable of performing the rated operating duty cycle of 0-0.3 sec-CO-3 mins-CO as per IEC:56 and in the event of failure of power supply to spring charging motor, the mechanism shall be capable of performing one sequence of 0-0.3Sec-CO duty.

Facility shall be provided for manual charging of closing springs by operating personnel from ground level.

8.16 OPERATING MECHANISM HOUSING:-

The operating mechanism housing/ control cabinet shall conform to the requirement specified in clause 8.30.

8.17 CONTROL:

8.17.1 The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.

8.17.2 Each breaker pole shall be provided with the independent tripping circuits, valves and coils; each connected to a different set of protective relays. The trip coils circuit shall

be such that to facilitate trip circuit supervision in Pre & post closing the control panel of control room. The trip circuit supervision relay would be provided by the Owner. Necessary terminals shall be provided in the central control cabinet of the circuit breaker by the Bidder.

These two trip coils shall be arranged separately and electrically wired up to control cubicle with schematic connections such that healthiness of both trip coils individually could be checked in the control cubicle itself.

17.3 The breaker shall normally be operated by remote electrical control. The electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local / remote selector switch and close and trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided by the Owner in the control room panel.

8.17.4 A conveniently located manual mechanical tripping lever or push button shall also be provided for tripping the breaker and simultaneously opening the reclosing circuit.

8.17.5 Closing coil shall operate correctly at all values of voltage between 135% and 110% of the rated voltage of closing coil. Shunt trip coils shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of D.C. supply voltage between 70% and 110% of rated voltage. However, even at 50% of rated voltage, the breaker shall be able to perform all its duties. If

additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on outdoor circuit shall be clearly brought out in the additional information schedules. In the absence of adequate details the offer is likely to be rejected.

8.17.6 Suitable relay for monitoring of DC Supply voltage to the control cabinet shall be provided. The pressure switches used for interlock purposes shall have adequate contact ratings to be directly used in the closing and tripping circuits. In case the contacts are not adequately rated and multiplying relays are used then the interlock for closing/ opening operation of breaker shall be with NO logic of the relay i.e. if the DC supply to the interlock circuit fails operation lockout shall take place.

8.17.7 The auxiliary switch of the breaker be preferably positively driven by the breaker operating rod and where due to construction features, same is not possible a plug in device shall be provided to simulate the opening and closing operations of circuit breaker for the purpose of testing control circuits.

8.18 INTERLOCKS:

It is proposed to electrically interlock the circuit breaker with Owner's associated air break isolating switches in accordance with switchyard safety interlocking scheme. The details of the scheme will be furnished to the Successful Bidder. All accessories required on breaker side for satisfactory operation of the scheme shall be deemed to be included in the scope of supply of this specification.

8.19 SUPPORT STRUCTURE:

The price of support structure(Hot dip galvanized) & foundation bolts etc. should be included in the price of the circuit breakers. The support structure shall meet the following requirements:-

i) The minimum vertical clearance -from any energised metal part to the bottom of the circuit breaker (structure) base, where it rests on the foundation pads shall be 5.5 meters for 220 kV.

ii) The minimum clearance between the live parts and earth shall be 2.4 meters for 245 KV circuit breakers. In case the structures are not ordered, the supplier shall furnish drawings for fabrication of structure at site.

8.20 FITTINGS AND ACCESSORIES:

8.20.1 Following is a partial list of some of the major fittings and accessories to be furnished by Bidder as an integral part of equipment. Number and exact location of these parts shall be indicated in the bid.

a) Operating mechanism housing in accordance with clause no. 5.31 & shall be complete with

i) Padlocks and duplicating keys,
ii) trip coils/ closing coil,
iii) Space heater equipped with industrial grade switch.
iv) Cable glands.
v) Industrial grade receiptable type pin 15 Amps, power plug & socket with switch.
vi) Local/ remote changeover switch.
vii) Manually operated tripping Push button / lever (mechanical device conveniently located to trip all three phases simultaneously).
viii) Pistol grip circuit breaker control switch having trip /normal / close position.
ix) Terminal Boards.
x) Spring charged / discharged indicator.
xi) Operation counter.
xii) Facility for manual charging of spring.
xiii) Pneumatic pressure gauges.
xiv) Fuses/ MCBs as required for AC & DC supply.

xv) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 20% spare terminals for owner's use.
xvi) Manual charging spring operating handle for maintenance.
xvii) Auxiliary switch.
xviii) Mechanical ON & OFF Indicator.
xix) Cubicle lamp with cage & switch.
xx) Anti-pumping relay.

b) Set of 6 nos. gravity die cast terminal connector clamps.
c) Rating and diagram plate in accordance with IEC incorporating year of manufacture.
d) SF_6 gas leakage detector.
e) Additional fittings for pneumatically operated circuit breaker.
i) Damping resistors
ii) Unit compressed air system in accordance with clause no. 8.28.
iii) Breaker local air receivers / Tee connection with control valve to allow for emergency air supply.
iv) Pressure gauge spring loaded safety valve. Pressure switch with adjustable contacts and explosion vents, stop non return and other control valve) piping with ail accessories up to breaker mechanism housing.
iv) Pressure switch to initiate an alarm if the pressure in the aux. Reservoir remains below a preset level for longer than it is normally necessary to refill the reservoir.
v) Stop non-return and other control valves, pipings and all accessories up to breaker mechanism housing.

8.21 SURFACE FINISH, PAINTING GALVANIZING

8.21.1 All interiors and exteriors of tanks, mechanism, enclosures, cabinets and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulating oil, as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paint. Steel surfaces exposed to the weather shall be hot dip galvanised.

8.21.2 All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped or otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling. All external paintings shall be as per shade no. 697 of IS : 5.

8.21.3 All ferrous hardware exposed to atmosphere shall be hot dip galvanised.

8.22 GALVANISING

All ferrous parts & steel structure including all sizes of nuts, bolts plain and spring washers, support channels, structures, etc. shall be hot dip galvanised to conform to latest version of IS: 2629 or any other equivalent authoritative standard.

8.23 EARTHING:

The operating mechanism housing, cabinets, dead tanks, support structure etc shall be provided with two separate earthing terminals suitable for bolted connection to 50 x 8 mm MS flat to be provided by the owner for connection to station earth mat.

8.24 RATING AND NAME PLATE

Circuit breaker and its operating device shall be provided with a rating plate or plates marked with but not limited to following data:

a. Manufacturer's name or trade mark.
b. Serial number or type designation making it possible to get all the relevant information from the manufacturer.
c. Year of manufacture.

d. Rated nominal / highest voltage.
e. Rated insulation level.
f. Rated frequency.
g. Rated normal current.
h. Rated capacitive /inductive breaking current.
i. Rated short circuit breaking current.
j. First pole to clear factor.
k. Rated duration of short circuit.
l. Rated auxiliary D.C. supply voltage of closing and opening devices.
m. Rated pressure of compressed Air for operation and interruption.
n. Rated out of phase breaking current.
o. Rated AC supply voltage of auxiliary circuits.
p. Rated DC supply voltages of auxiliary circuits.
q. Mass of circuit breaker.
r. Owner's Purchase order number & date.

The rating plate shall be visible in position of normal service and installation. The rating plate shall be weather proof and corrosion proof.

8.25 LIMITS OF TEMPERATURE RISE:

The temperature rise and the maximum temperature attained on any part of equipment when in service at site under continuous full load conditions and exposed continuously to the direct rays of the sun, shall not exceed the maximum temperature rise specified below in the table. The permissible temperature rise indicated in the table is for a maximum ambient, temperature of 50ºC. If the maximum ambient temperature rises, permissible values shall be reduced accordingly.

S. No.	Nature of the Part or of the Liquid	Maximum values of	
		Temperature	temperature rise at a maximum ambient air temperature not exceeding 50°C
1	Contacts in Air Silver Faced Copper, Copper Alloys Or Aluminum Alloys (See Notes 1 &2) Bare Copper Or Tinned Aluminum Alloy.	105 75	55 25
2	Contacts In Oil Silver Faced Copper Alloy Or Aluminum Alloy (See Notes 2) Bare Copper Or Tinned Aluminum Alloys	90 80	40 30
3	Terminal to be connected to external Conductor by Screws Or Bolts, Silver Faced (See Notes 3)	105	55
4	Metal Parts Acting As Springs	See note IV	See note IV
5	Metal Parts in Contact with Insulation of following clauses :-		
	Class Y: For Non Impregnated Materials	90	40
	Class A: For Materials Immersed In Oil Or Impregnated	100	50
	Class "E" a. In Air b. In Oil	 120 100	 70 50
	Class "B" a. In Air b. In Oil	 130 100	 80 50

	Class "F" a. In Air b. In Oil	 155 100	 105 50
	Enamel : Oil Base a. Synthetic In Air b. Synthetic In Oil	100 120 100	50 70 50
6	Any Part of Metal Or of Insulating Material in contact with oil except contacts	100	50
7	Oil	90	40

Notes:

i) While applying the temperature rise of 55 deg. C, care should be taken to ensure that no damage is caused to the surrounding insulating materials.

ii) The quality of the silver facing stall be such that a layer of silver remains at the points of contact after the mechanical endurance test. Otherwise, the contacts shall be regarded as "bare".

iii) The values of temperature and temperature rise are valid whether or not the conductor connected to the terminals is silver-faced.

iv) The temperature shall not reach a value where the elasticity of the material is impaired. For pure copper, this implies a temperature limit of 75° deg.C.

8.26.1 CONTROL AND CONTROL EQUIPMENT:

a) Duplicate incoming supply of 415 V, AC shall be provided by the Owner, at switch yard motor control centre.

b) All control equipments shall be housed in a totally enclosed sheet steel cabinet, Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet.

8.26.2 ISOLATING SWITCHES:

The incoming power supply isolating switch, operating handle shall be interlocked with the control cabinet door so as to prevent opening of door when main switch is closed. Device for by-passing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

8.26.3 FUSES:

All fuses shall be of the HRC cartridge type, conforming to IS : 2208 and suitable for mounting on plug-in type of fuse bases. Fuses shall be provided with visible operation indicators to show that they have operated. All accessible live connections shall be adequately shrouded, and it shall be possible to change fuses with the circuit alive, without danger of contact with live conductor. Insulated fuses pulling handle shall be supplied with each control cabinet.

8.27 **TERMINAL CONNECTORS:**

8.27.1 Terminal clamp for 220 KV Circuit breakers shall be suitable for twin zebra ACSR conductors. Clamps shall be designed adequately to take care of any bimetallic effect.

a) CB terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL.

b) The clamp shall have two parts. The part connecting CB stud shall be of copper and that connecting conductor shall be of Aluminium.No part of a clamp shall be less than 12mm thick. Minimum conductor coverage on the clamp shall be 100mm. Minimum bushing terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

c) GI nuts, bolts and washers shall be used. Nuts and bolts shall have hexagonal head with threads as per IS and shall be fully threaded type. Also instead of spring washers check/lock nuts shall be provided.

d) The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor. The terminal connector of 33 KV side shall be suitable for twin Zebra conductors

Clamps shall be designed adequately to take care of any bimetallic effect. The temperature at the clamp shall not exceed 80° deg. C. The bushing side of connector shall be of copper and conductor side shall be of aluminium.

The terminal connectors shall also meet the following requirements:

i) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc
ii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
iii) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.
iv) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be provided.

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

The temperature at the clamp shall not exceed 80° deg. C. Corona rings shall be provided at the breaker terminals to control the radio interference. Two numbers grounding terminals for connection with station earth mat shall be provided on each circuit breaker. Size of the earthing pad shall be suitable for 50 x 8 or 60 x 8 M.S. flat.

8.27.2 The terminal connectors shall be designed to be corona free in accordance with the requirements stipulated in IS : 5561.

8.27.3 Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The terminal connectors should be manufactured by gravity die-casting process only.

8.28 SPECIFICATION FOR CONTROL CABINETS:

1. Control cabinets shall be of the free standing floor mounting type.
2. Operating mechanism and all accessories shall be enclosed in weather & vermin proof mechanism cabinet of hot dip galvanised sheet steel construction. The thickness of which shall not be less than 3 mm intended for outdoor operation. Control cabinets shall be provided with a hinged door. The door hinges shall be of union Joint type and giving access to the mechanism at the front and sides shall be properly braced to prevent wobbling. Suitable gasket shall be provided to make the mechanism housing water proof and dust proof. The housing latch shall accommodate padlock requiring a 12 mm dia hole. Padlock and duplicate keys shall be furnished by the bidder.
3. Equipment and devices shall be suitable for operation on a 400 V, 3 phase 4 wire 50 Hz A.C. system or single phase 230 volts 2 wire systems. The frequency can vary between 95% to 105% of normal frequency of 50 Hz and voltage from 110% to 75% of normal value.
4. Bus bar shall be of tinned copper of adequate cross-section to carry the normal current, without exceeding the permissible temperature rise over an ambient temperature of 50 deg. C outside the cubicle. The buses shall be braced to withstand forces corresponding to short circuit current of 25 kA
5. Motors rated 1 kW and above being controlled from the control cabinet would be suitable for operation on a 400 V, 3 phase 50 Hz system. Fractional kW motors would be suitable for operation on a 230 V, 1 phase, 50 Hz supply system.
6. Isolating switches shall be group operated units (3 pole for use on 3-phase supply systems and 2 pole for single phase supply systems) quick make quick break type, capable of Breaking safely and without deterioration, the rated current of the associated circuit. Control cabinet door shall be interlocked with the operating handle of the switch so as to prevent opening of the door when the switch is closed. A device for bypassing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

7. Fuses shall be HRC cartridge link type having prospective current rating of not less than 46 kA (r.m.s.). They shall be provided with visible operation indicators to show when they have operated. One fuse pulling handle shall be supplied for every ten fuses or a part thereof.
8. Push button shall be rated for not less than 6 Amps, 400 V A.C. or 2 Amps, 220V D.C. and shall be flush mounted on the cabinet door and provided with appropriate name plates. Red, Green and Amber indicating lamps shall be flush mounted and provided with series resistors to eliminate the possibility of short circuiting of control supply in the event of fusing of lamps.
9. For motors up to 5 kW, contactors shall be direct-on-line, air break single throw type and shall be suitable for making and breaking the stalled current of the associated motor which shall be assumed equal to 6.5 times the full load current of the motor at 0.2 p.f. For motors above 5 kW, automatic star delta type starters shall be provided. 3 pole contactors shall be furnished for 3 phase motors and 2-pole contactors for single phase motors. Reversing contactors shall be provided with electrical interlocks between forward and reverse contractors. If possible mechanical interlock shall also be provided. contactors shall be suitable for uninterrupted duty and shall be of duty category class AC4 as defined in IS : 2959. The main contacts of the contactors shall be Silver plated and the insulation class for the coils shall be class E or better. The dropout voltage of the contactors shall not exceed 70% of the rated voltage.
10. Contactors shall be provided with a three element Positive acting, ambient Temperature compensated, time lagged, hand reset type thermal overload relay with adjustable setting. hand reset button shall be flush with the front door of the cabinet and suitable for resetting with starter compartment door closed, Relays shall be either direct connected or CT operated depending on the rated motor current.
11. Single phasing preventing relays provided for 3 phase motors to provide positive protection against single phasing.
12. Mini starters shall be provided with no volt coils whenever required.
13. Owner's power cables will be of 1100/650 volts grade stranded aluminium conductor. PVC insulated, PVC sheathed single steel wire armoured and PVC jacketed. All necessary cable terminating accessories such as glands, crimp type tinned copper lugs etc. for power as well as control cables shall be included in Bidder's scope of supply. Requisite number of suitable brass cables glands shall be provided for cable entry at the bottom of the operating cabinet to receive purchaser's Control cables. Number & size of cable glands will be intimated to the successful tenderers. These shall be mounted in accessible position and floor level so joints can be made easily. Cable glands shall be double compression type.
14. Separate terminal blocks shall be provided in the mechanism housing for terminating circuits of various voltage classes. Terminals for DC & AC shall be provided separately and isolated from each other. CT loads shall be terminated on a separate block and shall have provision for short circuiting the CT secondary terminals. Terminals for the control & other circuits shall be suitable for accommodating 3 mm stranded conductor cable leads. A minimum of six spare terminals for control wiring shall be provided. The housing shall be complete with all the necessary wiring in the housing.
15. Wiring for all control circuits shall be carried out with 1100/ 650 volts grade PVC insulated tinned copper stranded conductors of sizes not smaller than 2.5 m.m. at least 20% spare terminal blocks for control wire terminations shall be provided on each panel. The terminal blocks shall be ELMEX type or equivalent. All terminals shall be provided with ferrules indelibly marked or numbered and these identifications shall correspond to the designations on the relevant wiring diagrams. The terminals shall be rated for adequate capacity which shall not be less than 10 Amperes.
16 Control cabinet shall be provided with 230 V, 1 phase 50 Hz, 20 W fluorescent light fixture and a suitably rated 230V, 1 phase, 5 amps, 3 pin socket for hand lamps. Suitably rated switches shall be provided to enable the control supply to the breaker to be cut off from the mechanism housing.

17. Suitable strip heaters shall be provided inside each cabinet with thermostat to prevent moisture condensation. Heaters shall be controlled by suitably rated industrial switch unit with fuse shall be provided. Heater shall be suitable for 230 volts AC supply unless otherwise specified.
18. Signal lamps provided shall be of neon screw type with series resistors, enclosed in bakelite body. Each signal lamp shall be provided with a fuse integrally mounted in the lamp body.
19. Items inside the cabinet made of organic material shall be coated with a fungus resistant varnish.
20. All doors, panels removable covers and breaker openings shall be gasketed all around. All louvers shall have screen and filters. Cabinet shall be dust, moisture and vermin proof.

8.29 MOTORS:

8.29.1 Motors shall be "squirrel cage" three phase induction motors or self starting single phase motor of sufficient size capable of satisfactory operation for the applications and duty as required for driven equipment.

8.29.2 Stator Frame: The stator frame and all external parts of the motor shall be rigid, fabricated steel or of casting. They shall be suitably annealed to eliminate any residual stresses introduced during the process of fabrication and machining.

i) Stator Core: The stator laminations shall be made from suitable grade magnetic sheet steel varnished on both sides. They shall be pressed and clamped adequately to reduce the core and teeth vibrations to minimum.

ii) Insulation and Winding:

a. All insulated winding conductor shall be of copper. The overall motor winding insulation shall be conventional class B type. The winding shall be suitable for successful operation in hot, humid and tropical climate with the ambient temperature of 50 deg. C. The insulation shall be given fungicidal and tropical treatment as per IS: 3202.

b. Any joints in the motor insulation such as at coil connections or between slot and winding section shall have strength equivalent to that of slot section of the coil.

c. For 400 Volt motors, after the coils are placed in slots and all connections are made, entire motor assembly shall be impregnated by completely submerging core and winding in suitable insulating compound or varnish followed by proper baking. At least two additional submersions and bakes shall be applied either making a total of at least three submersions and bake treatment.

8.29.3 Rotor:

a. Rotors shall be adequately designed to avoid overheating during the starting and running conditions.

b. Rotors shall be properly balanced so as to keep the vibration under running condition within the limits.

c. Rotors of induction motors shall be of rigid core construction with bars firmly secured and solidly bonded to the end rings. The end rings assembly shall be such that it is free to move with expansion of the bars without distortion. The connection of the bars to the end ring shall be made by brazing or fusion welding.

d. Rotors shall be so designed as to keep the combined critical speed with the driven equipment away from the running speed by at least 20%.

e. Rotors shall also be designed to withstand 120% of the rated speed for 2 minutes in either direction of rotation..

f. All high speed rotors shall be constructed with provision of rebalancing the rotor on its site position without major dis-assembly.

8.29.4 Bearings:

a. Depending upon the capacity and loading conditions, the supplier shall design suitable grease lubricated or oil lubricated bearings.

b. Greased ball and roller bearing when used shall be of reputed make subject to purchaser's approval. The minimum standard life of the bearing shall not be less than 30,000 working hours taking all motor and driven loads into account these shall be pressure grease gun lubricated type fitted with grease nipples and shall have grease relief devices.

c. Bearing shall be so constructed that the loss of grease and its creeping along with shaft into motor housing is prevented. It shall also prevent dirt and water from getting into the motor.

d. Unless otherwise approved bearing lubrication system shall be such that no external forced oil or water is necessary to maintain the required oil supply or to keep bearing temperature within permissible limits.

e. For oil lubricated bearings drain plugs shall be provided for draining any residual oil when required.

8.29.5. Enclosures:

a) Motors to be installed outdoor shall have hose proof enclosure equivalent to IP-55 as per IS : 4691. For motors to be installed indoor, the enclosure shall be dust proof to IP-54 as per IS : 4691.

b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.

c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.

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

8.29.6. Cooling Method:

Motors shall be of self ventilated type having TEFC (totally enclosed fan cooled) enclosure.

8.29.7. Rating Plate:

The rating plate shall conform to the requirements of IEC incorporating the year of manufacture.

8.29.8 Operational Features:

a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be overloaded at any operating point of driven equipment that will arise in service.

b) Motors shall be capable of giving rated output without reduction in expected life span when operated continuously in the system having the particulars as given in principal parameters.

8.29.9. Starting Requirements.

a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed along with the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 85% of the rated voltage.

b) Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS : 325.

d) Motors, when started with the driven equipment imposing full starting torque under the supply voltage conditions; specified under clause 8.31.9 (a) above, shall be capable of withstanding at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the supplier shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

9.0 **TESTS & TEST REPORTS**

9.1. All the equipment offered, shall be fully type tested as per the relevant standards. In case the equipment of the type and design offered has already been type tested, the supplier shall furnish two sets of the type test reports along with the offer. For any change in the design/ type already type tested and the design/ type offered against this specification the purchaser reserves the right to demand repetition of tests without any extra cost. In case the equipment has not been type tested earlier, all the type tests as per relevant standards shall be carried out by the successful supplier in the presence of purchaser's representative without any extra cost.

9.2. The test reports of the type tests and the following additional type tests shall also be submitted for Purchaser's review:

i) Corona extinction voltage test.
ii) Out of phase closing test as per IEC:62271-100.
iii) Line charging breaking current for proving parameters.
iv) Test to demonstrate the Power Frequency withstand capability of breaker in open condition at Zero Gauge pressure and at lockout pressure.
v) Seismic withstand test in unpressurised condition.
vi) Verification of the degree of protection.
vii) Low & high temperature test.(if applicable)
viii) Humidity test.(if applicable)
ix) Static Terminal Load test.
x) Critical Currents test (if applicable).
xi) Switching of Shunt Reactors.

9.3 **Routine Tests**

Routine tests as per IEC : 62271-100 shall be performed on all circuit breakers.
In addition to the mechanical and electrical tests specified by IEC, the following tests shall also be performed.

1) Speed curves for each breaker shall be obtained with the help of a suitable operation analyser to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic/hydraulic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at

   site for which the necessary operation analyser along with necessary transducers, cables, console, etc. where included in scope of supply shall be furnished and utilised. In case of substations where operation analyser is existing the bidder shall utilise the same. However necessary adopter and transducers etc. if required shall have to be supplied by the bidder.
2) Measurement of Dynamic Contact resistance measurement for arcing &main contacts. Signature of Dynamic contact resistance measurements shall be taken as reference for comparing the same during operation and maintenance in order to ascertain the healthiness of contacts.

9.4 **Site Tests:**

All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site.

10.0 INSPECTION:

10.1 The purchaser reserves the right to insist for witnessing the acceptance/ routine testing of the bought out items.

10.2 No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested

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

11.0 DOCUMENTATION

11.1 All drawings shall conform to International Standards Organisation (ISO) 'A' series of drawing sheet/ Indian Standards Specification IS.-656. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

11.2 List of Drawings and Documents :
The supplier shall furnish sets of relevant descriptive and illustrative published literature pamphlets and the following drawings for preliminary study alongwith the offer.

a) General outline drawings showing dimensions and shipping weights, quantity of insulating media, air receiver capacity etc.,
b) Sectional views the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts with lifting dimensions for maintenance.
c) All drawings & data typical and recommended schematic diagram for control supervision & reclosing
d) Drawings & details of terminal connectors.
e) Structural drawing, design calculations and loading data for support structures.
f) General arrangement of foundation structure mounting plan including weights of various components and impact loading data for foundation design.
g) Type test reports of short circuit withstand capability of 3 sec including oscillogram & relevant certificate of similar type tested breaker.

11.3 The successful supplier after receipt of purchase order shall within 10 days of placement of order submit four sets of final version of all the above drawings for purchaser's approval. The purchaser shall communicate his comments/ approval on the drawings to the supplier within reasonable period. The supplier shall, if necessary, modify the drawings and resubmit four copies of the modified drawings for purchaser's approval within two weeks from the date of comments. After receipt of purchaser's approval, the supplier shall, within three weeks, submit 4 prints per breaker and two good quality reproducible of the approved drawings for purchaser's use.

11.4 The successful supplier shall also furnish adequate copies of bound manuals covering erection, commissioning, operation and maintenance instructions and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices of 3 sets per breaker. Marked erection drawings shall identify the component parts of the equipment as shipped to enable purchaser to carry out erection with his own personnel. Each manual shall also contain one set of all the approved drawings, type test reports as well as acceptance reports of the corresponding consignment dispatched.

11.5 The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser, all manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the supplier's risk.

11.6 Approval of drawings/ work by the purchaser shall not relieve the supplier of any of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirements of the latest revision of the applicable standards, rules and codes of practices. The equipment shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of supply and

purchaser shall have power to reject any work or materials which in his judgement is not in full accordance therewith.

11.7 Additional data to be furnished along with offer:

A comprehensive spare parts catalogue listing all component parts with their item wise unit prices shall be furnished.

a. Drawing, showing contacts in close, arc initiation, full arcing, arc extinction and open position.

b. The temperature v/s pressure curves for each setting of density monitor, along with details of density monitor.

c. Method of checking the healthiness of voltage distribution devices, condensers provided across the breakers at site.

d. Data on capabilities of circuits breakers in terms of time and number of operations at duties ranging from 100% fault currents to load current of the lowest possible values without requiring any maintenance orchecks.

e. The effect of non-simultaneity between contacts within a pole or between poles and also how it is covered in the guaranteed total break time.

f. Sectional view of non return couplings used for SF_6 pipes.

g. Details and type of filters used in interrupter assembly and also the operating experience with such filters (for SF_6 C.B.)

h. Details of SF_6 gas:

i) The test methods used in controlling the quality of gas used in the Circuit beakers particularly purity and moisture content

ii) Proposed, tests to assess the conditions of SF_6 within acircuit breaker after a period of service particularly with regard to moisture contents of the gas.

iii) The precise procedure to be adopted by maintenance personnel, for handling equipment, who are exposed to the products of arcing in SF_6 gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, methods of disposal of circuit breaker cleaning utensils and other relevant matters.

i) A complete catalogue on operation analyser satisfying all the requirements stipulated in this specification.

j) The supplier shall furnish along with the bid, curves supported by the test data indicating the opening time under close open operation with combined variation of trip coil voltage and pneumatic/ pressure.

k) Detailed literature and schematic diagrams of switching mechanism for closing resistor showing the duration of insertion shall also be furnished along with the calculations in respect of thermal rating of resistors for the duties.

l) All duty requirements shall be proved with the support of adequate test reports to be furnished along with the bid failing which the bid is likely to be rejected.

m) Field test reports in case of C.B. meant for Reactor switching duty.

11.8 TEST REPORTS:

i) Two copies of type test reports shall be furnished to the purchaser within one month of conducting the tests.

ii) Two copies of acceptance test reports shall be furnished to the purchaser. The material shall be despatched only after approval of test reports.

iii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.

iv) All test reports of test conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

12. PACKING AND FORWARDING:

Bidder shall ensure that all equipments covered by this specification prepared for ocean shipment (foreign equipment) or rail /road transport (local equipment). Equipment shall be packed in suitable crates in such a manner to protect it from damage and withstand handling during transit. The supplier shall be responsible for and make good at his own expense any or all damage to the equipment during transit due to improper and inadequate packing and handling. The easily damageable materials shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost.

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

1. Name of the consignee,
2. Details of consignment.
3. Destination.
4. Total weight of consignment.
5. Sign showing upper / lower side of the crate.
6. Handling and unpacking instructions.
7. Bill of material indicating contents at each package and spare material.
8. The supplier shall ensure that the packing list and bill of material are approved by the purchaser before despatch.

13. SUPERVISION OF ERECTION & COMMISSIONING:

Erection and commissioning of the breakers shall be supervised by the supplier's engineers, if required by the purchaser. For the supervision of erection and commissioning the bidder shall quote the charges of the supervising and commissioning Engineers. Actual assembly and erection of circuit breakers shall be done by skilled and semi skilled workers of the purchaser. However, these works shall arrange assembly and erection under the supervision of erection foreman of the supplier. Charges for the services of erector / foreman shall also be stated.

14 **SPARE PARTS AND MANDATORY MAINTENANCE EQUIPMENT:**

The rates of the breakers should be quoted including mandatory spare parts and maintenance equipments i.e. gas filling adopters, tool sets required for erection & maintenance etc.

6. TECHNICAL SPECIFICATION FOR 220 KV CT

(*Note:- 220 KV CT shall be provided by CSPTCL*.)

1 Scope:

This specification covers the design, manufacture, and assembly, testing at manufacturer's works, supply and delivery of 220 KV outdoor, single-phase current transformers for solidly grounded system.

1.1 Type & rating:

The instrument transformers for 220 KV solidly grounded system shall be of outdoor type, oil cooled, single phase, 50 cycles, self cooled and suitable for operating in humid atmosphere and in the tropical sun with ambient temperatures upto 50° degree C. The equipment should be suitable for use in areas subjected to heavy lightening storms.
The principal parameters of the CTs shall be as given below.

PRINCIPAL TECHNICAL PARAMETERS OF 220KV CURRENT TRANSFORMERS

Sl.No.	Particulars	220KV CT 1600-800/1-1-1-1-1-1A
1	Type	Single phase, dead tank, oil filled Hermetically sealed /outdoor type
2	Type of mounting	Pedestal Type
3	Suitable for system Frequency	50 Hz
4	Highest System voltage	245(kV rms)
5	(a) No. of cores	6
	(b) Ratio	1600-800/1-1-1-1-1-1 Amp.
6	Accuracy class & related VA burden	Core - I,II, III & IV-PS Core - V & VI – 0.2S/15VA
7	Ratio taps	On secondary side
8	Method of earthing the system	Effectively earthed
9	Rated continuous thermal current (A)/ for CT	120%
10	Rated voltage factor for PT	N.A.
11	Acceptable partial discharge level at 1.2/ 3 times the rated voltage	5 pico-coulmbs Max.
12	Max. radio interference voltage at 1.1 times the rated voltage	Less than 500 micro volts
13	1.2/50 microsecond lightning impulse withstand voltage (kVp)	1050
14	1 minute dry power frequency withstand requirement for secondary winding (kV rms) for 1 second.	460
15	Power frequency overvoltage withstand requirement for secondary winding (kV rms) for 1 second	3 KV
16	Min. creepage distance of porcelain housing (mm)	6125
17	Rated short time withstand current for 1 second duration (kA rms)	40
18	Rated dynamic withstand current (kAp)	100
19	Visual corona extinction voltage (KV Rms)	156
20	Min knee point voltage at lowest (kV rms) Ratio in volts (Core I,II,III & V)	30x(RCT+36)
21	Max. magnetizing current at Guaranteed KPV at the lowest ratio(mA)	100
22	Seismic acceleration	0.3g
23	a. Grade of Oil b. Minimum quantity of oil	EHV Gr.I as per IS:355 minimum 15% of total weight of CT

24	Secondary resistance of CTs	1 Ohm per100 Amp. Primary current
25	Flux density at knee point voltage for CTs	1.4 Tesla
26	Flux density at rated voltage Factor of 1.5	NA
27	Number of primary turns	4(Max) (Only for dead tank CTs)
28	Current density in primary winding at rated primary current	Maximum 1.5 A/sq.mm
29	Dieelectric dissipation factor (Tan delta) at 1/ √3 rated voltage & ambient temperature (10 deg C. to 40 deg C.)	Max 0.005
31	Oil quantity	minimum 15% of total weight of CT
32	Temperature rise of primary winding with permissible overlaoding	Should be 5 deg less than prescribed in ISS
33	Instruments security factor for metering core	≤5
34	Instruments security factor for 5 P core	≤ 10
35	Base mounting of CT	4 nos.holes for 5/8 " bolt 400 mm apart
36	CT Sealing arrangement	Bottom tank of the CT shall be provided with 2 Nos. bolt diagonally with holes for sealing arrangement.
37	Punching of Serial number	Serial Number of the CT shall be punched on the Bottom tank
38	Base mounting of CT	Should be suitable for mounting on CSPTCL's structure. Drawing of structure is enclosed.
39	IR Value	>20000MΩ

Note: Primary and secondarywinding of all class CTs shall be of **Copper** only.

1.2 Special requirement for instrument transformers:

i) Maximum continuous over loading:

C.T.:- It should be specifically confirmed that CTs are suitable for continuous overloading of 20% of rated primary current. For this purpose, precaution taken in design of equipment may be suitably explained**.**

ii) Consistency of accuracy**:**

It should be specifically confirmed that with continuous overloading as given in above para, the ratio/phase angle errors of the CTs shall be maintained strictly within specified limits without any drift and no variation shall take place due to overloading condition.

1.3 **Standard:**

The instrument transformers shall comply with the latest issue of Indian Standard i.e. IS-2705, BS-3941 or IEC-60044.1 for CTs except where specified otherwise, equipments meeting any other authoritative standard which ensures an equal or better quality than the standard mentioned above, is also acceptable.

1.4 **Climatic conditions:**

Peak ambient temperature	50° Degree Celsius
Minimum temperature in shade	4° Deg. C.
Maximum relative humidity	95%
Average number of thunderstorm days per annum	40 days
Average number of rainy days per annum	90 days.
Average annual rainfall	125 cm.
Altitudes (not exceeding)	1000 mtrs.

Maximum wind pressure	150 kg/meter sq.

1.5 **Basic design for instrument transformers:**

The Instrument Transformers for solidly grounded system shall be outdoor type. Single-phase oil immersed and self cooled type suitable for services indicated as above complete in all respect, conforming to modern practices of design and manufacture.

As stated, all CTs shall be paper-insulated oil filled. After providing paper insulation they shall be housed in the tank containing oil. Please note epoxy casting in primary & secondary cores is not acceptable. Compound filled CTs are also not acceptable. Manufacturers should describe complete process of manufacturing.

1.5.1 The insulation as per IS:4800 of the instrument transformers shall be so designed that the internal insulation shall have higher electrical withstand capability than the external insulation. The designed dielectric withstands values of external and internal insulations shall be clearly brought out in the guaranteed technical particulars. The dielectric withstand values specified in this specification are meant for fully assembled instrument transformers.

1.5.2 The Instrument transformers should be designed using single Porcelain housing.

1.5.3 No joints shall be provided in the porcelain. The housing shall be made of homogeneous, vitreous porcelain of high mechanical and dielectric strength, glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface arranged to shed away rain water or condensed water particles, (fog). The profile of porcelain shall be aerodynamic type as per IEC-815. To make the instrument transformer leak proof a metallic flange should be cemented to the porcelain.

1.5.4 Details of attachment of metallic flanges to the porcelain shall be brought out in the offer.

1.5.5 Special precaution will have to be taken towards selection of material for the metal tank and the following will have to be ensured:

i) Material for metal tank should be minimum 3 mm thick.

ii) The material should be clearly mentioned against relevant clause of technical questionnaire.

iii) Welded joints have to be minimized to avoid possibility of oil leakage. In any case welding in horizontal plane shall be avoided.

1.5.6 Preventionof Oil leakages and Entry of Moisture:-

The sealing of CTs shall be properly achieved. The following should be properly taken care of & arrangement provided by the supplier shall be described:

i) Locations of emergence of primary and secondary terminals.

ii) Interface between porcelain housing and metal tank/s.

iii) Cover of the secondary terminal box.

1.5.7 For gasketed joints, wherever used, nitrite butyl rubber gaskets neoprene or any other improved material shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

You have to justify that the quality of gaskets which will be used between the joints and also for mounting of oil level indicator will be of best quality to avoid leakage of; oil. The quality of gasket should be selected keeping in mind that the ambient temperature in Chhattisgarh now touches 55 deg. centigrade.

1.5.8 During inspection each CTs will be subjected to pressure test at 0.7 kg /cm^2 for 8hrs.

1.5.9 The Instrument transformers shall be so constructed that it can be easily transported to site within the allowable transport limitation and in **horizontal position.**

1.5.10 For indication of oil level, suitable arrangement by way of clear glass window or any other superior arrangement shall be provided.

1.5.11 The CTs should be provided with pressure relief diaphragm.

1.5.12 The secondary terminals shall be brought out in a weather proof terminal box. Firstly the connections will be terminated on a internal board and then the same shall be brought out in the Secondary terminal box. The terminal box shall be provided with removable gland plate and gland/s suitable for 1100 volts grade, PVC insulated, PVC sheathed multi core 4 or 6 sq.mm for CT.

The terminal box shall be dust and vermin proof. Suitable arrangement shall be made for drying of air inside the secondary terminal box. The dimensions of the terminal box and its openings shall be adequate to enable easy access and working space with use of normal tools. The outer cover of secondary terminal box shall have provision for sealing by way of insertion of wire in the bolt hole. A drawing indicating above arrangement may please be furnished along with the offer.

1.5.13 Polarity shall be invariably marked on each primary & secondary terminals. All marking shall be engraved or through anodised plate to be fixed firmly.

1.5.14 The Instrument transformers shall be provided with a rating plate with dimensions and markings as per IS:2705. The markings shall be punched/engraved and not painted. This rating plate shall also contain our purchase order no. and date.

1.5.15 The instrument transformer shall be vacuum filled with oil after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Oil filling valve/or oil sampling cocks, if provided to facilitate factory processing, should be permanently sealed before despatching. The method adopted for hermetic sealing shall be either Stainless steel bellow or N-2 cushion only

1.5.16 The castings of base, collar etc. shall be die-cast and tested before assembly to detect cracks and voids if any.

1.5.17 The instrument security factor of metering core shall be low enough and not greater than 5. This shall be demonstrated on all the ratios of the metering core, in accordance with procedure specified in IEC-816 or IS:2705.

1.5.18 Instrument transformer shall be provided with two separate earthing terminal s for bolted connection to 50 x 8 mm MS flat to be provided by the Purchase for connection to station earth-mat.

1.5.19 Instrument transformer shall be provided with suitable lifting arrangement, to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. Lifting arrangement (lifting eye) shall be positioned in such a way as to avoid any damage to the porcelain housing or the tanks during lifting for installation/transport. Necessary string guides shall be offered which shall be of removable type.

1.6 Primary windings:

1.6.1 Primary winding shall be made out of electrolytic grade 99.9% conductivity copper. The primary winding shall be housed in rigid metallic shell. Joints in the primary winding shall not be provided.

1.6.2 It is desired that from the point of view of adequate mechanical strength in the normal course and also during short circuit, proper precaution should be taken as under:-

i) The primary winding should be housed in rigid metallic shell.

ii) The winding assembly should be held firmly and for this purpose suitable clamping arrangement at the bottom shall be provided and explained through suitable sketch. Firm clamping arrangement is a must and **holding of winding using nylon rope etc. shall not be acceptable.**

1.6.3 The primary winding current density shall not exceed 1.5 A/sq.mm. The design density for short circuit current as well as conductivity of the metal used for primary windings of CTs shall meet the requirement of IS:2705. The supplier in his offer shall submit the detailed calculation for selection of winding cross sections. The selected Amp turns for the CT shall be justified on the basis of Type test reports.

1.7 **Secondary windings:**

Suitably insulated copper wire of 99.9% conductivity electrolytic grade shall be used for secondary windings. The exciting current of the CTs shall be as low as possible. The magnetisation curve for all the cores of CTs should be submitted with the offer.

1.8 **Primary terminals:**

For various rating of CTs, selection of primary terminal only of copper material shall be made carefully. The primary terminal on either side of the tank shall be of not less than 80 mm length to accommodate terminal connector and ratio changing strip. For CTs the dia/size of the primary terminal shall be 30mm dia copper fully threaded.
The primary terminals shall be of heavily tinned electrolytic copper. The minimum thickness of tinning shall be 15 microns.

1.9 **Secondary terminals:**
Secondary terminal studs shall be provided with atleast three nuts and adequate plain and spring washers for fixing the leads. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum out side diameter of the studs shall be 8 mm. The length of at least 15 mm shall be available on the studs for inserting the leads. The horizontal spacing between centres of the adjacent studs shall be at least 1.5 times the outside circumdia of the nuts. The arrangement should be shown through suitable sketch.

1.10 **Core**:
The grade M4 toroidal core shall be of high-grade non-ageing electrical silicon laminated steel of low hysterics loss and high permeability to ensure high accuracy. The instrument transformer core to be used for metering shall be of accuracy class specified or appropriate class suitable for commercial and industrial metering.Enamel, if used for conductor insulation, shall be either polyvinyl acetate type or amide type and shall meet the requirements of IS:4800. Polyester enamel shall not be used.In case of CTs the saturation factor of the metering core shall be low enough not to cause any damage to measuring instruments in the event of maximum short circuit current. The 5 P 10 cores shall be designed for a minimum saturation factor of 10 for the highest setting. The magnetisation curves for this core shall be furnished with the tender. As far as PS class core is concerned all precautions shall be taken in design to achieve KPV as mentioned at S.No. 19 of Principal Parameters & magnetisation curve for the same shall be furnished.

1.11 **Insulation oil**:
The quantity of oil for first filling of oil in each transformer shall be in the scope of supplier. Only best quality new EHV Gr.I transformer oil should be filled in the equipments with BDV of 70 KV. The BDV of oil filled in the equipment will have to be recorded in the test certificate.

1.12 **Surface finish:**
The metal tanks & all the ferrous parts/hardware, exposed to atmosphere, shall be hot dip galvanised conforming to IS;2633. All other fixing nuts, bolts, washers shall be made out of stainless steel.

1.13 **Terminal connectors:**
Terminal connectors suitable for single ACSR Zebra conductor for CTs will be in two parts:-

(a) Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL.

(b) The clamp shall have two parts. The part connecting CT stud shall be of copper and that connecting conductor shall be of Aluminium.No part of a clamp shall be less than 12mm thick. Minimum conductor coverage on the clamp shall be 100mm. Minimum CT terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

c) GI nuts, bolts and washers shall be used. Nuts and bolts shall have hexagonal head with threads as per IS and shall be fully threaded type. Also instead of spring washers check/lock nuts shall be provided.

d) The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor. The terminal connector of 33 KV side shall be suitable for twin Zebra conductors

Terminal connector shall be suitable for Zebra ACSR conductors. Clamps shall be designed adequately to take care of any bimetallic effect. The temperature at the clamp shall not exceed 80° deg. C. The bushing side of connector shall be of copper and conductor side shall be of aluminium.

The terminal connectors shall also meet the following requirements:

i) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc.
ii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
iii) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.
iv) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be integral with aluminium body.

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

Temperature rise:

The current transformers shall be designed to limit the temperature of winding and other parts as specified in the standards, when corrected for the difference between the temperature prevailing at site and temperature as per item No. 32 of Principal parameters. The temperature rise at 1.25 times rated primary current as specified in Sl. No.(32) of Principal Parameters when applied continuously at rated frequency and at rated burden shall not exceed the limits specified above.

1.14 **Tests:**

(a) **Current Transformers**:- Type test reports from Govt. Lab./Govt. approved laboratory not conducted earlier than 5 years from date of Techno commercial bid opening should be furnished along with Techno Commercial bid. The type test reports to be submitted for 220KV CTs shall be as follows:-

(i) Short time current tests
(ii) Temperature rise test
(iii) Lightening impulse voltage test.
(iv) Wet test for outdoor type CTs (as per clause 7.4 IEC 44-1)
(v) Determination of errors

In addition to the above reports of following special tests as per IEC 44-1 on the CTs should also be submitted along with TC bid:-

(i) Chopped lightening impulse tests(as per clause 9.1 of IEC 44-1)
(ii) Measurement of capacitance & die electric dissipation (as per clause 9.2 of IEC 44-1)
(iii) Multiple chopped impulse tests on primary(as per annex B of IEC 44-1)
(iv) Mechanical tests (as per clause 9.3 of IEC 44-1)

It may please be noted that offers not incorporating the above test reports shall be liable for rejection.

(b) **Routine test:** The following routine tests shall be carried out on the CTs in presence of CSPTCL's officer:-

(i) Verification of terminal marking
(ii) Power frequency withstand test on primary and secondary winding
(iii) Partial discharge measurement (as per clause 8.2.2 of IEC 44-1)
(iv) Power frequency withstand tests between section (as per clause 8.3 of IEC 44-1)
(v) Inter turn voltage testas per clause 8.4 of IEC 44-1)
(vi) Determination of errors.

* * * * * * *

7. TECHNICAL SPECIFICATION FOR 220 KV PT

(*Note:- 220 KV PT shall be provided by CSPTCL.*)

1.0 Scope:

This specification covers the design, manufacture, assembly, testing at manufacturer's works, supply and delivery of 220 KV outdoor, single phase Potential Transformers for solidly grounded system.

Type & rating:

The current transformers for 220 KV solidly grounded system shall be of outdoor type, oil cooled, single phase, 50 cycles, self cooled and suitable for operating in humid atmosphere and in the tropical sun with ambient temperatures upto 55 degree C. The equipment should be suitable for use in areas subjected to heavy lightening storms.

The principal parameters of the PTs shall be as given below.

(a)PRINCIPAL PARAMETERS FOR 220 KV POTENTIAL TRANSFORMERS

S. N.	Particulars	220 KV P.T.
1.	Type	Single phase, out door type.
2.	Manufacturer's type/designation	Hermetically sealed, oil filled
3.	Rated primary voltage	$220/\sqrt{3}$ KV
4.	Number of secondary windings	Three
5.	Rated secondary voltage	
	i. Winding -I	$110/\sqrt{3}$ Volts
	ii. Winding -II	$110/\sqrt{3}$ Volts
	iii. Winding –III	$110/\sqrt{3}$ Volts
6.	Rated burden	
	i. Winding -I	100 VA
	ii. Winding -II	200 VA
	iii. Winding -III	200 VA
7.	Accuracy class	
	i. Winding -I (for metering)	0.2
	ii. Winding -II (for protection) (open delta connection)	3P
	iii. Winding -III (for protection)	3 P
8.	Max. ratio error with rated burden and 5% normal primary voltage	As per IS 3156 - 1992
9.	Max. phase angle error with rated burden and 5% normal primary voltage	As per IS 3156 - 1992
10.	Grade of oil	EHV Grade, as per IS.355
11.	Temperature rise at 1.2 times rated voltage with rated burden at 50 ^{0}C Ambient.	45 ^{0}C (Max.)
12.	Rated voltactor & time	1.20 / continuous, 1.5 / 30 seconds
13.	Temperature rise for 12 above	As per IS 3156
14.	One minute power frequency withstand test (dry) voltage	460 KV rms
15.	One minute power frequency	460 KV rms

S. N.	Particulars	220 KV P.T.
	withstand test (wet) voltage	
16.	1.2/50 micro second impulse wave withstand test voltage	1050 KV (peak)
17.	One minute power frequency withstand voltage on secondaries	3 KV
18.	Total creepage distance	6125 mm
19.	Surface treatment	Hot dip galvanised

Special requirement for Potential Transformers:

i) **Maximum continuous operating voltage:**

It should be specifically confirmed that PTs offered are suitable for continuous overloading of 20% of rated system voltage. For this purpose, precaution taken in design of equipment may be suitably explained**.**

For all the PTs which are to be designed for 25% continuous overvoltage the allowable temperature rise at 125% rated voltage shall be 5deg less than the permissible value as specified in the relevant IS.

ii) **Consistency of accuracy:**

It should be specifically confirmed that with 25% continuous overloading as given in above para, the ratio/phase angle errors of the PTs shall be maintained strictly within specified limits without any drift and no variation shall take place due to overloading condition.

Standard:

The instrument transformers shall comply with the latest issue of Indian Standard 3156, BS-3941 or IEC-186 except where specified otherwise, equipments meeting any other authoritative standard which ensures an equal or better quality than the standard mentioned above, is also acceptable.

Climatic conditions:

Peak ambient temperature	50° Degree Celsius
Minimum temperature in shade	4° Deg. C.
Maximum relative humidity	95%
Average number of thunderstorm days per annum	40 days
Average number of rainy days per annum	90 days.
Average annual rainfall	125 cm.
Altitudes (not exceeding)	1000 mtrs.
Maximum wind pressure	150 kg/meter sq.

Basic design for PTs:-

The PTs for solidly grounded system shall be outdoor., single phase oil immersed and self cooled type suitable for services indicated as above complete in all respect, conforming to modern practices of design and manufacture.

As stated, all PTs shall be paper insulated oil filled. After providing paper insulation they shall be housed in the tank containing oil. Please note epoxy casting in primary & secondary cores is not acceptable. Compound filled PTs are also not acceptable. Manufacturers should describe complete process of manufacturing.

1.6.1 The insulation as per IS:4800 of the instrument transformers shall be so designed that the internal insulation shall have higher electrical withstand capability than the external insulation. The designed dielectric withstand values of external and internal insulations shall be clearly brought out in the guaranteed technical particulars. The dielectric withstand values specified in this specification are meant for fully assembled instrument transformers.

1.6.2 The Instrument transformers should be designed using single Porcelain housing.

1.6.3 No joints shall be provided in the porcelain. The housing shall be made of homogeneous, vitreous porcelain of high mechanical and dielectric strength, glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface arranged to shed away rain water

or condensed water particles, (fog). The profile of porcelain shall be aerodynamic type as per IEC-815.

1.6.4 Details of attachment of metallic flanges to the porcelain shall be brought out in the offer.

1.6.5 Special precaution will have to be taken towards selection of material for the metal tank and the following will have to be ensured:

i) Material for metal tank should be minimum 3 mm thick.
ii) The material should be clearly mentioned against relevant clause of technical questionnaire.
iii) Welded joints have to be minimised to avoid possibility of oil leakage. In any case welding in horizontal plane shall be avoided.

1.7 Prevention of Oil leakages and Entry of Moisture**:-**

The sealing of PTs shall be properly achieved. The following should be properly taken care of & arrangement provided by the supplier shall be described:

i) Locations of emergence of primary and secondary terminals.
ii) Interface between porcelain housing and metal tank/s.
iii) Cover of the secondary terminal box.

1.7.1 For gasketed joints, wherever used, nitrite butyl rubber gaskets neoprene or any other improved material shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

The quality of gasket should be selected keeping in mind that the ambient temperature in Chhattisgarh now touches 55 deg. centigrade.

1.8 The Instrument transformers shall be so constructed that it can be easily transported to site within the allowable transport limitation and in horizontal position.

1.8.1 For indication of oil level, suitable arrangement by way of clear glass window or any other superior arrangement shall be provided.

1.8.2 The P.T. secondary terminals shall be brought out in a weather proof terminal box. Firstly the connections will be terminated on a internal board and then the same shall be brought out in the Secondary terminal box. The terminal box shall be provided with removable gland plate and gland/s suitable for 1100 volts grade, PVC insulated, PVC sheathed multicore 2.5 or 4 sq.mm stranded copper cable.

The terminal box shall be dust and vermin proof. Suitable arrangement shall be made for drying of air inside the secondary terminal box. The dimensions of the terminal box and its openings shall be adequate to enable easy access and working space with use of normal tools. The outer cover of secondary terminal box shall have provision for sealing by way of insertion of wire in the bolt hole. A drawing indicating above arrangement may please be furnished along with the offer.

1.8.3 Polarity shall be invariably marked on each primary & secondary terminal. Facility shall be provided against short circuiting & grounding of the PT secondary terminals inside the terminal box.All marking shall be engraved or through anodised plate to be fixed firmly.

1.8.4 The Potential transformers shall be provided with a rating plate with dimensions and markings as per IS:3156. The markings shall be punched/engraved and not painted. This rating plate shall also contain our purchase order no. and date.

1.8.5 The Potential transformer shall be vacuum filled with oil after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Oil filling valve/or oil sampling cocks, if provided to facilitate factory processing, should be permanently sealed before despatching.The method adopted for hermetic sealing shall be described in the offer.

1.8.6 The castings of base, collar etc. shall be diecast and tested before assembly to detect cracks and voids if any.

1.8.7 The instrument security factor of metering core shall be low enough and not greater than 5. This shall be demonstrated on all the ratios of the metering core, in accordance with procedure specified in IEC-816 or IS:3156.

1.8.8 Potential transformer shall be provided with two separate earthing terminals for bolted connection to 50 x 8 mm MS flat to be provided by the Purchase for connection to station earth-mat.

1.8.9 Potential transformer shall be provided with suitable lifting arrangement, to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. Lifting

arrangement (lifting eye) shall be positioned in such a way as to avoid any damage to the porcelain housing or the tanks during lifting for installation/transport. Necessary string guides shall be offered which shall be of removable type.

1.9 Primay windings:

1.9.1 Primary winding shall be made out of electrolytic grade 99.9% conductivity copper. The primary winding shall be housed in rigid metallic shell.Joints in the primary winding shall not be provided.

1.9.2 It is desired that from the point of view of adequate mechanical strength in the normal course and also during short circuit, proper precaution should be taken as under:-

(i) The primary winding should be housed in rigid metallic shell.

(ii) The winding assembly should be held firmly and for this purpose suitable clamping arrangement at the bottom shall be provided and explained through suitable sketch. Firm clamping arrangement is a must and holding of winding using nylon rope etc. shall not be acceptable.

(iii) All primaries of PTs will be connected in phase to neutral with neutral point solidly earthed. The neutral of the system is also solidly earthed.

1.10 Seondary windings:

Suitably insulated copper wire of 99.9% conductivity electrolytic grade shall be used for secondary windings. All PTs for wye or phase to ground connection shall be provided, with separate windings. The star winding to be used for metering & relaying shall be of accuracy class as specified for appropriate class. The rated burden oil the winding shall not be less than specified value.

1.11 **Primary terminals:**

Selection of primary terminal only of copper material shall be made carefully. The primary terminal on either side of the tank shall be of not less than 80 mm length to accommodate terminal connector and ratio changing strip.

1.12. **Secondary terminals:**

Secondary terminal studs shall be provided with atleast three nuts and adequate plain and spring washers for fixing the leads. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum out side diameter of the studs shall be 8 mm. The length of atleast 15 mm shall be available on the studs for inserting the leads. The horizontal spacing between centres of the adjacent studs shall be atleast 1.5 times the outside circumdia of the nuts. The arrangement should be shown through suitable sketch.

1.13 **Core:**

The grade M4 toroidal core shall be of high grade non-ageing electrical silicon laminated steel of low hysterics loss and high permeability to ensure high accuracy.

The Potential transformer core to be used for metering shall be of accuracy class specified or appropriate class suitable for commercial and industrial metering.

1.14 Enamel, if used for conductor insulation, shall be either polyvinyl acetate type or amide type and shall meet the requirements of IS:4800. Polyester enamel shall not be used.

1.15 **Insulation oil:**

The quantity of oil for first filling of oil in each transformer shall be in the scope of supplier. Only best quality new EHV Gr.I transformer oil should be filled in the equipments with BDV of 70 KV. The BDV of oil filled in the equipment will have to be recorded in the test certificate.

1.16 **Surface finish:**

The metal tanks shall be coated with atleast two coats of zinc rich epoxy painting. All the ferrous parts/hardware, exposed to atmosphere, shall be hot dip galvanised conforming to IS;2633. All other fixing nuts, bolts, washers shall be made out of stainless steel.

1.17 **Terminal connectors:**

Terminal connectors shall be suitable for single ACSR Zebra conductor for all PTs The terminal connector suitable for horizontal take off and vertical take off (Universal type) shall be supplied. Suitable terminal for earthing connection shall also be supplied.

a) PT terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL.

b) i) The clamp shall have two parts. The part connecting PT stud shall be of copper and that connecting conductor shall be of Aluminium.No part of a clamp shall be less than 12mm thick. Minimum conductor coverage on the clamp shall be 100mm. Minimum PT terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

e) GI nuts, bolts and washers shall be used. Nuts and bolts shall have hexagonal head with threads as per IS and shall be fully threaded type. Also instead of spring washers check/lock nuts shall be provided.

f) The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor. The terminal connector of 33 KV side shall be suitable for twin Zebra conductors

Terminal connector shall be suitable for Zebra ACSR conductors. Clamps shall be designed adequately to take care of any bimetallic effect. The temperature at the clamp shall not exceed 80° deg. C. The bushing side of connector shall be of copper and conductor side shall be of aluminium.

The terminal connectors shall also meet the following requirements:

v) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc

vi) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

vii) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

viii)For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm.

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

1.18 **Tests & Inspection:**

Reports of all type tests as tipulated in latest version of IS:3156 (Part-I,II,III & IV) or IEC 086 shall be supplied along with the bids. This is essential. The tenderer must carefully go through our specification regarding short time current rating, impulse level and all type test reports as per IS should be furnished on demand.

Each instrument transformer shall be subjected to routine tests as specified in IS;3156, or IEC 186 in the presence of purchaser. All test report should be submitted and should be got approved by the purchaser before despatch of the equipments.

1.19 **Temparature rise:**

The potential transformers shall be designed to limit the temperature of winding and other parts as specified in the standards, when corrected for the difference between the temperature prevailing at site and temperature specified by the standards. The temperature rise at 1.25 times rated primary voltage when applied continuously at rated frequency and at rated burden shall not exceed 5 deg less than the limits prescribed in the ISS. This should be supported with relevant calculations.

* * * * * * *

8. TECHNICAL SPECIFICATION FOR 220 KV CVT

1. SCOPE:-

This specification covers the design, manufacture, and assembly, testing at manufacturer's works, supply and delivery of 220 KV outdoor, capacitive voltage transformers for solidly grounded system.

1.1 TECHNICAL SPECIFICATION CVT :-

1.2 TYPE & RATING: -

The 220 KV CVT for solidly grounded system shall be of outdoor type, oil cooled, single phase, 50 cycles, self cooled and suitable for operating in humid atmosphere and in the tropical sun with ambient temperatures up to 50 degree C.

These CVTs should be mechanically strong to withstand the stresses due to wind pressure of 150 Kg / Sq meter. The outer shell be wet processed porcelain with liberal creepage distance to prevent flashover under the most adverse tropical condition. The capacitive voltage transformer shall have three secondary winding detail of ratings are as given here under:-

S.No.	Particulars	220 KV CVT		
1.	Nominal system voltage	220 kV/ √3		
2.	Highest system voltage	245 kV / √3		
3.	Rated frequency	50 Hz		
4.	Earthing	Effective		
5.	No. of secondary windings	3 (Three)		
6.	Rated Transformation ratio	(220 kV/ √3) / (110V/√3)		
7.	Rated Burden	Wdg I	Wdg II	Wdg III
		100	100 VA	100 VA
8.	Accuracy Class	3P	3P	0.2
9.	Basic insulation level	1050 KV		
10.	Rated capacitance (pf)	4400 PF+ 10% - 5%		
11.	Creepage distance	Min 23mm / kV (Approx. 5700mm)		
12.	Frequency pass band	50 KHz – 500 KHz		

a) The 220 KV CVT shall incorporate potential devices suitable for connection to synchronizing equipments. The apparatus will include the synchronoscope, voltmeter, synchronizing lamps and the automatic synchronizer.

b) Each 220 KV CVT shall be suitable for connection directly to the line without the use of auxiliaries such as isolating switches or fuses. The capacitors of the unit shall be so designed that the application of impulse voltage shall not damage the internal working elements or cause a change in their electrostatic capacitance.

c) The primary and secondary capacitors shall preferably be housed in entirely sealed off and oil filled porcelain insulator to eliminate breathing and prevent air and moisture entering the assembly. Provision shall however be made to accommodate the expansion and contraction of oil. An oil level gauge and a pressure relief device capable of releasing abnormal internal pressure shall be provided.

d) The magnetic type intermediate transformer for CVT shall be of oil immersed and self cooled design and shall be suitable for metering, relaying and synchronizing services. The core of this transformer shall be of high grade, non-aging, cold rolled, laminated, electrical silicon steel of low hysteresis loss and of high permeability so as to ensure high accuracy at normal and high over voltages. The primary windings shall be connected through a compensating reactor between phase and neutral with the neutral point solidly grounded.

Suitable for use in areas subjected to heavy lightening storms.

1.3 STANDARDS:

The 220 kV Capacitive Voltage Transformers covered under this specification shall confirm to the requirements of the latest edition of relevant IEC/IS standard.

1.4 CLIMATIC CONDITIONS:-

The equipment offered shall operate satisfactorily under following climatic conditions: conditions:-

Peak ambient temperature	-	50ºC
Minimum temperature in shade	-	4ºC
Maximum relative humidity	-	95%
Average number of thunderstorm days per annum	-	40 days.
Average number of rainy day per annum	-	90 days.
Average annual rain fall	-	125 Cm.
Maximum wind pressures	-	150 kg/sq.mtr
Altitude not exceeding	-	1000 mtrs.

1.5 DAMPING DEVICES :-

A) Each CVT shall be provided with the suitable damping device so that ferro resonance oscillations due to saturation of iron core of transformer or of any inductance connected in parallel with it or initiated by any other condition shall disappear immediately and shall not affect the proper working of protective relays. The design of compensating reactor and the intermediate transformer as well as of the additional damping device inserted in the secondaries of the intermediate transformer shall be such that the phenomenon of ferro resonance can not occur.

B) The design of capacitor shall generally be based on the following requirements:

i) Comparatively low specific voltage between capacitor coils.
ii) Low dielectric loss over a wide frequency band.
iii) Low variation of capacitance due to change of temperature.
iv) Vary high natural frequency.
v) Corona free design to keep the noise level of carrier frequency link low.
vi) Low stray capacity to ground to reduce the carrier frequency energy losses in the neighborhood of carrier connection.
vii) High mechanical strength of porcelain and its fastenings to ensure that it is resistant against bending stresses which might occur due to wind pressure off 150 kg/ sq.mtr.

C) The design of potential unit of CVT shall be based on the following requirements in connection with protective relaying :-

i) They must transmit accurately sudden drop of primary voltage.
ii) The measuring errors on the three phases of a set of CVT should be matched in accuracy.
iii) The CVT must not enter in to sub-harmonic resonance and transient oscillations during energisation must be clamped out sufficiently rapidly.
iv) They must have sufficiently low short circuit impedance as seen from secondary.
v) They shall be suitable for rapid reclosing service.
vi) A transformer grounding switch which when closed shall remove voltage from the potential device to permit adjustment of the potential device without interrupting high voltage line operation and carrier current operation.
vii) A voltage arrestor connected across the capacitance potential device transformer unit to limit the voltage impressed on the transformer and the auxiliary or shunt capacitors used.

1.5.1 **BASE HOUSING** :-

The measuring or the secondary unit comprising of compensating reactor, intermediate transformer along with its accessories, damping impedances etc., shall be contained in a heavily hot dip galvanized steel enclosure which will also serve as a mounting base for the

capacitor stack and a housing for carrier accessories. Separate Earth switch shall be provided on the outer wall of base near cable box of CVT to earth the HF signal during removal of coupling device from the live line.

1.5.2 **TERMINAL CONNECTORS** :-

Terminal connectors shall be suitable for single ACSR Zebra conductor for all PTs The terminal connector suitable for horizontal take off and vertical take off (Universal type) shall be supplied. Suitable terminal for earthing connection shall also be supplied.

a) CVT terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL.

b) The clamp shall have two parts. The part connecting CVT stud shall be of copper and that connecting conductor shall be of Aluminium.No part of a clamp shall be less than 12mm thick. Minimum conductor coverage on the clamp shall be 100mm. Minimum CVT terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

c) GI nuts, bolts and washers shall be used. Nuts and bolts shall have hexagonal head with threads as per IS and shall be fully threaded type. Also instead of spring washers check/lock nuts shall be provided.

d) The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor. The terminal connector of 33 KV side shall be suitable for twin Zebra conductors

Terminal connector shall be suitable for Zebra ACSR conductors. Clamps shall be designed adequately to take care of any bimetallic effect. The temperature at the clamp shall not exceed 80° deg. C. The bushing side of connector shall be of copper and conductor side shall be of aluminium.

The terminal connectors shall also meet the following requirements:

i) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc

ii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

iii) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

iv) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm.

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

The secondary terminals of the potential device and the terminal for HF coupling as well as the earthing terminal shall be placed inside a water proof terminal cabinet outside the steel enclosure. This cabinet shall also be hot deep galvanized and shall have hinged door provided with locking arrangements. Cable boxes to receive HF cable and control cables shall be mounted on the bottom of this cabinet.

1.5.3 **MOUNTING** :-

Each 220 KV CVT shall be of self supporting type and shall be mounted on steel pedestal which shall be provided by us. However before manufacturing CVT, the drawing of CVT including the details of bottom unit shall be got approved by us. Data regarding minimum recommended phase to phase spacing between the 220 KV CVTs and the Clearance from the grounded objects required at various hights of CVTs shall be mentioned in the offer.

INSULATION OIL :-

The quantity of insulating oil for first filling of oil in each CVT and the complete specification of oil shall be stated in the tender. The oil shall be of EHV grade type meeting all requirements as per latest IS.

****

9. TECHNICAL SPECIFICATION FOR METAL OXIDE LIGHTNING ARRESTORS FOR 220 KV SYSTEM

1. SCOPE:

The specification covers Design, Manufacturing, Assembly, Testing at manufacturer's works, Supply and Delivery of Single Phase Outdoor 198 KV metal oxide type gap-less surge arrestors for 220 KV systems complete with discharge counters, insulating base, Grading ring and other accessories.

2. CLIMATIC CONDITIONS:-

i)	Peak Ambient Temperature	50° C
ii)	Minimum Temperature in Shade	1° C
iii)	Average Daily Ambient Temperature	30° C
iv)	Maximum Relative Humidity	100%
v)	Average number of Rainy days per annum	90 days
vi)	Maximum Wind Pressure	150 Kg/ Sq. Metre
vii)	Average Annual Rain fall	1250 mm
viii)	Altitude not exceeding	1000 M.
ix)	Seismic Level	0.3 g

3. SPECIAL CONDITIONS:-

The atmosphere at places is laden with dust in suspension during the dry months and subject to fog in cold months. The temperature variation between the daily minimum and maximum is large. Heavy lightning is usual in the area during the months from May to November. This area is also subjected to heavy monsoon rains 80% to 90% of the annual precipitation during the months of June to October.

4. SYSTEM CONDITIONS:-

S.No.	Particulars	
1.	Nominal System Voltage	220 KV
2.	Highest System Voltage	245 KV
3.	Frequency	50 Hz.
4.	Short Circuit Level (KA) for 3 Seconds	40 KA
5.	Anticipation Levels of Temporary Over voltage & its duration	
	a. Voltage	1.5 PU
	b. Duration (Cycles)	5 Cycles

Note:- 1 PU = [(V * Root 2) / (Root 3)] KVP Where V is the highest System voltage.

5. Our system is 3 phase 50 Hz, solidly grounded.

5.1 We will place one of the surge Arrestor at the entry of the each line (Feeder) in the sub-station and one Set nearer to each transformer.

5.2 The insulation level provided in our transformer is 950 kVp for 220 KV system respectively.

6. STANDARD:- The surge Arrestors shall strictly conform to IEC 99-4 in all respects & shall also conform to the latest editions of and amendments available at the time of supply of the Standards listed hereunder :-

S. No.	Standard reference No.	TITLE
1	IEC : 99-4	Specification For Metal Oxide Surge Arrestors Without Gap For AC Systems.
2	IS : 3070	Specification For Lightning Arrestors For AC System

	(Part-I & III)	
3	IS : 4759	Hot Dip Zinc Coating On Structural Steel And Allied Products
4	IS : 2633	Method For Testing Uniformity Of coating on Zinc Coated Articles.
5	IS : 5621	Specification For Large Hollow Porcelain For Use In Electrical Installations
6	IS : 2147	Degree Of Protection Provided By Enclosures For Low Voltage Switchgear & Control.
7.	-	Indian Electricity Rules – 1956
8.	IS : 5561	Specification for Electric Power Connector
9.	IS : 2629	Recommended Practice For Hot Dip Galvanisation of Iron & Steel

Notes:-

(a) For the purpose of this specification all Technical Terms used herein shall have the meaning as per IEC 99-4.

(b) For the parameters of the Arrestors which are not specified in IEC draft specification for Surge Arrestors, the provisions of IS : 3070 (Part – 3) shall be applicable.

c) The surge Arrestors meeting any other authoritative standards which ensure equal or better performance than mentioned above shall also be acceptable.

7. TECHNICAL REQUIREMENTS:-

The technical requirements have been detailed out here-in-below:-

(a) The supplier should offer nearest rating of Surge Arrestors & Minimum residual voltage shall comply with the requirements given under clause S.No. 15 & 16 below:-

(b) The transformer which is to be protected has BIL of 950 kVp for 220 KV system considering 20% safe margin as per IEC. The impulse voltage of more than 780 KVp should not appear across the transformer of 220 KV. We will be installing our L.A.s at a distance of 5 / 10 metres from the transformer (another 5 metres be added towards height of LAs lead length and bushing of the transformers). It should be explained with suitable graphs and calculations, the voltage more than that specified above will not appear on transformer. This requirement is essential and in absence of this, the offer shall be liable for rejection.

(c) The graph for TOV capability should be submitted alongwith the offer.

(d) Calculation for energy handling capability should essentially be submitted alongwith the offer. The calculations should be as per IEC -99-4. The energy handling capability for single shot of wave and multiple shots of wave as per IEC should be submitted alongwith the offer.

(e) The Technical particulars are as under :-

The equipment offered under this specification shall conform to the parameters given below:

S. No.	**Particulars**	
1.	Manufacturer type Designation.	Gap less type
2.	Applicable Specification and Standards.	IEC 99-4 :1991 & IS: 3070 (Part I & III)
3.	Rated frequency of Arrestors	50 Hz.
4.	Applicable ambient temperature	50° C
5.	Nominal System Voltage	220 KV
6.	Maximum Continuous Operating Voltage(MCOV)	168 KV
7.	Rated Arrestor voltage	198 KV
8.	Highest System Voltage	245 KV

9.	Duty for which suitable	Heavy Duty
10.	Class designation	Station Class
11	Temporary power frequency voltage withstand capacity	
	1. 0.1 Second	237 KV rms.
	2. 1.0 Second	218 KV rms.
	3. 10 Seconds	198 KV rms.
12.	Nominal discharge current (8 / 20 micro second)	10 KA
13.	Minimum Energy Discharge Capability (KJ / KV)	As per Long duration discharge class 3 IEC 99-4 (for single shot 5 KJ/ KV)
14.	Long duration energy Discharge Class	3
15.	Maximum residual voltage at normal discharge current of 8/20 micro second wave for 10 KA	480 KVp
16.	Minimum prospective symmetrical fault current for pressure relief test (KA rms)	40
17.	Impulse current withstand capacity : High current short (4/10 microwave) (KA)	100
18.	Maximum Radio interference voltage when energised at MCOVI (micro volts)	Less than 250
19.	Creepage distance of porcelain housing (in m.m.)	6125
20.	Pressure Relief Device	Class "A"
21.	Insulation level of Housing:- Lightning Impulse withstand voltage (kVp) of housing	1050 kVp

(f) While furnishing technical details, it is obligatory on the part of Bidder to furnish value of current peak and virtual duration for each of LAs for long duration current test.

(g) Residual voltage test for 8 / 20 micro second wave of 10 KA are specified above, however, we will prefer still lower residual voltage to ensure better protection .

(h) The requirement of energy rating is very specific, based on our system. The Bidders are requested to offer nearest energy rating of LAs for both single and double shot.

8. GENERAL TECHNICAL PARTICULARS FOR 198 KV LIGHTING ARRESTOR :-

8.1 The surge Arrestors shall conform to the Technical requirements as per 6 above.

8.2 The energy handling capability of Arrestors both for single shot and double shot offered should be supported by the calculations. It is obligatory on the part of Bidder to offer energy handling capability for single shot and double shot alongwith calculations. In absence of this the offer shall be liable for rejection.

8.3 The grading ring on each complete arrester shall be provided if required for proper stress distribution for attaining relevant technical particulars for 198 KV LAs.

8.4 The surge Arrestors shall be fitted with pressure relief devices and arc diverting ports and shall be tested as per the requirements of IEC draft specifications for minimum prospective symmetrical fault current as specified in S.No. 16 of the technical particulars.

8.5 The basic insulation levels and switching impulse withstand levels of the lines and equipment to be protected have been specified in clause 6 (b) above. The protective characteristics of the

Arrestors offered shall be clearly specified in Schedule – I of Guaranteed Technical Particulars.

8.6 The materials and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment are deemed to be included in the scope of supply unless specifically excluded.

8.7 Unless otherwise brought out separately by the bidder in the schedule of deviations, the surge Arrestors shall conform to the specifications scrupulously. All deviations from the specifications shall be brought out in the schedule of Technical Deviations. The discrepancies between the specification and the catalogues or literature submitted as part of offer shall not be considered as valid deviations unless specifically brought out in the schedule of deviations.

8.8 The minimum permissible separation between surge Arrestors and any earthed object shall be indicated by the bidders in their offer.

8.9 Each and every individual unit of surge Arrestors shall be hermetically sealed and fully protected against the ingress of moisture. The hermetic seal shall be effective for entire life time of arrestors and under the service conditions specified. The supplier shall furnish sectional view showing details of sealing employed. Complete details of sealing arrangements may please be furnished.

8.10 Bidders shall furnish in the offer sectional view of pressure relief device employed in the arrestors offered.

8.11 All the Units of Arrestors of the same rating shall be interchangeable type without adversely affecting the performance.

8.12 The lightening (Surge) Arrestors shall be suitable for pedestal type mounting which shall be arranged by purchaser. The drawing of mounting structure for LAs will be provided after placing of order.

8.13 All necessary bolts, nuts, clamps etc. required for mounting on support structure to be supplied by bidder shall be included in the scope of supply.

8.14 The surge counter & Leakage current meter shall be provided for 198 KV LAs. The leakage current meter should be marked for normal leakage current & threshold current of operation.

8.15 All exposed ferrous parts shall be hot dip galvanised as per IS : 2633. The material shall be galvanised only after completing all shop operations.

8.16 **TERMINAL CONNECTORS :-**

(a) All castings shall be free from blow holes, surface blisters, cracks & cavities. All sharp edges and corners shall be blurred and rounded off.

(b) All current carrying parts shall be designed and manufactured to have minimum contact resistance.

(c) The contact surface must be machined smooth to obviate excessive current density.

(d) The terminal connector for connection of conductor should be suitable for Zebra conductor for 198 KV LAs with vertical / horizontal take off arrangement and should have adequate current carrying capacity.

(e) The terminal connector shall be manufactured out of Aluminium alloy LM6 as per IS and by gravity die casting process only.

(f) Terminal connector should have six bolts to hold the conductors. Conductor hold length shall not be less than 100 m.m.. All nuts, bolts, washers etc. shall be of Galvanised iron.

(g) The minimum thickness of any part of clamps body shall not be less than 12 m.m.

8.17 **PORCELAIN BUSHING** :-

(a) All porcelain housing shall be free from lamination cavities and other flaws affecting the maximum level of mechanical and electrical strength.
(b) The porcelain shall be well vitrified and non-porous.
(c) The creepage distance of arrester housing shall be as per technical particulars detailed out in clause 6 above.
(d) The porcelain petticoat shall be preferably of self cleaning type (Aerofoil design).
(e) The details of porcelain housing such as height, angle of inclination, shape of petticoats, gap between the petticoats, diameters (I.D. & O.D.) etc. shall be indicated by the Bidder in his offer in the form of a detailed drawing.

(f) The arrester housing shall conform to the requirements of IEC specification.
(g) Galvanising, Nickel plating etc. shall be generally as under :-
  (i) All ferrous parts exposed to atmosphere shall be hot dip galvanised as per BIS : 2628 as amended from time to time. Tinned Copper / Brass lugs shall be used for internal wirings of discharge counter. Screws used for electrical connector shall be either made of brass or Nickel plated.
  (ii) Ground terminal pads and name plate brackets shall be hot dip galvanised.
  (iii) The material shall be galvanised only after completing all shop operations.

9. **ACCESSORIES &FITTINGS :-**

9.1 The discharge counter shall be provided for the arrester meant for 220 KV systems. The discharge counter shall be provided with milli ampere meter for measuring the leaking current and shall not require any DC or AC auxiliary supply. It shall be suitable for outdoor use. The installation of discharge counter shall not adversely affect the arrester performance.

9.2 The discharge counter shall register operation whenever lightning or any other type of surge strikes the surge arrester.

9.3 All necessary accessories and earthing connections leads between the bottom of the arrestors and the discharge counter shall be in the suppliers scope of supply. The discharge counter shall be so designed that the readings of discharges recorded by the counter and the readings of milli-ammeter shall be clearly visible through an inspection window to a person standing on ground. The minimum height of purchasers support shall be 2.5 m.

9.4 Each surge counters shall have terminals of robust construction for connection to earthing and these shall be suitably arranged so as to enable the incoming and outgoing connection to be made with minimum bends.

9.5 The grounding terminals (2 no.) shall be suitable for bolted connection of 65 x 8 mm M.S. flat to be provided by the purchaser for connection to station earth mat. Proper functioning of surge counter with Surge Arrestor shall be ensured by the supplier.

10. NAME PLATE:-

The arrestors shall be provided with non-corrosive legible name plate indelibly marked with the following information:

1	Power Transmission Co. Ltd.
2	Order Number
3	Manufacturer's name or Trade Mark and Identification Number of the arrestors being supplied
4	Rated Voltage
5	Maximum continuous voltage
6	Type
7	Rated frequency
8	Long duration discharge class
9	Pressure relief current in KA rms.

10	B.I.L. of the equipment to be protected
11	Year of manufacture

11. The supplier shall furnish two sets of following drawings along with his offer:-

a. General outline drawings of the complete arrester with technical parameters.
b. Drawings showing clearance from grounded and other live objects and between adjacent poles of surge Arrestors required at various heights of surge Arrestors.
c. Drawing showing details of pressure relief devices.
d. Detailed drawing of discharge counters along with the wiring and schematic drawing of discharge counters and meters.
e. Details of grading rings if used.
f. Outline drawing of insulating base.
g. Mounting details of surge Arrestors.
h. Details of the line terminal connector and ground terminals.
i. Volt time characteristics of surge Arrestors.
j. Details of galvanising being provided and different ferrous parts.
k. The detailed dimensional drawing of porcelain housing such as ID, OD, thickness and insulator details such as height, profile of petticoats angle of inclination and gap between successive petticoats, total creepage distance etc.
l. Name Plate drawing.

****

10. TECHNICAL SPECIFICATION FOR 220 KV DOUBLE BREAK ISOLATORS (Metallics only)

1. **Scope:**

This specification provides for design, manufacture, stage testing, inspection and testing before dispatch, packing and delivery of **220 KV double break Isolators with and without earth switch**.Tandem Isolators shall not be accepted.

2. **Standards:**

The rating as well as performance and testing of the isolators shall conform to the latest revisions and amendments of the following standards. Equipment meeting any other authoritative standard, which ensures an equal or better quality than that standard mentioned below, will also be accepted.

Sl. No.	Standard No.	Title
1.	IS:9921(part I to V)	Alternating current isolators (disconnectors) and earthing switches
2.	IEC:129	
3.	IS:2147	Degree of protection provided by enclosure
4.	IS:4691	Degree of protection provided by enclosure
5.	IS:2629	Recommended practice for hot dip galvanizing of iron and steel.
6.	IS:4759	Hot dip galvanization coating on structural steel
7.	IS:2633	Method of testing, weight, thickness and uniformity of coating on fasteners
8.	IS:1573	Electroplated coating of zinc on iron and steel
9.	IS:3033	Spring washers
10.	IS:2016	Plain washers

3. **Climatic Conditions:**

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

(a)	Location	Outdoor
(b)	Max. ambient air temperature (°C)	50° C
(c)	Min. ambient air temperature (°C)	1° C
(d)	Average daily ambient air temperature	30° C
(e)	Max. Relative Humidity (%)	95%(sometimes approaches saturation)
(f)	Max. altitude above mean sea level (meters)	1000 mtrs
(g)	Average annual rainfall	1250 mm
(h)	Max. wind Pressure	150 kg/m2
(i)	Seismic level (Horizontal acceleration.)	0.3

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

4 **Particulars of the system :-**

The isolators to be procured under this specification are intended to be used on 3 phase A.C. 50 cycles, effectively grounded system. The nominal system voltage is 220 KV.

4.1 **AUXILIARY POWER SUPPLY**

4.1.1 Auxiliary Electrical equipment shall be suitable for operation on the following supply system Particulars.

(i) **AC control & protective devices**: 240 V, single-phase, 2-wire, lighting & space heaters AC supply with one Lead grounded.

(ii) **DC alarm, control and protective device**: 220 V DC supply from station batteries.

(iii) **AC/DCControl for motor operating**: 415 V, 3-phase, 4 wire, Mechanism neutral grounded AC supply or 220V DC supply by providing diode rectifier circuit for converting AC supply to DC supply for DC motor only.

4.1.2 **In the above supply, voltage may vary as follows**:-

All devices shall be suitable for continuous operation over entire range of voltage. Stated below:-

(i) AC supply :Voltage variation ±10%.
Frequency variation ± 3%

(ii) DC supply : -15% to +10% variation

5. **Type & rating:-**

5.1. Isolators shall have three posts per phase triple pole single throw, gang operated out-door type silver-plated contacts with horizontal operating blade and isolators posts arranged vertically. **The Isolators will be double break type**. Rotating, blade feature with pressure relieving contacts is necessary i.e. the isolators shall have turn and twist arrangement. This arrangement shall be described in detail along with the offer. However, the design of turn & twist arrangement shall be to subject to our approval. **(Banging type feature is not acceptable).**
All isolators shall operate through 90 degree from their fully closed position to fully open position so that the break is distinct and clearly visible from the ground level.

5.2 The current rating of Isolators shall be 2000Amps RMS suitable for continuous service at the system voltages specified herein. The isolators are not required to operate under load but they must be called upon to handle magnetization currents of the power transformers and capacitive currents of bushings, bus-bar connections, very short lengths of cables, & current of voltage transformers.

5.3 The rated insulation strength of the equipment shall not be lower than the levels specified in IS-9921. The Isolators should meet the following principal parameters:-

Sr	Technical Parameter	
1	Rated Freq.	50 HZ
2	System earthing	Effectively earthed
3	No. of phases(poles)	3
4	Safe duration of overload	
	a) 150% of rated current	5 minutes
	b) 120% of rated current	30 minutes
5	Rated voltage	245 KV RMS
6	Type of disconnect(AB)	Double Break
7	Rated Normal current (A RMS)	2000 A
8	Rated short time withstand current for 3 secs (KA RMS) of main	40
9	Rated peak current of main switch (KA peak)	100
10	Rated short time making current (KA peak)	100
11	Standard withstand positive KV peak	
	a) across isolating distance	1200
	b) To earth & between poles	1050
12	One minute Power Freq. Withstand voltage KV(rms)	
	a) across isolating distance	530
	b) To earth & between poles	460
13	Minimum creepage distance (mm)	6125
14	Rated mech. Term load	

	(i) straight load(Kg.)	102
	(ii) Across load(Kg.)	33.65
15	Rated magnetising current/ capacitive current make & break (A rms)	0.7
16	Minimum clearances	
	a) ph to earth(mm)	2150
	b) ph to ph (mm)	2350
17	Ph to ph spacing for installation	4000
18	Height of lowest live point above ground level (mm)	6500
19	PCD of insualtors to be provided : Top	127 mm
	Bottom	225 mm

5.4 The 220 KV Isolators are required without post insulators of solid core type and mounting structures. The isolators should be suitable for mounting on the CSPTCL's standard structure. The CSPTCL will arrange the mounting structures. However, the isolators shall be supplied with base channels along with fixing nuts, bolts and washers of GI for mounting on the structure which will be provided by the CSPTCL. The drawing of CSPTCL's structure shall be provided to successful bidder along with the order.

5.5 **Temperature rise:- (as per IS:9921)**

The maximum temperature attained by any part of the equipment when in service at site under continuous, full load conditions and exposed to the direct rays of sun shall not exceed 45 degree centigrade above ambient. The limit of temperature shall not be exceeded when corrected for the difference between ambient temperature at site and the ambient temperature specified in the approved specifications. The corrections proposed shall be stated in the tender and shall be subject to approval of the purchaser.

5.6 **Isolator insulation:**

Insulation to ground, insulation between open contacts and the insulation between phases of the completely assembled isolating switch shall be capable of withstanding the dielectric test voltage specified in clause 5.3 above.

5.7 **Main contacts:**

All current carrying parts in the Isolator shall be of hard drawn electrolytic copper. **Aluminium shall not be used at all.**

All Isolators shall have heavy-duty self-aligning, self cleaning contacts and so designed that binding can not occur after remaining closed for prolonged period of time in a heavily polluted atmosphere. The fixed contact of the Isolator shall be made of hard drawn electrolytic copper. The fixed contact should be of reverse loop type. The various parts shall be accordingly finished to ensure inter-changeability of similar components. The design of contact assemblies shall ensure that :

a. Electro-dynamic withstand capability of contacts should be sufficient to ensure that during short circuit there is no risk of repulsion of contacts.
b. The current density in the Copper parts shall not be more than **1.5A/sq.mm** but may be less.
c. Thermal withstand capability during short circuit should be adequate to ensure that during short circuit there is no over heating of contacts.
d. Constant contact pressure even when the live parts of the insulator stacks are subjected to tensile stresses due to linear expansion of connected bus bar of flexible conductors either because of temperature variations or strong winds.
e. Wiping action during closing and opening.
f. Self-alignment assuring closing of the switch without minute adjustment.

5.7.1 **Fixed Contact**:

The fingers of the fixed contacts shall be made of electrolytic copper in four pieces of section 6x30 mm for 2000 amp Isolators and each shall form the reverse loop with a oval shape to hold fixed contact intact. The ends of the reverse loops of the fixed contact shall touch the stopper. The fixed contact finger shall be mounted on a copper pad 175x140 mm with thickness 10 mm for 2000 Amp isolator . **Please note aluminium pad will not be accepted. No aluminium / bimetallic material shall be used in fixed contact assembly.**

The fixed contacts would be placed in 'C' clamp. The thickness of 'C' clamp shall be of 5 mm. This 'C' clamp shall be placed on a channel of 5 mm thickness. This channel shall be welded on a insulator mounting plate of **12 mm** thickness. The spring of fixed contact shall have housing to hold the moving contact in place. This spring shall be made of stainless steel with adequate thickness. The proper spring pressure is a must for good contact. The spring shall not carry any current and shall not loose their characteristic due to heating effects.

Contacts and spring shall be designed so that readjustment in contact pressure shall not be necessary throughout the life of the Isolator or earth switch. Each contact or pair of contact shall be independently sprung so that full pressure is maintained on contacts at all time.

5.7.2 **Moving blade:**

The switch blades forming the moving contacts shall be made from tubular section of hard drawn electrolytic copper with OD 52 mm & ID 30 mm of length 3200 mm for 2000 amp Isolators. The contact should be in a single piece and there should not be any joint in the moving blade. These contacts should withstand safely the highest short circuit and over voltage that may be encountered during service. The surfaces of the contacts shall be rendered smooth and silver-plated. In nut shell, the male and female contacts assemblies shall be of robust construction .

The earthing switch shall be provided with three sets of suitable type of fixed contacts below the fixed contacts assemblies of the main switch on the incoming supply side and the sets of moving contacts having ganged operation. These contacts shall be fabricated out of electrolytic copper for 220 KV Isolators with earth switch and dimensioned to withstand current on the line. The earthing switch shall have the same short time current rating as that of main switch.

5.8 **Auxiliary switches:--**The operating mechanism of main switch shall be equipped with eight nos. each of NO & NC contacts exclusively for purchasers interlocking & protective schemes. The aux. switches should be rated to carry a current of 10 amps continuously. The operation of Auxiliary switches should be as per clause 8.3 of IS: 9921(part-III). The Aux. switches should be actuated by a cam or similar arrangement mounted on the isolator shaft without any intermediate levers, linkages etc. to ensure fool-proof operation.

5.9 **Connectors:-**

a) Isolator terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL.

b) No part of a clamp shall be less than 12mm thick. Minimum conductor coverage on the clamp shall be 100mm. Minimum terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

e) GI nuts, bolts and washers shall be used. Nuts and bolts shall have hexagonal head with threads as per IS and shall be fully threaded type. Also instead of spring washers check/lock nuts shall be provided.

f) The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor. The terminal connector of 33 KV side shall be suitable for twin Zebra conductors

Terminal connector shall be suitable for Zebra ACSR conductors. Clamps shall be designed adequately to take care of any bimetallic effect. The temperature at the clamp shall not exceed

80° deg. C. The bushing side of connector shall be of copper and conductor side shall be of aluminium.

The terminal connectors shall also meet the following requirements:

i) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc
ii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
iii) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.
iv) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm.

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

5.10 **(A)Operating mechanism for 220 KV Isolators:**

a) The isolators shall be suitable for electrical motor operated mechanism and manual operation and the mechanism shall be easy to operate by a single person. The height of the handle above the foundation shall be such as to ensure ease of operation. The operating mechanism shall have smooth movement and shall be designed for simultaneous manual operation of all three single pole units through single operating rod of adjustable length and operating mechanism mounted on one end of switch only. Operating mechanism of main switch shall be on opposite ends. The rotating insulators stacks shall be provided with **double roller or double ball bearings** and shall be adjustable and easily accessible for dismantling in the field. Bearing housing shall be weather and dust proof. The vertical operating shaft of requisite length shall be supported on ball or roller thrust bearing. Position indicators shall be provided near the operating mechanism for open and close position. Provision shall be made for pad locking the mechanism of isolators in both the close and open positions. The isolator shall be such that its stack position will not be affected by wind pressure, vibration, reasonable shocks etc. Auxiliary switches shall be mounted in weather proof housing which shall have provision of entry of conduits of proper size and for fixing of cable glands

b) **Operating mechanism and control :-**The operating mechanism shall provide a quick, simple and effective operation. One man shall able to operate the isolator without undue effort.

c) The Bidder shall offer the operating mechanism as specified. The design of operating mechanism shall be such that minimum energy is required for operation. Each pole of isolator shall have individual drive for main blade and earth switch. The operating mechanism of the three poles shall be well synchronized and interconnected.

d) The isolator shall be provided with positive continuous control throughout the entire cycle of operation. The operating pipes end rods shall be sufficiently rigid to maintain positive control under the most adverse conditions and when operated in tension or compression for isolator closing. It shall also be capable of withstanding all torsion and bending stresses due to operation of the isolator.

e) After final adjustment has been made there should not be any displacement at any point to allow improper functioning of the isolator during opening and closing operation at any speed. All holes in cranks, linkages and drives through shafts of MOM should be provided with eye coupling to minimize slack and lost motion in the entire mechanism.

f) All isolators shall be provided with detachable type operating handles with padlocking arrangements. All brackets, angles or other members necessary for attaching the operating mechanism to the isolator supporting structure shall be supplied.

g) All bearings wherever provided shall be of reputed make. Bearings shall be provided with required members of nipples for lubrication. The type of bearing shall be stated.

h) The control cabinet shall be sheet steel / aluminium enclosure and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick and properly braced to prevent wobbling. Control cabinet shall be with double hinged doors with

padlocking arrangement. Control cabinet shall be of free standing, floor mounting type or wall mounting type or pedestal mounting type as applicable.

i) All doors, removable covers and plates shall be gasketed all round with continuous neoprene gaskets, louvers shall have screens and filters. The screen shall be of fine wire mash made of Brass or GI wire.

j) Cable entries shall be from bottom Suitable removable cable gland plate shall be provided on the cabinet for this purpose. Necessary number of cable glands shall be supplied fitted on to this gland plate. Cable gland shall be screw-on-type and made of Brass.

k) Suitable heaters shall be mounted in the cabinet to prevent condensation. Heaters shall be controlled by differential thermostat so that the cubical temperature is always maintained approximately 10 ºC above the out side air temperature. ON/OFF switch and fuse shall be provided. Heater shall be suitable for 240 V AC supply voltage.

l) The terminals shall be so staggered that the connection of external cable to anyterminal block should be possible without disturbing the rest of the connections. The terminals blocks arrangements shall be such as to provide maximum accessibility to all conductor terminals and any arrangement preventing ready access to other terminal. Screws shall not be accepted. Stud type terminals preferable. 20% spare terminals shall be provided in each block.

m) The arrangement shall be such that it is possible to safely connect or disconnect terminals on live circuits and replace fuse-links when the cabinet is live.

n) The enclosure of the control cabinets shall provide a degree of protection of not less than IP:55 (as per IS:2147).

o) A 'local/remote' selector switch and a set of open/close push buttons shall beprovided on the control cabinet of the isolator to permit its operation through local or remote push buttons.

p) Provision shall be made in the control cabinet to disconnect power supply to prevent local/remote power operation.

q) The control cabinet shall be provided with a 240 V, 1Phase, 50 Hz, 40 W lighting for interior illumination controlled by a ON/OFF switch. Power source for this interior lighting shall be completely independent of control power source.

(B) MOTOR OPERATED MECHANISM

a) The motor shall be squirrel cage induction motor and shall be totally enclosed, weather proof, out door type conforming to the latest edition. The DC source shall be made available by providing Diode circuit for converting AC supply to DC supply for DC motor only.

b) Suitable reduction gear shall be provided between the motor and the drive shaft of the isolator. The mechanism shall come to standstill quickly on switching OFF the power supply to the motor.

c) Limit switches for motor control shall be fitted on the isolator shaft, within the cabinet, to sense the open and close positions of the isolator.

d) Motor for operating mechanism to be supplied with the isolator shall be of reputed make to assure trouble free performance of the operating mechanism. Bidder should confirm to attend the defects if any without any extra charge within the guarantee period.

e) Control & monitoring of Isolators shall be integrated in Sub-station Automation System.

(C) INTERLOCKING

a) Isolators shall be provided with padlocking facilities to lock them in full open or fully closed position.

b) Isolator shall be interlocked such that it will not be possible to close the earthing switch when the isolator is closed and vice-versa.

c) Each Isolator shall have the provision to electrically interlocked with its associated breakers, such that the isolators can not operated unless the associated circuit breakers is in open position.

d) Electrical interlocking arrangement shall be fail safe type.

Operating arm for connection to Tandem pipes: This shall be made of channel section size 75 x 40 mm.

5.11 **Pipes:** The Isolators should have two Tandem pipes, one on each side of B-class GI pipe of 3.15 mm thickness with 40mm nominal bore. Thus the thickness of the pipe shall be 3 mm. The operating handle shall be class B type having at least 37 mm internal dia-meter. The vertical operating pipe (down pipe) shall also be class B with internal dia-meter of at least 75 mm for 220 KV Isolators. The height of structures should be provided by CSPTCL from down level is approximately 3900 mm. the length of operating pipe should be such that the operating handle should be mounted at a height of 1000 mm from the ground level.
The pipe shall be terminated into suitable universal type joints between the insulator bottom bearing and operating mechanism.

5.12 **Base channels:** The isolator shall be mounted on a base fabricated from one piece ISMC steel channel section of **150x75mm** to withstand total weight of isolator and insulators and also all the forces that may be encountered by the isolator during service. Suitable holes shall be provided on this base channel to facilitate its mounting on our standard structures. The steel channel in each phase shall be mounted in horizontal position and over it two mounting plates at least 10 mm thick with suitable nuts and bolts shall be provided for minor adjustment at site.

5.13 **Clearances:**

We have adopted the following minimum clearances for isolators in our system. The tenderer should therefore keep the same in view while submitting their offers. For further details the drawings will be provided at the time of placing order.

Description	Centre distance between poles (centre to centre) i.e. ph to ph clearance	Distance between centre lines of outer posts on same pole
220KV Isolators	4000 mm	3130 mm

5.14 Interlocks:

For; the purpose of; making the operation of the isolator depending upon the position of associated circuit breaker, mechanical interlocks may be required. The supplier shall ensure that the design of equipment will facilitate provision of such interlock.

Line earth switches shall consist of three earthing links per Isolator, which will normally rest against the frame when the connected isolator is in closed position. The earthing links for the three phase shall be mechanically linked to a coupling shaft which shall be capable of being fitted on either side of the isolator. Earth switch shall be mechanically interlocked with the connected isolating switch so that it is possible to close and open the earth switch only when the connected isolating switch is in the open and closed positions respectively. In the earth switch only banging type feature is required. Therefore the earthing switches should be provided with counter balance weight so that the earth switches do not fall due to gravity and it moves very smoothly in upward direction i.e. against gravity. Each earthing switch shall be designed to withstand electro dynamic stress due to currents up to 40 KA (peak).
All shafts, couplings etc. shall be galvanised. Flexible copper connectors of at least 50 sq. mm cross-section shall be provided between the rotating shafts and the frame works.

5.16 **Bearings for moving insulators & operating vertical pipe:-**
The design and construction of the various bearings shall embody all the features required to withstand climatic conditions specified, so as to ensure dependable and effective operation even after long periods of inaction of these isolators. Bearing housings should be weather proof. Facilities should be provided for lubrication of bearings. The number of bearings to be provided for reducing friction for smooth operation of Isolator shall be total 8 Nos. 2 No. on each on 3 phase rotating insulators and 2 No. for operating vertical pipe.

The bearing housing for insulators shall be made of gravity die-cast alluminium with smooth surface suitably machined for sealing the bearings. For each phase, below the moving insulator, there shall be an assembly of 2 bearings .The top one will be tapered
or load bearing. The lower one shall be normal ball bearing. In addition there shall be two nos ball bearings for operating(down) pipe. Then overall 8 Nos bearings for each isolator. Complete details of arrangement offered shall be furnished.
The complete bearing assembly for moving insulator shall be such that the moving insulator is exactly VERTICAL and there is no play around the vertical position.

Bearing should be provided for Turn & twist arrangement (bushes shall not be acceptable)

5.17 Design, material and workmanship:

The successful tenderer shall assume full responsibility for co-ordination and adequate design. All materials used in the construction of the equipment shall be of the appropriate class, well finished and of approved design and make. All similar parts should be accurately finished and inter-changeable.
All interiors and exteriors of control cabinets shall be thoroughly cleaned to remove all rust, scales, corrosion, grease and other adhering foreign matter and the surfaces treated by recognized phosphating (e.g. seven tank phosphating sequence). After such preparation of surfaces, two coats of zinc oxide primer shall be given by suitable storing and air drying before final painting. Colour of the final paints shall be of shade No. 697 of ISI i.e. epoxy light grey. The finally /painted cubicle shall present esthetically pleasing appearance free from any dent or un-even surface. Paint inside the metallic housing shall be of anti-condensation type and the paint on outside surfaces shall be suitable for outdoor installation. All components shall be given adequate treatment of climate proofing as per IS-3202 so as to withstand corrosive and severe service condition.
All other ferrous parts shall be heavily hot dip galvanized. Bolts, nuts pins and washers, etc. used on the Isolators shall also be galvanized. All the nuts, bolts and washers in current carrying parts shall be of galvanized steel. Special attention shall be paid to give tropical treatment to all the equipment as it will be subjected during service to extremely severe exposure to atmospheric moisture and for a long period to high ambient temperature. All current carrying parts shall be of non-ferrous metal or alloys and shall be designed to limit sharp points edges and similar sharp faces.

6. **Guaranteed data and other technical particulars: -**

Guaranteed data and other technical particulars of the isolators should be given in the form of Schedule-I. Any other particulars considered necessary by the supplier may also be given in addition to those listed in the schedule.

7. **Drawings & literatures:**

All the dimensioned drawings along with illustrated and descriptive literature for all equipment offered must be submitted along with the tender; otherwise the tender will be treated as incomplete. The following drawings shall be enclosed with the tender.

i. The drawing showing the outline dimensions of the isolator.
ii. Drawing showing details of main contacts.
iii. Drawings showing arrangement of mechanical interlock.
iv. Drawing showing the details of fixed and moving contacts and the arrangement of pressure relief.
v. Drawing showing bearing assembly.
vi. Drawings for terminal connectors.
vii. Name plate to be provided.

*****

11. TECHNICAL SPECIFICATION FOR POWER LINE CARRIER COMMUNICATION EQUIPMENTS:-

1.1 SCOPE

This specification covers manufacture, assembly and testing at manufacturer's work, stage inspection, testing, packing and delivery of line carrier communication equipments. The specifications covers supply of outdoor as well as indoor equipments required for providing, power line carrier communication between two sub-stations. The scope covers supply of multi purpose carrier cabinet with latest technology suitable for speech, tele-protection, signalling, telemetry, and telex / fax transmission.

1.2 LIMITS OF CONTRACTS:

1.3.1 OUTDOOR EQUIPMENTS:-

The contractor's scope of supply shall include the outdoor apparatus required for carrier system such as Wave trap, Coupling capacitor, Line matching unit along with protective device (Drainage coil, surge arrestor & earth switch etc).

1.3.2 INDOOR EQUIPMENTS

The scope of supply shall also include all the indoor equipments required, viz Carrier panel, Protection couplers, Electronic private automatic exchange and Telephones. HF Coaxial cable interconnecting the outdoor and indoor apparatus shall be included in this section.

1.4 REQUIREMENTS:-

The power line carrier communication equipment to be supplied and erected under this contract shall be suitable to provide the following services:-

a) Speech communication between the stations.
b) EHV line protection signal transmission/reception through Carrier equipment.
c) VFT facilities for data communication.

The supplier shall provide Power Line Carrier Cabinet sharp cut-off filter, speech compression & expansion (compander) facility & transit band pass filter. The equipment shall be immune to corona & other noises which are predominantly present in EHV S/Stns. The Carrier cabinet shall work on Amplitude modulation principal however advanced versions working on QAM (Quadrature Amplitude Modulation) shall also be acceptable. The carrier equipment shall support 600 Baud data transmission rate along with speech transmission & 1200 Baud with out speech.

Presently AF coupler unit (carrier protection unit) is not required, however, the Carrier Cabinet should be compatible to be connected with protection coupler working on coded command principle. Coded commands for direct tripping & fixed frequency/combination of frequency commands for permissive trip may be added in future.

1.5 COMMUNICATION SYSTEM:-

Contractor may offer power line carrier equipment according to their standard practice to fulfil the requirement of this specification. The equipment offered should be the single side band fixed frequency type. The equipments shall have full scope for further extension and alteration.

It is to be noted that the existing 220 KV &132 KV system of the CSPTCL already has a power line carrier communication system, based on the details of the existing equipments and existing frequencies network which will be furnished to successful contractor. The contractor if desired shall be responsible for proposing suitable frequencies for section on which PLC equipments are to be installed. In choosing the frequency for the proposed sections, the contractor shall pay due attention to the frequencies already in use.

For the protection signalling separate carrier frequency is not required. The 4 KHz. AF Band of PLC cabinet shall carry speech from 0- 2 KHz & rest of the portion of band can be utilized for protection signalling data transmission.

The equipment would be used on 132 KV transmission line. For selection of frequency, due consideration should be given to the transposition aspect as the signal attenuation is likely to be substantially affected by transposition of phases and other parameters. The contractor will have to carry out the necessary studies and furnish the required calculations and conclusion

drawn there from for satisfaction of the customer. The details of the transposition shall be furnished to the successful contractors. In any case the frequencies to be finally adopted will be subject to approval by the Government of India and the contractor shall agree to modify the frequencies in accordance with the final requirement without any extra cost. The requirement will have to be complied with, without any extra charges to us even if the approved frequency plan calls for utilisation of fractional frequencies.

1.5.1 **FACILITIES REQUIRED**:-

The communication system shall be used for speech transmission/reception in duplex mode, data transmission & protection signalling. The carrier cabinet will be compatible to be connected with EPAX. The EPAX must support E&M signalling in addition to other facilities. Thus the local subscriber of exchange will be able to make local as well as trunk calls.

1.5.2 **FREQUENCIES TO BE ADOPTED**:- The frequencies to be used shall be chosen from PLC band i.e. 50 - 500 KHz. Higher frequencies can be adopted for smaller sections and lower for longer sections. For this purpose it is obligatory for the contractor to furnish frequencies plan for all sections in the tender.

1.5.3 **COUPLING TO HIGH TENSION LINES**:- For all the line sections covered by this specifications phase to phase coupling shall be adopted. On 132 KV line sections 132 KV class Coupling Capacitors are to be provided. However, carrier panels LMU with protective device and drainage coil for 132 KV section are included in this specifications.

1.5.4 **MODULATIONS**:- Carrier equipments working on Amplitude modulation technique may be offered however equipments working on QAM & Digital modulation techniques are also acceptable.

1.5.5 **PHYSICAL LAYOUT OF EQUIPMENTS**

The following equipments will be installed in the outdoor switchyard.

i) Wave trap.
ii) Coupling Capacitor
iii) Line Matching Unit along with protective device.

All the remaining equipments viz. Carrier transmitter receiver set, emergency power supply equipment etc., will be installed inside the control building adjacent to switchyard. The lead of coaxial cable connecting the Line Matching Unit and the carrier set will be lead in underground cable ducts. It may be necessary to lay part of the coaxial cable in ducts as well as direct in ground. The cable should thus be suitable to embedded in ground.

The cabinet should be suitable for transmission of speech and data at 1200 Baud. The carrier cabinet should be designed in such manner that programming of AF speech band, pilot, line filter, transmit frequency, & receive frequency is possible on site. The cabinet should have remote loop testing facility.

1.5.6 **STANDARD.**

The PLCC equipments shall comply with the latest issue of I.S. and IEC standard as mentioned below:-

S. No.	Name of equipment	IEC no.	IS no.
1	Wave trap	353	8792
2	Coupling device	481	8793
3	Carrier set	495	8997
4	Protection coupler	834-1 2	---

1.5.7 **POWER LINE CARRIER COMMUNICATION CABINET**:

PLCC terminals shall use amplitude modulation (QAM in case of Digital PLCC panel) and shall have SSB transmission mode. The carrier cabinet shall work on fixed frequency & Duplex mode. The PLCC terminal shall comprise of HF hybrid & high quality, sharp filters & crystal generated highly stable frequency.

The various printed circuit board of carrier set shall be housed in heavy gauge steel (12/14 gauge) indoor cabinet for floor mounting type with adequate arrangements for ventilation and screening of the same to avoid dust getting in and to avoid any adverse effect from

moisture during rainy season. The cabinet shall be finished with paints of suitable colour coated inside and outside.

Screw clamp type terminals shall be provided for inter connection wiring. The cabinet shall be suitable for bottom cable entry.

All individual parts of set shall be accessible from the front to permit testing and repair. The front shall have hinged doors, equipped with handles and locks. Necessary testing and indication device shall be provided on the front panel to enable checking of important functions and circuits. The whole circuit shall be mounted on one panel which is hinged at top and bottom of the cabinet. This will facilitate approach to backside of the circuit. The cabinet shall be provided on the outer side with visual and audio alarm indications to announce failure of power supply, absence of carrier signal for both receiver and transmitter etc. the audio alarm would be provided for this purpose which should be audible from 8 metres distance. The carrier set shall be suitable for operation with EPAX i.e. E&M signalling. In addition, two telephone sets shall be provided with each carrier set (one jack telephone, and one four wire telephone), for testing purpose and for carrying on emergency conversion without the help of the associated automatic exchange.

A monitoring and checking system shall be provided on the panel with selector switch to indicate all important levels. (DC, VF, IF and HF). The PLCC terminal should be provided with facility on 2 wire conversation on Express mode with the help of pilot shifting (necessary print for this type of conversation should be provided.

S.No.	Particulars	Description
1.	Operating mode	Single side band with suppressed carrier, with multiple conversion i.e. preferably 3 stage modulation& 4 stage demodulation to suppress noises present in electrical network & maintain high receiver selectivity.
2	Carrier frequency range a. Overall b. Programmable	40 KHz. To 500 KHz. 50 KHz. To 500 KHz.
3	Nominal band with a. Single channel b. Twin channel	 4 KHz. 8 KHz.
4	Maximum Line Attenuation a. Single Channel b. Twin Channel	 60 dB 54 dB
5	Effective working on the line attenuation excluding line noise level a. Single Channel b. Twin Channel	 35 to 40 dB 30 to 35 dB
6	Nominal output impedance	75 or 125 Ohm unbalanced
7	Return Loss Tolerance in Transition band	$\geq$12 dB
8	Carrier frequency stability	$\leq+$ 5 Hz.
9	Useful A.F. Band width	300 t0 3840 Hz.

1.5.8 **ALLOWABLE ATTENUATION DISTORTION OF A.F. CHANNEL**

A	Broad band repeater, operation 0.3 KHz. to 3.84 KHz.	i. 0.3 to 0.4 KHz. – 0.9/+1.7 dB ii. 0.4 to 3.7 KHz. –0.9/+0.9dB iii. 3.7 to 3.84 KHz. – 0.9/+1.7 dB
B	Broad band repreater operation 0.3 KHz. To 3.6 KHz. (with low pass filter)	i. 0.3 to 0.4 KHz. – 0.9/+1.7 dB ii. 0.4 to 3.7 KHz. –0.9/+0.9dB iii. 3.4 to 3.6 KHz. – 0.9/+1.7 dB
C	Speech band 0.3 to 3.4 KHz. Without compander	Comply with IEC 495
D	Speech band 0.3 to 3.4 KHz. Without compander	Comply with IEC 495

1.5.9 **TELEMETRING BAND**

1.	Tele Control Inputs	Minimum 3 inputs precoupled, independently adjustable 600 ohms
2.	Broad Band repeater operation 0.3 to 3.6 KHz. (with low pass filter)	i. 0.5 to 0.6 KHz. $\leq$3.0 ms. ii. 0.6 to 1.0 KHz. $\leq$1.5 ms. iii. 1.0 to 2.6 KHz. $\leq$0.5 ms. iv. 2.6 to 3.4 KHz. $\leq$1.5 ms. V. 3.4 to 3.6 KHz. $\leq$5.0 ms.
3.	Speech Bands. a) 0.3 KHz to 3.4 KHz. b) 0.3 KHz. T0 2.4 KHz. c) 0.3 KHz. T0 2.0 KHz.	Comply with IEC 495

1.5.10 **FILTER CHARACTERISTICS:-**

1.	Allowable ripple for Band pass, High pass & Low pass filters	+ 0.9 dB/-0.9 db
2	Rejection	$\geq$ 50 dB
3	Filter Frequencies	Programmable
4	Selectivity	$\geq$ 50 dB/120 Hz.
5	Band Stop Attenuation	50 dB
6	Band Pass Attenuation	Flat in a band of $\pm$ 0.9 dB

1.5.11 **COMPANDER CHARACTERISTICS**

It should comply with C.C.I.T.T.-G-162.

HARMONIC DISTORTION: 350 Hz. Speech Signal

1	4- Wire	$\leq$(-) dBm for each component at (-) 3 dBm without attenuation
2	2-Wire	$\leq$ (-) 30 dBm for each component at (-) 3 dBm with compander
3	Tele control signal	$\leq$ 1 % at maximum gain
4	Near & Far end cross talk	$\leq$ (-) 50 dBm
5	Near & Far end cross talk attenuation	$\geq$ 50 dB

1.5.12 **SUPERVISION ALARMS: Should come under following conditions:-**

1.	Loss of Transmitter signal.	
2.	Loss of Receiver signal (2 to 5 dB below the AGC range).	
3.	Low SNR in speech & telecontrol channels	15 dB
4.	Low of Auxiliary supply	
5.	Excessive impulse interference.	

1.5.13 **A.F. MUTING**

1.	Slow Muting Rx signal strength alarm	2 to dB below the AGC range.
2.	Fast Muting alarm for burst noise	Pick up delay < 10 ms at a burst noise level of > O dBmo/SNR <o dB

1.5.14 **R.F. OUTPUT POWER**

1.	Peak envelope power including pilot signal under normal load conditions at c0-axial o/p	40 Watt (+46 dB)
2.	Spurious Signal suppression at the limits of the band width for Single & Twin channel	$\geq$ 60 dB
3.	Harmonic suppression for Single & Twin channel	$\geq$ 80 dB
4.	Suppression of unwanted side bands	$\geq$ 80 dB

1.5.15 **RECEIVER REQUIREMENTS:-**

1.	R.F. sensitivities with reference to test tone level at R.F.I/P	(-) 24 dBm
2.	Image Rejection	$\geq$80 dB
3.	I.F. rejection	$\geq$ 80 dB
4.	A.G.C.	A.F. Output level should remain within $\pm$ 0.5 dB for variation of + 14 dB to (-) 26 dB in R.F. Input level.
5.	A.G.C. Time constant	0.5 dB/Sec For level increase/ decrease
6.	Frequency response equalization range	$\pm$ 6 dB

1.5.16 **TELEPHONE INTERFACES:**

1.	2/4 Wire P.A.X. interface	Should be provided
2.	Remote & Local loop testing facilities for A.F. Signals	Should be provided
3.	2/4 wire Input & output level	Adjustable in steps of 0.25 dB
4.	Input Range-Nominal	(-) 20 dB to + 10 dB in steps of 0.25 dB
5.	Balance referred to ground	$\geq$ 56 dB
6.	Return Losses	$\geq$ 20 dB

1.5.17 **TELECONTROL OUTPUTS**

1.	Telecontrol Output	Minimum 3 nos Decoupled, independently adjustable 600 ohms balances. Programmable as transit filter or Board band outputs.
2.	Nominal Output level	0 dBr, 600 ohms balances.
3.	Output level range (Single Tone)	(-) 20 dBr to + 10 dBr in steps of 0.25 dB across 600 ohms
4.	Maximum Output Level (PEP)	+ 14 dBm across 600 ohms
5.	Balance referred to ground	$\geq$ 56 dB
6.	Return Losses	$\geq$ 20 dB

1.5.18 **ALLOWABLE GROUP DELAY DISTORTION**

1.	Board band repeater operation 0.3 KHz. To 3.84 KHz.	i. 0.5 to 0.6 KHz. ≤ 3.0 ms. ii. 0.6 to 1.0 KHz. ≤ 1.5 ms. iii. 1.0 to 3.2 KHz. ≤ 0.5 ms. iv. 3.2 to 3.7 KHz. ≤ 3.0 ms.
2.	Balance referred to ground	≥ 56 dB
3.	Return Losses	≥20 dB
4.	DC Resistance	≥ 2 M Mega-ohms
5.	Speech cutoff frequency adjustable	1.8 KHz. _ 3.4 KHz. In steps of 200 Hz.
6.	Telephony signalling	Pilot Oscillation Keying syste. E.M. Signalling mode.

1.6 GUARANTEED TECHNICAL PARTICULARS FOR TWIN CHANNEL POWER LINE CARRIER COMMUNICATION EQUIPMENT

SN	DESCRIPTION	TECHNICAL PARTICULARS
	Carrier Cabinet	
1	Mode of transmission	Single side band amplitude modulation
2	Carrier frequency range	24 to 500 KHz
3	Nominal carrier frequency band width.	8KHz
4	Oscillator for generating carriers	Crystal controlled oscillator with frequency divider
5	Frequency stability	Less than + /- 5 Hz
6	Effectively transmitted speech frequency band.	300 Hz to 2000 / 2200/ 2400 / 2600 / 2800 / 3000 /3200 / 3400 Hz Upper limit programmable in steps of 200 Hz using plug- in jumpers.
7	Available band for superimposed signals.	Depends on the Speech cut off frequency. With Speech band of 300 Hz to 2000 Hz the available band for superimposed channels is 2160 Hz to 3600 Hz programmable in steps of 60 Hz.
8	Signalling frequency	3780 + /- 30 Hz Pilot frequency is used for signalling (Programmable)
9	HF Power Output	40 watt PEP. Adjustable output power
10	Nominal impedance i) Carrier frequency side ii) V.F. side	75/ 125 Ohms Unbalanced and 150 Ohms Balanced (Optional) 600 Ohms
11	Relative VF levels across 600 Ohms (Balanced) i) 4 wite transit ii) 4 wire receive iii) 2 wire transit iv) 2 wire receive	 -3.5 dBr.(Adjustable using DIP switches from- 20 dBr to +10 dBr) -3.5dBr.(Adjustable using DIP switches from – 20 dBr to +10 dBr) 0dBr.(Adjustable using DIP switches from – 16dBr to + 7 dBr) -7dBr. (Adjustable using DIP switches from – 16 dBr to +7dBr)
12	Details of power supply required.	48V DC (Variation allowed +20%/15%)
13	Power consumption	80 Watts approx. for Twin channel
14	Spurious emissions	As per IEC 495
15	Receiver Sensitivity	-24 dBm referred to the Test Tone level at the RF I / P.
16	Automatic volume control	AF O/P level remains within + / - 0.5 dB for a + /-14/-

SN	DESCRIPTION	TECHNICAL PARTICULARS
		26dB variation of RF I/P level.
17	Signal to Noise ratio over current carrier channels.	<40 dB
18	Selectivity	70 dB for 300 Hz 100 dB for 4 KHz.
19	Any other technical particulars not mentioned above, but considered necessary may please be also furnished.	-

1.7 BILL OF MATERIAL OF TWIN CHANNEL CARRIER CABINET

Each Carrier cabinet shall consist of the following components:

(1). 01 no. dummy load module.
(2). 01 no. 2 wire telephone for each channel.
(3). 01 no. 4 wire telephone set, push button type for each channel.
(4). 01 no. jack telephone hand set for each channel.
(5). 01 no. 125 ohm load.
(6) Transit band pass filter.
(7) Print puller.
(8) Exhaust fan.
(9) Test meter print.

PROTECTION COUPLER – NSD50

Sr. No.	Technical parameters	System Particulars
1	Name of Manufacturer and Country	-----
2	Type, Model and Catalogue Number	NSD-50
3	Whether equipment works on frequency shift principle of coded signal principle	Coded / Uncoded Principle
4	Whether Equipment is suitable for Independently Protecting Two Circuits	Yes
5	Frequencies used in the equipment for transmission of signal for coded Signal transmission (a) Guard frequency (b) Working frequency (Trip System - I) (c) Working frequency (Trip System - II) (d) Working frequency (Trip System I&II)	(a) Same as Pilot frequency of PLCC (b) Uncoded A 872 Hz B 1090 Hz A & B 1308 Hz (c) Coded C 654 / 1526 Hz D 654 / 1745 Hz C & D 654 / 1963 Hz (d) A & D 1745/ 1963 Hz B & C 1526 / 1745 Hz
6	Criteria used for command Transmission	Pilot Criterion & Command Criterion
7	Whether equipment is protected against	Yes, Noise detector/blocking unit provided

	Tripping by Spurious Signals.	
8	Transmission time for protection signals	
	(a) Permissive trip code	12ms
	(b) Direct trip code	26ms
9	Whether in the presence of spurious signals as well as Protection Signals simultaneously, the equipment will initiate a Trip Command.	The equipment works on the following criteria for initiation of the command.
		a) Absence of pilot/guard frequency
		b) Presence of trip command
10	Mode of Transmission of guard signal	Pilot freq. 3780 Hz
11	Whether equipment is suitable for Direct Circuit Breaker tripping.	Yes
12	Maximum number of Noises Impulses pps in Presence of which the equipment will satisfactorily perform its duty.	200ms Noise Burst / 1 sec pause.
13	Signal Delay with Two Terminals connected back to back	Not applicable since Carrier sets are used on point to point basis for protection only
14	Whether the Command Signal is acknowledged at receiving end and in the event of non-receipt of the correct signal, the command is repeated or not by the transmitter?	Command is acknowledged by the Receiver and command is transmitted in the form of continuous code
15	Whether it is possible to alter the priority of commands of various codes at site.	Not required as coded has priority over uncoded
16	What are the performance based results under severe line noise conditions for	
	(a) False trip probability	Better than 10^5
	(b) Fail to trip probability	Better than 10^2
17	Transmitter Input Requirements (Contact Ratings)	
	(a) Voltage	48V to 250V
	(b) Current	<10mA
	(c) Power	0.25W
	(d) No. of Contacts	2 Optocouplers used i.e. : 1 no. for start input & 1 no. for command input
18	Receiver Output (Contact Rating)	
	(a) Voltage	250V DC
	(b) Current	2A
	(c) Power	100VA
	(d) No. of Contracts	1 no. Solid State (MOSFET) Relay.
19	Additional facilities provided in Receiver output	One Auxiliary Relay provide with a contact rating of 250VDC, 10W.
20	Supervisory and Alarm Contact Facilities	Two change over contacts
	(a) Current	600 mA
	(b) Voltage	250V

	(c) No. of contacts	Two
21	Installation	In slot provided in PLC terminal ETL
22	Power Supply	Power derived from ETL
	(a) Voltage	
	(b) Current	
	(c) Power	
23	Type and number of counter for recording the number of Trip Commands sent and number of Trip Commands received	Provided
24	Whether loop test is possible	Yes, automatic as well as manual
25	Insulation Level	Command signal input, output & alarm output to chassis 2kV, 50 Hz 1 min.
26	Whether the equipment is suitable for transmitting and receiving more than two independent commands	Yes, can go upto 4 commands

12. TECHNICAL SPECIFICATION FOR 220KV WAVE TRAP

1.1 **SCOPE** :This specification covers the design, manufacture, assembly testing at manufacturer works, supply and delivery of suspension type **220KV WAVE TRAPS.**

1.2 **STANDARDS** :

The 220 KV wave traps covered under this specification shall confirm tothe requirements of the following IEC/IS standard : IEC 353 / IS : 8792-1978/IS 8793- 1978/IS 9859-1

1.3 **TYPE & RATING:-**

Out door type of wave traps shall be of 0.5 mH 800A rating for 220KV system. However, it may be made explicitly clear that the wave traps are suitably designed to block any desired frequency in the range of 50 KHz to 500 KHz by providing suitable tuning pot in such a manner that a minimum resistive component of 570 ohms is available. The tuning pot should be such that with the rating of wave trap 0.5 mH 800 A for 220 kV any frequency between 50 to 500 KHz may be blocked. The various blocking bands which could be offered with 0.5 mH 220 kV wave traps may please be stated in your offer. However, it may please be clearly confirmed that suitable strapping are provided for choosing different blocking bands with each rating of wave traps offered.

1.4 The wave traps shall have the following specifications:-

S.No.	Particulars	For 220KV
1.	Maximum Operating voltage of the line on which the traps are to be used.	245 kv
2.	Continuous current rating	800 Amps
3.	Instantaneous symmetrical short circuit current capacity.	40 KA (1 sec.)
4.	Tuning range	50-500 KHz
5.	Change in resonance frequency due to ambient temperature variation not to exceed.	0.01% per C
6.	Inductance of main coil.	0.5 mH
7.	Change in impedance due to ambient temperature variation not to exceed.	0.3% Per degree C
8.	Minimum resistive components of Impedence matching within carrier Frequency blocking range.	570 Ohms

1.6 The wave trap shall be broad band type and suitable for blocking the transmitted and received frequencies of the section concerned where transmit and receive frequencies may be wide apart. The wave trap shall consist of a main coil designed to carry continuously the rated current without exceeding the limit of temperature rise. It should be provided with a protective device and a tuning device. The wave traps shall effectively block the high frequency current but allow the 50 cycle current to pass without losses.

1.7 The wave traps shall be of robust in construction with the metal parts made of non-magnetic materials to reduce heating due to induced heavy load and short circuit conditions. Sharp corners shall be avoided on the outer surface of wave traps to minimize corona losses. Insulating material used shall be unaffected by moisture. Suitable bird barrier shall be provided. Suitable surge arrestor shall be provided in the wave trap for protection. The clamps should be suitable for horizontal as well as vertical take off. In the past it is observed that due to failure of clamps the wave trap in service become defective and caused the mal-operation in the system. It is therefore essential that design of clamps should be submitted for our approval. Any modification in the design shall have to be carried out without any extra cost.

1.8 The design of wave traps should be robust and maintenance free. The performance of wave traps shall not get affected in the long run even if the same are utilized in polluted atmosphere. All terminal bolts and fasteners used shall be of non magnetic stain less steel to avoid any risk of corrosion. The installation should not be very heavy in weight. The

mounting arrangement i.e. suspension eye bolt shall be provided centrally at the top as well as the bottom of the wave traps.

1.9 Blocking bands of wave traps should be written at suitable place on the outside of the traps in bold letters by paint, so that after its installation on gantry, the frequency band can be readout from ground. The paint should be such that it will not fade out at a later stage. To ensure high electrical and mechanical strength, it may be noted that we will prefer wave traps of completely encapsulated design, where the equipment is fully encapsuled in epoxy impregnated fiber glass material. Any other design which may offer better performance would also be acceptable.

1.10**GUARANTEED TECHNICAL PARTICULARS FOR 220 KV WAVE TRAPS**

SN	DESCRIPTION	**0.5 mH, 800 A 220 KV Wave Trap**
1	Type & model	
2	Manufacturers catalog no.	
3	Construction	Open coil air cored/Epoxy impregnated
4	Continuous current rating (in Amp)	800 A
5	Inductance in mH	0.5 mH
6	Instantaneous symmetrical short circuit current	40 KA (1 sec.)
7	Resonant frequency range	N/A
8	Min. guaranteed resistive component over blocking range	570 Ohm
9	Blocking bands (with suitable strapping)	50 - 500 KHz
10	Change in resonant frequency due to ambient temp. variation	0.01% /Deg Centigrade/ Negligible
11	Change in impedance due to ambient temp. variation	0.3% /Deg Centigrade/ Negligible
12	Ultimate tensile strength	Twice the weight of LT + 5000 N.
13	Weight (kg)/ Dimension	
14	Material of main coil	Aluminium alloy
15	Type of mounting	Suspension
16	Bird barriers	Provided
17	Corona rings	Not required
18	Details of protection against lightning	By LA
19	Details of other tech. Particular which are considered essential	---
20	Technical particulars of lightning arrestor and tuning pot.	LA 9 KV

13. TECHNICAL SPECIFICATIONS OF 220 KV, 132 KV & 33 KV CONTROL & RELAY PANELS

(Applicable for Sub-station with Automation System)

1.0 SCOPE :

This section contains the technical specifications for the indoor control, indication, relay and metering panels associated with the outdoor switchgear for the sub-station under the 220 KV, 132 KV and 33 KV transmission scheme of purchaser. The various control and relay panels shall be complete in themselves with all main and auxiliary relays, fuses, link switches wherever necessary, small wiring, labels, terminal boards, earthing terminals, foundation bolts etc.

1.01 STANDARD SPECIFICATION:-

1.01.1 Panel finish and Colour :-

The CSPTCL has standardised the colour finish and this shall be opaline green as per colour no. 275 of B.S.271-C: 1948, equivalent colour as per relevant Indian Standards or any other standard shall be accepted. This colour finish shall be applied on the exterior steel works of the panels.

1.01.2 Protective Relays &Instruments :-

The protective relays shall be manufactured tested and supplied with guaranteed particulars generally confirming to the latest issue of following Indian standards Specifications.

IS-3842 (Part I to V)	Application guides for electric relays for AC system
IS-3231	Electric relays for power system protection.
IS-1885 (Part I to II)	Electric technical vocabulary electrical relay And Electrical power system protection.
IS-1248	Indicating instruments
IS-722	Energy meters, control switches (LV switching devices for control & auxiliary circuits.)
IS-2715	Current transformer
IS-3156	Voltage transformer
IS-4237	General requirements for switch gear & Control gear for voltage not exceeding 1KV
IS-375	Marking & arrangement for switch gear bus bars, main connection & auxiliary wiring.
IS-8686	Specification for static relays.

1.1 CONSTRUCTIONAL FEATURES

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

1.1.2 Relay panels shall be of simplex type design as indicated.It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes is properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions. No price increase at a later date on this account shall be allowed. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

1.1.3 Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than **IP-31** in accordance with IS:2 147.

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

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

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

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

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

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

2. MOUNTING

2.1. All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. No equipment shall be mounted on the doors.

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

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

2.4. The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel

2.5. The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top lines of all meters, relays and recorders etc. shall be matched.

2.6. No equipment shall be mounted on the doors.

3. **PANEL INTERNAL WIRING**

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

3.2. All wiring shall be carried out with 1100V grade, single core,numbered at convenient distances, stranded copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

- All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 1.5mm sq. per lead.
- All current transformer circuits one 2.5 sq.mm lead.
- Voltage transformer circuit (for energy meters): One 2.5 mm sq.per lead
- CT/PT wires shall have red,yellow,blue colours for phases and black for neutral.
- Control wires(DC) wires shall be grey AC wires shall be black.

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

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

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

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

3.7. Contractor shall be solely responsible for the completeness and correctness of the internalwiring and for the proper functioning of the connected equipments

4. TERMINAL BLOCKS

4.1. All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 1100 V grade and have 10 Amps. continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.Stud type terminal connectors suitable for ring type lugs shall be used.

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

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

4.4. Unless otherwise specified, terminal blocks shall be suitable for connecting the followingconductors of external cable on each side

- All CT & PT circuits: minimum of two of 4 mm Sq. copper.
- AC/DC Power Supply Circuits : One of 4mm Sq. copper.
- All other circuits: minimum of one of 2.5mm Sq. Copper.

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

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

4.7. The number and sizes of the Owner's multi core incoming external cables will be furnished to the Contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included the scope of supply.

5. PAINTING

5.1. All sheet steel work shall be phosphated in accordance with the IS:6005 "Code of practiceforphosphating iron and steel".

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

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

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

5.5. The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

5.6. After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting.

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

6. NAME PLATES AND MARKINGS

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

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

6.3. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

6.4. Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Name plates shall beblack with white engraving lettering.

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

7. MISCELLANEOUS ACCESSORIES

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

7.2. **Interior Lighting:** Each panel shall be provided with a fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Simplex panels.

7.3. **Switches and Fuses:** Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. MCBs shall confirm to IS: 13947. Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. However voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. Fuse carrier base as well as MCBs shall have imprints of the fuse 'rating' and 'voltage'.

8. EARTHING

8.1. All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq. mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

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

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

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

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

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

9. RELAYS

9.1. All protective relays shall conform to the requirements of IEC61850 and other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.

9.2. **All main protective relays shall be of numerical type and communication protocol IEC 61850 compliant. All the numerical relays/BCU/IEDs shall have minimum two Ethernet/RJ45 ports.The numericalprotection relays/BCU/IEDsshall support PRP on IEC 62439-3. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these. The exact model of the relays shall be finalised by CSPTCL at the time of engineering and that shall be binding on the contractor. Bay controller Unit being the heart of the Substation Automation System, shall be a separate state of art Numerical relay dedicated for the purpose having at least 20 % spare input and 20 % spare output contacts over and above the used contacts. The BCU shall also have two Ethernet/RJ ports for achieving redundancy** in **Ethernet switch connection.In 132 KV and 33 KV panels, any other numerical relay of the bay shall be configured to perform as a back up BCU for critical monitoring and control functions in the event of outage of main BCU.**

9.3. All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply. All protective relays shall have sufficient nos of spare output and input contacts.

9.4. All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 220 Volts VT secondary and current operated relays for 1 amp CT secondary. All DC operated relays and timers shall be designed for the 220 DC voltage as specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

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

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

9.7. Timers shall be of solid state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided.

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

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

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

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

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

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

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

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

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

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

9.11. All protective relays and alarm relays shall be provided with one extra isolated pair ofcontacts wired to terminals exclusively for future use.

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

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

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

9.15. All relays and their drawings shall have phase indications as R-red, Y-yellow, B-blue 9.16. For numerical relays, the scope shall include the following:

a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation.

b) The relay shall have suitable communication facility for connectivity to SCADA. The relays shall be capable of supporting IEC 61850 protocol.

10. 220 KV/ 132 KV TRANSMISSION LINE PROTECTION

10.1. All relays shall be suitable for series compensated line.

10.2. The line protection relays are required to protect the line and clear the faults on line within shortest possible time with reliability, selectivity and full sensitivity to all type of faults on lines. The general concept is to have two main distance protections having equal performance requirement viz. Main-I & Main-II for 220 KV transmission line and one Main Distance protection one back up O/c & E/F protection for 132 KV Transmission lines. These Distance protection relays should have sub cycle operating time.

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

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

10.5. Fault Recorder, Distance to fault Locator and Over voltage relay (stage -1) functions if offered as an integral part of line protection relay, shall be acceptable provided these meet the technical requirements.

10.6. Inbuilt Auto reclose relay function if offered as an integral part of Numerical LBB relay, shall be acceptable for 220kV lines only provided the auto reclose relay feature meets the technical requirements as specified in the respective clause.

10.7. **i) The following protections shall be provided for each of the 220 KV Transmission line**:

Main-I: Numerical distance protection scheme (with back up IDMT directional earth fault protection).

Main-II: Numerical distance protection scheme (with back up IDMT directional earth fault protection) of a make or type different from that of Main –I

ii) For 132 KV Transmission line: Numerical distance protection scheme (with back up IDMT directional earth faultprotection).

10.8. The detailed description of the protection relays is given here under:

10.8.1 Numerical Distance Protection schemes:

The relay shall be suitable to the following:-

i. **DC auxiliary supply**: - 220 V (Minimum range +/- 30 %)
ii. **Line length**: - 0.5 km to 300 km, single/double circuits
iii. **System earthing**: - solidly grounded
iv. **Max. Ambient temperature**: 55 degrees centigrade
v. **AC Voltage inputs (Secondary**): Nominal 220 Volts
vi. **AC Current Inputs (Secondary)**: 1 Amp. Nominal, 3 Amps. Continuous
vii. **Nominal System frequency**: 50 Hz.
viii. The relay shall have independently adjustable reactive or impedance and resistive reaches for all zone characteristic for maximum selectivity and maximum fault resistance coverage. It shall have adjustable characteristic line angle.
ix. The relay shall have a maximum operating time up to trip impulse to circuit breaker (complete protection time including applicable carrier and trip relay time) with CVT being used on the line for all types of faults anywhere in the protected line section during both max and min generation conditions.
    a) For SIR 0.01-4, as 40 ms at the nearest end and 60 ms at the other end of the line with carrier transmission time taken as 20 ms.

b) For SIR 4-15 as 45 ms at the nearest end and 65 ms at the other end of line with carrier transportation time taken as 20 ms.

x. **Output Contacts**: At least 18 Standard outputs.

xi. **Opto isolated inputs**: At least 18 inputs with no shared terminals. DC voltage – 110/220 (compatible with supply voltage) Volts DC

xii. **Phase Distance Protection.** The relay shall incorporate at least four zones of mho/quadrilateral distance protection for detection of phase faults. At least one zone shall be settable for either forward or reverse direction. Positive-sequence memory polarization shall be used to provide stable reach and reliable operation for zero voltage faults.

xiii. **Ground Distance Protection.** The relay shall incorporate at least four zones of mho/ quadrilateral distance protection for detection of faults involving ground. At least one zone shall be settable for either forward or reverse direction. Ground elements shall not overreach on multiphase faults and shall not be affected by load flow.

xv. **The relay shall be suitable for single and three pole tripping.**

xvi**. Relay setting Groups:** The relay shall have at least four setting groups.

xvii. Include fuse failure protection/ Loss of voltage feature which shall:

a) Monitor all three phase fuses of capacitance / electro-magnetic voltage transformer and associated cables against open circuit.

b) Inhibit tripping on sudden total loss of voltage or one/two fuse fail condition and initiate annunciation.

c) Have an operating time less than 7 ms.

d) Remain operative for system earth fault..

xviii. **Over current/Earth Fault Protection**. The relay shall have built in an independent directional/non- directional (selectable) Earth fault protection element to detect highly resistive faults. These elements shall have IDMT characteristic with a definite minimum time of 3.0 sec. at 10 times setting and shall have variable setting range of 20-80% of rated current and characteristics angle 45 degree lag.

Further it shall have directional/ non-directional (selectable) back up over current function in built. This element shall have IDMT characteristic with a definite minimum time of 3-0 seconds at 10 times setting having a variable setting.

xix. **Breaker Failure Logic**. The relay shall incorporate breaker failure logic for single-and three-pole tripping and reclosing Re-trip and transfer trip initiate contacts shall be provided. Pole discordance logic shall be included.

xx. **SOTF**: The relay shall have switch on to fault protection function.

xxi. **Auto-Reclosing with synchro-check facility.** The relay shall incorporate both single- and three- pole reclosing with four separately set open time intervals for three-pole and two intervals for single-pole reclosing.It shall

a) Have single phase and three phase re-closing facilities
b) Have a continuously variable single phase dead time of 0.5 to 5 seconds
c) Have continuously variable three phase dead time range of 0.5 to 5 seconds.
d) Have a continuously variable reclaim time range of 5-25 seconds
e) Incorporate a four-position selector switch from which single phase/three phase/single and three phase/auto re-closure and non-auto re-closure mode can be selected
f) Have facilities for selecting check synchronizing or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.
g) Be of single/multishot type
h) Include check synchronizing relay which shall
   i Have a time setting variable between 0.5 to 5 seconds.

ii Have a response time within 200 ms with the timer disconnected.

i) Include dead line charging relay.

j) Incorporate necessary auxiliary relays and timers to give comprehensive scheme.

k) Incorporate a separate pole discrepancy relay with timing range of 0.1 to 1 sec

l) Auto re-closure of the line shall take place only when fault is cleared in first zone by the main protection.

m) Incorporate auto re-closure lockout features to prohibit auto re-closure under the following conditions.

i Tripping due to operation of bus bar protection.

ii Tripping immediately after the manual closer of line breaker.

iii Tripping for faults in 2nd and 3rd zone as backup.

iv When tripping takes place after a power swing condition.

v In the event of trip on pole discrepancy.

vi When carrier is out of service.

n) It should have positive phase selections under all operating conditions. The scheme should be such that shut down and testing on one Main protection should not affect the other Main protection. The auto re-closure should then be connected to the other Main protection.

o) Come in to operation with distance protection when these protections operate for Zone-I fault and trip the breaker.

Auto re-closure settings

a)	Operating Mode	Only 1-Pole, Only 3-Pole, 1 or 3-Pole
b)	Dead Time	0.5 to 5 sec
c)	Reclaim Time	5 to 25 sec

xxii. **Event Reporting and Sequential Events Recorder**. The relay shall store event data recorded in nonvolatile memory. The relay shall include an SER (Sequential Events Recorder) report that stores the latest 500 entries of at least 50 monitored points.

xxiii. **Operator controls.** The relay shall include operator control pushbuttons on the relay front panel. Each pushbutton shall be programmable and accessible in the relay control logic. Facilities shall be available through a soft touch keypad on the HMI for setting alteration, display of all settings, scheme logics and any other requirements as per the software and hardware configuration of the system other than the menu driven alarms.

xxiv**. LED indications:** The relay shall have minimum 12 Nos. freely configurable LED indications for immediate visual information of relay operation.

xxv. **Fuse failure protection/ Loss of voltage feature.** It shall **:**

a) Monitor all three phase fuses of capacitance / electro-magnetic voltage transformer and associated cables against open circuit.

b) Inhibit tripping on sudden total loss of voltage or one/two fuse fail condition and initiate annunciation.

xxvi. **Pass word Protection.** The relay shall have multilevel pass wards to safeguard protection and automation settings.

xxvii. **Fault Locator**. The relay shall include a fault-locating algorithm to provide an accurate estimate of fault location without communications channels or special instrument transformers. It shall have an accuracy of 5% or better for all types of faults and fault levels.

a) It shall provide digital indication of distance to fault in percentage of the supervised line length of kilometers or in kilometers directly without requiring further calculations.

b) It shall provide distance to the fault together with information about the measuring loop that has been used in the calculations.

c) Information of the last 08 disturbances should be available.

d) The fault locator algorithm compensates the effect of the load currents, the apparent fault resistance and zero sequence mutual impedance.

e) It shall meet IEC-255 or other equivalent recognized standards.

f) It shall be suitable for breaker operation time of 2 cycles.

g) The above accuracy shall not be impaired under the following conditions.

i Presence of remote end in feed.

Ii Predominant DC components in fault current.

iii High fault Arc resistance.

Iv Severe CVT transients.

xxviii. **Digital Relay-to-Relay Communications.** The relay shall have send and receive logic elements, and analog and virtual terminal elements in each of two communications ports for dedicated relay-to-relay communications. Channel aided schemes should be implementable.

xxix. **Relay Logic.** The relay shall include programmable logic functions for a wide range of user-configurable protection, monitoring, and control schemes. Logic shall have the ability to use relay elements, math functions, comparison functions, and Boolean logic functions.

xxx. **IEC 61850 Ethernet Communications.** The relay shall provide IEC 61850-compliant communications. The IEC 61850 capability shall include GOOSE messaging and defined logical node data point.

Relay shall have two independent Ethernet communication ports (internal switch in the relay shall not be acceptable) on the rear supporting both fiber as well as RJ 45 communication options to provide (1) all the facilities available via the integral user interface and (2) facilities supplier under IEC 61850 interface.

xxxi. Communication. The relay shall include independent EIA-232 serial port for external communication.

xxxii. **PC Interface.** The relay shall be capable of being set by Windows-base graphical and ASCII terminal interface.

xxxiii. **IRIG-B Time Input.** The relay shall include an interface port for either a standard or high-accuracy demodulated IRIG-B time synchronization input signal.

xxxiv. **HMI Display.** The relay shall include custom configurable display information to display status on HMI, analog quantities, text and alarm information.

xxxv**. Environment.** The relay shall be suitable for continuous operation over a temperature range of -5 degree to + 55 degree Celsius.

xxxvi. **Self-monitoring**: Upon detecting a failure, the relay shall be able to provide useful diagnostic information to speed up maintenance. The relay shall be provided with a continuous self-monitoring and diagnostic unit to give alarm in case of abnormalities and locate defective units immediately. Self-monitoring should cover microprocessor, EPROM contacts, measuring elements, battery status and all associated program.

xxxvii. **Metering Functionality:** Shall include metering capabilities for real time current, Voltage, power, energy qualities, as well as phase demand and peak demand current values. Necessary software for relay settings, configuration of digital inputs, outputs, logic, viewing of fault records disturbance records etc. should be supplied as part of relay.

xxxviii. The maximum fault current could be as high as 40KA & minimum fault current could be as low as 20% of rated CT secondary current

xxxix. I/P, O/P and LED should be freely configurable.

xxxx. Numerical full scheme distance protection terminal shall be suitable for use with any communication scheme (permissive under reach, over reach, blocking) and have facility for connection to sub – station automation system.

xxxxi. Have **Disturbance recording** facility, which records a minimum of 08 analogue channels (phase and residual values) and a minimum of 32 digital programmable digital channels, which shall include various digital inputs, output relays and internal digital signals. The facility must be capable of recording at least 10 disturbances. The duration of record shall be settable and be adequate to capture maximum possible information and be bifurcated in pre-fault & post-fault time. Necessary software shall be provided for retrieving and analyzing the records.

xxxxii. **Out-of-Step Characteristics**. The relay shall detect stable and unstable power swings. User settings shall determine whether the relay trips or blocks tripping It shall:

a) Have separate measuring element for power swing detection.
b) Have fast detection of power swing.
c) Shall be on the principle of measurement of the rate of impedance vector change and monitoring of the vector path.
d) Have selective blocking of zones.
e) Have settable unblocking criteria for earth faults, phase faults and three phase faults.
f) Have the Earth fault detection feature, which shall over ride power swing blocking and allow the relay to operate for trip as per zone detection.
g) The relay shall be blocked for the set time for the first PS sensed and remain unblocked for the set time for the successive PS.

xxxxiii. The relay shall have provision of Broken Conductor Detection / protection with alarm/trip facility to detect open conductor condition by way of level detector or negative sequence measurement.

xxxxiv. Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc.

xxxxv. shall have two Ethernet ports with IEC62439-3 "PRP" support

The Following shall also be ensuredfor Distance Protection relays:

(a)**shall have subcycle (less than 20 ms) operating time**
(b)shall have resetting time of less than 55 milli-seconds (including the resetting time of trip relays)
(d) shall have variable residual compensation.
(e) shall have weak end in-feed feature
(f) **Shall have sufficient nos of freely configurable output and input contacts.(shall have min 20% extra output and input contacts over and above what is required in the scheme for future use)**

(g) shall have a continuous current rating of two times of rated current. The voltage circuit shall be capable of operation at 1.2 times rated voltage. The relay shall also be capable of carrying a high short time current of 50 times rated current without damage for a period of 1 sec.

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

(i) shall be suitable for use in permissive under reach / over reach /blocking communication mode.

(j) shall have suitable number of potential free contacts for Carrier aided Tripping,Auto reclosing, CB failure, Disturbance recorder & Data acquisition system.

(k) include power swing blocking protection which shall

- have suitable setting range to encircle the distance protection described above.
- block tripping during power swing conditions.
- release blocking in the event of actual fault

(s) include fuse failure protection which shall monitor all the three fuses of C.V.T. and associated cable against open circuit.

- inhibit trip circuits on operation and initiate annunciation.
- have an operating time less than 7 milliseconds
- remain inoperative for system earth faults

(t) The relays shall have terminal blocks suitable for wiring ring(eye) type lugs for CT and PT wires.

(u) Have Embedded IEEE 1588 time synch protocol support / dedicated IRIG-B

(v) Have IEC62439-3 "PRP" support

(w) Support for inter-relay protection communications via direct fiber as well as different interfaces.

10.8.3 Back-up Directional Over Current and Earth fault protection scheme.Shall be a separate relay other than Main I and II relays.

Numerical Directional Numerical Over current and Earth fault Relay shall be IEC 61850 compliant. it shall have;

i. 3 over current and 1 earth fault elements.
ii. selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic.
iii. High set over current with selectable time delay.
iv. High set Earth fault with selectable time delay
v. adjustable characteristic angle, lead/ lag, for Directional over current/ Earth Fault respectively Suitable to decide directionality through zero sequence quantity and through external open delta voltage input
vi. in built Breaker Failure Protection.
vii. Include hand reset Flag/LED indicators for fault.
viii. Readable Human Machine Interface with LCD display. viz. Fault current, Faulty Phase etc with time stamp.
ix. Shall have Disturbance Recording facility for minimum 3 sec for each fault.
x. Should be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp.
xi. Disturbance Recording facility for minimum 3 sec for each fault.
xii. Shall be Self monitoring type.
xiii. Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc.

xiv. The relay shall include an interface port for IRIG-B time synchronization input signal.
xv. The relay shall have Auto reclose and Check-synchronising feature also.
xvi. Embedded IEEE 1588 time synch protocol support / dedicated IRIG-B
xvii. Shall have IEC62439-3 "PRP" support
xviii. Support for inter-relay protection communications via direct fiber as well as different interfaces.

Technical Parameters:

a.	Current Rating	1A, 50 Hz ±2.5 Hz
b.	Voltage Rating	220 V, 50 Hz ±2.5 Hz
c.	Auxiliary Supply	220 V DC ±25 %
	Relay settings:	
a.	Over Current	50% - 200% (In steps of 5%)
b.	Earth Fault	5% - 80% (In steps of 5%)
c.	High set O/C	0.5 – 15 times In or more
d.	High set E/F	0.5 – 12 times In or more
e.	Time multiplier for IDMT	0.05 – 1.0 (In steps of 0.025) (Independent for O/C & E/F)
f.	Time delay for high set element	0.02 to 2 sec (in steps of 0.01 sec)
g.	Pick up	Within 1.1 times of set current value
h.	Reset current	95% to 90% of pick-up current
i.	Operating Time	As per selectable characteristic. For Inst. Element < 40 ms for 2xIn
	Other Features	
a.	Binary inputs	Min. 12 No. freely configurable and suitable 220 VDC
b.	Outputs	Minimum 12 freely configurable contacts
c.	Continuous carry	5 A
d.	Make & Carry for 0.5 s	30 A
e.	Make & Carry for 3.0 s	15 A
f.	Station Aux. DC	110 V/220 V DC
g.	Communication	• RS232/RS485, Fiber optic ports
		• IEC 61850 protocol
		• Time Synchronization: IRIG B port
h.	Housing	• Flush Mounting
		• Screw Terminals ('O' Lug for CT Connection)

10.8.4. Numerical Circuit Breaker Auto Reclosure Relay : This shall include followingfunctions:
AUTO RECLOSING function shall be incorporated in a Numerical relay separate from Main-I and Main-II protection and shall have single phase or/and three phase reclosing facilities

(a) shall be IEC61850 compliant and shall have at least two nos Ethernet/RJ45ports.
(b) The exact model of the relay shall be finalised by CSPTCL at the time of the engineering and it shall be binding on the contractor.
(c) have a continuously variable single phase dead time range of 0.1-2 seconds.

(d) have a continuously variable three phase dead time range of 0.1-2 seconds.

(e) have a continuously variable reclaim time range of 5-300 seconds.

(f) incorporate a four-position selector switch/ from which single phase/three phase/single and three phase auto reclosure and non-auto reclosure mode can be selected. Alternatively, the mode of auto reclosing can be selected through programming.

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

(h) be of single shot type.

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

(j) shall have check synchronising feature which shall

- have a time setting continuously variable between 0.5-5 seconds. with a facility of additional 10 seconds.
- have a response time within 200 milli seconds with the timer disconnected.
- have a phase angle setting not exceeding 35 degree
- have a voltage difference setting not exceeding 10%
- include dead line charging relay which shall
- shall be able to monitor the three phase voltage where one set shall be connected to the line CVTs with a fixed setting of 20% of rated voltage and the other set shall be connected to the bus CVTs with a fixed setting of 80% of rated voltage.
- incorporate necessary auxiliary relays and timers to give comprehensive scheme.
- Embedded IEEE 1588 time synch protocol support / dedicated IRIG-B
- IEC62439-3 "PRP" support
- Support for inter-relay protection communications via direct fiber as well as different interfaces.

10.8.5. LOCAL BREAKER BACK-UP PROTECTION SCHEMEshall be of Numericaltype and separate from Main 1 and Main 2 relays.It shall be IEC61850compliant and shall have two nos ethernet ports.

(a) Shall be phase segregated type.

(b) have an operating time of less than 15 milli seconds

(c) have a resetting time of less than 15 milli seconds

(d) have three over current elements

(e) be arranged to get individual initiation from the corresponding phase of main protections of line for each over current element. However, common three phase initiation is acceptable for other protections and transformer /reactor equipment protections

(f) have a setting range of 20-120 % of rated current

(g) have a continuous thermal withstand two times rated current irrespective of the setting

(h) have a timer with continuously adjustable setting range of 0.1-1 seconds

(i) have necessary auxiliary relays to make a comprehensive scheme.

(j) The exact model of the LBB relay shall be finalised by the customer at the time of the engineering and it shall be binding on the contractor.

(k) In case the breaker fails to trip within 200 ms of the trip relay operation; the LBB relay shall be allowed to trip all the breakers connected to the BUS. An independent numerical LBB relay, IEC: 61850 compliant should be provided. The LBB relay shall have IRIG B port time synchronization. This relay shall have the provision for independent setting of current and independent time delay. The relay contacts shall be terminated up to terminal block. LBB trip circuits ferrule numbers shall be 'P' series.

(l) Local breaker backup protection scheme shall:

a)Comprise of a breaker failure initiating relay, breaker failure relay which supervises the fault current flowing through the breaker being protected against failure and breaker failure time delay relay and breaker failure lockout relay.

b)The operation of both breaker failure initiating relay and breaker failure relay will initiate timer relay which in turn operate lockout relay. The lockout relay will haveN/O contacts for annunciation and for energisation of bus bar protection trip relays (available separately as per the scheme) for tripping all the other breakers connected to the bus.

(m) Breaker failure relay scheme above shall:

(n) Be suitable for 220 V DC supply.

(o) have a resetting time of less than 15 ms.

(p) Have necessary auxiliary relays to make a comprehensive scheme. The scheme shall be so engineered that in the event of persisting breaker lockout condition and simultaneous incidence of fault shall result in instantaneous tripping of the concurred bus bar to which the faulty breaker is connected.

(q) Embedded IEEE 1588 time synch protocol support / dedicated IRIG-B

(r) IEC62439-3 "PRP" support

(s) Support for inter-relay protection communications via direct fiber as well as different interfaces.

10.8.6. TRIP CIRCUIT SUPERVISION RELAY

(a) The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.

(b) The relay shall have adequate contacts for providing connection to alarm and event logger.

(c) The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

10.8.7. LINE OVER VOLTAGE PROTECTION RELAYshall be of Numerical typeand IEC61850 compliant.

(a) monitor all three phases

(b) have two independent stages and stage- 1 & II relay are acceptable as built inwith line distance relays Main I & II respectively .

(c) have an adjustable setting range of 100-170% of rated voltage with an adjustabletime delay range of 1 to 60 seconds for the first stage.

(d) have an adjustable setting range of 100-170% of rated voltage with a time delay of100-200 mill seconds for the second stage.

(e) be tuned to power frequency

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

(g) have a drop-off to pick-up ratio greater than 95%.

(h) provide separate out-put contacts for each 'Phase' and stage for breaker trip relays,event logger and other scheme requirements.

10.8.8 TRANSFORMER DIFFERENTIAL PROTECTION

The following protections shall be provided for Transformers :

Main-I: Numerical Differential protection scheme

Main-II: Numerical Differential protection scheme (of a make or type different from that of Main –I)

Numerical Transformer differential protection scheme (three winding)one each on separate panels, shall have sufficient nos of freely configurable output and input contacts.(shall have min 20% extra output and input contacts over and above what is required in the scheme for future use)

(a) shall be IEC61850 compliant and shall have two nos RJ45 ports or other Ethernet ports.

(b) The exact model of the relay shall be finalised by the customer at the time of the engineering and it shall be binding on the contractor.

(c) be triple pole type, with faulty phase identification/ indication

(d) **have an operating time not greater than 25 milli seconds at 5 times the**

ratedcurrent.

(c) have three instantaneous high set over-current units

(d) have an adjustable bias setting

(e) be suitable for rated current of 1 Amp.

(f) have second harmonic or other inrush proof features and also should be stable under normal over fluxing conditions. Magnetizing inrush proof feature shall not be achieved through any intentional time delay e.g use of timers to block relay operation or using disc operated relays

(g) have an operating current setting of 15% or less

(g) have internal feature in the relay to take care of the angle & ratio correction

(h) have 3 phase Bus PT voltage inputs also

(i) have Embedded IEEE 1588 time synch protocol support / dedicated IRIG-B

(j) have IEC62439-3 "PRP" support

(k) have support for inter-relay protection communications via direct fiber as well as different interfaces.

(l) have a disturbance recording feature to record graphic form of instantaneous values of current in all three windings in nine analogue channels, during faults and disturbances for the pre fault and post fault period. The disturbance recorder shall have the facility to record the following external digital channel signals apart from the digital signals pertaining to differential relay.

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

Necessary hardware and software for down loading the data captured by disturbance recorder to the personal computer in the substation shall be included in the scope.

10.8.9. Over fluxing protection Relaysshall be Numerical type and IEC 61850 compliant and independent relay.

(a) operate on the principle of Voltage to frequency ratio and shall be phase to phase connected

(b) have inverse time characteristics, matching with transformer over fluxing withstand capability curve.

(c) provide an independent 'alarm' with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of 'v/f' between 100% to 130% of rated values

(d) tripping time shall be governed by 'v/f' Vs. time characteristics of the relay

(e) have a set of characteristics for Various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at 'v/f' values of 1.4 and 1.5 times, the rated values, respectively.

(f) have an accuracy of operating time, better than ±10%.

(g) have a resetting ratio of 95 % or better.

(h) Not acceptable as a built in feature of numerical transformer differential relay

(i) have Embedded IEEE 1588 time synch protocol support / dedicated IRIG-B

(j) have IEC62439-3 "PRP" support

(k) have support for inter-relay protection communications via direct fiber as well as different interfaces.

10.8.10. Numerical Restricted Earth Fault Protectionshall be Numerical type and IEC 61850 compliant. It shall

(a) be single pole type

(b) be of current /voltage operated high impedance type
(c) have a current setting range of 10-40% of 1 Amp.! have a suitable voltage setting range.
(d) be tuned to the system frequency
(e) have Embedded IEEE 1588 time synch protocol support / dedicated IRIG-B
(f) have IEC62439-3 "PRP" support
(g) have support for inter-relay protection communications via direct fiber as well as different interfaces.

10.8.11. Back-up Directional Over Current and Earth fault protection scheme for Transformers.

Shall be a separate relay other than Main I and II relays and shall have the same specification as mentioned at clause 10.8.3

10.8.12. Numerical Transformer Overload Protection Relay shall

(a) be of single pole type
(b) be of definite time over-current type
(c) have one set of over-current relay element, with continuously adjustable setting range of 50-200% of rated current
(d) have one adjustable time delay relay for alarm having setting range of 1 to 300.0 seconds, continuously.
(e) have a drop-off/pick-up ratio greater than 95%.
(f) have Embedded IEEE 1588 time synch protocol support / dedicated IRIG-B
(g) have IEC62439-3 "PRP" support
(h) have support for inter-relay protection communications via direct fiber as well as different interfaces.

10.8.13. Numerical Transformer Neutral Displacement Relay for 220 KV transformer.

(a) Shall be IEC61850 compliant and have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated voltage.
(b) have Embedded IEEE 1588 time synch protocol support / dedicated IRIG-B
(c) have IEC62439-3 "PRP" support
(d) have support for inter-relay protection communications via direct fiber as well as different interfaces.

10.8.14.Technical Specifications of High Speed Trip Relays:

High Speed Tripping Relay shall

(a) be instantaneous (operating time not to exceed 10 milli-seconds).
(b) reset within 20 milli seconds
(c) be D.C. operated
(d) have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc.
(e) be provided with operation indicators for each element/coil.
(f) As per the system design sufficient relays having potential free contacts for trip circuit 1 & 2 of main breaker and TieCB/TBC. The contacts for trip circuit shall be Heavy Duty.
(g) Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation. Auto re-close relay, LBB relay, DR/SER Data acquisition and optional trip facility to be connected by Purchaser where needed.
(h) It shall be instantaneous with operating time less than 12 ms. It shall have minimum 18NO & 2NC hand resetting type contacts. It shall be rated for 220VDC operating voltage.
(i) Be provided with operation indicators.

(j) shall be of self-monitoring type

(k) All trip relays used in protection scheme shall be of self/electrical reset type depending on application requirement.

10.8.15.DC SUPPLY SUPERVISION RELAY

(a) The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.

(b) It shall have adequate potential free contacts to meet the scheme requirement.

(c) The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and be provided with operation indicator/flag.

10.8.16 Energy Meter:- SEMS make 0.2S class, electronic 4 quadrant, import-export, 3phase 4wire,trivector energy meters shall be provided with heavy duty 4STB type DAV make TTB on the front panel. The energy meters shall indicate instantaneous parameters like KW, KVA, KVAR, Pf, current, voltage etc.The energy meter shall have 15 minutes load survey for KW& KVA for a minimum period of 60 days. The CT/PT ratio of the energymeter shall be matched with that of the individual bay. The meter should have RS485 port for data communication with modbus protocol or shall be compliant with IEC61850 on Ethernet port.

11. BUS BAR PROTECTION SCHEME

220 KV Bus bar Protection scheme& 132 KV Bus bar Protection Scheme

The numerical, LOW IMPEDENCE, Centralized configurations busbar protection scheme shall be suitable for 1A secondary current,110V secondary PT voltage, 50 Hz double busbar with transfer bus.

The Bus bar protection scheme shall be suitable for following requirement:

11.1 The numerical, low impedance, centralized configuration type with based differential characteristics, should have operative and restraint characteristics suitable for 220V DC Aux. supply with variation of (-)20% (minus20%) and +10%. The DC voltage of the panel shall be informed at the time of detailed engineering.

11.2 The scheme shall be suitable to ensure the isolation of the faulty zone, stable during through fault and shall be backed up by check zone and end zone protection.

11.3 The system shall have maximum operating time from trip impulse to trip relay for all types of faults not more than 20 milliseconds at 5 times current setting value.

11.4 The scheme shall have operating selectivity for each busbar and shall also have dynamic zone selection through isolator replica without the use of external CT switching relays. It shall be possible to isolate any particular bay or zone of the busbar protection scheme during the maintenance activity without affecting the protection of the complete scheme. The scheme shall be highly stable for external fault.

11.5 It shall give hundred percent security up to 40KA fault level.

11.6 The scheme shall have continuous supervision for CT secondary against any possible open circuit and CT saturation and if it occurs, shall render the relevant zone of protection in operative and initiate an alarm.

11.7 The scheme shall be of phase segregated and triple pole type and shall not give false operation during normal load flow in bus bars and incorporate clear zone indication.

11.8 The bus bar protection scheme should have minimum 4 zones of protection with zone distribution as mentioned here under:

Bus-I : zone-I
Bus-II : zone-II
Transfer bus : zone-III
Check zone : zone-IV

11.9 The Bus bar protection scheme shall include necessary CT switching through relay software or through isolator contract/ replica directly without using external CT switching relays.

11.10 The Bus bar protection scheme shall include individual high speed electrically reset tripping relay for each feeder.

11.11 The scheme shall ensure that all configuration and logics are realized in the relay software. The dynamic replicas shall be provided to show busbar linking as desired by the system.

11.12 The scheme shall annunciate all faults events and monitoring status on a Microprocessor based 24 point annunciation relay with RS 485 port to accommodate all annunciations related to the scheme. However, even more number of windows shall be provided to fulfill scheme requirement, if required. The scheme shall have at least two numbers of independent setting groups. The scheme should have at least 8Nos.LEDs for fault indication.

11.13 The scheme should be transient free in operation.

11.14 TheschemeshouldincludecontinuousDCsuppliessupervisionforalarmandtrip circuits.

11.15 The scheme should include protection 'IN/OUT' switch for each zone with alarm and window on annunciation indication.

11.16 The scheme shall have disturbance recorder, event logger etc.i.e. complete in all respect.

11.17 The busbar protection scheme shall have at least two numbers Ethernet communication ports supporting PRP. It shall have one number independent front Ethernet port/RJ45/RS-232/LAN port for local communication for relay setting, modification, extraction analysis of fault/event/disturbance records from laptop and are fibre optic port on IEC-61850 standard for remote communication to SCADA system. In addition the scheme shall have capability for accurate times unchronization with GPS clock through (IRIG-B port/PPM/SNTP). The scheme should confirm to at least following requirement of IEC-61850 and necessary certificate shall be furnished for the compliance.

(a) Basic Data Exchange
(b) Data Sets
(c) Un buffered reporting
(d) Generic object oriented substation events
(e) Time synchronization
(f) File transfer.

11.18 The scheme shall have continuous comprehensive self-diagnostic feature to monitor the healthiness of all the hardware and software elements of the relay. Any failure detected shall be annunciated.

11.19 The scheme shall be a complete package in all respect including all software hardware etc, all auxiliary relays, individual high speed hand reset tripping relays for each feeder, indication lamps etc, if required.

11.20 The scheme shall ensure that no region within the busbar zone should be left unprotected by the offered busbar scheme. Fault between isolator and CT in bus coupler section should be detected by the bus bar scheme.

11.21 The scheme shall include necessary software for CT ratio correction. No ICT etc. shall be allowed to be used.

11.22 The bus bar protection scheme should be equipped with IRIGB Port.

11.23 It shall include continuous supervision of each DC supply separately.

11.24 Test terminal block shall be fully enclosed with removable covers and shall be made of moulded, non-inflammable good quality material with boxes barriers molded integrally.

11.25 The Bus Bar protection scheme shall have 3 phase Bus PT inputs for all PTs.

11.26 The scheme should not trip for the differential current below the load current of heaviest loaded feeder. This feature should be provided with enable/disable option.

11.27 The scheme shall provide on the unit and should be accessible for checking of the menu, setting and DR etc at least in the following way:

(a) HMI on the front of the relay. The busbar protection scheme shall have a large HMI in the front capable of displaying bay current and all calculated differential current etc.

(b) The relay should display the menu, setting, DR & ER etc. through the keyboard provided on the front of the relay.

(c) TheschemeshouldhaveRS232/LAN port on the front of the panel for accessing by using personal computer to go through the menu, Setting measurements and disturbance records and dynamic busbar replica etc. This may be on the propriety protocol. The associated software shall be supplied along with the relay.

(d) It should be provided with suitable port so that all the relays in the system could be brought on the common bus and connected to a common computer available in the S/S for communication for accessibility of menu, disturbance records, event record and bus bar replica etc.

(e) have Embedded IEEE 1588 time synch protocol support

(f) have IEC62439-3 "PRP" support

(g) have support for inter-relay protection communications via direct fiber as well as different interfaces.

11.28 The numerical relay should have in built breaker failure with 3 phase LBB initiation scheme with the operation and resetting time not more than 20 milli second. The relay shall have adjustable time delay of 100 to 500 ms with tripping time delay of relay not more than 20 milli second.

11.29 All the Busbar panels shall be suitable for at least 16 (sixteen) Number of bays.

11.30 The number of analog inputs & digital inputs should be sufficient for 16 number of bays required in the busbar protection panel.

11.31The scheme should be capable to monitor minimum 64 number Isolators and to provide individual alarm for each Isolator.

11.32 IEC62439-3 "PRP" support

11.33 The scope of supply of BusBar Protection scheme shall also include the following:

a) Necessary software and hardware to up/down load the data to/from the relay from/to the Data Extraction Device.

b) Data Extraction Device having following specifications or better;

Powered by 5th Generation Intel® Core i5-5200U Processor with Windows 8.1 Single Language (64Bit) English, RAM - 8GB Dual Channel DDR3L 1600 MHz (4GBx2), Hard Drive - 1TB 5400 rpm, Display : 15.6-inch HD (1366 x 768) Truelife LED-Backlit Touch Display, Video card : AMD Radeon™ R7 M270 4GB DDR3,Ports/slots- USB 3.0 with Power Share (1), USB 3.0 (1), USB 2.0 (1) HDMI™ v1.4a, Combination headphone/ microphone jack Noble Lock Slot AC Power In, Multi-media Card Reader - Digital (SD) Memory Card, Secure Digital High Capacity (SDHC), Secure Digital Extended Capacity (SDXC), Power - Prismatic (58 WHr) Lithium Ion. Security Software -McAfee® Security Center 15 month subscription, Warranty - 1Yr ProSupport: Next Business Day Onsite Service w/ Accidental Damage.

12. OTHER REQUIREMENTS FOR RELAYS:

12.1 All relays shall be contained in dust proof cases. All cases shall be mounted on the control and relay panels and the details of mounting shall be to CSPTCL's approval. Relays shall be of the projecting pattern or flush pattern as specified. Main relays shall have protocol IEC 61850 and IRIG–B for GPS time synchronising and have facility of oscillographic disturbance recording as well as trip value recording. Main protective relays should preferably have facility to log in Aux. supply failure and restoration time accurately.

12.2 Indicators shall also be provided on such additional elements as will enable the type of phase of the fault condition to be identified. Each indicator whether of the electrically or mechanically operated type shall be capable of the reset by hand without opening the relay case. Each indicator shall be so designed that it cannot move before the relay has completed its operation. It shall not be possible to test and operate any relay by hand without opening case. On operation of protective relay, operation indicator shall appear permanently unless reset. On demand type indicators are not acceptable.

12.3 All relays shall be so arranged that on opening the case it shall be impossible for any dust, which have collected in or upon the case to fall on the relay mechanism.

12.4 All relays shall confirm to the requirement of IS-3231 or other applicable approved standards. Relays shall be suitable for flush or semi flush mounting on the front with connections from the rear. Relays shall be rectangular in shape and shall have dust tight, dull black or egg shell black enamel painted cases with transparent cover removable from the front.

12.5 All protective relays shall be in draw out or plug in type/module cases with proper testing facilities. The testing facilities provided on the relays shall be specifically stated in the bid. **Necessary test plugs shall be supplied loose and shall be included in contractor's scope of supply**. Test block and switches shall be located immediately below each relay for testing. CSPTCL reserves the right for accepting any one of the above two testing facilities. Unless otherwise specified all auxiliary relays and times shall be supplied in non-draw out cases/plug in tight modular cases.

12.6 All AC relays shall be suitable for operation at 50 Hz AC voltage operated relays shall be suitable for 220 Volt VT secondaries and current operated relays of 1 amp CT secondaries as specified in the specification. DC auxiliary relays and timers shall be designed for the 220 V DC and shall operate satisfactorily on ±20% of rated voltage. Voltage operated relays shall have adequate thermal capacity of continuous operation.

12.7 The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts/suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring circuits etc. and also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least three pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme; contacts shall be silver faced with spring action. Relay cases size shall be so chosen as not to introduce any limitations on the use of available contacts on the relay due to inadequacy of terminals.

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

12.9 Timers shall be of numerical type.

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

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

12.12 All relays shall withstand a test voltage of 2.5 KV 50 Hz. rms voltage for one second except static relays.

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

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

12.15 In order to minimise the effects of electro-osmosis, flag coils and DC relay operating coils shall be so placed in the circuit that they are not connected to the positive pole of the battery except through contacts which are normally open.

12.16 All protective relays and alarm relays shall be provided with minimum three extra isolated pair of contacts wired to terminals exclusively for future use.

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

12.18 All relays and their drawings shall have phase indications as R-Red, Y-yellow, B-Blue.

For numerical relays, the scope shall include the following:

a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation.

b) The relay shall have suitable communication facility for connectivity to workstation of S/S. The relays shall be capable of supporting IEC 61850 protocol.

13. TIME SYNCHRONISATION EQUIPMENT

13.1 The Time synchronisation equipment shall receive the co-ordinated Universal Time (UTC) transmittedthrough Geo Positioning Satellite System (GPS) and synchronise equipments to the Indian Standard Time in a substation.

13 .2 Time synchronisation equipment shall include antenna, all special cables and processingequipment etc.

13.3 It shall be compatible for synchronisation of Event Loggers, Disturbance recorders and SCADA at a substation through individual port or through Ethernet realised through optic fibre bus.

13.4 Equipment shall operate up to the ambient temperature of 50 degree centigrade and100% humidity.

13.5 The synchronisation equipment shall have accuracy better than 500 ns. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, &temperature variations, propagation & processing delays etc).

13.6 Equipment shall meet the requirement of IEC 60255 for storage & operation.

13 .7 The system shall be able to track the satellites to ensureno interruption ofsynchronisation signal.

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

13.9 The equipment offered shall have four (4) spare output ports over and above required ports. Various combinations of output ports shall be selected by the customer, during detailed engineering, from the following :

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

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

13.11 Time synchronisation equipment shall be suitable to operate from 220V DC

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

14. Relay Test Accessories to be provided with BusBar Protection panels

14.1 One relay test kit shall comprise of the following equipment as detailed here under

Relay tools kits -3 sets

Test plugs – one each for each test block.

15. TYPE TESTS

15.1 The reports for following type tests shall be submitted by the bidder for the Protective relays, Fault locator, Disturbance recorder and Event Logger

a) Insulation tests as per IEC 60255-5
b) High frequency disturbance test as per IEC 60255-4
c) Fast transient test as per IEC 1000-4, Level III(not applicable for electromechanical relays)
d) Relay characteristics, performance and accuracy test as per IEC 60255
   - Steady state Characteristics and operating time
   - Dynamic Characteristics and operating time for distance protection relays and current differential protection relays
   - For Distrubance recorder and Event logger only performance tests are intended under this item.
e) Tests for thermal and mechanical requirements as per IEC 60255-6
f) Tests for rated burden as per IEC 60255-6
g) Contact performance test as per IEC 60255-0-20

15.2 Steady state & Dynamic characteristics test reports on the distance protection relays, as type test, shall be based on test programme specified in Appendix A on simulator/network analyser/PTL. Alternatively, the files generated using Electromagnetic transient Programme (EMTP) can also be used for carrying out the above tests. Single source dynamic tests on transformer differential relay shall be/ should have been conducted based on general guidelines specified in CIGRE committee 34 report on Evaluation of characteristics and performance of Power system protection relays and protective systems.

16. 132 KV & 33 KV CONTROL & RELAY PANELS:-The panels shall be required for 132 KV (3- ϕ) & 33 KV lines, transformers, bus transfer, 33 KV capacitor bank. All panels shall be of Simplex type for 132 KV and 33 KV.

i. **The control and relay boards required for 132 KV side shall be separate and shall be of simplex type panel. The relay panels shall be placed in Bay marshalling room and the control panels shall be placed in Control room. However, for 33 KV side control and relay facility shall be supplied in single panel for individual bays. The 33 KV combined C&R panels shall be placed in control room.**The control, recording and indication apparatus shall be mounted in the front panel. These shall be of the flush pattern. However, if relays of "draw out" type are offered, these may be arranged to be flush.

ii The labelling for the circuits shall be provided at the front of control panels& the relay panels as well as on the inside of the panels.

iii The panels shall be of uniform thickness and level sheet steel of minimum14 gauge (3 mm for load bearing sides & 2mm for other sides). The bottom of the cubicle shall be open for the purpose of wiring and cable entrance. The panel shall be designed to be self supporting and wherever additional structural strength is required, inconspicuous braking, gusset, welding etc., shall be used. All control panels and switchgear cubicles shall be made absolutely vermin proof design of the approval of the CSPTCL.

iv The panels shall be made in suitable sections to facilitate easy transport and handling and shall be later assembled at site. It may please be noted carefully that it should be possible to dissemble the relay control board of a substation in length of 700/800 mm for ease of handling, single continuous sheet steel should not be used to make a single board for all the panels required. The panels should have unitized construction with facility to bolt together the panels where more than one panel is involved.

v The panels shall be provided with best quality independent TTBs for Differential relay, REF relay, O/C & E/F relay, Distance Protection relay, Over fluxing relay, LBB relay and overload relay etc.

16.1 PANEL CUT OUT AND DIMENSIONS:

i) The panels shall be fabricated of not less than 14 SWG sheet steel free from all surface defects. The panels shall have sufficient structural reinforcement to ensure a plain surface to limit vibration and to provide rigidity during despatch and installation.

ii) **The 132 KV and 33 KV Panels shall have the following dimensions:**

Type	**Simplex Panel**
Height	2300 mm
Depth	800 mm.
Width	800 mm.

iii) The panels shall be made in suitable sections as described elsewhere in the specification so that while mounting, the panels can be located side by side bolted together to form a compact unit.

iv) Design material selection and workmanship shall be such as to present a peak appearance, outside and inside with no works of welds, reverts, screw or bolts head apparent from the exterior surfaced of the control boards.

16.2 AUXILIARY SUPPLY:-

i. (415 V + 10% to –25% 4 wire, 3 phase 4 wire 50 C/s, neutral grounded AC supply. The contractor shall arrange for providing proper looping of these power supplies to the different panels of the control board group.

ii. H.R.C. fuses shall be provided at each panel for both the AC and DC power supplies. Distribution and wiring of the same shall be utilised through fuses and links in such a way so that isolation of respective system unit is possible without affecting the rest of the system or unit.

iii. All H.R.C. fuses and links shall be with holder, and the same shall be mounted on slant support and with identification labels.

iv. For each control and relay panel, the contractor will arrange to provide a separate cable from DCDB for 220 V DC supply.

v. The H.R.C. fuses as per following details shall be provided:

S. No.	**CIRCUIT**	**FUSE RATING 132 KV**
1.	Circuit breaker closing circuit.	16A
2.	Trip circuit I & II	16 A
3.	Main protection	10 A
4.	Back up protection	10 A
5	Indication	4A
6	Annunciation	4A
7	P.T. Circuit	4 A

16.3 CONTROL WIRING:

i) Wiring shall be done with flexible heat resistant multi strand wires, PVC insulated with standard copper conductor. The conductor size shall be equivalent to 2.5 mm square for CT/PT and LV AC and 1.5 mm square for control circuit unless otherwise specified in this tender.

ii) Coloured wires shall be used for wiring as per latest revision of IS-375 viz; red, yellow, blue and black for R,Y,B, phases and neutral respectively, green for earthing , grey for annunciation & control circuits & white for trip circuit.

iii) Each wire shall be identified at both ends with wire designation number by plastic ferrule as per wiring diagram based on latest revision of IS-375 to denote the different circuit functions. The contractor shall take approval for the system of wire numbering.

iv) All wires termination shall be made with compression type connectors. Wires shall not be tapped or spliced between terminal points. All wire shall have crimp type termination and direct connection at any place is not at all required.

v) All series connected devices and equipment shall be wired up in sequence. Loop-in Loop out system of wiring shall be avoided as far as possible and the common buses shall normally be made through the terminal block for better reliability of testing and maintenance.

vi) Fuses and links shall be provided for isolation of individual circuit from bus bars without disturbing other circuits and equipments.

vii) The DC trip and DC voltage supplies and wiring to main protective gear shall be segregated from those for special purposes. Each such group shall be fed through separate fuses, either direct from main supply fuses or the bus wires.

viii) Since a number of wires will run from one point to another, it is desired that the support arrangement should be adequate and neat. The conventional method of bunching of wires should not be adopted since the same creates problems in case any wire is to be removed. The wires should be accommodated in a suitable plastic channels with sliding plastic cover, which may be mounted inside the panels suitably. Inspection/removal of wires should be possible by sliding the covers.

ix) Blank plastic channels should be provided by the sides of the panels to accommodate the incoming cables from switchyard through the cable glands.

x) Stud type terminal connectors suitable for ring type lugs shall be used.

16.4 CABLE ENTRY:-

i) The control board shall have provision of cable entry from the bottom. Necessary cable glands should also be provided.

ii) The wiring through the terminal blocks shall be so located so as to be convenient for floor openings.

iii) The control board shall have provisions for fixing the multi-core cable glands which shall be included by the contractor in scope of supply. For fixing these cable glands, detachable gland plates of 4 mm thickness shall be mounted.

iv) Gland plate shall be supplied with factory made gland holes with suitable blanking arrangement for un used gland holes. The gland plate and doors shall be properly gasketted.

v) Rigid supports shall be provided along with terminal block for holding plastic channel. Suitable clamps may also be provided in plastic channel for holding cables.

16.5 CONTROL & INDICATION CIRCUITS:

16.5.1 The control and indication circuit for each circuit breaker controlling feeder or transformer shall generally comprise the following:

i) Mimic diagram (main and transfer bus scheme)
i) Ammeters and voltmeters where specified.
ii) PF, Mega Watt, MVAR meter where specified.
iii) Circuit Breaker Control switch.
iv) "Trip Circuit Healthy" I & II lamps.
v) Alarm Cancellation arrangement.
vi) Breaker ON/OFF indication lamps.
vii)Breaker Spring Charge indication lamp.

16.5.2 The mimic diagram offered shall be at the eye level to indicate the position of each breaker, isolating and grounding switch. Other equipments such as transformer, voltage transformers etc., shall be represented by suitable symbols. The arrangement shall be of over laid design. Painted type mimic diagram is not acceptable. Mimic diagram shall be for single main & single transfer arrangement.

16.5.3 Rotating disc type semaphore shall be used to indicate the position of each breaker. The position of the circuit breaker whether closed or open shall be indicated by semaphore indicator to be provided for this purpose. It may be noted that the circuit breaker will have two trip coils in parallel and since their DC source of supply is one at present, necessary arrangement shall be made in the panel circuitry. For this purpose contact multiplication will not be involved but the rating of the control switch should be adequate to handle; the burden of two trip coils. Along with pistol grip type control switches red and green indicating lamps for ON/OFF indication shall be provided.

16.5.4 **ANNUNCIATION SYTEM:**

16.5.5 Alarm annunciation system shall be provided for the control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltages specified in this specification.

16.5.6 The annunciation shall be of visual and audible type. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels. The audible alarm shall be provided by alarm hooter or bell .The annunciator facia shall be provided with translucent plastic window for alarm point with minimum size of 35 mm x 50 mm. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.

16.5.7 Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long-life lamps shall be used. The lamp circuit shall include series resistor of adequate rating. The cover plate of the facia windows shall be flush with the panel and shall be capable of easy removal to facilitate replacement of lamps. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure clear visibility of the inscriptions in the control room having high illumination intensity (500 Lux) from the location of the operator's desk.

16.5.8 **TRIP AND NON TRIP** facia shall be differentiated. All trip shall have red colour and all non trip facia shall have white colour.

Sequence of operation of the annunciator shall be as follows:-

Sl. No.	Alarm condition	Fault contact	Visual Annunciation	Audible Annunciation
1	Normal	Open	OFF	OFF
2	Abnormal	Close	Flashing	ON
3.	Acknowledge push button is pressed.	Close	Steady on	OFF
		Open	Steady on	OFF
4	Reset push button is pressed.	Close	On	OFF
		Open	Off	OFF
5	Lamp test push button pressed.	Open	Steady on	ON

16.5.9 The annunciation system described above shall meet the following additional requirements:

i The annunciation system shall be capable of catering to atleast 80% simultaneous signals (of windows provided) at a time.

ii. One self resetting push button shall be provided on each panel for testing the facia window lamps. Push buttons for testing flasher and audible alarm circuit of annunciation system and for testing the annunciation supply failure monitoring circuit shall also be provided. These testing circuits shall also be so connected that while test is being done it shall not prevent the registering of any new annunciation that may land during the test.
One set each of the following push buttons shall be provided on each panel as shown in the front view drawing:

a) Reset push button for annunciation system.
b) Accept push button for annunciation system.

iii. The annunciations shall be repetitive type and shall be capable of registering the fleeting signal. Minimum duration of the fleeting signal registered by the system shall be 15 milli seconds.

iv. The annunciation shall be suitable for operation with normally open fault contacts which close on a fault. For fault contacts which open on a fault it shall be possible at site to change annunciators from "close to fault" to "open to fault" and vice versa.

v. In case of static annunciation scheme, special precaution shall be taken by contractor to ensure that spurious alarm condition does not appear due to influence of external electromagnetic/electrostatic interferences on the annunciation wiring and switching disturbances from the neighbouring circuits within the panels.

vi. The annunciation scheme (wherever called for) offered shall be complete in all respects including annunciation relay, flasher relay test, accept and reset arrangement.

vii. The CSPTCL reserves the right to ask for a sample of annunciation system for approval, if so considered necessary from the successful contractor.

17. CONTROL CONNECTIONS AND INSTRUMENT WIRING:

17.1 Panel connection shall be insulated and shall be neatly and securely fixed to the back of the panel. All instrument and panel wiring shall be of an approved type which will not support combustion and shall run in porcelain or non-rustable metal cleats or in non-rustable tubes or galvanised steel tubes as may be approved. All panel wiring shall be taken to approve terminal boards which shall comply with requirements of multicore cable boxes where applicable. Switch board wiring shall be PVC or VC braid impregnated with flame proof compound. Rubber insulation is not acceptable.

17.2 All wiring diagrams shall be clearly marked with the number which are shown on the ferrules of the individual cores. 20% spare and blank ferrule shall be supplied with each panel.

17.3 Flat terminals shall not be used but each end of each instrument or control wire shall be terminated with a Rose Corstney or other approved type of washer.

17.4 Each set of current/ voltage transformer secondary connections shall be complete in itself and shall be earthed at one point only. Each such earthing connection to the earth bar shall be made in accordance with the requirement of the earthing system and shall be made through a link of approved design which can be removed when insulation tests are required without breaking any circuit normally carrying current.

17.5 For each circuit on the panel, the control indication and trip wiring shall be suitably segregated so that these could be isolated to permit testing or other work. The semaphore and other indication circuits shall be connected to the DC bus by a set of fuses. Similarly, the trip and close circuits shall also be connected by a separate set of fuses. The fuses shall be labelled clearly showing the circuits connected.

17.6 All secondary fuses shall be of an approved type. HRC fuses of some standard make shall only be used.

17.7 Where specified test blocks shall be provided for testing of meters and relays. They shall be of the switch board type back connected for front of panel mounting. The test blocks shall provide complete isolation of meters, instruments and relays and the arrangements shall be such that testing power could be connected at the test block from the external source or may be taken from the instrument transformer. Provision shall be made for short circuiting current transformers, by sliding type element connectors.

18. METERING AND CONTROL:-

a) **Ammeter**:-The ammeter shall be 96 Sq.mm, digitaltype of class-I accuracy.
b) **Voltmeter:-**One number digital self powered voltmeter shall be provided with voltmeter selector switch.The LED display shall not be less than 1 inch.

c) **Energy Meter**:- SEMS make 0.2S class, electronic 4 quadrant, import-export, 3phase 4wire,trivector energy meters shall be provided with heavy duty 4STB type DAV make TTB on the front panel. The energy meters shall indicate instantaneous parameters like KW, KVA, KVAR, Pf, current, voltage etc.The energy meter shall have 15 minutes load survey for KW& KVA for a minimum period of 60 days. The CT/PT ratio of the energymeter shall be matched with that of the individual bay. The meter should have RS485 port for data communication with modbus protocol or shall be compliant with IEC61850 on Ethernet port.

d) A 18-window facia annunciator with following inscription shall be provided on the front with audible DC alarm bell. The make shall be Alan/Bharani/ Minilec/ JVS.

S. N.	Name Of Annunciation	Initiation From
1.	IDMT O/C Relay Trip	Over Current Earth Fault IDMT relay
2.	L.B.B. Operated	L.B.B. Operated
3.	Low SF6 Gas Alarm	Auxiliary Relay For Low SF6 Gas Alarm
4.	SF6 / Low Trip Block	Auxiliary Relay For SF6 Low Trip Block
5.	Trip Circuit-1 Fail	TCH Relay Coil 1
6.	Trip Circuit-2 Fail	TCH Relay Coil 2.
7.	O/C & E/F relay faulty	From Numerical IDMT Relay Supervision Contact
8.	Inter Trip operated	----
9.	DC Fail	---
10.	AC Fail	---
11.	IDMT E/F relay trip	Over Current Earth Fault IDMT relay
12.	Spare	---

e) Breaker indication:- Separate breaker ON – OFF lamp indication shall be provided in addition to CB semaphore indications.

f) Mimic diagram:- It is not necessary for the manufacturer to match the other details of the switch yard. The standard mimic diagram of single main and transfer bus feeding the x-mer is sufficient.

g) CT cores:-. One core of class 5P10 for over current and the second core shall be for metering.

h) inter trip indication lamp:- In addition to above all, this panel shall have lamp indication for inter trip.

The CT & PT circuit wires should be colour coded i.e. red, yellow, blue and black for three phases and neutral. The d.c. and control wires should be grey. The cable size shall be 2.5 mm2 for CT & PT and 1.5 mm2 for control circuit. However, **for tripcircuit wires** shall be 2.5 Sq.mm.

19. ERECTION AND MAINTENANCE TOOL EQUIPMENTS

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule

20. TROPICALISATION

Control room will be normally air-cooled/air- conditioned. All equipments shall however be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions specified in the specification. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and otherharmful effects due to tropicalenvironment.

21. ENERGY METERS: Panel shall have Secure make true four quadrant,Exp/Imp, ABT type APEX energy meters as per the requirements of the purchaser with automatic downloading facility of data/reading from meter to PC with RS 485 port communication port.Automatic data logging facility shall be implemented at an independent PC workstation for all energy meters.

22. All the software interfaces of the relays and energy meters are to be provided in one number data extraction Device. Specifications for Operating/Data Extraction/Analysis Device **along with interface cable for 220 KV S/s.** Necessary software and hardware to up load /down load the data to/from the relay from/to the Data Extraction Device. Operating/Data Extraction/Analysis Device having following specifications or better; Powered by 5th Generation Intel® Core i5-5200U Processor with Windows 8.1 Single Language (64Bit) English, RAM - 8GB Dual Channel DDR3L 1600 MHz (4GBx2), Hard Drive - 1TB 5400 rpm, Display : 15.6-inch HD (1366 x 768) True life LED-Backlit Touch Display, Video card : AMD Radeon™ R7 M270 4GB DDR3,Ports/slots-USB 3.0 with Power Share (1), USB 3.0 (1), USB 2.0 (1) HDMI™ v1.4a, Combination headphone/ microphone jack Noble Lock Slot AC Power In, Multi-media Card Reader - Digital (SD) Memory Card, Secure Digital High Capacity (SDHC), Secure Digital Extended Capacity (SDXC), Power - Prismatic (58 WHr) Lithium Ion, Security Software-McAfee® Security Center 15 month subscription, Warranty - 1Yr ProSupport: Next Business Day Onsite Service w/ Accidental Damage.

23. THE DETAILS OF RELAYS AND OTHER FACILITIES REQUIRED IN EACH PANEL ARE MENTIONED BELOW :-

SN	Protection Schemes	40 MVA		132 KV feeder bay	132 KV Bus Transfer bay	33 KV feeders	33KV Capacitor Bank	33 KV Bus Transfer	160 MVA		220 KV feeders	220 KV Bus Transfer bay	220 KV Bus Coupler bay	33 KV Station transformer bay
		132 KV Side X'mer	33 KV Side X'mer						220 KV Side X'mer	132 KV Side X'mer				
1	Bay control unit	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	2 No.	2 No.	2 No.	2 No.	2 No.	1 No.
2	Numerical Differential protection relay	1 No.	NIL	NIL	NIL	NIL	NIL	NIL	2 No.	NIL	NIL	NIL	NIL	NIL
3	Numerical Distance protection relay	NIL	NIL	1 No.	1 No	NIL	NIL	NIL	NIL	NIL	2	1 No.	NIL	NIL
4	Numerical Over fluxing relay	1 No.	NIL	NIL	NIL	NIL	NIL	NIL	1 No.	NIL	NIL	NIL	NIL	NIL
5	Numerical Over voltage Protection	In built	In built	NIL	NIL	NIL	1 No.	NIL	In built	NIL	NIL	NIL	NIL	NIL
6	Under voltage Protection	NIL	NIL	NIL	NIL	NIL	1 No.	NIL	NIL	NIL	NIL	NIL	NIL	NIL
7	Trip circuit supervision relay	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	Nil.
8	DC Auxiliary 220 V supply voltage monitoring relay	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	Nil
9	PT fuse failure relay	NIL	NIL	In built	In built	NIL	NIL	NIL	NIL	In built	In built	In built	In built	NIL
10	Numerical Local Breaker back up relay	1 No.	1 No.	1 No.	1 No.	1 No	1 No	1 No	1 No.	1 No.	1 No	1 No	1 No	Nil
11	Numerical Neutral displacement relay	NIL	NIL	NIL	NIL	NIL	1 No.	NIL	01	NIL	NIL	NIL	NIL	Nil
12	Numerical directional IDMT relay with high set (3 O/C + 1 E/F)	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	2 No.	Nil
13	Over load Protection	1 No.	NIL	NIL	NIL	NIL	NIL	NIL	1 No.	NIL	NIL	NIL	NIL	NIL
14	Double stage U/F relay	NIL	NIL	NIL	NIL	In built	NIL	In built	NIL	NIL	NIL	NIL	NIL	NIL
15	Master trip relay	2 Nos.	2 No.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	Nil
16	LBB Trip relay	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	NIL.

17	Transformer body protection relays.	1 Set	NIL	NIL	NIL	NIL	NIL	NIL	1 set	NIL	NIL	NIL	NIL	NIL
18	Digital MW Meter	1 No.	NIL	1 No.	1 No.	1 No.	NIL	1 No.	NIL	1 No.	NIL	NIL	NIL	NIL
19	Digital MVAR Meter	1 No.	1 No.	1 No.	NIL	NIL	1 No.	NIL	NIL	NIL	NIL	NIL	NIL	NIL
20	Digital Ampere meter (with selection switch where necessary)	3 No.	3 No.	3 No.	3 No.	3 No.	3 No.	1 No.	NIL	3 No.	NIL	NIL	NIL	NIL
21	Digital Volt meter (with selection switch where necessary)	3 No.	1 No.	3 Nos	1 No.	NIL	1 No.	3 No.	NIL	1 No.	NIL	NIL	NIL	NIL
22	Digital frequency meter (1 inch LED display)	NIL	NIL	NIL	1 No.	NIL	NIL	1 No.	NIL	NIL	NIL	NIL	NIL	NIL
23	Annunciator relay	1 Set	1 Set	1 Set	1 Set	1 Set	1 Set	1 Set	NIL	NIL	NIL	NIL	NIL	NIL
24	Trip transfer switch	1 No.	1 No.	1 No.	NIL	NIL	NIL	NIL	1 No.	1 No.	1 No.	1 No.	1 No.	Nil
25	TNC switch	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	Nil
26	Numerical REF Relay	2 No.	NIL	NIL	NIL	NIL	NIL	NIL	1 No.	NIL	NIL	NIL	NIL	NIL
27	SEMS make Energy Meter 3 Phase 4 wire Export-import, with load survey facility, with TTB (heavy duty screw type TTB).	1 No.	1 No.	1 No.	1 No.	1 No.	NIL	1 No.	1 No.	1 No.	1 No.	1 No.	NIL	1 No.
28	Indicating LEDs, semaphores	As per requirement												
29	220 KV Bus bar Protection Scheme	1 No. as per Tender Specification (In 3 No. Panels)												
30	132 KV Bus bar Protection Scheme	1 No. as per Tender Specification (In 3 No. Panels)												
31	No. of Independent Control panel	1 No.	Nil.	1 No.	1 No.	NIL	NIL	NIL	NIL	NIL	NIL	NIL	NIL	Nil
32	No. of Independent Protection panel	1 No.	Nil	1 No.	1 No.	NIL	NIL	NIL	2 No.	1 No.	2 No.	1 No.	1 No.	Nil
33	No. of combined Control &Relay panel	NIL	1 No.	NIL	NIL	1 No.	1 No.	1 No.	NIL	NIL	NIL	NIL	NIL	NIL

220 KV Feeders shall be provided with two sets of single phase trip relays also.

15. TECHNICAL SPECIFICATION FOR SYNCHRONISING TROLLEY

Trolley type synchronizing cubicle shall comprise of:

One no	Circuit label.
One no	Flush mounted 96mm x 96mm size synchroscope suitable
	for 110V AC with synchroscope IN/OUT switch EBS
	(External box for synchroscope) 63.5/110AC.
Two nos	Digital AC voltmeter
	Range 0-250kV and 0-450 kV suitable for 110V/ (Square root of 3) V PT/CVT secondary voltage.
Two nos.	Digital frequency meters, suitable for range 45 to 55hz.
	With a resolution of 0.01 Hz, PLS Make.
One no.	Numerical Check synchronizing relay. with
	percentage voltage difference lock out. Phase angle
	difference +/- 20 degree. Auxiliary relay for guard. Alstom make VAA 21.
Two nos.	Indicating lamps, one colored one white for synchronizing.
Two nos.	Indicating lamps for check synchronizing relay IN/OUT.
L.S.	Adequate length of flexible control multi-strand copper cable. 12
	cores x 1.5mm square x 5 meter length with BCH make 12
	pin socket with adopter.

The trolley shall comprise following items.

- Green lamp (Synchronising in limit)
- Bright lamp(synchroninsing bright)
- Numerical synchronizing relay.
- Auxiliary relay VAA – 21 Alstom make
- Voltmeter 0 – 250 KV and 0 – 450 kV operated by 63.5 volts.
- Frequency meters 45-50 -55 Hz (digital PLA make with two decimals.)
- Synchroscope in/out switch.
- External box for synchroscope 63.5/110V AC
- Voltage reversing VT
- Synchronizing plug suitable for 12 pin BCH make synch. Socket.
- Link to be inserted for frequency check feature.
- Synchronizing society BCH make 12 pin.
- Synchroscope.

15. TECHNICAL SPECIFICATION FOR 145 KV CIRCUIT BREAKERS

1.1 SCOPE:

This specification covers design, engineering, manufacture, assembly, inspection & testing before supply, packing & delivery of 145 KV class outdoor SF_6 Normal Duty, Spring operated circuit breakers along with support structures and ladder, terminal connectors, all accessories and auxiliary equipments required for their satisfactory operation in EHV grid substation.

1.2 It is not the intent to specify completely here all the details of design and construction of the circuit breakers. However the, breaker shall conform in all respects to the high standard of engineering design and workmanship and shall be capable of performing in continuous commercial operation up to the contractor's guarantee in a manner acceptable to the CSPTCL who will interpret the meanings of drawings and specifications and shall have power to reject any work or material which in his judgment is not in accordance therewith. The circuit breakers offered shall be complete with all components necessary for their effective and trouble free operation up to the end of guarantee period, to the entire satisfaction of CSPTCL. Such components shall deemed to be included within the scope of supply of the contractor irrespective of whether these are specifically brought out in this specification and/or in the work order or not.

1.3 STANDARDS:

The offered circuit breakers shall conform to meet the requirement of the latest revisions of relevant standards of international Electro-Technical commission or equivalent national standards of the country with amendments of relevant standards, rules and codes, available at the time of testing at the manufacturer's work. Some of the standards & codes are listed herein for ready reference.

Equipment meeting with the requirements of any other authoritative standards, which ensures equal or better quality than the standard mentioned below shall also be acceptable. If the equipment offered by the contractor conforms to any other standards, salient points of comparison between the standards adopted and the specific standards shall be furnished. Copies of such standards with authentic English Translations shall be furnished along with the offer.

Sl.	STANDARD	TITLE
1.	IEC-62271-100/ IS-13118	Specification for alternating current circuit breakers.
2.	IEC-376	Specification and acceptance of new supply of sulphur hexafluoride
3.	IS-375	Marking and arrangement for switchgear, busbar, main connections & auxiliary wirings.
4.	IS-2147	Degree of protection provided for enclosures for low voltage switchgear and control gear.
5.	IS-325	Specification for three phase induction motors.
6.	IS-2629	Recommended practice for Hot dip galvanizing of iron and steel.
7.	IS-5	Colour for ready mix paints.
8.	IS-2099	High voltage porcelain bushings.
9.	IS:5561	Electric Power connectors.

1.4 **AUXILIARY POWER SUPPLY**:

Auxiliary electrical equipment shall be suitable for operation on the following supply system:-

a)	Power device (like dry motor)	415V 3ϕ, 4 wire, 50Hz, neutral grounded AC supply
b)	DC alarm, control and protective device	110V DC, 2 wire

The supply voltage may vary as shown below and all devices shall be suitable for continuous operation over entire range of voltage variations:-

S.No.	Type of Supply	Range Variation
1	AC supply voltage	+10% to (-) 25%
2	AC supply frequency	frequency (±) 5%
3	DC Supply	(-) 15% to +10%.

1.5 **TYPE & RATING**

The offered circuit breakers shall be of Sulphur Hexa-Fluoride (SF_6) gas type suitable for outdoor operation under all climatic conditions specified above without any additional protection from the sun, dust and rain.

As far as 132 KV network of CG system is concerned, studies carried out show that system stability is ensured with total fault clearing time of 80 milli seconds which also includes a small margin for the relay operating time over the guaranteed performance to allow for fault locations under varying system conditions. The CSPTCL has come to the conclusion that the circuit breaker shall have a total break time not exceeding 60 milli seconds for the range of fault levels likely to be experienced in the CG system. It is therefore desired that total break time of any 145 KV class breaker shall not exceed 60 milli seconds which should be guaranteed for interrupting ratings from 30% to 100% of the specified interrupting capacity.

1.6 **PRINCIPAL PARAMETERS:**

The breakers shall conform to the specific technical requirements specified hereunder:

S.No	Items	Requirement of 145 KV SF_6 Circuit Breaker
1.	Nominal System Voltage	132 KV
2.	Highest System Voltage	145 KV
3.	Rated Frequency	50 Hz.
4.	Rated Normal Current (A_{rms}) At 50°C Ambient Temperature	2000 Amperes
5.	Type	Outdoor SF_6
6.	Mounting Structural Details	Hot dip galvanised lattice steel support structure to be supplied for all breakers. Spacing between supporting legs shall be 2500 mm ± 5%
		One platform with steps shall be provided of such height that operator can easily operate the breaker climbing this platform.
7.	System Neutral Earthing	Solidly earthed
8.	Number of Poles	3
9.	Type of operation	Normal Duty

S.No	Items	Requirement of 145 KV SF_6 Circuit Breaker
10.	Phase to phase spacing in the switch yard i.e., inter pole spacing for breaker	1700 m.m.
11.	Centre to Centre distance between two structure foundation for supporting the complete Breaker assembly	**2530 mm**
12.	Required ground clearance from the lowest live terminal to structure base place to be erected on concrete plinth in mm.	4600 m.m
13.	Max. height of concrete plinth	300 m.m.
14.	Operating mechanism	Spring operated mechanism with electrical control individually for each breaker.
15.	Auto reclosing duty	Three phase
16.	Rated operating sequence	0-0.3 sec -CO -3 min-CO
17.	"First pole to clear" factor (Type of Tripping)	1.3
18.	Maximum closing time not exceeding in millisecond	150
19.	Maximum total break time (For any current upto the rated breaking current) at limiting conditions of operating coil voltage & quenching media pressure in milliseconds	60
20.	Rated insulating level 1.2/ 50 micro second lightning impulse withstand voltage: (KVp)	650
21.	1 Minute power frequency withstand voltage KV rms.	275
22.	Maximum radio interference voltage at 1.1Un/√3	1000 micro Volts at 92 KVrms line to ground voltage (both in closed & open condition)
23.	**Rated breaking current capacity** i) Line charging at rated voltage at 90° Degree leading power factor (A_{rms}) ii) Rated small inductive current iii) rated short circuit breaking current in KA a. AC Component b. % DC Component c. Asymmetrical breaking current including DC Component	 As per relevant IEC standard As per relevant IEC standard 40 K.A. As per relevant IEC standard As per relevant IEC standard
24.	Minimum corona extinction voltage (KVrms)	>92 KV
25.	Transient recovery voltage for terminal fault	As per IEC 56-2, 1971 Clause no. 7.
26.	Rated characteristics for short line faults	As per IEC 56-2, 1971 Clause no. 8.

S.No	Items	Requirement of 145 KV SF_6 Circuit Breaker
27.	Rated out of phase making current	Breaking 25% of the rated fault current of twice rated voltage under out of phase conditions as per IEC publication no. 267
28.	Rated short circuit making current capacity	79 KA
29.	Permissible limits of temperature rise	As per IS
30.	Maximum acceptable difference in the instants of closing / opening of contacts i) within a pole (milli second) ii) between poles (milli second)	5 10 The above timings will be at rated controlled voltage & rated operating & quenching media pressure.
31.	Total creepage distance of support insulator in m.m.	3,625 m.m.
32.	Type of tripping	The contractors should specifically mention whether the breaker is trip free or fixed trip according to IEC 56-1.
33.	Short time current carrying capacity for three seconds (kilo amperes) KA	40 KA.
34.	Breaking capacity of auxiliary contacts	10 A DC with the circuit time constant not less than 20 mili second.
35.	Noise level at base and upto 50 metres.	140 dB.
36.	Seismic acceleration	0.3 g (horizontal)

1.7 SPECIAL DUTY REQUIREMENT

1.7.1 DUTY CYCLES:

a. Terminal faults (C-1 min-O-CO-2 min-C-1 min-O-CO)
b. Reclosing against trapped charge: Same but with first, third and fourth closing being on de-energised line and second closing against trapped charge of 1.2 p.u. of opposite polarity.
c. Out of phase closing one closing operation under phase opposition i.e. with twice the normal voltage across the terminals.

The contractor shall highlight the design features provided to effectively deal with the charging of long lines open at other end.

1.7.2 TRANSFORMER CHARGING CURRENT BREAKING CAPACITY:

The offered 145 KV class circuit breakers shall be capable of interrupting small inductive current, such as those occurring while switching off unloaded transformers of rating 63 MVA, for 132 KV breakers with/ without reactor/capacitor loaded transformers under all conditions, including those of high dynamic or temporary over voltages without giving rise to undue over voltage and without re-strikes. The maximum over voltage value which will not be exceeded under such conditions shall also be stated.

1.7.3 **DYNAMIC OVER VOLTAGES**:

The circuit breaker shall be capable of satisfactorily performing all their duties including, but not limited to, clearing of faults and interrupting the line charging and transformer charging currents without causing undue over voltage and showing signs of undue strain while operating under conditions of high temporary (Power frequency) over voltage of the order of 1.5 p.u.

The stability of circuit breakers for working satisfactorily under such conditions should be explicitly guaranteed by the contractor and it should be supported with clear technical elaborations and details.

1.8 **PROTECTION SCHEMES**:

Two independent trip coils shall be provided on the breakers for segregation of two main relaying schemes. The local breaker back-up protection is also being provided and the breaker shall be suitable for its operation. Two separate DC sources shall be available one for each trip coil.

1.8.1 **DEVELOPING FAULTS**:

The circuit breakers shall be capable to withstand the high stresses imposed on them during fault clearing, developing faults, load rejection and re-energization of line, with trapped charges within the full rating of the breaker. The breaker shall also withstand the voltage specified in "Principal Parameters of this specification"

1.8.2 **TRIP FREE OPERATION:**

The circuit breakers mechanism shall be suitable for trip-free operation.

1.8.3 **SMALL FAULT-CURRENT INTERRUPTING CAPACITY:**

The circuit breakers shall be capable of interrupting Small fault Currents of magnitude between 0.5 KA to 10 KA along with the usual short circuit current interrupting capacity in the range of 2 KA to 40 KA without causing any re-strikes or causing un-permissible over-voltage on the system in which these are to be installed. The over-voltage shall not exceed 2.3 pu.

The test certificates in support of this capacity of circuit breaker must be submitted.

1.8.4 **RECOVERY VOLTAGE AND POWER FACTOR**:

Each circuit breaker shall be capable of interrupting rated short circuit breaking current under the condition of recovery voltage corresponding to highest system voltage and to power factor not exceeding 0.15

1.8.5 The circuit breakers shall be capable of satisfactory operation even under conditions of phase opposition that may arise due to faulty synchronising or otherwise. The maximum power in accordance with relevant IEC Specification which the circuit breaker can satisfactorily interrupt under-phase opposition shall be stated in the offer.

1.8.6 **RESTRIKING VOLTAGE**:

The rated transient recovery voltage for terminal faults shall be as specified in IEC. The measures adopted for ensuring proper operation at high rate of rise of restriking voltage and for limiting the actual values across the breakers shall be described in the offer. No opening resistors shall be necessary for ensuring conformity with the duty cycle.

1.9 **LINE CHARGING CURRENT INTERRUPTING CAPACITY**

Circuit breaker shall be designed so as to be capable of interrupting line charging currents as given in "Principal Parameters" of this specification under the conditions of high dynamic over voltages of the order of 1.5 pu without showing signs of undue strain. The contractor shall have to carry out adequate acceptance tests with proper representation of actual system conditions, including correct simulation of natural

frequency of bus bars so as to properly reproduce the initial part of the recovery voltage, to prove the charging current interrupting capability of the breaker. The contractor shall furnish complete details of procedure in respect of this acceptance test.

The guaranteed over voltage, if any, which will not be exceeded while interrupting line charging current as given in clause 3.6' "Principal parameters" shall be furnished.

The over voltage caused while interrupting the line charging current shall not exceed the limits of switching surges and dynamic over voltages as given in the specification. The result of the test conducted along with copies of the oscillo-graphs to prove the capability of the circuit breakers to interrupt these and lower line charging current values shall also be furnished.

1.10 **INSULATING SUPPORTS**

The basic impulse insulation level of the external insulator supports bushing & interrupting insulator bushing shall match with that of the SF_6 circuit breakers and shall be specified and suitable for insulation in the contaminated atmosphere. Insulating supports shall be designed to have ample insulation and adequate mechanical strength and rigidity for satisfactory operation under various operating conditions detailed in this specification.

All hollow insulator & interrupter housing of identical rating shall be interchangeable. The puncture strength of the hollow insulator & interrupter housing shall be greater than the flash over value.

The hollow insulator & interrupter housing shall be type tested as per relevant IEC standards and the type test reports shall be submitted.

1.11 **BREAKING CAPACITY FOR KILOMETRIC FAULTS:**

All circuit breakers shall have high capacity for breaking short line (kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified. The interrupting capacity of the circuit breakers for kilometric faults (short line faults) should be equal to its interrupting capacity. The details of tests conducted to guarantee the capability of the circuit breaker operation under kilometric fault condition shall be furnished.

1.12 **AUTOMATIC RAPID RECLOSING:**

132 KV circuit breakers shall be suitable for three pole automatic rapid reclosing. The dead time corresponding to automatic rapid reclosing of the circuit breakers shall be adjustable at least within limits of 15 cycles (0.3 sec) to 35 cycles and actual limits of adjustment provided in the offered circuit breaker shall be stated in the offer. The relay or timer required for adjustment of the dead time shall form a part of the scope of supply. The breaking capacity of the circuit breakers shall be guaranteed for second and third interruptions.

1.13 **TEMPERATURE RISE**:

The temperature rise and the maximum temperature attained by any part of the equipment when in service at site under continuous full load conditions and exposed continuously to the direct rays of the sun shall not exceed the permissible limits as per limits given. The permissible temperature rise indicated is for a maximum ambient temperature of 50° deg. centigrade. If the maximum ambient temperature is higher, the temperature rise permissible limit shall be reduced accordingly.

1.14 **INSULATION OF CIRCUIT BREAKERS:**

The insulation to ground, insulation between open contacts and the insulation between phases of the completely assembled circuit breaker shall be capable of withstanding satisfactorily dielectric test voltage corresponding to the stipulations made in

"Principal parameters". The exposed live parts shall be placed high enough above ground to meet the requirements of local safety codes.

1.15 **ADDITIONAL REQUIREMENTS:**

a) The circuit breakers shall be single pressure type, the design and construction of the circuit breaker shall be such that there is minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF_6 gas on the internal insulating surface of the circuit breaker.

b) All gasketed surfaces shall be smooth, straight and reinforced, if necessary to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF_6 media) shall have adequate seals, Double "O" ring seals and test holes for leakage test of the internal seal shall be provided on each static joint.

c) In the interrupter assembly there shall be an absorbing product box to eliminate SF_6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be fully compatible with SF_6 gas.

d) The SF_6 gas density monitor shall be adequately temperature compensated. The density monitor shall meet the following requirements:

   i) It shall be possible to dismantle the density monitor for checking/ replacement without draining the SF_6 gas by using suitable interlocked non-return couplings.

   ii) It shall damp the pressure pulsation while filling the gas in service so that the flickering of the pressure switch contacts does not take place.

   iii) Air & gas pressure indicator shall also be supplied. The pressure indicator shall have uniform graduated dial.

e) Means for pressure relief shall be provided in the gas chamber of circuit breaker to avoid the damages or distortion during occurrence of abnormal pressure increase or shock waves generated by internal electric fault / arcs. The position of vents, diaphragms and pressure relief devices shall be arranged so as to minimize danger to the operators in the event of gas or vapour escaping under pressure.

f) Facility shall also be provided to reduce the gas pressure within the breaker to a value not exceeding 8 milli-bars within 4 hours or less. Each circuit breaker shall be capable of withstanding this degree of vacuum without distortion or failure of any part.

g) Sufficient SF_6 gas shall be provided to fill all the circuit breakers installed. In addition to this 20% of the total gas requirement shall be supplied in separate cylinders as spare requirement.

h) Provisions shall be made for attaching an operation analyser after installation at site to record contact travel, speed and making measurement of operation timings and synchronisation of contacts in one pole.

1.16 **GENERAL TECHNICAL REQUIREMENTS:**

1.16.1 Circuit breaker offered shall be Sulphur hexafluoride (SF_6) type only suitable for outdoor installation. Circuit breaker shall be designed to withstand seismic acceleration equivalent to 0.3g. If construction of the breaker is of wheel mounted type suitable locking clamps shall be provided designed to sustain above seismic acceleration.

1.16.2 Exposed live parts shall be placed high enough above ground to meet the requirement of local safety codes.

1.16.3 Any part of' the breaker, especially the removable ones, shall be freely inter-changeable without the necessity of any modification at site.

1.16.4 Circuit-breaker shall comprise of three identical single pole units which should be linked together.

1.16.5 Complete circuit breaker with all the necessary items for successful operation shall be supplied, including but not limited to the following:

a) Breaker assemblies with bases, support - structure for circuit breaker as well as for control cabinet, central control cabinet and foundation bolts for main structure as well as control cabinet and central control cabinet (except concrete foundations), terminals and operating mechanisms.

b) Compressed SF_6 gas, pneumatic systems complete including compressors, tanks, pipings, fittings, valves and controls and necessary supports for inter-pole piping for pneumatic systems.

c) One central control cabinet for each breaker and one control box with all the required electrical devices mounted therein and the necessary terminal blocks for termination of inter-pole wiring. The supply of necessary inter pole cables & cabling at site shall be in the scope of contractor based on the schematic wiring diagram and termination schedule provided by the contractor & approved by CSPTCL.

d) Instruments, gauges and leakage detector for SF_6 gas pressures pneumatic pressure supervision.

e) All necessary parts to provide a complete & operatable circuit breaker installation such as main equipment, terminal connectors, control parts, cable connectors, pipe lines and other devices, whether specifically called for herein or not.

1.16.6 Circuit breaker shall be suitable for hot line washing.

1.16.7 All breakers shall be supplied with terminal connectors having double nut GI and double set of washers for firm connections. The contractors are required to confirm that the offered prices are inclusive of terminal connectors.

1.16.7 The current density adopted for the design of the terminal pads shall in no case exceed the following values. For copper pads - 1.5 A/sq.mm and aluminium - 1.0 A/sq.mm.

1.17 **CONTACTS:**

i) Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise which may cause pitting or welding. Contacts shall be adjustable to allow for wear, easily replaceable and shall have a minimum of moveable parts and adjustments to accomplish these results.

ii) All making and breaking contacts shall be sealed free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacements due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

iii) Main contacts shall be first to open and the last to close so that there will be little contact burning and wear.

iv) If arcing contacts are used, they shall be first to close and the last to open. These shall be easily accessible for inspection and replacement. If there are no

separately mounted arcing contacts, the main contacts shall be easily accessible for inspection and replacements. Tips of arcing contacts and main contacts shall be silver plated or have tungsten alloy tips.

v) Any device provided for voltage grading to damp oscillations or to prevent re-strike prior to the complete interruption of the circuit or to limit over voltages on closing shall have a life expectancy comparable to that of the breaker as a whole.

vi) Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life or the material used. The temperature shall not exceed that indicated in IEC-56 under specified ambient conditions.

vii) Contacts shall be kept permanently under pressure of SF_6 gas. The gap between the open contacts shall be such that it can withstand atleast the rated phase to ground voltage continuously at zero gauge pressure of SF_6 gas due to its leakage.

viii) If multi-break interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstands of the grading elements shall be adequate for the service conditions and duty specified.

1.18 **PORCELAIN HOUSING**:

i) The porcelain housing shall be of single piece construction without any joint or coupling. It shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect high mechanical, and dielectric strength and shall be thoroughly vitrified, tough and impervious to moisture.

ii) Glazing of porcelain shall be uniform brown or dark brown colour, free from blisters, burns and similar other defects with a smooth surface arranged to shed away rain water or, condensed water particles (fog).

iii) Housings shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation for the conditions under which they will be used. All housings of identical ratings shall be interchangeable.

iv) Puncture strength of housings shall be greater than the dry flash-over value. When operating at normal rated voltage there shall be no electric discharge between the conductors and housing which would cause corrosion or injury to conductors, insulators or supports by the formation of substance produced by chemical action. No radio disturbance shall be caused by the housing when operating at the normal rated voltage.

v) All iron parts shall be hot dip galvanized and all joints shall be air-tight. Surfaces of the joint shall be made burr free, porcelain parts by grinding and metal parts by machining. Bushing design shall be such as to ensure a uniform compressive pressure on the joints.

vi) All current carrying contact surfaces shall be silver plated.

vii) Bushings shall satisfactorily withstand the insulation level specified in the IEC Specification.

1.19 **SULPHUR HEXA FLUORIDE GAS (SF_6 GAS)**

a. The SF_6 gas shall comply with IEC 376, 376A & 376 B and be suitable in all respects for use in the switch gear under the worst operating conditions,

b. The high pressure cylinders in which the SF_6 gas is shipped and stored at site shall comply with requirement of the following standards and regulations:

i) IS: 4379 Identifications for the contents of industrial gas cylinder.
ii) IS: 7311 Seamless high carbon steel cylinders for permanent and high pressure liquefiable gases.
iii) The cylinders shall also meet Indian boiler regulations.

c. Test: SF_6 gas shall be tested for purity, dew point, break down voltage, water contents as per IEC 376, 376A & 376B and test certificates shall be furnished to CSPTCL indicating all the tests as per IEC 376 for each lot of SF_6 gas.

1.20 **AUXILIARY CONTACTS**:-

The auxiliary switches (contacts) required for satisfactory operation of the circuit breaker including automatic reclosing (single shot three phases) ON/ OFF indicators both in control room and switch yard semaphore indicators in the mimic diagram in the control room and anti pumping in the mimic diagram in the control room and anti pumping features shall be provided on each circuit breaker and shall be clearly indicated in the offer. All these auxiliary switches shall be included in the scope of supply. In addition to the auxiliary switches mentioned above, the contractor shall provide as spares 10 auxiliary contacts each of the "normally open" and "normally closed" types which shall be used to operate the closing or opening of each of the three poles of circuit breakers. These spare switches shall be utilised for safety interlocking and other monitoring devices by the CSPTCL. Special contacts for use with the trip coils and single shot reclosing operations which permit the relative adjustment with respect to the travel of the circuit breaker shall also be provided. All auxiliary switches shall be placed in a weather proof galvanised casing and current rating of the switches shall be mentioned in the offer. There shall be provision to add more auxiliary switches at a later date and to convert the "normally open" contacts to the "normally closed" type and vice versa. Minimum two auxiliary switch set (NO & NC contact) be provided which should operate independently.
Arrangement proposed for connecting control cables to the auxiliary switches shall be clearly stated. Provision shall be made for suitable cable glands for receiving control cable for terminating connections in the auxiliary switches.

1.21 **TOTAL BREAK TIME:**

1.21.1 The "Total Break Time" as specified in clause 3.6, "Principal Parameters" of this section shall not be exceeded under any of the following duties:

i) Test duties 1,2,3,4,5 (with TRV as per IEC)
ii) Short line fault L90, L75 (with TRV as per IEC-56).

1.21.2 The Contractor may please note that there is only one specified break time of the breaker which shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, (70-110%) pneumatic/ pressure and arc extinguishing medium pressure etc. while furnishing the proof for the total break time of complete circuit breaker, the Contractor may specifically bring out the effect of non-simultaneity between contacts within a pole or between poles and show how it is covered in the guaranteed total break time.

1.21.3 The values guaranteed shall be supported with the type test reports.

1.22 OPERATING MECHANISM AND ASSOCIATED EQUIPMENTS:

i) Each circuit breaker shall be designed for remote control operation from the control room. In addition there shall be provision for local tripping & closing operations both by electrical control. Mechanical arrangement should also be provided to facilitate manual tripping of circuit breaker for emergency trip when

DC is not available or tripping coil is burnt or trip lever mechanism becomes defective etc., under healthy arc quenching medium condition.

ii) Only spring type tripping & closing mechanisms are acceptable. **It may be noted offers for pneumatic or other type of mechanisms shall not be considered.** The mechanism shall be adequately designed & capable of performing satisfactorily the specified tripping and re-closing duty indicated above within the time specified. The entire operating mechanism control circuitry including electrical controls & monitoring devices and all other accessories, etc., as required, shall be housed in an outdoor type, hot dip galvanised steel enclosure. This enclosure shall conform to the degree of protection IP-55 of BIS 2147. The enclosure shall be invariably mounted on a separate concrete plinth of 300 mm height. However in case due to IP-55 protection limitations, if operating mechanism is mounted below the pole housing, in that case it should be possible for operating personnel to charge the spring from ground level including making ON/OFF operation without using any stool/platform or otherwise a suitable operating platform with steps shall be essentially provided and the same shall be deemed to be included in the scope of supply. **Please note manually spring charging mechanism should be such that the operator shall charge the spring from the front side only**

iii) All working parts in the mechanism shall be of corrosion resistant material. All bearings which require greasing, shall be equipped with pressure grease fittings. Bearing pins, bolts, nuts and other parts shall be adequately pinned or blocked to prevent loosening or charging adjustment with repeated operation of the breaker.

iv) The design of the operating mechanism shall be such that it shall be practically maintenance free. The guaranteed years of maintenance free operation, the number of full load and full rated short circuit current breaking/operation without requiring any maintenance or overhauling, shall be clearly stated in the offer. As far as possible the need for lubricating the operating mechanism shall be kept to the minimum and eliminated altogether if possible.

v) The operating mechanism shall be suitable for high speed three phase re-closing. It shall be non-pumping and trip free electrically and mechanically under every method of closing. A latch checking switch shall be provided on mechanically trip free mechanism to prevent re-closing before the breaker latches have reset. There shall be no objectionable rebounds in the mechanism and it shall not require any critical adjustments at site. It shall be string, rigid, positive and fast in operation. Mechanism shall be such that the failure of any auxiliary spring will not cause tripping or closing. Operation of the power operated closing device, when the circuit breaker is already closed, shall not cause damage to the circuit breaker or endanger the operator life. Provision shall be made for attaching an operation analyser similar to concinnatic operation analyser to facilitate speed test after installation of the breaker at site. ON-OFF indicating lamps shall be provided on the mechanism box.

vi) A mechanical indicator shall be provided to show open and close position of each pole of the breaker in addition to facilitate remote electrical indication. An operation counter shall also be provided in the central control cabinet. The mechanical indicator and operation counter shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed.

vii) Should the settings of the three breaker poles not be the same (e.g. failure of an operating or closing coil) all three poles shall trip simultaneously on appropriate

electrical command. An out of step relay shall be supplied with each breaker to give a remote trip discrepancy alarm.

viii) Should the most unlikely situation occur in SF_6 breakers where there is a substantial pressure loss in a pole already open, the main interrupting chamber column should be blocked off (by a non return valve) so that the main interrupting chambers remain pressurised and can retain their full insulating capacity for several more hours.

ix) Circuit breaker operating mechanism shall incorporate an electrically achieved positive acting anti-pumping feature to prevent the circuit breaker from re-closing after an automatic opening when the initiating closing device is maintained in the position for closing. Necessary anti-pumping relay shall be included in the scope of supply.

x) The contractor shall furnish detailed operation and maintenance manual of the mechanism alongwith the operation manual for the circuit breaker.

xi) All material for making connection between the circuit breaker and its local control cabinet shall be included in the scope of supply.

xii) All the similar contacts of 3 pole circuit breaker shall be designed to touch or open essentially simultaneously & in any case shall close or open within a period of half a cycle or less. The auxiliary circuit through resistors shall be closed in sufficient time before the main contacts closes to ensure that the over-voltage will be held to guarantee value under most favourable sequence of contact closing.

xiii) **MOTOR COMPRESSED SPRING CHARGING MECHANISM:**

Spring operated mechanism shall be complete with motor, opening & closing spring with mechanical electric lamp indication for spring charged / discharged condition which should be easily visible through the glass section provided in the front door and all necessary accessories to make the mechanism a complete operating unit. Each mechanism shall be so designed as to enable a continuous sequence of circuit breaker opening and closing operations to be obtained by the control switch as long as power is available to the motor and at least one circuit breaker opening and closing after failure of power supply to the motor. Breaker operation shall be independent of the motor which shall be used solely for the purpose of compressing the closing spring. Motor rating shall be such that it required only about 30 seconds for fully charging the closing spring. Closing action of the circuit breaker shall compress the opening spring ready for tripping. Motors for spring charging mechanism shall operate satisfactorily at all supply voltages between 85% and 110% of the rated voltage. Spring charging motor shall be AC motor (Single or 3 phase 230/ 400 volts). DC Motors are not acceptable. The mechanism shall be capable of performing the rated operating duty cycle of 0-0.3 sec-CO-3 min-CO as per IEC: 56. and in the event of failure of power supply to spring charging motor, the mechanism shall be capable of performing one sequence of 0-0.3 Sec-CO duty.

xiv) Motors rated 1 KW and above, being controlled from the control cabinet would be suitable for operation on a 400 V, 3 phase 50 Hz system.

xv) Facility shall be provided for manual charging of closing springs by operating personnel from ground level standing in up right position on the front side of the panel i.e. the operating handle should be on the front side of control cubicle

(horizontal type spring charging drive). Suitable preventive (Blocking) scheme be provided to avoid manual overcharge of spring.

1.23 **CONTROL**:

i) The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.

ii) Each breaker pole shall be provided with the tripping coils, each connected to a different set of protective relays. The trip coils circuit shall be such that to facilitate trip circuit supervision in Pre & post closing the control panel of control room. The trip circuit supervision relay & necessary terminals shall be provided in the central control cabinet of the circuit breaker by the manufacturer.

Two trip coils shall be arranged separately suitable for the operation through two different DC sources. Separate DC fuse circuit shall be wired with schematic connections to monitor the healthiness of both trip coils individually.

iii) The breaker shall normally be operated by remote electrical control. The electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local / remote selector switch and close and trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall also be provided by the contractor in the control room panel.

iv) A conveniently located manual mechanical tripping lever or push button shall also be provided for tripping the breaker and simultaneously opening the re-closing circuit.

v) Closing coil shall operate correctly at all values of voltage between 70% and 110% of the rated voltage of closing coil. Shunt trip coils shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of DC supply voltage between 70% and 110% of rated voltage. However, even at 50% of rated voltage, the breaker shall be able to perform all its duties. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on outdoor circuit shall be clearly brought out in the additional information schedules.

vi) Suitable relay for monitoring of DC Supply voltage to the control cabinet shall be provided. The pressure switches used for interlock purposes shall have adequate contact ratings to be directly used in the closing and tripping circuits. In case the contacts are not adequately rated or not provided in sufficient numbers then multiplying relays shall be used.

vii) The auxiliary switch of the breaker be preferably positively driven by the breaker operating rod and where due to construction features, same is not possible a plug in device shall be provided to simulate the opening and closing operations of circuit breaker for the purpose of testing control circuits.

viii) **INTERLOCKS:** It is proposed to electrically interlock the circuit breaker with associated air break isolating switches in accordance with switchyard safety interlocking scheme. All accessories required on breaker side for satisfactory operation of the scheme shall be deemed to be included in the scope of supply.

ix) The connectors shall be of stud and bolt type**.**

1.24 SUPPORT STRUCTURE:

The price of GI support structure, foundation bolts and operating platform etc. is deemed to be included in the price of the circuit breakers. The support structure shall meet the following requirements:-

i) The minimum vertical clearance from any energised metal part to the bottom of the circuit breaker (structure) base, where it rests on the foundation pads shall be 4.6 meters for 132 KV.
ii) The minimum clearance between the live parts and earth shall be 1.3 meters for 145 KV circuit breakers.
iii) Spacing between supporting legs shall be 2500 mm ± 5%

1.25 **FITTINGS AND ACCESSORIES**:

Following is a partial list of some of the major fittings and accessories to be furnished by manufacturer as an integral part of equipment. Number and exact location of these parts shall be indicated in the offer.

a) Operating mechanism box:-Each 145KV Circuit breaker shall be provided with a Operating mechanism box (separate from control cubicle).

Operating mechanism box shall be complete with -

i) Padlocks and duplicating keys,
ii) trip coils/ closing coil,
iii) Space heater equipped with industrial grade switch.
iv) Cable glands.
v) Industrial grade receiptable type pin 15 Amps, power plug & socket with switch.
vi) Terminal Boards.
vii) Mechanical Spring charged / discharged indicator.
viii) Operation counter.
ix) Facility for manual charging of spring (from front side only).
x) SF6 pressure gauges.
xi) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 20% spare terminals for CSPTCL's use. All the terminals connector shall be of stud type.
xii) Manual charging spring operating handle for maintenance.
xiii) Auxiliary switch.
xiv) Mechanical ON & OFF Indicator.
xv) Cubicle lamp with cage & switch.
xvi) 2 Nos. earthing terminals.
xvii) Rating and diagram plate in accordance with IEC incorporating year of manufacture.
xviii) Any other component as required.

b) Control cubicle:-Each 145KV Circuit breaker shall be provided with a control cabinet (separate from operating mechanism). Control cabinets shall be of the free standing floor mounting type.

Control cubicle shall be complete with -

i) Padlocks and duplicating keys,
ii) Space heater equipped with industrial grade switch.
iii) Cable glands.
iv) Industrial grade receiptable type pin 15 Amps, power plug & socket with switch.
v) Local/ remote changeover switch.

vi) Manually operated tripping Push button / lever (mechanical device conveniently located to trip all three phases simultaneously).

vii) Pistol grip circuit breaker control switch having trip /normal / close position.

viii) Terminal Boards.

ix) Fuses/ MCBs as required for AC & DC supply.

x) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 20% spare terminals for CSPTCL's use. All the terminals connector shall be of stud type.

xi) Auxiliary switch.

xii) Cubicle lamp with cage & switch.

xiii) Anti-pumping relay.

xiv) Lamp(LED type) ON , OFF and spring charge Indicator

xv) Contactor for SF6 trip block and closing block.

xvi) 2 Nos. earthing terminals.

xvii) Rating and diagram plate in accordance with IEC incorporating year of manufacture.

xviii) Any other component as required.

c) Set of 6 nos. gravity die cast terminal connector clamps as per tender specifications.

1.26 SURFACE FINISH, PAINTING & GALVANIZING

i) All interiors and exteriors of tanks, mechanism, enclosures, cabinets and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulating oil, as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paint. Steel surfaces exposed to the weather shall be hot dip galvanised.

ii) All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped or otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

iii) All external paintings shall be as per shade no. 697 of IS-5.

iv) All ferrous hardware exposed to atmosphere shall be hot dip galvanised.

v) **GALVANIZING :** All ferrous parts & steel structure including all sizes of nuts, bolts plain and spring washers, support channels, structures, etc. shall be hot dip galvanised to conform to latest version of IS: 2629 or any other equivalent authoritative standard.

1.27 EARTHING:

The operating mechanism housing, cabinets, dead tanks, support structure etc shall be provided with two separate earthing terminals suitable for bolted connection to 50 x 8 mm MS flat to be provided by the contractor for connection to station earth mat.

1.28 RATING AND NAME PLATE

1.28.1 Circuit breaker and its operating device shall be provided with a rating plate or plates marked with but not limited to following data:

i) Manufacturer's name or trade mark.
ii) Serial number or type designation making it possible to get all the relevant information from the manufacturer.
iii) Year of manufacture.
iv) Rated nominal / highest voltage.
v) Rated insulation level.
vi) Rated frequency.
vii) Rated normal current.
viii) Rated capacitive /inductive breaking current.
ix) Rated short circuit breaking current.
x) First pole to clear factor.
xi) Rated duration of short circuit.
xii) Rated auxiliary DC supply voltage of closing and opening devices.
xiii) Rated pressure of compressed air for operation and interruption.
xiv) Rated out of phase breaking current.
xv) Rated AC supply voltage of auxiliary circuits.
xvi) Rated DC supply voltages of auxiliary circuits.
xvii) Mass of circuit breaker.
xviii) CSPTCL's work order number & date
xix) The rating plate shall be visible in position of normal service and installation. The rating plate shall be weather proof and corrosion proof.

1.28.2 Breaker wiring diagram should be engraved on the back side of the front door of the panel.

1.29 LIMITS OF TEMPERATURE RISE:

The temperature rise and the maximum temperature attained on any part of equipment when in service at site under continuous full load conditions and exposed continuously to the direct rays of the sun shall not exceed the maximum temperature rise specified below in the table. The permissible temperature rise indicated in the table is for a maximum ambient, temperature of 50 deg. C. If the maximum ambient temperature rises, permissible values shall be reduced accordingly.

S. No.	Nature of the Part or of the Liquid	Maximum values of Temperature	Temperature rise at a maximum ambient air temperature not exceeding 50°C
1	Contacts In Air Silver Faced Copper, Copper Alloys Or Aluminium Alloys (See Notes 1 &2)	105	55
	Bare Copper Or Tinned Aluminium Alloy.	75	25
2	Contacts In Oil		
	Silver Faced Copper Alloy Or Aluminium Alloy (See Notes 2)	90	40
	Bare Copper Or Tinned Aluminium Alloys	80	30

S. No.	Nature of the Part or of the Liquid	Maximum values of Temperature	Temperature rise at a maximum ambient air temperature not exceeding 50°C
3	Terminal To Be Connected To External Conductor By Screws Or Bolts, Silver Faced (See Notes 3)	105	55
4	Metal Parts Acting As Springs	See note iv	See note iv
5	Metal Parts In Contact With Insulation Of Following Clauses		
	Class Y: For Non Impregnated Materials	90	40
	Class A: For Materials Immersed In Oil Or Impregnated	100	50
	Class "E" In Air In Oil	 120 100	 70 50
	Class "B" In Air In Oil	 130 100	 80 50
	Class "F" In Air In Oil	 155 100	 105 50
	Enamel: Oil Base a. Synthetic In Air b. Synthetic In Oil	100 120 100	50 70 50
6	Any Part Of Metal Or Of Insulating Material In Contact With Oil Except Contacts	100	50
7	Oil	90	40

Notes:

i) While applying the temperature rise of 55 deg. C, care should be taken to ensure that no damage is caused to the surrounding insulating materials.

ii) The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test. Otherwise, the contacts shall be regarded as "bare".

iii) The values of temperature and temperature rise are valid whether or not the conductor connected to the terminals is silver-faced.

iv) The temperature shall not reach a value where the elasticity of the material is impaired. For pure copper, this implies a temperature limit of 75° C.

1.30 ISOLATING SWITCHES:

The incoming power supply isolating switch, operating handle shall be interlocked with the control cabinet door so as to prevent opening of door when main switch is closed. Device for by-passing the door interlock shall also be provided. Switch handle shall have provision for locking in both fully open and fully closed positions.

1.31 FUSES:

All fuses shall be of the HRC cartridge type, conforming to IS: 2208 and suitable for mounting on plug-in type of fuse bases. Fuses shall be provided with visible operation

indicators to show that they have operated. All accessible live connections shall be adequately shrouded, and it shall be possible to change fuses with the circuit alive, without danger of contact with live conductor. Insulated fuses pulling handle shall be supplied with each control cabinet.

1.32 **TERMINAL CONNECTORS**:

Terminal clamp for 132 KV Circuit breakers shall be suitable for Zebra ACSR conductors. Clamps shall be designed adequately to take care of any bimetallic effect. The temperature at the clamp shall not exceed 80° deg. C. Corona rings shall be provided at the breaker terminals to control the radio interference.

The terminal connectors shall also meet the following requirements:

i) Terminal connectors shall be manufactured and tested as per IS: 5561.
ii) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The terminal connectors should be manufactured by gravity die-casting process only.Bushing terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL
iii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
iv) No part of a clamp shall be less than 12 mm thick.
v) Minimum conductor coverage on the clamp shall be 100mm. Minimum bushing terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.
vi) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.
vii) For bimetallic connectors, copper alloy liner of minimum thickness of 4 mm (2 mm cu and 2 mm Al) shall be integral with aluminium body.
viii) Flexible connectors shall be made from tinned copper/aluminium sheets.
ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance. The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor.
x) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561

Two numbers grounding terminals for connection with station earth mat shall be provided on each circuit breaker. Size of the earthing pad shall be suitable for 50 x 8 mm or 60 x 8 mm GI flat.

1.33 SPECIFICATION FOR CONTROL CABINETS:

Each 145KV Circuit breaker shall be provided with a control cabinet (separate from operating mechanism)

i) Control cabinets shall be of the free standing floor mounting type.

ii) Control cabinet and all accessories shall be enclosed in weather & vermin proof mechanism cabinet of hot dip galvanised sheet steel construction. The thickness of which shall not be less than 3 mm intended for outdoor operation. Control cabinets shall be provided with a hinged door. The door hinges shall be of union Joint type and giving access to the mechanism at the front and sides shall be properly braced to prevent wobbling. Suitable gasket shall be

provided to make the mechanism housing water proof and dust proof. The housing latch shall accommodate padlock requiring a 12 mm dia hole. Padlock and duplicate keys shall be furnished.

iii) Equipment and devices shall be suitable for operation on a 400 V, 3 phase 4 wire 50 Hz AC system or single phase 230 volts 2 wire systems. The frequency can vary between 95% to 105% of normal frequency of 50 Hz and voltage from 110% to 75% of normal value.

iv) Busbar shall be of tinned copper of adequate cross-section to carry the normal current, without exceeding the permissible temperature rise over an ambient temperature of 50 deg. C outside the cubicle. The buses shall be braced to withstand forces corresponding to short circuit current of 25 KA.

v) Isolating switches shall be group operated units (3 pole for use on 3-phase supply systems and 2 pole for single phase supply systems) quick make quick break type, capable of Breaking safely and without deterioration, the rated current of the associated circuit.

vi) Fuses shall be HRC cartridge link type having prospective current rating of not less than 46 KA (r.m.s.). They shall be provided with visible operation indicators to show when they have operated. One fuse pulling handle shall be supplied for every ten fuses or a part thereof.

vii) Push button shall be rated for not less than 6 Amps, 400 V AC. or 2 Amp, 110V DC and shall be flush mounted on the cabinet door and provided with Red, Green and Amber indicating lamps shall be flush mounted and provided with series resistors to eliminate the possibility of short circuiting of control supply in the event of fusing of lamps.

viii) For motors upto 5 KW, contractors shall be direct-on-line, air break single throw type and shall be suitable for making and breaking the stalled current of the associated motor which shall be assumed equal to 6.5 times the full load current of the motor at 0.2 p.f., 3 pole contactors shall be furnished for 3 phase motors and 2-pole contactors for single phase motors. Reversing contactors shall be provided with electrical interlocks between forward and reverse contractors. If possible mechanical interlock shall also be provided. Contactors shall be suitable for uninterrupted duty and shall be of duty category class AC4 as defined in IS: 2959. The main contacts of the contactors shall be Silver plated and the insulation class for the coils shall be class E or better. The dropout voltage of the contactors shall not exceed 70% of the rated voltage.

ix) Contactors shall be provided with a three element Positive acting, ambient Temperature compensated, time lagged, hand reset type thermal overload relay with adjustable setting. Hand reset button shall be flush with the front door of the cabinet and suitable for resetting with starter compartment door closed, Relays shall be either direct connected or CT operated depending on the rated motor current.

x) Single phasing preventing relays shall be provided for 3 phase motors to provide positive protection against single phasing.

xi) Mini starters shall be provided with no volt coils whenever required.

xii) Power cables will be of 1100volts grade stranded aluminium conductor. PVC insulated, PVC sheathed single steel wire armoured and PVC jacketed. All necessary cable terminating accessories such as glands, crimp type tinned copper lugs etc. for power as well as control cables shall be included in Contractor's scope of supply. Requisite number of suitable brass cables glands

shall be provided for cable entry at the bottom of the operating cabinet to receive CSPTCL's Control cables. Number & size of cable glands will be provided by the contractor. These shall be mounted in accessible position and floor level so joints can be made easily. Cable glands shall be double compression type.

xiii) Separate terminal blocks shall be provided in the control cubicle for terminating circuits of various voltage classes. Terminals for DC & AC shall be provided separately and isolated from each other. Terminals for the control & other circuits shall be suitable for accommodating 3 mm stranded conductor cable leads. A minimum of 06 spares terminals for control wiring shall be provided. The housing shall be complete with all necessary wiring.

xiv) Wiring for all control circuits shall be carried out with 1100 volts grade PVC insulated tinned copper stranded conductors of sizes not smaller than 2.5 m.m. at least 20% spare terminal blocks for control wire terminations shall be provided on each panel. The terminal blocks shall be ELMEX type or equivalent. All terminals shall be provided with ferrules indelibly marked or numbered and these identifications shall correspond to the designations on the relevant wiring diagrams. The stud type terminals shall be rated for adequate capacity which shall not be less than 10 Amperes. White coloured wire shall be used for trip (positive) circuits.

xv) Control cabinet shall be provided with 230 V, 1 phase 50 Hz, 20 W fluorescent light fixture and a suitably rated 230V, 1 phase, 5 amps, 3 pin socket for hand lamps. Suitably rated switches shall be provided to enable the control supply to the breaker to be cut off from the mechanism housing.

xvi) Suitable strip heaters shall be provided inside each cabinet with thermostat to prevent moisture condensation. Heaters shall be controlled by suitably rated industrial switch unit with fuse shall be provided. Heater shall be suitable for 230 volts AC supply unless otherwise specified.

xvii) Signal lamps provided shall be of neon screw type with series resistors, enclosed in bakelite body. Each signal lamp shall be provided with a fuse integrally mounted in the lamp body.

xviii) Items inside the cabinet made of organic material shall be coated with a fungus resistant varnish.

xix) All doors, panels removable covers and breaker openings shall be gasketed all around. All louvers shall have screen and filters. Cabinet shall be dust, moisture and vermin proof.

1.34 **MOTORS:**

I) Motors shall be "squirrel cage" three phase induction motors or self starting single phase motor of sufficient size capable of satisfactory operation for the applications and duty as required for driven equipment.

The rating plate shall conform to the requirements of IEC incorporating the year of manufacture.Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be overloaded at any operating point of driven equipment that will arise in service.

Motors shall be capable of giving rated output without reduction in expected life span when operated continuously in the system having the particulars as given in principal parameters.

II) **STARTING REQUIREMENTS.**

a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 85% of the rated voltage.

b) Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS: 325.

d) Motors, when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under clause 8.31.9 (a) above, shall be capable of withstanding atleast two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by atleast two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the supplier shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speeds lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

1.35 **TESTS & TEST REPORTS**

i. The equipment offered shall be fully type tested as per the relevant standards. In case the equipment of the type and design offered has already been type tested, the manufacturer shall furnish two sets of the type test reports along with the offer. For any change in the design/ type already type tested and the design/ type offered against this specification the CSPTCL reserves the right to demand repetition of tests without any extra cost. In case the equipment have not been type tested earlier, all the type tests as per relevant standards shall be carried out by the successful supplier in the presence of CSPTCL's representative without any extra cost.

ii. Contractor shall indicate the manufacturer's standard routine tests. Contractor shall completely assemble and test each breaker to ensure satisfactory working of all component Parts and also assembled breakers as a whole. Routine test and acceptance test as per latest IEC publication shall be carried out on breakers without any extra cost.

iii. All vessels and accessories which operate under pressure shall be tested according to relevant standards and adequate number of copies of test certificates shall be submitted.

iv. All tests shall be conducted in accordance with the latest IEC Standards and in the presence of CSPTCL's representative The contractor shall give advance notice of readiness for inspection of components parts and / or before final assembly and tests so that CSPTCL's representative may witness such final and acceptance tests before shipment. CSPTCL's representative may at any time inspect and copy any or all test data.

v. Speed curves for each breaker shall be obtained with the help of a suitable operation analyser to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under, normal as well

as limiting operating conditions (control voltage, pneumatic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break/ make operation etc. This test shall also be performed at site for which the necessary operation analyser alongwith necessary transducers, cables, console etc. shall be provided if required.

vi. A preliminary copy of the test results shall be supplied for approval before despatch shipment of the circuit breakers Two copies of complete test results shall be furnished with the circuit breakers. These shall include complete reports and results of the routine test.

vii **ADDITIONAL TESTS:** The CSPTCL reserves the right for carrying out any other tests of a reasonable nature at the works of the manufacturer or at any other recognized laboratory/ research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the CSPTCL to satisfy that the material complies with the intent of this specification.

1.36 **INSPECTION:**

i. The CSPTCL reserves the right to insist for witnessing the acceptance/ routine testing of the bought out items.

ii. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

iii. The manufacturer shall submit the routine test certificates of bought out items and raw material at the time of routine testing of the fully assembled breaker.

1.37 **DOCUMENTATION**

i. All drawings shall conform to International Standards Organisation (ISO) 'A' series of drawing sheet/ Indian Standards Specification IS.-656. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

1.38 **LIST OF DRAWINGS AND DOCUMENTS:**

The contractor shall furnish sets of relevant descriptive and illustrative published literature, pamphlets and the following drawings for preliminary study during detailed engineering-

a) General outline drawings showing dimensions and shipping weights, quantity of insulating media, air receiver capacity etc.,
b) Sectional views the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts with lifting dimensions for maintenance.
c) All drawings & data typical and recommended schematic diagram for control supervision & reclosing.
d) Drawings & details of terminal connectors.
e) Structural drawing, design calculations and loading data for support structures.
f) General arrangement of foundation structure mounting plan including weights of various components and impact loading data for foundation design.
g) Type test reports of short circuit withstand capability of 3 sec including oscillogram & relevant certificate of similar type tested breaker.

* * * * * *

16. TECHNICAL SPECIFICATIONS FOR 33 KV VACUUM CIRCUIT BREAKERS

4.1 **SCOPE**: This Specification covers design, Manufacturing, testing, and supply of 33 KV Vacuum Circuit Breakers complete with all accessories required for its satisfactory operation in the system.

4.2 TYPE AND RATING: The circuit breaker shall be suitable for outdoor operation under the climatic conditions, as specified in Tender specification, without any protection from sun and rain.

The circuit breaker shall have the following rating:-

S.No.	Particulars	33 KV VCB
i)	Number of poles	3 Nos.
ii)	Frequency	50 Hz
iii)	Nominal system voltage	33KV
iv)	Highest system voltage(Rated)	36 KV
v)	Interrupting capacity at nominal system voltage	1500 MVA
vi)	Rated continuous current (RMS)	1600 Amps.
vii)	Basic insulation level	170 KV Peak
viii)	Power frequency withstand voltage for one minute	70 KV
ix)	Total break-time for any current up to the rated breaking current.	3 Cycles (Max 60 MS)
x)	Control circuit voltage	220 V DC
xi)	Operating duty for gang operation	0-0.3Sec-CO-3 Min-C0
xii)	The VCB shall be suitable for one reclosing followed by one delayed reclosing and lock out.	
xiii)	Minimum clearances:-	
	(a)Between phases	360 mm
	(b)Between live parts & ground	3700 mm
	(d) Creepage distance	900 mm or more
xiv)	IR value live part to earth	50 G ohm
xv)	Fault level for 1 Sec.	25 KA
xvi)	Mounting Structural Details	Hot dip galvanised lattice steel support structure to be supplied for all VCB
		One platform with steps shall be provided of such height that operator can easily operate the VCB climbing this platform.
xvii)	Centre to Centre distance between two structure foundation for supporting the complete CB assembly	**1500 mm**

The above are our minimum requirement. The suppliers may offer their standard design, keeping in view our minimum requirements.

4.3 STANDARDS:-

The circuit breakers shall comply with the requirements of IEC 56 or IS-13118 (1991) with latest amendment thereof except wherein specified otherwise. Equipment, meeting any other authoritative standard, which ensures equal or better quality then

the standards mentioned above, will also be acceptable. The contractors shall clearly indicate the applicable standards to which their equipment complies-with. A copy of such standard, may also be enclosed.

4.4 GENERAL:-

The circuit breaker shall be of porcelain clad vacuum type. The breaker, complete in all respect, shall be supplied with all accessories in place and all internal wiring installed and terminated in the mechanism housing and the equipment shall be complete in all respects.

The circuit breaker shall provide rapid and smooth interruption of current under all conditions, completely suppressing all undesirable phenomena, even under the most severe and persistent short-circuit conditions or when interrupting small current or leading/lagging reactive currents. The details of any device incorporated to limit or control the rate of rise of restriking voltage across the circuit breaker contacts shall be stated. The over voltage caused by the circuit breaker switching on inductive or capacitive load shall not exceed 3.2 times the normal phase to neutral voltage. The total break-time for the circuit breaker, throughout the range of breaker operating duty, shall be stated in the tender and shall be guaranteed. The breaker shall be fit for capacitor switching (breaking) capacity atleast 400 Amps for Single Capacitor Bank breaking current.The breakers shall be provided with trip free mechanism.

Circuit breakers shall be suitable for mounting on steel structures. The cost of necessary frames for mounting the circuit breakers shall be included in the offered prices. All the structures shall be hot dip galvanized with 3 dips. Please note that cantilever type supports for mechanism box are not acceptable. The mechanism box shall have firm supports from bottom. This is necessary to minimize vibration of mechanism box, which in turn may disturb various settings.

The mechanism box shall be centrally mounted in front of the middle pole, Breaker with mechanism box mounted by the side of one of the extreme poles is not acceptable.

The CSPTCL intends to operate the rural 33 KV feeders with automatic reclosing scheme, the arrangement envisaged is as under:-

On the occurrence of a fault the concerned protective relay will open the circuit breaker as per its own characteristic. Thereafter, the breaker shall reclose but after pre-set time delay, which shall be adjustable (say range 4-10 sec. or near about).There shall be no further automatic reclosing. A simple type of reclosing relay (reputed make) for this purpose shall be provided under this kind of operation. It is also necessary that the breaker shall be suitable for this reclosing duty.

4.5 SPECIFICATION FOR CIRCUIT BREAKER:-

The circuit breakers shall consist of three identical phase units with a common operating mechanism. While offering the circuit breaker, the following details should be confirmed and furnished:-

Complete construction details of the equipment offered. It should be noted that the breakers should be suitable for outdoor duty, indoor breakers accommodated in outdoor kiosks are not acceptable.

Type, Make & source of vacuum bottles with relevant details shall be indicated in the offer, clearly.

The capacity of breaker to interrupt inductive and capacitive currents shall be indicated in the offer (rating of capacitor bank should be stated and type test report shall be furnished).

4.6 **VACUUM INTERRUPTER:-**

The design of the vacuum interrupter shall be such that it gives trouble free operation under normal load and fault conditions throughout the life of the equipment. As the efficiency of the breaker depends on the degree of vacuum inside the interrupter manufacturer shall ensure that the same is maintained consistently during service. To know the Residual life of vacuum interrupter, an indicator to indicate the status of contact erosion shall be provided.

The insulating ceramic body of the interrupter should have high mechanical strength and it should be capable of withstanding high temperature without any significant deterioration in its mechanical and electrical properties.

The metal/alloy used for the fixed and moving contacts shall have very low resistivity and low gas content. They should be resistant to arc erosion and the contact should have no tendency to get cold-welded under the high vacuum in the interrupter.

The interrupter design should ensure rapid denomination of the gas so that normal electrical strength of the gap is restored instantaneously.

The metallic below or any other similar vacuum sealing arrangement should be provided at the moving contact and should have a long fatigue life.

Manufacturers catalogue on vacuum bottle, indicating all the details shall essentially be submitted with the tender.

4.7 **TEMPERATURE RISE**:-

The maximum temperature attained by any part of the equipment, when in service, at site, under continuous full load conditions, exposed to the direct rays of the sun, shall not exceed 45 degree centigrade, above ambient temperature. The limits of temperature rise shall be as per relevant standards. The corrections proposed shall be stated in the tender and shall be subject to approval of the CSPTCL.

4.8 **INSULATION OF THE CIRCUIT BREAKER**:- The insulation to ground, the insulation between open contacts and the insulation between phases of the completely assembled circuit breaker shall be capable of withstanding satisfactorily di-electric test voltage corresponding to specified basic insulation level in the standard.

4.9 **INSULATORS:-** The basic insulation level of the Insulator and insulating porcelains shall be as specified and porcelain shall be homogenous and free from cavities and other flaws. They shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above. All insulators of identical ratings shall be interchangeable. The puncture strength of the insulators shall be greater than the flash over value. The insulators shall be type tested from independent Govt. Lab. as per relevant standards.

4.10. **OPERATING MECHANISM**:-

4.10.1 ***The circuit breaker shall be designed for remote control from the control room and in addition there shall be provision for manual operation of circuit breakers during maintenance and for local tripping and closing by the normal means***.

4.10.2 The circuit breakers shall have operation control and mechanical open closed indicator in addition to facilities for remote electrical indication.

4.10.3 The operating mechanism shall be of the spring charging type by electric control under normal operation. The mechanism shall be trip free electrically and mechanically. The mechanism shall be capable of performing satisfactorily, the reclosing duty cycles indicated above, within the time specified. All working parts in the mechanism shall be of corrosion resistant material and all bearings which require

greasing shall be equipped with pressured grease fittings. The mechanism shall be strong quick in action and shall be removable without disturbing the other parts of the circuit breaker.The mechanism and breaker shall be such that the failure of any spring will not prevent tripping and at the same time will not cause any false tripping or closing. The operating mechanism should be motor operated spring charged type preferably without chain drive. The motor for spring charging shall be suitable for operation on 230 volt AC supply.The AC Motor should have overload protection. Provision should also be made for Mounting of Mechanism Box at an adequate height and gear ratios shall be so chosen that one man should be able to charge the spring, without any additional efforts. **Please note that providing DC motor with rectifier is not acceptable**.

4.10.4 **CONTROL CUBICLE**:-

A common control cubicle shall be provided to house electrical, Controls, monitor devices and all other accessories except those which must be located on individual poles. The cubicle shall be IP 55 class protection and shall have weatherproof construction fabricated from sheet steel of minimum 2.5 mm. Thickness. The type test report on degree of protection test (IP--55) shall also be furnished.

The cubicle shall have front access door with lock and keys, Space heater, internal illumination lamp, 3 pin 5A socket with individual ON-OFF switches shall be provided in the cubicle.

For local operation following shall be provided:-

LOCAL/REMOTE selector switch

TRIP/NORMAL/CLOSE control switches with pistol grip handle.

4.10.5 The control circuits shall be designed to operate on 220 V DC & it shall be possible to adopt to work on other voltages by simply changing the operating coils. The closing and tripping coils shall be designed to operate satisfactorily at any control voltage from 70% to 110% of the specified normal DC voltage.

4.10.6 AC Power supply for auxiliaries will be available at 230 volt single phase 50 C/s.

4.10.7 Necessary cable glands for the cables of the operating mechanism shall be provided. The cables used for operation are all un-armoured 2.5 sq. mm copper control cables of 1100 V grade. The cable glands shall be suitable for 1 no. 8 core and 2 nos. 4 core cables.

4.10.8 The Circuit breaker shall be provided with trip free Mechanism so that tripping instructions could over-ride the closing instructions. An additional tripping coil shall also be provided in the trip circuit. The second coil shall have separate tripping level arrangement in the mechanism so as to avail advantages of second trip coil. Two trip coil shall be arranged separately for the operation of two different DC sources. Separate DC fuse circuit and electrically wired for schematic connection such that the healthiness of both trip coils could be checked individually.

4.10.9 The circuit diagram of Control circuit of VCB along with operating instructions (DO'S/DON'T) shall be embossed on metallic plate duly laminated and the same shall be fixed on the rear door of the Control cubicle from inside.

4.10.10 **WIRING**:-Wiring shall be completed in all respects to ensure proper functioning of the control, protection, monitoring and interlocking schemes.

a. All the wiring shall be carried out with 1100 V grade, PVC insulated stranded copper conductor of 2.5 Sq.mm.

b. Each wire shall be identified at both ends with permanent markers bearing wire numbers as per wiring diagram.

c. Wire termination shall be done with crimping type connectors with insulating sleeves. Wires shall not be spliced between terminals.

d. All spare contacts of auxiliary switches etc. shall be wired upto terminal blocks in the control cubicle.

4.10.11 **TERMINAL BLOCKS:-**

Stud type Terminal blocks shall be of 1100 V grade box clamp type ELMEX 10 Sq mm or approved equivalent, not more than two wires shall be connected in one terminal, Spare terminals equal in number to 20% of active terminals shall be provided. All the terminals should be of stud type only.

Terminal block shall be such located as to allow easy access. Wiring shall be so arranged that individual wires of an external can be connected to consecutive terminals.

4.10.12 **TERMINAL CONNECTORS**:-

6 Nos Terminal connector suitable for Zebra conductor shall be supplied with each breaker. The terminal connectors shall also meet the following requirements:

i) Terminal connectors shall be manufactured and tested as per IS: 5561.

ii) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The terminal connectors should be manufactured by gravity die-casting process only.Bushing terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL

iii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

iv) No part of a clamp shall be less than 12 mm thick.

v) Minimum conductor coverage on the clamp shall be 100mm. Minimum bushing terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100 x 100 mm.

vi) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

vii) For bimetallic connectors, copper alloy liner of minimum thickness of 4 mm (2 mm cu and 2 mm Al) shall be integral with aluminium body.

viii) Flexible connectors shall be made from tinned copper/aluminium sheets.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance. The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor.

x) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561

Two numbers grounding terminals for connection with station earth mat shall be provided on each circuit breaker. Size of the earthing pad shall be suitable for 50 x 8 mm or 60 x 8 mm GI flat.

4.10.13 **AUXILIARY CONTACTS**:-

Eight numbers each of auxiliary contacts both of the normally open and normally closed types shall be provided in each circuit breaker for use in the remote indication and control scheme of the circuit breaker and for providing safety interlocking.

Special contacts for use with trip coils which permit for relative adjustment with respect to the travel of the circuit breaker contact shall also be provided, wherever required. There shall be provision to add more auxiliary contacts at a later date. If required.

4.10.14 **ACCESSORIES:-**

The vacuum circuit breaker shall be supplied as a complete unit with internal wiring installed and terminated in mechanism box and equipped with the following accessories:-

S.NO.	PARTICULARS	QTY.
1.	Motor operated spring charged mechanism Motor voltage- 230 V AC)	1 No.
2.	Trip coils suitable for 220 V DC:	2 Nos.
3.	Closing coil suitable for 220 V DC:	1 No.
4.	Pistol grip C.B, Control switch having trip/ Normal/ Close position:	1 No.
5.	Local/Remote selector switch	1 No.
6.	Mechanical Spring Charged indicator	1No.
7.	Manual operating handle for maintenance	1 No
8.	Facility for manual charging of spring	1 No.
9.	Operation counter	1 No.
10.	Auxiliary contacts 8 NO - 8 NC	1 Set
11.	Anti pumping device suitable for 110V DC	1 No.
12.	Terminal connectors suitable for connecting Zebra conductor	6 Nos.
13.	Cubical illuminating lamp with cage & switch	1 No.
14.	MCB for both AC and DC supply	1 No. each
15.	Spare terminal connectors	20% of total terminals
16.	Mechanical ON /OFF indicator	1 No
17.	Space Heater with thermostat and ON /OFF switch	1 No
18.	Power Type 3 PIN socket with ON /OFF switch (5A)	1Set
19.	Earthing terminals	2 Nos.
20.	Duly laminated metallic Plate embossed with Circuit Diagram of control circuit of VCB along with Operating Instructions	1 No.
21	Lamp (LED) ON /OFF and spring charge indicator (Red lamp for ON,Green Lamp for OFF and Blue for Spring charge)	3 Nos

4.11 Other standard accessories which are not specifically mentioned above, but are required for efficient and trouble free operation of breaker, should also be provided, without any extra cost.

4.12 **TYPE TESTS**:-

1. Type test certificates on VCB for the following tests as per IS 13118 with latest amendment there of from any of the Govt. of independent Govt. approved Laboratory shall invariably be furnished:-

   (i) Short circuit duty test.
   (i) Short time current rating test.

(ii) Mechanical endurance test.
(iv) Temperature rise test.
(iii) Lightning impulse voltage withstand test.
(iv) Capacitor switching off duty test for single bank of atleast 400 Amps for Single capacitor bank breaking current.
vi) Power Frequency with stand voltage test dry and wet
vii) Degree of protection IP 55 for the Control Cubicle

4.12.2 The above type test certificates must accompany drawings of type tested equipment duly signed by type testing authority.

4.12.3 The above tests must not have been conducted on the equipment earlier than 5 years from the date of opening of bids.

4.12.4 In case of any change in design of Breaker already type tested and the one offered against this specification the CSPTCL reserves the right to demand repetition of tests, without any extra cost.

4.13. **ACCEPTANCE AND ROUTINE TESTS:-**

4.13.1 All acceptance and routine tests as stipulated in relevant standards shall be carried out by the supplier in presence of CSPTCL representative.

4.13.2 Immediately after finalisation of the programme of type testing, the suppliers shall give fifteen days advance intimation to the CSPTCL, to enable him depute his representative for witnessing the tests.

4.14 **RATING PLATES:-**

The detailed rating plate shall be as per IS and in addition, shall indicate serial number of the equipment manufacturer's name our order number and date.

4.15 **SCHEDULE OF IMPORTANT TECHNICAL SPECIFICATION / REQUIREMENT FOR 33 KV VCBs TO BE ORDERED AGAINST THIS TENDER**

Certain important technical specification requirements have been described hereunder. The requirement may please be studied and incorporated carefully in the equipment.

1) Please note that support structure shall be hot dip galvanized and this should be incorporated on OGA Drawing. Ensure furnishing details of loading on the structure both vertical and horizontal in normal condition as well as in broken wire condition at plinth level to develop foundation design of your make VCBs. This information should be indicated in general arrangement drawing.

2) Please note that all breakers shall be provided with trip free mechanism. In order to ensure full proof trip free operation of circuit breaker the design should ensure that the stored energy is definitely available for tripping operation before closing operation of circuit breaker is performed. In the absence of stored tripping energy closing operation is to be prevented.

3) In order to improve reliability, circuit breaker shall be provided with double trip coil. However, as far as possible efforts should be made to provide both trip coils at different locations to actuate individual trip latch. Independent DC circuit may be provided for the two trip coils and a separate DC circuit for the closing coil. These two trip coils shall be electrically wired upto control cubicle so that healthiness of both trip coils could be checked individually.

4) The circuit breaker shall be designed for remote control from the control room and in addition there shall be provision for manual operation of circuit breakers during maintenance and for local tripping and closing. In addition there shall be provision for mechanical arrangement for emergency trip.

5) The circuit breakers shall have a mechanical "Open" / "Close" indicator in addition to electrical indication. It shall be visible to operating personnel standing on the ground level.

6) An operation counter shall be provided with the operating mechanism.

7) The terminal connector for connection of conductor should be suitable for Zebra conductor with Universal take off arrangement. In case if required one "L" shaped clamp may be provided to facilitate horizontal as well as vertical take off arrangement. Terminal connector shall be manufactured out of Aluminium alloy grade LM 6 or LM 25 as per IS and by gravity die casting process only and should have six bolts to hold the conductor and conductor hold length shall be 100 mm approximately.

   All nuts and bolts shall be stainless steel and no part of the terminal connector clamps shall be less than 12 mm thick.

8) For bimetallic connector bimetallic strips of electrical grade copper of adequate thickness well amalgamated surface to surface with aluminium sheet should be provided.

9) Following drawings are required to be submitted on priority for scrutiny and approval incorporating above observations / requirement positively:-

   i) General arrangement drawing indicating location of control cubicle, mechanical ON-OFF indicator, operation counter, device for manual / emergency trip upper and lower terminal connector, and bushing creepage distance (at least 900 mm for 33 KV).

   ii) Detailed structure drawing clearly indicating the foundation details, details of loading on the structure as explained above, various dimensions details of various members of structure and weight of circuit breaker etc.

   iii) Schematic diagram indicating details of auxiliary contacts, ON, OFF healthy trip and spring charge indication, double trip coil arrangement, antipumping and trip free mechanism feature etc.

   iv) Wiring diagram for above schematic diagram.

   v) Details of auxiliary contacts utilized for various internal scheme and details of auxiliary contacts available for customer use.

   vi) Packing details drawing indicating total number of package and content of each package.

   vii) The name (rating) plate shall be engraved / anodise in which apart from basic details following information may also be incorporated.

   Capacitor bank switching off capacity in MVA,
   Applicable standard IES/ IS,
   Interrupting capacity of the breaker in MVA

   viii) Engraved electrical wiring diagram could be permanent / refixed on the rear of front door of the control cubicle. Details required for casting of foundation may also be engraved / refixed by the side of electrical /

diagram or this purpose, the various schematic drawing may be condense and one separate drawing may be submitted to us for our approval.

10) All wirings in the cabinet shall be done neatly and accommodated in plastic channels with sliding cover. Practice of colour coding / feruling / bunching etc. shall be followed to present a neat installation. All glands / cable entry points shall be provided with suitable blanking plates to prevent entry of moisture / vulture. At least 20% spare terminals shall be provided. Three-pin power plug shall be of control panel grade with removable lid.

11) Backup mechanical tripping arrangement should be provided to facilitate tripping of circuit breaker for the condition when DC is not available or tripping coil is burnt and other similar emergencies. Suitable lever device may be provided for trip operation under these conditions.

12) Please ensure that no wire / cable is left exposed to atmosphere directly. In case if any connection is required from circuit breaker operating box to control cubicle etc, these connections should be taken through cable but through proper guided channel with sliding covers rigidly fixed on support structure. Please note that both ends of this connecting cable shall be properly sealed to prevent ingress of rain water / moisture.

13) The support structure should have proper Earthing arrangement and this should be indicated in the drawing.

14) In case if cementing of porcelain bushing is required, please ensure that proper cementing process has been adopted.

15) The auxiliary switches shall be properly designed wherein change of contacts takes place by snap action and change of status of contact is visible physically.

16) Identification mark may be done on the each breaker pole to co-relate the serial number of bottles engraved on breaker poles with that of circuit breaker Sl. No.

17) For spring charging operating through operating handle it is desired that mechanism box may be mounted at adequate height and gear ratio shall be so chosen that one man is able to charge the spring without any additional efforts. Suitable latching arrangement shall be provided such that during manual charging operation, if power supply gets restored, jerk to operating personnel is avoided. The handle shall be either at normal operable height or otherwise a suitable foldable ladder shall be provided to facilitate manual charging of spring. Suitable arrangement for storage of handle in the box shall be provided.

****

17. TECHNICAL SPECIFICATION FOR INSTRUMENT TRANSFORMERS

(*Note:- 132 KV CT & 132 KV PT shall be provided by CSPTCL*.)

1.1 SCOPE

This specification provides for design, manufacture, stage testing, inspection and testing before despatch, packing and delivery of outdoor instrument transformer (CT and PT) for protection/metering .

1.2 STANDARDS

The rating as well as performance and testing of the instrument transformers shall conform but not limited to the latest revision and amendments available of all the relevant standards as listed hereunder.

S.N	STANDARD No.	TITLE
1	IS 2165	Insulation co-ordination for equipment of 100 KV and above
2	IS2705 (I – IV)	Current transformers
3	IS 2099	High voltage porcelain bushings
4	IS 3347	Dimensions of porcelain transformer bushings
5	IS 2071	Method of high voltage testing
6	IS 335	Insulating oil for transformers and switchgears
7	IS 2147	Degree of protection provided by enclosures for low voltage switchgear and control
8	IEC 185	Current transformers
9	IEC 270	Partial discharge measurement
10	IEC 44 (4)	Instrument transformer measurement for P.D.s
11	IEC 171	Insulation co-ordination
12	IEC 60	High voltage testing techniques
13	IEC 8263	Method of R.I.V. test on high voltage insulators
14	IS 3156 (Part IV)	Capacitor voltage transformers
15	IEC 186	Voltage transformers
16	IEC 186 A	First supplement of IEC publication 186
17	IEC 358	Coupling capacitor divider
18	IS 9348	Coupling capacitor and capacitor dividers
19		Indian electricity rules 1956.

1.3 BASIC DESIGN FOR INSTRUMENT TRANSFORMERS:-

The Instrument Transformers for solidly grounded system shall be outdoor type. Single-phase oil immersed and self cooled type suitable for services indicated as above complete in all respect, conforming to modern practices of design and manufacture.

As stated, all CTs shall be paper-insulated oil filled. After providing paper insulation they shall be housed in the tank containing oil. Please note epoxy casting in primary & secondary cores is not acceptable. Compound filled CTs are also not acceptable.

1.3.1 The insulation as per IS: 4800 of the instrument transformers shall be so designed thatthe internal insulation shall have higher electrical withstand capability than the external insulation. The designed dielectric withstands values of external and internalinsulations shall be clearly brought out in the guaranteed technical particulars. The dielectric withstand values specified in this specification are meant for fully assembled instrument transformers.

1.3.2 The Instrument transformers should be designed using single Porcelain housing. The OIP insulation in porcelain portion is to be provided with condenser grading. Details like number of grading foils, the method of insertion of grading tools in insulation, method to ensure grading foil location during manufacturing may be furnished.

1.3.3 No joints shall be provided in the porcelain. The housing shall be made ofhomogeneous, vitreous porcelain of high mechanical and dielectric strength, glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface arranged to shed away rain water or condensed water particles, (fog). The profile of porcelain shall be aerodynamic type as per IEC-815. To make the instrument transformer leak proof a metallic flange should be cemented to the porcelain.

1.3.4 Special precaution will have to be taken towards selection of material for the metal tank and the following will have to be ensured.

i) Material for metal tank should be minimum 3 mm thick.
ii) Welded joints have to be minimized to avoid possibility of oil leakage. In any case welding in horizontal plane shall be avoided.

1.3.5 Prevention of Oil leakages and Entry of Moisture**:-**
The sealing of CTs shall be properly achieved. The following should be properly taken care of & arrangement provided by the supplier shall be described:

i) Locations of emergence of primary and secondary terminals.
ii) Interface between porcelain housing and metal tank/s.
iii) Cover of the secondary terminal box.
iv) Oil level indicator shall be circular shaped with Teflon tape between threads to avoid oil leakage. It shall be fitted to the tank through circular inner thread on the tank. Oblong/rectangular shaped level indicator of old design fitted with screws shall not be accepted

1.3.6 While forming the OIP Insulation, the Insulating Paper has to be procured from Reputed Paper Manufacturers. The list of original paper suppliers is required to be submitted along with the tender. The new insulating oil is required to be used for impregnation of paper insulation and CT filling. Use of reclaimed or once used oil is prohibited.

1.3.7 The Insulating Oil used for impregnation and flooding is to be processed before use. The processing includes drying and degassing. Stainless steel bellows shall be used for volumetric compensation of oil.

1.3.8 All the sealing locations have to be provided with Moulded Rubber "O" Rings/ flat Gaskets. CT Designs with Cork Sheet as the sealing material are not acceptable. In case the gasket sealing surface is provided on mild steel material, details have to be provided regarding corrosion protection treatment provided on such surfaces. Also a description has to be provided on how the compression of the"O" Ring or Gasket is limited & controlled.

1.3.9 During inspection each CTs will be subjected to pressure test at 0.7 kg /cm^2 for 8hrs.

1.3.10 The CTs should be provided with pressure relief diaphragm.

1.3.11 The secondary terminals shall be brought out in a weather proof terminal box. Firstly the connections will be terminated on a internal board and then the same shall be brought out in the Secondary terminal box. The terminal box shall be provided with removable gland plate and gland/s suitable for 1100 volts grade, PVC insulated, PVC sheathed multi core 4 or 6 sq.mm for CT.

The terminal box shall be dust and vermin proof. Suitable arrangement shall be made for drying of air inside the secondary terminal box. The dimensions of the terminal box and its openings shall be adequate to enable easy access and working space with use of normal tools. The outer cover of secondary terminal box shall have provision for sealing by way of insertion of wire in the bolt hole.

1.3.12 Polarity shall be invariably marked on each primary & secondary terminals. All marking shall be engraved or through anodised plate to be fixed firmly.

1.3.13 The Instrument transformers shall be provided with a rating plate with dimensions and markings as per IS:2705. The markings shall be punched / engraved and not painted. This rating plate shall also contain CSPTCL's work order No. and date.

1.3.14 The instrument transformer shall be vacuum filled with oil after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Provision of oil sampling is required for each CT with proper sealing arrangement. The construction details and method to sample oil should be provided. Manufacturer shall provide limits of BDV Tan delta, moisture content and DGA to be followed for evaluation on oil samples at the time of routine testing.

1.3.15 The castings of base, collar etc. shall be die-cast and tested before assembly to detect cracks and voids if any.

1.3.16 The instrument security factor of metering core shall be low enough and not greater than 5. This shall be demonstrated on all the ratios of the metering core, in accordance with procedure specified in IEC-816 or IS:2705.

1.3.17 Instrument transformer shall be provided with two separate earthing terminals for bolted connection to 50 x 8 mm MS flat to be provided by the Purchase for connection to station earth-mat.

1.3.18 Instrument transformer shall be provided with suitable lifting arrangement, to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. Lifting arrangement (lifting eye) shall be positioned in such a way as to avoid any damage to the porcelain housing or the tanks during lifting for installation/transport. Necessary string guides shall be offered which shall be of removable type.

1.4 PRIMARY WINDINGS:-

1.4.1 Primary winding shall be made out of electrolytic grade 99.9% conductivity copper. The primary winding shall be housed in rigid metallic shell. Joints in the primary winding shall not be provided.

1.4.2 It is desired that from the point of view of adequate mechanical strength in the normal course and also during short circuit, proper precaution should be taken as under :-

i) The primary winding should be housed in rigid metallic shell.

ii) The winding assembly should be held firmly and for this purpose suitable clamping arrangement at the bottom shall be provided and explained through suitable sketch. Firm clamping arrangement is a must and <u>holding of winding using nylon rope etc. shall not be acceptable.</u>

1.4.3 The primary winding current density shall not exceed 1.5 A/sq.mm. The design density for short circuit current as well as conductivity of the metal used for primary windings of CTs shall meet the requirement of IS:2705. The manufacturer shall submit the detailed calculation for selection of winding cross sections. The selected Amp turns for the CT shall be justified on the basis of Type test reports.

1.5 **SECONDARY WINDINGS**:-

Suitably insulated copper wire of 99.9% conductivity electrolytic grade shall be used for secondary windings. The exciting current of the CTs shall be as low as possible. The magnetization curve for all the cores of CTs should be submitted with the offer.

1.6 **PRIMARY TERMINALS**:-

For various rating of CTs, selection of primary terminal of copper shall be made carefully. The primary terminal on either side of the tank shall be of not less than 100 mm clear length (i.e. after bolts) to accommodate terminal connector. For CTs the dia /size of the primary terminal shall be min 50mm dia.

The primary terminals shall be of heavily tinned electrolytic copper. The minimum thickness of tinning shall be 15 microns.

1.7 **SECONDARY TERMINALS**:-

Secondary terminal studs shall be provided with at least three nuts and adequate plain and spring washers for fixing the leads. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum out side diameter of the studs shall be 10 mm. The length of at least 15 mm shall be available on the studs for inserting the leads. The horizontal spacing between centers of the adjacent studs shall be at least 1.5 times the outside circum dia of the nuts. The arrangement should be shown through suitable sketch.

1.8 **CORE**:-

The grade M4 toroidal core shall be of high-grade non-ageing electrical silicon laminated steel of low hysterics loss and high permeability to ensure high accuracy.

The instrument transformer core to be used for metering shall be of accuracy class specified or appropriate class suitable for commercial and industrial metering.

Enamel, if used for conductor insulation, shall be either polyvinyl acetate type or amide type and shall meet the requirements of IS:4800. Polyester enamel shall not be used.

In case of CTs the saturation factor of the metering core shall be low enough not to cause any damage to measuring instruments in the event of maximum short circuit current. The 5 P 20 cores shall be designed for a minimum saturation factor of 20 for the highest setting. The magnetization curves for this core shall be furnished with the tender. As far as PS class core is concerned all precautions shall be taken in design to achieve KVP as mentioned in GTP (Principal Parameters) & magnetization curve for the same shall be furnished.

1.9 INSULATION OIL :-

The quantity of oil for first filling of oil in each transformer shall be in the scope of supplier. Only best quality new EHV Gr-I transformer oil should be filled in the equipments with BDV of 70 KV. The BDV of oil filled in the equipment will have to be recorded in the test certificate.

1.10 SURFACE FINISH:-

The metal tanks & all the ferrous parts/hardware, exposed to atmosphere, shall be hot dip galvanised conforming to IS; 2633. All other fixing nuts, bolts, washers shall be made out of galvanized steel.

1.11 **TERMINAL CONNECTORS**;-

The Terminal connector shall have two parts copper and Aluminium. Since the primary terminal is made up of copper, hence the part of terminal connector towards CT stud shall be made up of copper. The part of the clamp towards conductor shall be of Aluminium.

No part of a clamp shall be less than 15 mm thick. Minimum conductor coverage on the clamp shall be 100mm. Minimum bushing terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm.

GI nuts, bolts and washers shall be used. Nuts and bolts shall have hexagonal head with threads as per IS and shall be fully threaded type. Also instead of spring washers check/ lock nuts shall be provided.

The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR zebra conductor and the temperature rise under these conditions shall

not be more than 50% of that of the main conductor. The terminal connector of 132KV side should be suitable for twin zebra conductor.

Terminal connector shall be suitable for Zebra ACSR conductors. Clamps shall be designed adequately to take care of any bimetallic effect. The temperature at the clamp shall not exceed 80°C. The bushing side of connector shall be of copper and conductor side shall be of aluminium.

The terminal connectors shall also meet the following requirements:

i) Terminal connector shall be tested for short circuit current capability test, temperature rise test etc. The drawing of terminal connector offered shall have to be got approved by CSPTCL

ii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

iii) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

iv) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be integral with aluminium body.

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

1.12 The Instrument Transformer shall be suitable for mounting on steel structure of CSPTCL design.

1.13 The Capacitance and Tan Delta Measuring Terminal is to be provided on each CT.

1.15 TEMPERATURE RISE -

The current transformers shall be designed to limit the temperature of winding and other parts as specified in the standards, when corrected for the difference between the temperature prevailing at site and temperature as per GTP. The temperature rise at 1.25 times rated primary current as specified when applied continuously at rated frequency and at rated burden shall not exceed the limits specified above .

1.16 TESTS :-

All acceptance and routine tests as stipulated in the relevant standards shall be carried out in the presence of CSPTCL's representative:-

(vii) Verification of terminal marking.
(viii) Measurment of Tan Delta value at 27deg centigrade.
(ix) Power frequency withstand test on primary and secondary winding
(x) Partial discharge measurement (as per clause 8.2.2 of IEC 44-1)
(xi) Power frequency withstand tests between section (as per clause 8.3of IEC 44-1)
(xii) Inter turn voltage tests per clause 8.4 of IEC 44-1)
(xiii) Determination of errors.

Note: - The 132 KV & 33 KV CTs /PTs should have been type tested as per relevant IS & IEC in a NABL accredited lab and Type Test Certificate should be submitted

1.17 Other design features & Acceptance criteria for Current Transformer & Potential Transformer :-

i) For 132 KV PTs high voltage continuous running test for 8 hrs shall be conducted at 120% voltage as acceptance test for all PTs.

ii) The limits of errors of 132KV PT shall be checked at a rated voltage factor of 1.5.

iii) The current density of primary winding of CTs at rated current shall not exceed 1.5 Amp per Sq mm.

iv) The CT/PT should be completely leak proof. Even the slightest oil seepage from any part shall not be accepted.

v) Type test report from NABL accredited lab may be submitted for acceptance for all the equipments.

vi) All ferrous parts shall be Hot Dipped Galvanised as per relevant IS

1.18 PRINCIPAL TECHNICAL PARAMETERS OF CURRENT TRANSFORMERS.

S.N	ITEM	Specifications for 132 KV CT	Specification for 33 KV CT	
1	Type of C.T. / installation	Single phase, dead tank, oil filled, hermetically sealed / out door type.		
2	Type of mounting	Pedestal type	Pedestal type	
3	Suitable for system frequency	50 Hz.	50 Hz.	
4	Highest system voltage (KV rms.)	145	36	
5	Current ratio (A/A) a) Feeder b) Transformer	800-400/1-1-1-1A 400-200/1-1-1-1A	1200/1-1-1-1 A	800-400/1-1-1-1 A
6	Ratio taps	On primary side	On primary side	
7	No. of Cores	4	4 (X'mer & Transfer)	4 (Feeder)
8	Class of accuracy (winding I/II/III/IV)	PS/PS/0.2s/0.2s	PS/PS/0.2s/0.2 s	PS/PS/0.5s/0.2s
9	Burden in VA	---/---/15/15 VA	--/--/15/15 VA	---/---/30/15 VA
10	Knee point voltage	P.S.1100 V Min 30x(RCT+36)V	P.S > 1200 V	P.S > 800 V
11	Method of earthing the system	Solidly earthed	Solidly earthed	
12	Rated continuous thermal current (A)	120 %	125% of rated current	
13	Acceptable partial discharge level at 1.1 times the rated voltage	Less than 5 p Coulumbs		
14	Maximum radio interference voltage at 1.1 times the rated voltage	Less than 500 micro volts		
15	1.2 / 50 micro second lightening impulse withstand voltage (KVp)	650	170	
16	One minute dry power frequency withstand requirement for secondary winding (KV rms.) for one second	275	70	
17	Power frequency over voltage withstand requirement for secondary winding (KV rms.) for one second	3	3 KV	
18	Minimum creepage distance of porcelain housing (mm)	3625	900 mm	
19	Rated short time withstand current for one second duration (KA rms.)	31.5 KA	25 KA	
20	Rated dynamic withstand current (KAp)	78.75	65.5 KAp	
21	Seismic acceleration	0.3 g	0.3 g	
22	Temperature Rise with permissible overloading	5° C less than that permitted in I.S. (to be supported by calculations)		
23	Oil Weight	Minimum 15% of total weight of CT		

S.N	ITEM	Specifications for 132 KV CT	Specification for 33 KV CT
24	Bushing creepage factor	< 4	
25	IR value live part to earth	> 20 G ohm	> 20 G ohm
26	Flux density at knee point voltage for CT.	1.4 Tesla	1.4 Tesla
27	Current density of primary winding of CTs at ratedcurrent shall not exceed	1.5 Amp per Sq mm	
28	Dielectric dissipation factor (Tan delta) at 1/√3 rated voltage & ambient temperature (10 deg C. to 40 deg C.)	(i) For 33 KV 800-400 /1-1-1-1A - Max 0.005 (Tolerance +10 %) (ii) For 33 KV 1200/1-1-1-1 Amp - Max 0.005 (Tolerance +10 %)	
29	Material of primary winding	99.9% electrolytic copper	
30	Material of secondary winding	99.9% electrolytic copper	
31	Earthing terminal arrangements.	2 terminal for bolted connection to 50x6mm MS flat.	
32	Grade of oil	EHV Gr.-I as per IS:355	

1.19 PRINCIPAL TECHNICAL PARAMETERS OF POTENTIAL TRANSFORMERS.

S.N.	ITEM	SPECIFICATIONS	
1	Type / installation	Single phase, 132 KV dead tank oil filled, hermetically sealed, out door type	Out door oil immersed, self cooled, single phase
2	Type of mounting	Pedestal type	
3	Highest system voltage KV rms.	145 KV	36 KV
4	Suitable for system frequency voltage ratio a) rated primary voltage b) secondary voltage (volts)	50 Hz. 132/ √3 KV secondary -I,II,III 110 / √3 V	50 Hz. 33 /√3 KV secondary -I,II, 110 / √3 V
5	No. of secondary windings	3	2
6	Class : secondary – I secondary – II secondary - III	0.2 3 P 3P	0.2 3 P
7	VA : secondary - I secondary – II,III	50 100	50 100
8	Method of earthing the system	Solidly earthed	Solidly earthed
9	1.2/50 microsecond lightning impulse withstand voltage (KVP)	650	250
10	250/2500 microsecond switching impulse withstand (KVP)	Please Specify	Please Specify
11	1 minute dry power frequency withstand voltage primary (KV rms.)	275	95
12	Min creepage distance of porcelain housing (mm)	3625	1300
13	% over voltage capacity of PT to be indicated taking base as highest rated Primary voltage.	125%	125%
14	Rated short time with stand current for one second duration (KA rms.)	31.5 KA	25 KA
15	Power frequency withstand voltage for secondary for 1 sec.	3 KV rms	3KV rms
16	Grade of oil	EHV Gr.-I as per IS:335	EHV Gr.-I as per IS:335
17	Flux density at rated voltage factor of 1.5	Max. 1.8 Tesla	--

S.N.	ITEM	SPECIFICATIONS	
18	Primary to earth insulation resistance at 30 Deg. C.	Min. 50000 M Ohm	
19	Dielectric dissipation factor (Tan delta) at 1/√3 rated voltage & ambient temp.	Max. 0.003	--
20	Weight of oil.	≥ 133 Kg.	
21	Over all dimensions	2450x600x600 mm	**Please furnish with drawing**
22	Material of gaskets used	Nitrite butyl rubber/ Neoprine	--
23	Material of primary winding	99.9% electrolytic copper	--
24	Material of secondary winding	99.9% electrolytic copper	--
25	Core material used	Grade M4 toroidal core of high grade non ageing electrical silicon	--
26	Material of enamel used	Polyvinyl acetat3e or amide type.	--
27	Earthing terminal arrangements.	2 terminal for bolted connection to 50x6mm MS flat.	--

1.20 TERMINAL CONNECTORS :

The terminal connectors shall meet the following requirements:

i) Terminal connectors shall be manufactured and tested as per IS: 5561.

ii) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The terminal connectors should be manufactured by gravity die-casting process only. Bushing terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL

iii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off. Compression type of clamps should be supplied.

iv) No part of a clamp shall be less than 12 mm thick.

v) Minimum conductor coverage on the clamp shall be 100mm. Minimum bushing terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm

vi) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

vii) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm (1 mm Cu and 1 mm Al) shall be integral with aluminium body.

viii) Flexible connectors shall be made from tinned copper/ aluminium sheets.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance. The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor.

x) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561

xi) All connections with ACSR conductors shall be bolted type.

Two numbers grounding terminals for connection with station earth mat shall be provided on each CT & PT. Size of the earthing pad shall be suitable for 50 x 6 or 65 x 8 M.S. flat.

1.21 TECHNICAL SPECIFICATION FOR 72.5 KV INSULATION CLASS 33 KV POTENTIAL TRANSFORMERS

This specification covers the design, manufacture, assembly, testing at manufacturer's works, supply and delivery of 33 KV outdoor, single-phase voltage transformers for solidly grounded system.

SN	Type	33 KV
1	Manufacturer type / designation	Single phase out door type Hermetically sealed oil filled
2	Rated primary voltage	33 KV
3	Highest system voltage	72.5 KV
4	Number of secondary winding	Two
5	Rated Secondary voltage	
i	Winding-I	110V/√3
ii	Winding – II	110V/√3
6	Rated burden	
i	Winding-I (for metering)	50 VA
ii	Winding – II (for protection)	50 VA
7	Accuracy class	
i	Winding-I (for metering)	0.2
ii	Winding – II (for protection)	3 P
8	Maximum Ratio error with rated burden and 5% normal primary voltage	As per IS 3156 – 1992
9	Maximum Phase angle error with rated burden and 5% normal primary voltage	As per IS 3156 – 1992
10	Grade of oil	EHV grade as per IS 355
11	Temperature rise at 1.25 times rated voltage with rated burden at 50 deg C Ambient	45^{o}C (Max.) / as per IEC 186
12	Rated voltage factor & time	1.20 - continuous & 1.5 - 30 sec
13	Temperature rise for 12 deg C above	As per IS 3156
14	One minute power frequency withdstand voltage	140 KV rms
15	Lightning impulse vithstand voltage	325 KVp
16	One minute power frequency withstand voltage on secondaries	3 KV
17	Accuracy test of metering / protection windings	As per IS – 355
18	Surface treatment	Hot dip galvanized
19	System fault level	25 KA for 1 sec.

1.22 Special requirement for instrument transformers:

(i) Maximum continuous operating voltage:

It should be specifically confirmed that all PTs offered against the tender specification are suitable for continuous over voltage of 25% of rated system voltage. For this purpose, precaution taken in design of equipment may be suitably explained**.**

For all the PTs which are to be designed for 25% continuous over voltage, the allowable temperature rise at 125% rated voltage shall be as per permissible value as specified in IS.

(ii) Consistency of accuracy:

It should be specifically confirmed that with continuous over voltage as given in above para, the ratio/phase angle errors of the PTs shall be maintained strictly within specified limits without any drift and no variation shall take place due to overloading condition.

Standard:-

The instrument transformers shall comply with the latest issue of Indian Standard 3156, BS-

3941 or IEC-186 except where specified otherwise, equipments meeting any other authoritative standard which ensures an equal or better quality than the standard mentioned above, is also acceptable.

1.23 Climatic conditions:-

Peak ambient temperature	50 ^{o}C
Minimum temperature in shade	6 ^{o}C
Maximum relative humidity	95%
Average number of thunderstorm days per annum	40 days
Average number of rainy days per annum	90 days
Average annual rainfall	125 cm
Altitudes (not exceeding)	1000 mtrs.
Maximum wind pressure	

1.24 Basic design for PTs:-

The PTs for solidly grounded system shall be outdoor., single phase oil immersed and self cooled type suitable for services indicated as above complete in all respect, conforming to modern practices of design and manufacture.

As stated, all PTs shall be paper insulated oil filled. After providing paper insulation they shall be housed in the tank containing oil. **Please note epoxy casting inprimary & secondary cores is not acceptable. Compound filled PTs are also not acceptable**. Manufacturers should describe complete process of manufacturing.

1.24.1 The insulation as per IS: 4800 of the instrument transformers shall be so designed that the internal insulation shall have higher electrical withstand capability than the external insulation. The designed dielectric withstand values of external and internal insulations shall be clearly brought out in the guaranteed technical particulars. The dielectric withstand values specified in this specification are meant for fully assembled instrument transformers.

1.24.2 The Instrument transformers should be designed using single Porcelain housing.

1.24.3 No joints shall be provided in the porcelain. The housing shall be made of homogeneous, vitreous porcelain of high mechanical and dielectric strength, glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface arranged to shed away rain water or condensed water particles, (fog). The profile of porcelain shall be aerodynamic type as per IEC-815.

1.24.4 Special precaution will have to be taken towards selection of material for the metal tank and the following will have to be ensured. :

i) Material for metal tank should be **minimum 3 mm thick**.
ii) The material should be clearly mentioned against relevant clause of technical questionnaire.
iii) Welded joints have to be minimized to avoid possibility of oil leakage. In any case welding in horizontal plane shall be avoided.

1.24.4 Prevention of Oil leakages and Entry of Moisture**:-**

The sealing of PTs shall be properly achieved. The following should be properly taken care of & arrangement provided by the supplier shall be described:

i) Locations of emergence of primary and secondary terminals.
ii) Interface between porcelain housing and metal tank/s.
iii) Cover of the secondary terminal box.

1.24.5 For gasketed joints, wherever used, nitrite butyl rubber gaskets neoprene or any other improved material shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.

The quality of gaskets which will be used between the joints and also for mounting of oil level indicator will be of best quality to avoid leakage of oil. The quality of gasket should be selected keeping in mind that the ambient temperature in Chhattisgarh may touch 50 deg. centigrade.

1.5.8 The Instrument transformers shall be so constructed that it can be easily transported to site within the allowable transport limitation even in horizontal position also.

1.5.9 For indication of oil level, suitable arrangement by way of clear glass window or any other superior arrangement shall be provided.

1.5.10 The secondary terminals shall be brought out in a weather proof terminal box. Firstly the connections will be terminated on a internal board and then the same shall be brought out in the Secondary terminal box. The terminal box shall be provided with removable gland plate and gland/s suitable for 1100 volts grade, PVC insulated, PVC sheathed multi-core 2.5 sq. mm or 4 sq. mm. stranded copper cable.

1.5.11 The terminal box shall be dust and vermin proof. Suitable arrangement shall be made for drying of air inside the secondary terminal box. The dimensions of the terminal box and its openings shall be adequate to enable easy access and working space with use of normal tools. The outer cover of secondary terminal box shall have provision for sealing by way of insertion of wire in the bolt hole. A drawing indicating above arrangement may please be furnished along with the offer.

1.5.12 Facility shall be provided against short circuiting & grounding of the PT secondary terminal inside the terminal box. All marking shall be engraved or through anodised plate to be fixed firmly.

1.5.13 The Instrument transformers shall be provided with a rating plate with dimensions and markings as per IS:3156. The markings shall be punched/engraved and not painted. This rating plate shall also contain our purchase order no. and date.

1.5.14 The instrument transformer shall be vacuum filled with oil after processing and thereafter hermetically sealed to eliminate breathing and to prevent air and moisture from entering the tanks. Oil filling valve/or oil sampling cocks, if provided to facilitate factory processing, should be permanently sealed before despatching. The method adopted for hermetic sealing shall be described in the offer.

1.5.15 The castings of base, collar etc. shall be die cast and tested before assembly to detect cracks and voids if any.

1.5.16 Instrument transformer shall be provided with two separate earthing terminal s for bolted connection to 50 x 8 mm MS flat to be provided by the Purchase for connection to station earth-mat.

1.5.17 Instrument transformer shall be provided with suitable lifting arrangement, to lift the entire unit. The lifting arrangement shall be clearly shown in the general arrangement drawing. Lifting arrangement (lifting eye) shall be positioned in such a way as to avoid any damage to the porcelain housing or the tanks during lifting for installation/transport. Necessary string guides shall be offered which shall be of removable type**.**

1.6.1 **Primary windings:-**

1.6.2 Primary winding shall be made out of electrolytic grade 99.9% conductivity copper. The primary winding shall be housed in rigid metallic shell. Joints in the primary winding shall not be provided.

1.6.3 It is desired that from the point of view of adequate mechanical strength in the normal course and also during short circuit, proper precaution should be taken as under :-

(i) The primary winding should be housed in rigid metallic shell.

(ii) The winding assembly should be held firmly and for this purpose suitable clamping arrangement at the bottom shall be provided and explained through suitable sketch. Firm clamping arrangement is a must and holding of winding using nylon rope etc. shall not be acceptable.

1.6.4 All primaries of PTs will be connected in phase to neutral with neutral point solidly earthed. The neutral of the system is also solidly earthed.

1.7 **Secondary windings:-**

Suitably insulated copper wire of 99.9% conductivity electrolytic grade shall be used for secondary windings. The star winding to be used for metering & relaying shall be of

accuracy class as specified for appropriate class. The rated burden of the winding shall not be less than specified value**.**

1.8 **Primary terminals:-**

For various rating of PTs, selection of primary terminal only of copper material shall be made carefully. The primary terminal on either side of the tank shall be of not less than **80 mm length** to accommodate terminal connector.

The primary terminals shall be of heavily tinned electrolytic copper. The minimum thickness of tinning shall be 15 microns.

1.9 **Secondary terminals:-**

Secondary terminal studs shall be provided with at least three nuts and adequate plain and spring washers for fixing the leads. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum out side diameter of the studs shall be 8 mm. The length of at least 15 mm shall be available on the studs for inserting the leads. The horizontal spacing between centers of the adjacent studs shall be at least 1.5 times the outside circumdia of the nuts. The arrangement should be shown through suitable sketch.

1.10 **Core:**

The grade M4 toroidal core shall be of high grade non-ageing electrical silicon laminated steel of low hysterics loss and high permeability to ensure high accuracy.

1.10.1 The instrument transformer core to be used for metering shall be of accuracy class specified or appropriate class suitable for commercial and industrial metering.

1.10.2 Enamel, if used for conductor insulation, shall be either polyvinyl acetate type or amide type and shall meet the requirements of IS: 4800. Polyester enamel shall not be used.

1.11 **Insulation oil:-**

The quantity of oil for first filling of oil in each transformer shall be in the scope of supplier. Only best quality new EHV Gr.-I transformer oil confirming IS:355 should be filled in the equipments with BDV of 70 KV. **The BDV of oil filled in theequipment will have to be recorded in the test certificate.**

1.12 **Surface finish:-**

The metal tanks shall be hot dip galvanized only. All the ferrous parts/hardware, exposed to atmosphere, shall be hot dip galvanised conforming to IS; 2633. All other fixing nuts, bolts, washers shall be made out of stainless steel.

1.13 **Terminal connectors:-**

Terminal connectors shall be suitable for single ACSR Panther conductor. The terminal connector suitable for horizontal take off and vertical take off (Universal type) shall be supplied. Suitable terminal for earthing connection shall also be supplied.

The design of clamp shall be to our approval. The details of take off as required by us should be detailed out in drawing and should be submitted along with the offer. In respect of the terminal connectors following should be ensured:-

1. The terminal connector should be made of LM6 Aluminium Alloy and by gravity diecast only. Sand casted terminal connectors are not acceptable.
2. All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges should be rounded off.
3. No part of clamp shall be less than 12 mm thick.
4. The bimetallic strips/sleeve shall be 2 mm thick.
5. All nuts/bolts/washers shall be of stainless steel material only.

1.14 The PTs shall be suitable for mounting on our steel structure which shall be arranged by the CSPTCL. The drawings of structure shall be provided to the successful bidder by CSPTCL.

1.15 **Temperature rise: -**

The potential transformers shall be designed to limit the temperature of winding and other parts as specified in the standards, when corrected for the difference between the temperature prevailing at site and temperature specified by the standards. The temperature rise at 1.20

times rated primary voltage for PTs .

1.16 **Inspection & tests:-**

Reports of all type tests as stipulated in latest version of IS:3156 (Part-I,II,III & IV) shall be supplied along with the bids. This is essential. The Bidder must carefully go through our specification regarding short time current rating, impulse level and all type test reports as per IS should be furnished with the technical bid. Type test reports which are older than five years shall not be acceptable. The type test report of following tests is to be furnished in Technical bid.

1) Temperature rise test (as per clause 9.5 of IS 3156 part I)
2) Lightning impulse test (as per clause 9.6 of IS 3156 part-I)
3) Determination of errors
4) High voltage power frequency wet withstand test(as pet clause 9.7 of IS:3156 part-I)

Each instrument transformer shall be subjected to routine tests as specified in IS; 3156, or IEC 186 in the presence of purchaser. All test report should be submitted and should be got approved by the purchaser before despatch of the equipments. The routine tests to be carried out during final inspection shall be as follows:-

1) Verification of terminal markings & polarity (clause 9.2)
2) Power frequency dry withstand test on primary winding (clause 9.3)
3) Power frequency dry withstand test on secondary winding (clause 9.4)
4) Determination of errors

*****

18. TECHNICAL SPECIFICATION FOR 12 MVAR, 36 K.V. CAPACITOR BANK

6.1 **SCOPE**:- This specification provides for design, manufacture, stage testing, inspection and testing before dispatch, packing and delivery of 33 KV 10 MVAR capacitor bank.

6.2 **Technical Specifications for 12 MVAR 36 KV Capacitor Bank.**

S.N	PARTICULARS	VALUES	UNITS
1.	Nominal System Voltage	33	KV
2.	KVAR capacity at nominal system voltage	10,000	KVAR
3.	Rated Voltage of Capacitor Banks	33	KV
4.	Rated output of capacitor Bank at rated Voltage	10,000	KVAR
5.	Connection of capacitor Bank having unit protected with external fuses / internal fuse	Double Star	
6.	Rating of capacitor Unit	6.93	KV
7.	Basic insulation level	170	KVp
8.	P.F. withstand voltage	70	KV
9.	Rating of capacitor Unit	166.67	KVAR.
10.	No. of capacitor units per Bank	72 + 8 spare	Nos.
11.	Capacitor KVAR available at nominal system voltage	10000	KVAR
12.	Creepage distance	25	mm per KV
13.	Power Loss	Permissible losses should be between 0.18 watt per KVAR to 0.2 watt per KVAR including losses in fuse subject to tolerance as per I.S.S	
14.	NCT	10-5/1-1A, 15VA for both core, CL 1.0 for core 1 & 5P20 for core 2	
15.	Rated capacitance of capacitor unit	11.05 µfd	

COMPLETENESS OF EQUIPMENT:

33 KV, 10 MVAR, 3 phase 50 Hz double star connected capacitor bank is required complete with the following accessories:-

1) Each 10 MVAR bank will comprise of 72 capacitor units of 166.67 KVAR, 6.93 KV rating.
2) Each 10 MVAR capacitor bank will be organized in double star formation i.e. with 36 units in each star and the two stars of 10 MVAR capacitor bank will be protected through neutral current transformer.
3) 36 units in each star of the bank will be mounted in 3 series groups such that each series group will have four units of 166.67 KVAR, 6.93KV rating in parallel.
4) On the body of each Capacitor Unit rated voltage, rated KVAR rating, rated capacitance, S.No. (in the manner CSPTCL / SNo.), make and year of manufacture shall be engraved / inscribed.
5) One No. galvanized mounting structure, of minimum height of 3200mm, the drawings of which shall be approved by CSPTCL.
6) All interconnections, mounting arrangement, terminations, earthing arrangement, mounting racks, base insulator, terminal connector, nuts/bolts, required quantity of conductor/ strip for formation of neutral point and making connections to NCT

and all other required accessories for completing the bank in a neat manner. The terminal connector shall be suitable for Zebra ACSR.

7) Foundation bolts of 20 mm diameter for bolted type hot dip galvanized steel support structure.
8) One complete set of 2 mm thick MS sheet foundation templates for structure of each 10 MVAR capacitor bank, to be delivered in advance along with foundation bolts.
9) 8 Nos. spare capacitor units of rating 166.67 KVAR, 6.93 KV as per description furnished above.
10) 6 Nos. series reactor as per tender specification shall be provided, the design/ drawings of which shall be approved by CSPTCL.

6.3 **Specification of Series Reactor :-** Reactor should be copper wound.

S.N	PARTICULARS	VALUES	UNIT
1	Rated KVAR	4	KVAR
2	Rated voltage	36	KV
3	Rated current	96.22	Amp
4	Max. continuous current	130% of rated current	
5	Impedance / PH	0.432	Ohm

6.4 **TEST :-**The capacitor units will be tested at the manufacturers work as per IS: 2834 and IS:13925 for the following test:

A) Type Test:-

The contractor shall furnish a certificate of the following type test. CSPTCL may at its option call for these tests to be performed on one capacitor unit of each rating to be selected at random.

a) Test for dielectric loss angle(power factor)
b) Test for capacitor loss
c) Stability test
d) Impulse voltage test between terminals and container
e) Short circuit test
f) Endurance test as per IS: 13925 (Part – II)

B) ROUTINE TESTS:-

a) Tests for output and / or capacitance
b) Voltage test between terminals
c) Voltage tests between terminals and container.
d) Voltage tests between terminals and earth.
e) Insulation resistance test.
f) Test for efficiency of discharge device.

6.6 **DRAWING :-**

The contractor shall provide general outline drawing and GTP of capacitor banks, neutral current transformer.

***

19. TECHNICAL SPECIFICATION FOR 132 KV & 33 KV AIR BREAK DISCONNECTOR (ISOLATORS)

7.1 **SCOPE**:-This specification is provided for design, manufacture, stage testing, inspection & testing before despatch, packing and delivery of 132 KV class (disconnectors, double break type) isolators (metallic) and 33 KV class isolators double break type, and support / post rotating type insulator

STANDARDS:-

S. N.	Standard No.	Title
1.	IS:9921	Alternating current isolators (dis-connectors) and earthing switches.
2.	IEC:129	---- do ----
3.	IS:2544	Insulators
4.	IS:2147	Degree of protection provided by enclosures.
5.	IS:4691	---- do ----
6.	IS:325	Three phase induction motor
7.	IS:4722	Rotating electrical machines
8.	IS:2629	Recommended practice for hot dip galvanising of iron and steel.
9.	IS:4759	Hot dip galvanisation coating on structural steel.
10.	IS:2633	Method of testing, weight, thickness & uniformity of coating on fasteners
11.	IS:1573	Electroplated coating of zinc on iron & steel
12.	IS:3033	Spring Washers
13.	IS:2016	Plain Washers

7.2 PRINCIPAL PARAMETERS (ISOLATORS):-

The contractor should clearly note that tandem isolators shall not be accepted. The isolator should be provided with 02 Nos horizontal GI operating pipes. Current density for Copper current carrying parts should be less than 1.5 Amp per Sq mm. The isolator moving contact and fix contact shall have copper material only. The isolators for both 132KV and 33KV shall be manually operated only. The isolators provided with double bearing bushes shall not be accepted. The bearing sizes shall be minimum 40 mm for 33 KV isolator and 75 mm for 132 KV isolator. The equipment's covered in this specification shall meet the technical requirement listed below:-

7.3 132KV DOUBLE BREAK ISOLATORS.

7.3.1 TYPE & RATING:-

Isolators shall have three posts per phase triple pole single throw, gang operated out-door type silver-plated contacts with horizontal operating blade and isolators posts arranged vertically. The isolators will be double break type. Isolators should be of rotating blade feature of banging type only. **Please note that turn & Twist arrangement is not acceptable.** The arrangement shall be described in detail along-with the offer.

All the current carrying parts of isolators shall be of copper only.

All isolators shall operate through 90 degree from their fully closed position to fully open position so that the break is distinct and clearly visible from the ground level.

7.3.2 Isolators shall be suitable for continuous service at the system voltages specified herein. The isolators are not required to operate under load but they must be called upon to handle magnetization currents of the power transformers and capacitive currents of bushings, bus-bar connections, very short lengths of cables, & current of voltage transformers.

7.3.3 The rated insulation strength of the equipment shall not be lower than the levels specified in IS-9921 IEC Publication No. 129. The isolators should meet the following Principal parameters:-

Sr	Technical Parameter	
1	Rated Freq.	50 HZ
2	System earthing	Effectively earthed
3	No. of phases (poles)	3
4	Safe duration of overload	
	a) 150% of rated current	5 minutes
	b) 120% of rated current	30 minutes
5	Rated voltage	145 KV RMS
6	Type of disconnect (AB)	Double Break
7	Rated Normal current (A RMS)	800
8	Rated short time withstand current for 3 secs (KA RMS) of main & E/S	40
9	Rated peak current of main switch & E/S (KA peak)	100
10	Rated short time making current of E/S (KA peak)	100
11	Standard withstand positive KV peak	
	a) across isolating distance	700
	b) To earth & between poles	650
12	One minute Power Freq.Withstand voltage KV(rms)	
	a) across isolating distance	315
	b) To earth & between poles	275
13	Minimum creepage distance (mm)	3625
14	Rated mech. Term load	
	(i) straight load(Kg.)	51
	(ii) Across load(Kg.)	17.33
15	Rated magnetising current/ capacitive current make & break(A rms)	0.7
16	Minimum clearances	
	a) phase to earth(mm)	1270
	b) phase to phase (mm)	1430
17	Ph to ph spacing for installation	2500
18	Height of lowest live point above ground level (mm)	4600
19	PCD of insualtors to be provided Top Bottom	 127 mm 184 mm
20	Auxiliary Contacts	8 Nos NO + 8 Nos NC

The 132 KV Isolators are required with post insulators of solid core type and mounting structures.

7.3.4 TEMPERATURE RISE:- (As per IS:9921)

The maximum temperature attained by any part of the equipment when in service at site under continuous, full load conditions and exposed to the direct rays of sun shall not exceed 45°C above ambient. The limit of temperature shall not be exceeded when corrected for the difference between ambient temperature at site and the ambient temperature specified in the approved specifications.

7.3.5 ISOLATOR INSULATION:

Insulation to ground, insulation between open contacts and the insulation between phases of the completely assembled isolating switch shall be capable of withstanding the dielectric test voltage specified in clause 7.3.3 above.

7.3.6 MAIN CONTACTS

(i) All current carrying parts in the lsolator shall be of Hard Drawn Electrolytic copper. Aluminium shall not be used at all.

All isolators shall have heavy-duty self-aligning, self cleaning contacts and so design that binding can not occur after remaining closed for prolonged period of time in a heavily polluted atmosphere. The fixed contact of the Isolator shall be made of hard drawn electrolytic copper. The fixed contact should be of reverse loop type. The various parts shall be accordingly reverse loop type. The various parts shall be accordingly finished to ensure inter-changeability of similar components.

The fingers of fixed contacts shall be preferably in two pieces of section 4.5 X 30 mm and each shall form the reverse loops with a oval shape to hold fixed contact intact. The ends of the reverse loops of the fixed contact shall touch the stopper. The fixed contact finger shall be mounted on a copper pad of size 200 x 100x 8 mm thickness (Please note aluminium pad will not be accepted). No aluminium coating on the copper pad or bimetallic material shall be used in fixed contact assembly.

The fixed contacts would be placed in 'C' clamp. The thickness of 'C' clamp shall be 5 mm. This 'C' clamp shall be placed on a channel of 5 mm thickness. This channel shall be welded on a insulator mounting plate of 10 mm thickness. The spring of fixed contact shall have housing to hold the moving contact in place. This spring shall be made of stainless steel with adequate thickness. Since the Isolator design is banging type, the proper spring pressure is a must for good contact. The spring shall not carry any current and shall not loose their characteristic due to heating effects.

Contacts and spring shall be designed so that readjustment in contact pressure shall not be necessary throughout the life of the Isolator or earth switch. Each contact or pair of contact shall be independently sprung so that full pressure is maintained on contacts at all time.

(ii) **MOVING BLADE:**

The switch blades forming the moving contacts shall be made from tubular section of hard drawn electrolytic copper with OD 50 mm and ID 42 mm for 800 Amp.The moving blade shall be of length 2220 mm. The contact should be in a single piece and there should not be any joint in the moving blade. These contacts should withstand safely the highest short circuit and over voltage that may be encountered during service. The surfaces of the contacts shall be rendered smooth and silver-plated. In nut shell, the male and female contacts assemblies shall be of robust construction and design of these assemblies shall ensure that :

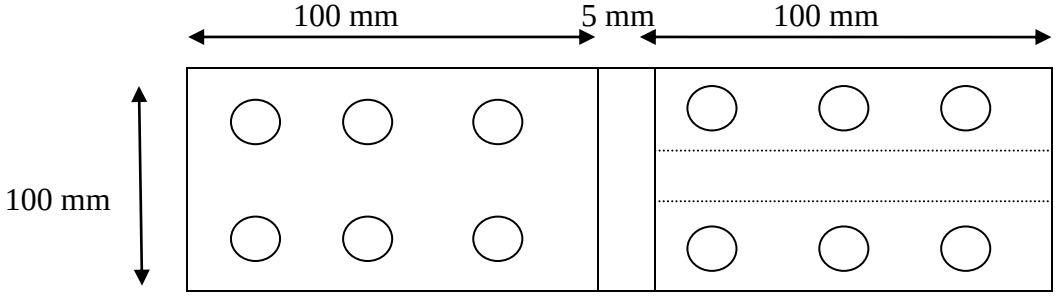
a. Electro-dynamic withstand capability of contacts should be sufficient to ensure that during short circuit there is no risk of repulsion of contacts.
b. The current density in the Copper parts shall not be more than 1.5A/sq.mm but may be less.
c. Thermal withstand capability during short circuit should be adequate to ensure that during short circuit there is no over heating of contacts.

d. Constant contact pressure even when the live parts of the insulator stacks are subjected to tensile stresses due to linear expansion of connected bus bar of flexible conductors either because of temperature variations or strong winds.
e. Wiping action during closing and opening.
f. Self-alignment assuring closing of the switch without minute adjustment.

7.3.7. ARCING CONTACTS/HORN:-
Arcing contacts are not required.

7**.3.8 AUXILIARY SWITCHES:--**The operating mechanism of main switch shall be equipped with eight nos. each of NO & NC contacts exclusively for CSPTCLs interlocking & protective schemes. The aux. switches should be rated to carry a current of 10 amps continuously. The operation of Auxiliary switches should be as per clause 8.3 of IS: 9921(part-III). The Aux. switches should be actuated by a cam or similar arrangement mounted on the isolator shaft without any intermediate levers, linkages etc. to ensure fool-proof operation.

7.3.9 TERMINAL CONNECTORS:-
The connectors for isolators shall be suitable for Zebra ACSR conductor. The material should be Aluminium LM6 grade.The terminal connector should have the dimensions of 205x100x12mm.Total 12 nos nut bolts of M-10 size should be provided & connector should be suitable for accommodating conductor clear length of 100 mm .The drawings of the terminal connectors is shown below.Also Bimetallic sleeve/liner with minimum **2 mm thickness** should be provided**.** The current density in the Aluminium parts shall not be more than **1.0A/sq.mm** but may be less.
The groove provided in the connector should be able to accommodate conductor size mentioned above smoothly. The design of clamp shall be subject to CSPTCL's approval. The clamps to be offered should be manufactured by gravity die-casting method only and not by sand casting process. Six nos. pad clamps suitable for zebra conductor, as per drawing shown below shall be supplied with each Isolator.



7.3.10 OPERATING MECHANISM FOR 132 KV ISOLATOR
All Isolators and earthing switches shall have separate independent manual operation. The isolator should be provided with padlocking arrangements for locking in both the end position to avoid unintentional operation. For this purpose padlocks with three keys shall be provided. The isolating distances should be visible for isolators.

The isolators with or without earth switch inclusive of their operating mechanism, should be such that they cannot come out of their open or closed position by gravity wind pressure, vibrations reasonable shocks or accidental touching of connecting rods of the operating mechanism. Isolators should be capable of resisting in closed position, the dynamic and thermal effects of maximum possible short circuit current at the installation point. They shall be so constructed that they do not open under the influence of the short circuit current. The operating mechanism should be robust construction, easy to operate by a single person and conveniently located for local operation in the switchyard.

The contractor should clearly note that tandem isolators shall not be accepted. The isolator should be provided with 02 Nos horizontal GI operating pipes. Current density for Copper current carrying parts should be less than 1.5 Amp per Sq mm. All the current carrying parts shall be of copper material only. The isolators shall have good quality auxiliary contacts in sufficient nos for status indications as well as implementation of interlocks. The isolators shall be provided with double bearing. Bushes shall not be accepted**.**

7.3.11 **PIPES**

Operating arm for connection to Tandem pipes: This shall be made of channel section size 75x40 mm. The diameter shall be 750 mm.

The isolators should have two Tandem pipes one on each side with a minimum internal diameter of 37 mm and outer diameter 43 mm. Length of each Tandem pipe shall be 5.5m.Thus the thickness of the pipe shall be 3 mm. The operating handle shall be class B type having at least 37 mm internal dia-meter. The operating pipe shall also be class B with internal dia-meter of at least 75 mm for 132 KV Isolators.

The pipe shall be terminated into suitable universal type joints between the insulator bottom bearing and operating mechanism.

7.3.12 **BASE CHANNELS:-**

The isolator shall be mounted on a base fabricated from one piece ISMC steel channel section of 125x65 mm size to withstand total weight of isolator and insulators and also all the forces that may be encountered by the isolator during service. Suitable holes shall be provided on this base channel to facilitate its mounting on our standard structures. The steel channel in each phase shall be mounted in horizontal position and over it two mounting plates at least 10 mm thick with suitable nuts and bolts shall be provided for minor adjustment at site. The weight of twin channel for one phase shall be 56 Kg or more.

7.3.13 **CLEARANCES:-**

We have adopted the following minimum clearances for isolators in our system. The contractor should therefore keep the same in view during detailed engineering.

Description	Centre distance between poles (centre to centre) i.e. ph. to ph. clearance	Distance between centre lines of outer post on same pole
132KV Isolators	2500 mm	2100 mm

7.3.14 INTERLOCKS;-

For the purpose of making the operation of the isolator depending upon the position of associated circuit breaker, mechanical interlocks may be required. The contractor shall ensure that the design of equipment will facilitate provision of such interlock.

Line earth switches shall consist of three earthing links per isolator, which will normally rest against the frame when the connected isolator is in enclosed position. The earthing links for the three phases shall be mechanically linked to a coupling shaft which shall be capable of being fitted on either side of the isolator. Earth switch shall be mechanically interlocked with the connected isolating switch so that it is possible to close and open the earth switch only when the connected isolating switch is in the open and closed positions respectively. In the earth switch only banging type feature is required. Therefore the earthing switches should be provided with counter balance weight so that the earth switches do not fall due to gravity and it moves very smoothly in upward direction i.e. against gravity. Each earthing switch shall be designed to withstand electrodynamics stress due to currents up to 50 KA (peak) as per IEC recommendations.

All the current carrying parts of earth switch shall be of copper material only.

All shafts, couplings etc. shall be galvanised. Flexible copper connectors of at least 50 sq. mm cross-section shall be provided between the rotating shafts and the frame works.

7.3.15 BEARINGS FOR MOVING INSULATORS & OPERATING VERTICAL PIPE:-

The design and construction of the various bearings shall embody all the features required to withstand climatic conditions specified, so as to ensure dependable and effective operation even after long periods of inaction of these isolators. Bearing housings should be weather proof. Facilities should be provided for lubrication of bearings. The number of bearings to be provided for reducing friction for smooth operation of Isolator shall be total 8 Nos., 2 No. on each on 3 phase rotating insulators and 2 No. for operating vertical pipe.

The bearing housing for insulators shall be made of gravity die-cast aluminium with smooth surface suitably machined for sealing the bearings. **For each phase, below the moving insulator, there shall be an assembly of 2 bearing .The top one will be tapered or load bearing. The lower one shall be normal ball bearing. In addition there shall be two nos ball bearings for operating(down) pipe. Then overall 8 Nos bearings for each isolator.**Complete details of arrangement offered shall be furnished with the offer.

The complete bearing assembly for moving insulator shall be such that the moving insulator is exactly VERTICAL and there is no play around the vertical position.

7.3.16 DESIGN, MATERIAL AND WORKMANSHIP:-

The contractor shall assume full responsibility for co-ordination and adequate design. All materials used in the construction of the equipment shall be of the appropriate class, well finished and of approved design and make. All similar parts should be accurately finished and inter-changeable.

The control cabinets shall be hot dip galvanized only with minimum thickness of galvanization of 60 microns. All ferrous parts shall be heavily hot dip galvanized. Bolts, nuts pins and washers, etc. used on the isolators shall also be galvanized. All the nuts, bolts and washers in current carrying parts shall be of GI only. Special attention shall be paid to give tropical treatment to all the equipment as it will be subjected during service to extremely severe exposure to atmospheric moisture and for a long period to high ambient temperature. All current carrying parts shall be of non-ferrous metal or alloys and shall be designed to limit sharp points edges and similar sharp faces.

All flanges should be galvanized and should be dispatched duly welded. No welding at destination site shall be done.

7.4 SPECIFICATION FOR POST INSULATOR:

132 KV solid core post insulators shall be procured from approved vendor of the vendor list of this tender. The solid core insulators shall conform to the latest applicable Indian or IEC standard and in particulars to the IS:2544 & 5354/IEC 168 specification for porcelain post insulators. The porcelain used to manufacture or solid core insulators shall be homogeneous, free from flaws or imperfections that might affect the mechanical or dielectric quality. They shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain shall be uniform brown colour, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

The porcelain and metal parts shall be assembled in such a manner that any thermal expansion difference between the metal and the porcelain parts throughout the range of temperature variation shall not loosen the parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base shall be

of high-grade cast steel or malleable steel casting and they shall be machine faced and smoothly galvanized. The cap and base of the insulators shall be interchangeable with each other.

132 KV solid core insulators used in the isolators should have technical particulars as detailed below:-

1.	Nominal system voltage KV (rms)	132
2.	Highest system voltage KV (rms)	145
3.	Dry. P.F. One minute withstand KV (rms)	275
4.	Wet P.F. One minsute withstand KV (rms)	275
5.	P.F. Puncture withstand test voltage KV	Puncture proof.
6.	Impulse voltage withstand test KV (Peak)	650
7.	Power frequency withstand KV(rms)	275
8.	Visible discharge test KV voltage	105 rms
9.	Creepage distance mm (min)	3625
10.	Tensile strength in kN	70 KN
11.	Torsional strength	3 KNM
11.	Bending strength	4 KN
12.	Compression strength	140 KN
13.	Height	1472 mm.
14.	PCD Top/bottom	Top: 127 mm Bottom: 184 mm

The design of the structure shall be as per the relevant standards and shall be got approved by CSPTCL.

7.5 33KV ISOLATORS:

7.5.1 TYPE & RATING:-

Isolators shall have three posts per phase triple pole single throw, gang operated out-door type silver-plated contacts with horizontal operating blade and isolators posts arranged vertically. The isolators will be double break type. Isolators should be of rotating blade feature of banging type only. **Please note that turn & Twist arrangement is not acceptable.** The arrangement shall be described in detail along-with the offer.

All isolators shall operate through 90 degree from their fully closed position to fully open position so that the break is distinct and clearly visible from the ground level.

7.5.2 1600/1200/800 Amp rms suitable for continuous service at the system voltages specified herein. The isolators are not required to operate under load but they must be called upon to handle magnetization currents of the power transformers and capacitive currents of bushings, busbar connections, very short lengths of cables, & current of voltage transformers.

7.5.3 The rated insulation strength of the equipment shall not be lower than the levels specified in IS-9921 IEC Publication No. 129. The isolators should meet the following Principal parameters:-

Sr.	Technical Parameter	Requirement
1	Rated Frequency	50 HZ
2	System earthing	Effectively earthed
3	No. of phases(poles)	3
4	Safe duration of overload	
	a) 150% of rated current	5 minutes
	b) 120% of rated current	30 minutes

Sr.	Technical Parameter	Requirement
5	Rated voltage	36 KV RMS
6	Type of disconnect (AB)	Double Break
7	Rated Normal current (Amp RMS)	1600/1200/800
8	Rated short time withstand current for 3 secs (KA RMS) of main & E/S	30
9	Rated peak current of main switch & E/S(KA peak)	75
10	Rated short time making current of E/S(KA peak)	63
11	Standard withstand positive KV peak	
	a) across isolating distance	195
	b) To earth & between poles	170
12	One minute Power Freq. Withstand voltage KV(rms)	
	a) across isolating distance	80
	b) To earth & between poles	70
13	Minimum creepage distance(mm)	900
14	Rated magnetising current/ capacitive current make & break(A rms)	0.7
15	Minimum clearances	
	a) phase to earth (mm)	430
	b) phase to phase (mm)	1400
16	Phase to phase spacing for installation	1400
17	Height of lowest live point above ground level (mm)	3700
18	PCD of insulators to be used Top Bottom	 76 mm 76 mm

7.5.4 The 33 KV Isolators are required with insulators of solidcore type and mounting structures. The isolators shall be supplied with base channels alongwith fixing nuts, bolts and washers for mounting on the structure.

7.5.5 TEMPERATURE RISE: - (as per IS:9921)

The maximum temperature attained by any part of the equipment when in service at site under continuous, full load conditions and exposed to the direct rays of sun shall not exceed 45 degree centigrade above ambient. The limit of temperature shall not be exceeded when corrected for the difference between ambient temperature at site and the ambient temperature specified in the approved specifications.

7.5.6 ISOLATOR INSULATION:

Insulation to ground, insulation between open contacts and the insulation between phases of the completely assembled isolating switch shall be capable of withstanding the dielectric test voltage specified in clause 7.5.3 above.

7.5.7 MAIN CONTACTS

(i) Fixed Contact: All isolators shall have heavy-duty self-aligning and high pressure line type fixed contact of modern design and made of hard drawn electrolytic copper. The fixed contact should be of reverse loop type. The various parts shall be accordingly reverse loop type. The various parts shall be accordingly finished to ensure inter-changability of similar components. The spring of fixed contact shall have housing to hold in place. This spring shall be made of stainless steel with adequate thickness. The pad for connection of terminal connector shall be of copper with thickness not less than 12 mm for isolators with current rating of 800 Amp,

1200Amp and thickness not less than 16mm for isolators with current rating 1600 Amp

(ii) Moving blades: The switch blades forming the moving contactsshall be made from tubular section of hard drawn electrolytic copper. The Outer & Inner diameter of the blade shall be sufficient to fulfill the requirements mentioned from (a) to (f) below.These contacts shall be liberally dimensioned so as to withstand safely the highest short circuit and over voltage that may be encountered during service. The surfaces of the contacts shall be rendered smooth and silver plated. In nut shell, the male and female contacts assemblies shall be of robust construction and design of these assemblies shall ensure the follwing :

(a) Electro-dynamic withstand ability during short circuit without any risk of repulsion of contacts.
(b) The current density in the Copper parts shall not be more than 1.5 A/sq.mm.
(c) Thermal withstand ability during short circuit.
(d) Constant contact pressure even when the live parts of the insulator stacks are subjected to tensile stresses due to liner expansion of connected busbar of flexible conductors either because of temperature variations or strong winds.
(e) Wiping action during closing and opening.
(f) Self alignment assuring closing of the switch without minute adjustment.

The earthing switch each shall be provided with three sets of suitable type of fixed contacts below the fixed contacts assemblies of the main switch on the incoming supply side and the sets of moving contacts having ganged operation. These contacts shall be fabricated out of electrolytic copper for 33 KV Isolators with earth switch and dimensioned to withstand current on the line. The earthing switch shall have the same short time current rating as that of main switch.

7.5.8 ARCING CONTACTS/HORN:-

Arcing contacts are not required.

7.5.9 AUXILIARY SWITCHES:--

The operating mechanism of main switch shall be equipped with four nos. each of NO & NC contacts exclusively for purchasers interlocking & protective schemes. The aux switches should be rated to carry a current of 10 amps continuously. The operation of Auxiliary switches should be as per clause 8.3 of IS:9921 (part III). The Aux. switches should be actuated by a cam or similar arrangement mounted on the isolator shaft without any intermediate levers, linkages etc. to ensure fool-proof operation.

7.5.10 CONNECTORS:-

The connectors for isolators shall be suitable for Zebra ACSR conductor with horizontal and vertical take off arrangement. The details in regard to dimensions, the number of bolts to be provided, material and manufacture shall be furnished. The groove provided in the connector should be able to accommodate conductor size mentioned above smoothly. The design of clamp shall be subject to CSPTCL's approval. The clamps to be offered should be manufactured by gravity die-casting method only and not by sand casting process.

It is necessary that suitable clamps are offered along with the isolator and also it is obligatory to give complete technical particulars of clamps along with the drawing, as per details given above and also as per following details:-

a) The terminal connector shall be manufactured and tested as per IS-5561.
b) All castings shall; be free from blow holes, surface blistors, cracks and cavities.
c) All the sharp edges shall be blurred and rounded off.

d) No part of the clamp shall be less than **12 mm thick**.
e) All current carrying parts shall be designed and manufactured to have minimum contact resistance.
f) Connectors shall be designed to be corona free in accordance with the requirement of IS-5561.
g) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.
h) Bimetallic sleeve/liner shall be **4 mm thick**. (2mm copper and 2mm aluminium) Wherever necessary bimetallic strip of standard quality and adequate dimension shall be used.

7.5.11 SPECIFICATION FOR POST INSULATOR:

33 KV solid core post insulators shall be of approved vendor as per vendor list enclosed with this tender.The solid core insulators shall conform to the latest applicable Indian or IEC standard and in particulars to the IS:2544 & 5354/IEC 168 specification for porcelain post insulators. The porcelain used to manufacture or solid core insulators shall be homogeneous, free from flaws or imperfections that might affect the mechanical or dielectric quality. They shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain shall be uniform brown colour, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

The porcelain and metal parts shall be assembled in such a manner that any thermal expansion difference between the metal and the porcelain parts throughout the range of temperature variation shall not loosen the parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base shall be of high-grade cast steel or malleable steel casting and they shall be machine faced and smoothly galvanized. The cap and base of the insulators shall be interchangeable with each other.

The contractors shall invariably enclose with the offer, the type test certificates and other relevant technical guaranteed particulars of insulators offered by them.
33 KV solid core insulators used in the isolators should have technical particulars as detailed below:-

1. Nominal system voltage KV (rms)	33
2. Highest system voltage KV(rms)	36
3. Dry. P.F. One minute withstand KV(rms)	75
4. Wet P.F. One minsute withstand KV(rms)	75
5. P.F. Puncture withstand test voltage KV	1.3 times the actual dry flash over voltage of the unit.
6. Impulse voltage withstand test KV (Peak)	170
7. Power frequency withstand KV(rms)	75
8. Visible discharge test KV voltage	27 rms
9. Creepage distance mm (min)	900
10. Tensile strength in kN	50 KN
11. Torsional strength	2 KNM
11. Bending strength	4 KN
12. Compression strength	100 KN
13. Height	508 mm.
14. PCD Top/bottom	76 mm

7.5.12 OPERATING MECHANISM FOR 33 KV ISOLATOR

All Isolators and earthing switches shall have separate dependent manual operation. The isolator should be provided with padlocking arrangements for locking in both the end position to avoid unintentional operation. For this purpose padlocks with three keys shall be provided. The isolating distances should be visible for isolators.

The isolators inclusive of their operating mechanism should be such that they cannot come out of their open or closed position by gravity wind pressure, vibrations reasonable shocks or accidental touching of connecting rods of the operating mechanism. Isolators should be capable of resisting in closed position, the dynamic and thermal effects of maximum possible short circuit current at the installation point. They shall be so constructed that they do not open under the influence of the short circuit current. The operating mechanism should be robust construction, easy to operate by a single person and conveniently located for local operation in the switchyard.

7.5.13 PIPES

The isolators should have two Tandem pipes one on each side with a minimum internal diameter of 25 mm & class-B. The operating pipe shall also be class B with internal diameter of at least **50 mm** for 33 KV Isolators.
The pipe shall be terminated into suitable universal type joints between the insulator bottom bearing and operating mechanism.

7.5.14 BASE CHANNELS;-

The isolator shall be mounted on a base fabricated from steel channel section of adequate size not less than **100x50 mm** to withstand total weight of isolator and insulators and also all the forces that may be encountered by the isolator during service. Suitable holes shall be provided on this base channel to facilitate its mounting on our standard structures. The steel channel in each phase shall be mounted in horizontal position and over it two mounting plates at least 8 mm thick with suitable nuts and bolts shall be provided for minor adjustment at site.

7.5.15 CLEARANCES:-

We have adopted the following minimum clearances for isolators in our system. The contractors should therefore keep the same in view while submitting their offers.

Description	Centre distance between poles (centre to centre) i.e. ph to ph clearance	Distance between centre lines of outer posts on same pole
33KV Isolators	1400 mm	960 mm

7.5.16 INTERLOCKS:-

For the purpose of making the operation of the isolator depending upon the position of associated circuit breaker, mechanical interlocks may be required. The contractor shall ensure that the design of equipment will facilitate provision of such interlock.

All shafts, couplings etc. shall be galvanised. Flexible copper connectors of at least 50 sq. mm cross-section shall be provided between the rotating shafts and the frame works

7.5.17 BEARINGS:-

The design and construction of the various bearings shall embody all the features required to withstand climatic conditions specified, so as to ensure dependable and effective operation even after long periods of inaction of these isolators. Bearing housings should be weatherproof. Facilities should be provided for lubrication of

bearings. The location and number of bearings provided for reducing friction shall be clearly intimated alongwith suitable drawings.

The bearing housing shall be made of gravity die-cast aluminum with smooth surface suitably machined for sealing the bearings. Each bearing assembly shall have two nos. (thrust and ball) bearing adequate shaft diameter. Suitable distance between thrust and ball bearings shall be provided. All other friction locations shall be provided with suitable bearings/stainless steel or brass bushes. The bearings shall be of at least 50 mm shaft diameter. Complete details of arrangement shall be offered at the time of detailed engineering.

7.6 TESTS:-

7.6.1 Type Tests:-

All the isolators offered shall be fully type tested as per the relevant standards.
Each Isolator and earth switch shall strictly comply with the requirements of all the type tests and shall be subjected to all routine tests stipulated in the relevant standard. All tests shall be made prior to dispatch in the presence of the CSPTCL's representative.

Copies of the following type tests already performed on similar type of Isolators must be submitted to judge the merits of the equipment offered by the contractor.

The type test certificate should not be older than five years. The type test should be performed in Govt. Laboratory preferably in CPRI or equivalent.

7.6.2 ACCEPTANCE & ROUTINE TESTS

All acceptance and routine tests are stipulated in the relevant standards shall be carried out in presence of CSPTCL's representative.
Mechanical operation tests (Routine tests) shall be conducted on dis-connects (main switch and earth switch).

7.6.3 SPECIAL TESTS:-

Special tests listed as under shall be carried out in presence of CSPTCL's representative.

S. No.	Name of the Test	Standard to which it Conforms
1.	Tests on insulators	IS: 2544, IEC: 168
2.	Tests on terminal connectors	IS:5561
3.	Test on Galvanised component	IS:2633

7.6.4 DRAWINGS & LITERATURES:

All the dimensioned drawings alongwith illustrated and descriptive literature for 132 KV & 33 KV isolators of various rating shall be submitted at the time of detailed engineering. The following drawings shall be submitted.

(a) The drawing showing the outline dimensions of the isolator.
(b) Drawing showing details of main contacts.
(c) Drawings showing arrangement of mechanical interlock.
(d) Drawing showing the details of fixed and moving contacts and the arrangement of pressure relief.
(e) Drawing showing bearing assembly.
(f) Drawings for terminal connectors shall be as per drawing shown in 7.3.9
(g) Name plate to be provided.

TECHNICAL SPECIFICATION FOR 33 KV ISOLATORS WITH INSULATION LEVEL 72.5 KV

1. **SCOPE** :

This specification provides for design, manufacture, stage testing, inspection and testing before dispatch, packing and delivery 66 KV insulation class (Disconnections, Double Break type, and support / post rotating type solid-core insulators).

2. STANDARDS :

The rating as well as performance and testing of the isolators shall conform to the latest revisions and amendments of the following standards. Equipment meeting any other authoritative standard, which ensures an equal or better quality than that standard mentioned above, will also be accepted.

SL.	Standard	Title
1.	IS:9921(part I to V)	Alternating current isolators (disconnectors) and earthing switches.
2.	IEC:129	----do—
3.	IS:2544	Tests on indoor & outdoor Insulators.
4.	IS:2147	Degree of protection provided by enclosure.
5.	IS:4691	--do----
6.	IS:2629	Recommended practice for hot dip galvanizing of iron and steel.
7.	IS:4759	Hot dip galvanization coating on structural steel
8.	IS:2633	Method of testing, weight, thickness and uniformity of coating on fasteners.
9.	IS:1573	Electroplated coating of zinc on iron and steel
10.	IS:3033	Spring washers.
11.	IS:2016	Plain washers.

3. CLIMATIC CONDITION:-

The equipment to be supplied under this specification shall be suitable for satisfactory operation under the following tropical humid conditions :-

Maximum temperature under hot sun	-	50 degree Centigrade
Minimum temperature of air in shade	-	4 degree Centigrade
Maximum relative humidity	-	**95% (sometimes reaches saturation)**
Average number of thunderstorm days per annum	-	40 days.
Average number of rainy day per annum	-	90 days.
Average annual rainfall	-	**125 Cm.**
Maximum wind pressure	-	150 kg/sq.mtr
Altitude above M.S.L.	-	**1000 mtrs.**

4. PARTICULARS OF THE SYSTEM :-

The isolators to be procured under this specification are intended to be used on 3 phase. A.C. 50 cycles, effectively grounded system. The nominal system voltage is 33 KV.

5. TYPE & RATING:-

5.1 Isolators shall have three posts per phase triple pole single throw, gang operated out-door type silver-plated contacts with horizontal operating blade and isolators posts arranged vertically. The isolators will be double break type Isolators should be of rotating blade feature of banging

type only. **Please note that turn & Twist arrangement is not acceptable.** The arrangement should be described in detail along-with the offer.

All isolators shall operate through 90 degree from their fully closed position to fully open position so that the break is distinct and clearly visible from the ground level.

5.2 1600Amps/1200 Amps/800 Amp RMS suitable for continuous service at the system voltages specified herein. The isolators are not required to operate under load but it must be suitable to handle magnetization currents of the power transformers and capacitive currents of bushings, busbar connections, very short lengths of cables, & current of voltage transformers.

5.3 The rated insulation strength of the equipment shall not be lower than the levels specified in IS-9921 IEC Publication No. 129. The isolators should meet the following Principal parameters:-

Sr.	**Technical Parameter**	**Requirement**
		33 KV Isolator (with insulation class 66 KV)
1	Rated Freq.	50 Hz
2	System earthing	Effectively earthed
3	No. of phases(poles)	3
4	Safe duration of overload	
	a) 150% of rated current	5 minutes
	b) 120% of rated current	30 minutes
5	Rated voltage	66 KV RMS
6	Type of disconnect(AB)	Double Break
7	Rated Normal current (A, RMS)	800
8	Rated short time withstand current for 3 secs (KA, RMS) of main & E/S	30
9	Rated peak current of main switch & E/S (KA peak)	75
10	Rated short time making current of E/S (KA peak)	63
11	Standard withstand positive KV peak	
	a) across isolating distance	375
	b) To earth & between poles	325
12	One minute Power Freq. Withstand voltage KV(rms)	
	a) across isolating distance	160
	b) To earth & between poles	140
13	Minimum creepage distance(mm)	1815
14	rated magnetising current/ capacitive current make & break (A rms)	0.7
15	Minimum clearances	
	a) ph to earth (mm)	Equal to dry arcing distance of insulator
	b) ph to ph (mm)	Please furnish
16	Ph to ph spacing for installation	Please furnish
17	PCD of insulators to be used Top Bottom	 127 mm 127 mm

5.4 The 33 KV Isolators with 66 KV insulation class are required with insulators of solidcore type but without mounting structures. The isolators should be suitable for mounting on the CSPTCL's standard structure The CSPTCL will arrange the mounting structures. However, the isolators shall be supplied with base channels alongwith fixing nuts, bolts and washers for mounting on the structure .

5.5 TEMPERATURE RISE:- (as per IS:9921)

The maximum temperature attained by any part of the equipment when in service at site under continuous, full load conditions and exposed to the direct rays of sun shall not exceed 45 degree centigrade above ambient. The limit of temperature shall not be exceeded when corrected for the difference between ambient temperature at site and the ambient temperature specified in the approved specifications. The corrections proposed shall be stated in the tender and shall be subject to approval of the purchaser.

5.6 ISOLATOR INSULATION:

Insulation to ground, insulation between open contacts and the insulation between phases of the completely assembled isolating switch shall be capable of withstanding the dielectric test voltage specified in clause 5.3 above.

5.7 MAIN CONTACTS **:**

(i) **Fixed Contact**: All isolators shall have heavy-duty self-aligning and high pressure line type fixed contact of modern design and made of hard drawn electrolytic copper. The fixed contact should be of reverse loop type. The various parts shall be accordingly reverse loop type. The various parts shall be accordingly finished to ensure inter-changability of similar components.

The spring of fixed contact shall have housing to hold in place. This spring shall be made of stainless steel with adequate thickness**. The pad for connection of terminal connector shall be of copper with thickness not less than 12 mm for isolators with current rating 800Amp,1200Amp and thickness not less than 16mm for isolators with current rating 1600 Amp. It shall have provision of six bolts.**

(ii) **Moving blades**: The switch blades forming the moving contacts shall be made from tubular section of hard drawn electrolytic copper. The Outer & Inner diameter of the blade shall be sufficient to fulfill the requirements mentioned from (a) to (f) below. These contacts shall be liberally dimensioned so as to withstand safely the highest short circuit and over voltage that may be encountered during service. The surfaces of the contacts shall be rendered smooth and silver plated. In nut shell, the male and female contacts assemblies shall be of robust construction and design of these assemblies shall ensure the following :

(a) Electro-dynamic withstand ability during short circuit without any risk of repulsion of contacts.
(b) The current density in the Copper parts shall not be more than ***1.5 A/sq.mm***.
(c) Thermal withstand ability during short circuit.
(d) Constant contact pressure even when the live parts of the insulator stacks are subjected to tensile stresses due to liner expansion of connected busbar of flexible conductors either because of temperature variations or strong winds.
(e) Wiping action during closing and opening.
(f) Self alignment assuring closing of the switch without minute adjustment.

5.8 Arcing Contacts/Horn:-

Arcing contacts are not required.

5.9 CONNECTORS :-

The connectors for isolators shall be suitable for Panther / Zebra ACSR conductor with horizontal and vertical take off arrangement. The details in regard to dimensions, the number of bolts to be provided, material and manufacture shall be furnished in the tender. The groove provided in the connector should be able to accommodate conductor size mentioned above smoothly.

The design of clamp shall be subject to our approval. **The clamps to be offered should be manufactured by gravity die-casting method only and not by sand casting process.**

It is necessary that suitable clamps are offered alongwith the isolator and also it is obligatory to give complete technical particulars of clamps alongwith the drawing, as per details given above and also as per following details:-

a) The terminal connector shall be manufactured and tested as per IS-5561.
b) All castings shall; be free from blow holes, surface blistors, cracks and cavities.
c) All the sharp edges shall be blurred and rounded off.
d) No part of the clamp shall be less than **12 mm thick**.
e) All current carrying parts shall be designed and manufactured to have minimum contact resistance.
f) Connectors shall be designed to be corona free in accordance with the requirement of IS-5561.
g) All nuts and bolts shall; be made of galvanised steel only.
h) Bimetallic sleeve/liner shall be **2 mm thick**.
i) The terminal connector should have conductor coverage length of minimum 100 mm inside the connector The clamp shall have six bolts.
Wherever necessary bimetallic strip of standard quality and adequate dimension shall be used.

5.10 SPECIFICATION FOR POST INSULATOR :

5.10.1 66 KV solid core insulators shall be of reputed make subject to purchasers approval. The solid core insulators shall confirm to the latest applicable Indian or IEC standard and in particulars to the IS:2544 & 5354/IEC 168 specification for porcelain post insulators. The porcelain used to manufacture solid core insulators shall be homogeneous, free from flaws or imperfections that might affect the mechanical or dielectric quality. They shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain shall be uniform brown colour, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

The porcelain and metal parts shall be assembled in such a manner that any thermal expansion difference between the metal and the porcelain parts throughout the range of temperature variation shall not loosen the parts or create undue internal stresses which may affect the electrical or mechanical strength and rigidity. Each cap and base shall be of high-grade cast steel or malleable steel casting and they shall be machine faced and smoothly galvanized. The cap and base of the insulators shall be interchangeable with each other.

The Bidders shall invariably enclose with the offer, the type test certificates and other relevant technical guaranteed particulars of insulators offered by them. Please note that offers without test certificates will not be entertained and without the type test report , offers may be rejected.

66 KV solid core insulators used in the isolators should have technical particulars as detailed below:-

S.N	Particulars	
1	Nominal system voltage KV (rms)	66
2	Highest system voltage KV(rms)	72.5 KV
3	Dry. P.F. One minute withstand KV(rms)	140
4	Wet P.F. One minsute withstand KV(rms)	140
5	P.F. Puncture withstand test voltage KV	1.3 times the actual dry flash over voltage of the unit
6	Impulse voltage withstand test KV (Peak)	325
7	Power frequency withstand KV(rms)	140
8	Visible discharge test KV voltage	53
9	Creepage distance mm (min)	1815
10	Tensile strength in kN	
11	torsional strength	Please furnish
12	Bending strength	Please furnish
13	Compression strength	Please furnish
14	Height	770 mm
15	PCD Top/bottom	127 mm

5.11 **OPERATING MECHANISM FOR 33 KV ISOLATOR**

All Isolators and earthing switches shall have separate dependent manual operation. The isolator should be provided with padlocking arrangements for locking in both the end position to avoid unintentional operation. For this purpose padlocks with three keys shall be provided. The isolating distances should be visible for isolators.

The isolators inclusive of their operating mechanism, should be such that they cannot come out of their open or closed position by gravity wind pressure, vibrations reasonable shocks or accidental touching of connecting rods of the operating mechanism. Isolators should be capable of resisting in closed position, the dynamic and thermal effects of maximum possible short circuit current at the installation point. They shall be so constructed that they do not open under the influence of the short circuit current. The operating mechanism should be robust construction, easy to operate by a single person and conveniently located for local operation in the switchyard.

5.12 **PIPES**

The isolators should have two Tandem pipes one on each side with a minimum internal diameter of 25 mm & class-B. The operating pipe shall also be class B with internal dia-meter of atleast **50 mm** for 33 KV Isolators.

The pipe shall be terminated into suitable universal type joints between the insulator bottom bearing and operating mechanism.

5.13 **BASE CHANNELS ;-**

The isolator shall be mounted on a base fabricated from steel channel section of adequate size not less than **100x50 mm** to withstand total weight of isolator and insulators and also all the forces that may be encountered by the isolator during service. Suitable holes shall be provided on this base channel to facilitate its mounting on our standard structures. The steel channel in each phase shall be mounted in horizontal position and over it two mounting plates atleast 8 mm thick with suitable nuts and bolts shall be provided for minor adjustment at site.

5.14 CLEARANCES:-

We have adopted the following minimum clearances for isolators in our system. The Bidders should therefore keep the same in view while submitting their offers. For further details the drawings of structures placed at Annexure-I may be referred.

Description	Centre distance between poles (centre to centre) i.e. ph to ph clearance	Distance between centre lines of outer posts on same pole
33KV Isolators	1400 mm	960 mm

5.15 INTERLOCKS **;-**

For; the purpose of; making the operation of the isolator depending upon the position of associated circuit breaker, mechanical interlocks may be required. The supplier shall ensure that the design of equipment will facilitate provision of such interlock. If so desired by the purchaser and cost of two castle locks for each isolator one for the isolator and another for the corresponding circuit breaker, may be offered separately.

All shafts, couplings etc. shall be galvanised. Flexible copper connectors of atleast 50 sq.mm cross-section shall be provided between the rotating shafts and the frame works.

5.16 **BEARINGS :-**

The design and construction of the various bearings shall embody all the features required to withstand climatic conditions specified, so as to ensure dependable and effective operation even after long periods of inaction of these isolators. Bearing housings should be weatherproof. Facilities should be provided for lubrication of bearings. The location and number of bearings provided for reducing friction shall be clearly intimated alongwith suitable drawings.

The bearing housing shall be made of gravity die-cast aluminum with smooth surface suitably machined for sealing the bearings. Each bearing assembly shall have two nos. (thrust and ball) bearing adequate shaft diameter. Suitable distance between thrust and ball bearings shall be provided. All other friction locations shall be provided with suitable bearings/stainless steel or brass bushes. . The bearings shall be of atleast 50 mm shaft diameter. For each phase, below the moving insulator, there shall be an assembly of 2 bearings .The top one will be tapered or load bearing. The lower one shall be normal ball bearing. In addition there shall be two nos ball bearings for operating(down) pipe. Then overall 8 Nos bearings for each isolator.Complete details of arrangement offered shall be furnished.

5.17 DESIGN, MATERIAL AND WORKMANSHIP:-

The successful Bidder shall assume full responsibility for co-ordination and adequate design. All materials used in the construction of the equipment shall be of the appropriate class, well finished and of approved design and make. All similar parts should be accurately finished and inter-changeable.

All interiors and exteriors of control cabinets shall be thoroughly cleaned to remove all rust, scales, corrosion, grease and other adhering foreign matter and the surfaces treated by recognized phosphating (e.g. seven tank phosphating sequence). After such preparation of surfaces, two coats of zinc oxide primer shall be given by suitable storing and air drying before final painting. Colour of the final paints shall be of shade No. 697 of ISI i.e. epoxy light grey. The finally /painted cubicle shall present ensthetically pleasing appearance free from any dent or un-even surface. Paint inside the metallic housing shall be of anticondensation type and the

paint on outside surfaces shall be suitable for outdoor installation. All components shall be given adequate treatment of climate proofing as per IS-3202 so as to withstand corrosive and severe service condition.

All ferrous parts shall be heavily hot dip galvanized. Bolts, nuts pins and washers, etc. used on the isolators shall also be galvanized. **All the nuts, bolts and washers in current carrying parts shall be of GI**. Special attention shall be paid to give tropical treatment to all the equipment as it will be subjected during service to extremely severe exposure to atmospheric moisture and for a long period to high ambient temperature. All current carrying parts shall be of non-ferrous metal or alloys and shall be designed to limit sharp points edges and similar sharp faces.

6. GUARANTEED DATA AND OTHER TECHNICAL PARTICULARS :-

Guaranteed data and other technical particulars of the isolators should be given in the form of Schedule-III Any other particulars considered necessary by the supplier may also be given in addition to those listed in the schedule.

7. DRAWINGS & LITERATURES :

All the dimensioned drawings alongwith illustrated and descriptive literature for all equipment offered must be submitted alongwith the tender, otherwise the tender will be treated as incomplete. The following drawings shall be enclosed with the tender.

(i) The drawing showing the outline dimensions of the isolator.
(ii) Drawing showing details of main contacts.
(iii) Drawings showing arrangement of mechanical interlock.
(iv) Drawing showing the details of fixed and moving contacts and the arrangement of presure relief.
(v) Drawing showing bearing assembly.
(vi) Drawings for terminal connectors.
(vii) Name plate to be provided.

8. NAME PLATE:-

Each Isolator shall be provided with Name-plate of 4" x 4" fitted on the base channel. The following shall be indicated on the plate :-

Name of manufacturer :
Order No. & date :
Name of purchaser :
Rating :
Sl.No. :

* * * * * *

20. TECHNICAL SPECIFICATION FOR LIGHTNING ARRESTORS (SURGE ARRESTORS)

8.1 **SCOPE:-**

This specification provides for the design, manufacture, stage testing, inspection & testing before despatch, packing and delivery of Metal Oxide (gapless) surge arrestors with discharge counter, insulating base and other accessories for 132 K.V. system, complete with discharge counters, insulating base and other accessories.

8.2 **STANDARDS**:- The surge arrestors shall conform to the latest editions and amendments available of the standards listed hereunder:-

S. No.	Standard reference No.	TITLE
1	IEC: 99-4	Specification For Metal Oxide Surge Arrestors Without Gap For AC Systems.
2	IS: 3070 (Part-I & III)	Specification For Lightning Arrestors For A C System
3	IS: 4759	Hot Dip Zinc Coating On Structural Steel And Allied Products
4	IS: 2633	Method For Testing Uniformity Of coating on Zinc Coated Articles.
5	IS: 5621	Specification For Large Hollow Porcelain For Use In Electrical Installations
6	IS: 2147	Degree Of Protection Provided By Enclosures For Low Voltage Switchgear & Control.
7.	-	Indian Electricity Rules - 1956
8.	IS: 5561	Specification for Electric Power Connector
9.	IS: 2629	Recommended Practice For Hot Dip Galvanisation of Iron & Steel

8.3 **PRINCIPAL PARAMETERS**: The equipment offered under this specification shall conform to the following parameters given below:

S. No.	Particulars	System 132 KV	Voltage 33 KV
1	Nominal system voltage KV (rms.)	132	33
2	Highest system voltage KV (rms.)	145	36
3	1.2 / 50 Micro second impulse withstand level	650 KVp	170 KVp
4	One minute power frequency withstand voltage(KV rms)	275	70
5	Anticipated levels of temperature over voltage and its duration. a. Voltage (P.U.) b. Duration (Seconds.)	------- 1.5/1.2 ----- -------- 1/10 -----	
6	Neutral grounding	Solidly earthed	
7	Rated arrestor voltage	120	30
8	M.C.O.V.(KV rms.)	102	25

S. No.	Particulars	System 132 KV	Voltage 33 KV
9	Installation	------ Out door-----	
10	Class	-- Station Class --	
11	Type of construction	Single Column, Single Phase	
12	Nominal discharge current corresponding to 8 /20 micro seconds wave shape.	----- 10 KA -----	
13	Type of mounting	Please Specify	
14	Connection		
15	Long Duration discharge class	3	
16	Ratio switching impulse residual voltage to rated voltage of arrestor.	--	
17	Minimum prospective symmetrical fault current for pressure relief test	31.5 KA	25 KA
18	Voltage corona extinction (KV rms.)	Rated Voltage	
19	Maximum radio interference voltage when energised at MCOV (micro volts)	----- 2500 -----	
20	Minimum creepage distance of arrestor housing (mm)	3625	900
21	High current impulse withstand value in KA (peak)	100	100
22	Partial discharge	Less than 10 PC	Less than 10 PC

8.4 **TESTS:**

Lightning arrestors shall conform to the type tests and shall be subject to routine tests in accordance with IEC-99. The following additional type tests are proposed to be conducted for 132 K.V. arrestors.

i) Radio interference voltage tests (as per I.S. 8263)
ii) Seismic withstand Test.

8.5 **ACCEPTANCE AND ROUTINE TESTS:**

All acceptance and routine tests as stipulated in the relevant standards shall be carried out in presence of CSPTCL's representative.

i) Acceptance tests wherever possible, shall be conducted on the complete arrestor unit.
ii) The artificial pollution test shall be carried out as per applicable standards.
iii) The special thermal stability test shall be carried out as acceptance test.
iv) The acceptance test shall include the galvanisation test on metal parts.
v) The functional (operational) acceptance test shall be carried out on the surge counter.

TECHNICAL SPECIFICATION FOR METAL OXIDE LIGHTNING ARRESTERS FOR 39 KV SYSTEM

1. SCOPE:

The specification covers design, manufacturing, assembly, testing at manufacturer's works, supply and delivery of Single Phase outdoor metal oxide type gap-less surge arresters for 39 KV systems complete with all accessories.

2. CLIMATIC CONDITIONS:-

i)	Peak Ambient Temperature	50° C
ii)	Minimum Temperature in Shade	1° C
iii)	Average Daily Ambient Temperature	30° C
iv)	Maximum Relative Humidity	100%
v)	Average number of Rainy days per annum	90 days
vi)	Maximum Wind Pressure	150 Kg/ Sq. Metre
vii)	Average Annual Rain fall	1250 mm
viii)	Altitude not exceeding	1000 M.
ix)	Seismic Level	0.3 g

3. SPECIAL CONDITIONS:-

The atmosphere at places is laden with dust in suspension during the dry months and subject to fog in cold months. The temperature variation between the daily minimum and maximum is large. Heavy lightning is usual in the area during the months from May to November. This area is also subjected to heavy monsoon rains 80% to 90% of the annual precipitation during the months of June to October.

4. SYSTEM CONDITIONS:-

S.No.	**Particulars**	**33 KV**
1.	Nominal System Voltage	33KV
2.	Highest System Voltage	36 KV
3.	Frequency	50 Hz.
4.	Short Circuit Level (KA) for 3 Seconds	25 KA
5.	Anticipation Levels of Temporary Over voltage & its duration	
	a. Voltage	2.0 PU
	b. Duration (Cycles)	5 Cycles

Note:- 1 PU=[(V * Root 2) / (Root 3)]KVp Where V is the highest System voltage.

4.1 Our system is 3 phase 50 Hz solidly grounded.

4.1.1 We will place one of the surge Arrestor at the entry of the each line (Feeder) in the sub-station and one Set nearer to each transformer.

4.1.2 The insulation level provided in our transformer is 170 kVp for 33KV system respectively.

5. STANDARD:- The surge Arrestors shall strictly conform to IEC 99-4 in all respects & shall also conform to the latest editions of and amendments available at the time of supply of the Standards listed hereunder:-

S.N.	**Standard ref. No.**	**TITLE**
1	IEC : 99-4	Specification for Metal Oxide Surge Arrestors without Gap for AC

		Systems.
2	IS : 3070 (Part-I & III)	Specification for Lightning Arrestors for AC System
3	IS : 4759	Hot Dip Zinc Coating on structural Steel and Allied products
4	IS : 2633	Method for testing uniformity of coating on zinc coated articles.
5	IS : 5621	Specification for large hollow porcelain for use in electrical installations
6	IS : 2147	Degree of protection provided by enclosures for low voltage Switchgear & Control.
7	-	Indian Electricity Rules – 1956
8	IS : 5561	Specification for Electric Power connector
9	IS : 2629	Recommended practice for Hot Dip Galvanisation of Iron & Steel

Notes:- For the purpose of this specification all Technical Terms used herein shall have the meaning as per IS:3070 (part-III).

6. **TECHNICAL REQUIREMENTS:**

The technical requirements have been detailed out here-in-below:-

(a) The supplier should offer nearest rating of Surge Arrestors & Minimum residual voltage shall comply with the requirements given under clause S.No. 15 & 16 below:-

(b) The transformer which is to be protected has BIL of 170 kVp for 33 KV system respectively considering 20% safe margin as per IEC. The impulse voltage of more than 136 KVp should not appear across the transformer's 33 KV side. We will be installing our Lightning Arrestors at a distance of 5 / 10 metres from the transformer (another 5 metres be added towards height of Lightning Arrestors lead length and bushing of the transformers). It should be explained with suitable graphs and calculations, the voltage more than that specified above will not appear on transformer. This requirement is essential and in absence of this, the offer shall be liable for rejection.

(c) The graph for TOV capability should be submitted alongwith the offer.

(d) Calculation for energy handling capability should essentially be submitted alongwith the offer. The calculations should be as per IS:3070. The energy handling capability for single shot of wave and multiple shots of wave as per IS:3070 should be submitted alongwith the offer.

(e) The Technical Particulars are as under :-

The equipment offered under this specification shall conform to the parameters given below:

SN	Particulars	Data for 39 KV
1.	Manufacturer type Designation.	Gap less type
2.	Applicable Specification and Standards.	IS: 3070 (Part – III)
3.	Rated frequency of Arrestors	50 Hz.
4.	Applicable ambient temperature	50° C
5.	Nominal System Voltage	33 KV
6.	Maximum Continuous Operating Voltage(MCOV)	30 KV
7.	Rated Arrestor voltage	39 KV
8.	Highest System Voltage	36 KV
9.	Duty for which suitable	Heavy Duty

10.	Class designation	Station Class
11	Temporary power frequency voltage withstand capacity 1. 0.1 Second 2. 1.0 Second 3. 10 Seconds	 69 KV rms (0.2 second) 64 KV rms. --
12.	Nominal discharge current (8 / 20 micro second)	10 KA
13.	Minimum Energy Discharge Capability (KJ / KV)	As per IS: 3070 (Part – III)
14.	Long duration Discharge Class	As per IS: 3070 (Part – III)
15.	Minimum prospective symmetrical fault current for pressure relief test (KA rms)	As per IS: 3070 (Part – III)
16.	Impulse current withstand capacity : High current short (4/10 microwave) (KA)	As per IS: 3070 (Part – III)
17.	Maximum Radio interference voltage when energised at MCOVI (micro volts)	As per IS: 3070 (Part – III)
18.	Creepage distance of porcelain housing (in mm)	1250
19.	Pressure Relief Device	As per IS: 3070 (Part – III)
20.	Insulation level of Housing : Lightning Impulse withstand voltage (kVp) of housing	As per IS: 3070 (Part – III)

(f) While furnishing technical details, it is obligatory on the part of tenderer to furnish value of current peak and virtual duration for each of Lightning Arrestors for long duration current test.

(g) Residual voltage test for 8 / 20 micro second wave of 10 KA are specified above, however, we will prefer still lower residual voltage to ensure better protection .

(h) The requirement of energy rating is very specific, based on our system. The tenderers are requested to offer nearest energy rating of Lightning Arrestors for both single and double shot.

7. GENERAL TECHNICAL PARTICULARS :-

7.1 The surge Arrestors shall conform to the Technical requirements as per 6 above.

7.2 The energy handling capability of Arrestors both for single shot and double shot offered should be supported by the calculations. It is obligatory on the part of tenderer to offer energy handling capability for single shot and double shot alongwith calculations. In absence of this the offer shall be liable for rejection.

7.3 The surge Arrestors shall be fitted with pressure relief devices and arc diverting ports and shall be tested as per the requirements of IEC draft specifications for minimum prospective symmetrical fault current as specified in S.No. 15 of the technical particulars.

7.4 The basic insulation levels and switching impulse withstand levels of the lines and equipment to be protected have been specified in clause 6 (b) above.

7.5 The minimum permissible separation between surge Arrestors and any earthed object shall be indicated by the tenderers in their offer.

7.6 Each and every individual unit of surge Arrestors shall be hermetically sealed and fully protected against the ingress of moisture. The hermetic seal shall be effective for entire life time of arrestors and under the service conditions specified. The supplier shall furnish sectional view showing details of sealing employed. Complete details of sealing arrangements may please be furnished.

7.7 Tenderer shall furnish in the offer sectional view of pressure relief device employed in the arrestors offered.

7.8 The lightening (Surge) Arrestors shall be suitable for pedestal type mounting which shall be arranged by purchaser. The drawing of mounting structure for LAs shall be given to successful bidder by CSPTCL.

7.9 All necessary bolts, nuts, clamps etc. required for mounting on support structure to be supplied by tenderer shall be included in the scope of supply.

7.10 All exposed ferrous parts shall be hot dip galvanised as per IS : 2633. The material shall be galvanised only after completing all shop operations.

7.11 TERMINAL CONNECTORS :-

(a) All castings shall be free from blow holes, surface blisters, cracks & cavities. All sharp edges and corners shall be blurred and rounded off.

(b) All current carrying parts shall be designed and manufactured to have minimum contact resistance.

(c) The contact surface must be machined smooth to obviate excessive current density.

(d) The terminal connector for connection of conductor should be suitable for Zebra conductor for 33 KV LAs with vertical / horizontal take off arrangement and should have adequate current carrying capacity.

(e) The terminal connector shall be manufactured out of Aluminium alloy LM6 as per IS and by gravity die casting process only.

(f) Terminal connector should have six bolts to hold the conductors. Conductor hold length shall not be less than 100 m.m.. All nuts, bolts, washers etc. shall be of galvanised steel only.

(g) The minimum thickness of any part of clamps body shall not be less than 12 m.m.

7.12 PORCELAIN BUSHING :-

(a) All porcelain housing shall be free from lamination cavities and other flaws affecting the maximum level of mechanical and electrical strength.

(b) The porcelain shall be well vitrified and non-porous.

(c) The creepage distance of arrester housing shall be as per technical particulars detailed out in clause 6 above.

(d) The porcelain petticoat shall be preferably of self cleaning type (Aerofoil design). The details of porcelain housing such as height, angle of inclination, shape of petticoats, gap between the petticoats, diameters (I.D. & O.D.) etc. shall be indicated by the tenderer in his offer in the form of a detailed drawing.

(e) The arrester housing shall conform to the requirements of IEC specification.

(f) Galvanising, Nickel plating etc. shall be generally as under :-

(i) All ferrous parts exposed to atmosphere shall be hot dip galvanised as per BIS : 2628 as amended from time to time. Tinned Copper / Brass lugs shall be used for internal wirings of discharge counter. Screws used for electrical connector shall be either made of brass or Nickel plated.

(ii) Ground terminal pads and name plate brackets shall be hot dip galvanised.

(iii) The material shall be galvanised only after completing all shop operations.

8. ACCESSORIES & FITTINGS :-

8.1 Each surge counters shall have terminals of robust construction for connection to earthing and these shall be suitably arranged so as to enable the incoming and outgoing connection to be made with minimum bends.

8.2 The grounding terminals (2 nos.) shall be suitable for bolted connection of 50 x 8 mm M.S. flat to be provided by the purchaser for connection to station earth mat. Proper functioning of surge arrestor shall be ensured by the supplier.

9. NAME PLATE:-

The arrestors shall be provided with non-corrosive legible name plate indelibly marked with the following information:

1.	CHHATTISGARH STATE POWER TRANSMISSION CO. LTD.
2.	Order Number
3.	Manufacturer’s name or Trade Mark and Identification Number of the arrestors being supplied
4.	Rated Voltage
5.	Maximum continuous voltage
6.	Type
7.	Rated frequency
8.	Long duration discharge class
9.	Pressure relief current in KA rms.
10.	B.I.L. of the equipment to be protected
11.	Year of manufacture

****

21.TECHNICAL SPECIFICATION FOR (220 V 600 AH AND 48 V 600 AH) BATTERY SETS :

S. No.	PARTICULARS	DESCRIPTION	
		220 V 600AH	**48 V 600 AH**
1	Type of Battery	Tubular Low Maintenance Lead Acid battery	
2	Reference of IS NO.	DIN40736/ IS 1651	
3	Normal voltage of battery.	220V	48V
4	No. of cells in each battery	110	24
5	Discharge capacity of battery		
i)	At 10 hours rate(AH)	600	600
ii)	At 1 hour rate(AH)	306	306
6	Voltage per cell	2.0 Volt	
7	Type of Construction:-		
i)	Positive plates	Lead Antimony alloy spine	
ii)	Negative plate	Lead Calcium alloy grid	
8	Method of connection between cells i.e. whether bolting of some other methods	Bolted	
9	Normal trickle charge rate without load.	Min- 600 mA Max- 2400 mA	Min- 600 mA Max- 2400 mA
10	Normal charge rate:		
i)	At starting	72 A	72 A
ii)	At finishing	36 A	36 A
11	Normal charging time after complete discharge	24 Hrs	24 Hrs
12	Voltage per cell at the end of charge at the quick charge	2.75 V(Boost charging)	2.75 V(Boost charging)
13	Type of material of separators	Synthetic fibre based material	Synthetic fibre based material
14	Material of container	Transparent SAN	Transparent SAN
15	Watt-hour efficiency at 10-hour rate of discharge.	>75%	>75%
16	Ampere-hour efficiency at 10 hours rate of discharge.	>90%	>90%
17	Voltage across battery terminal when under quick charge rate	NA	NA
18	Voltage at specified tapping point when under quick charge.	NA	NA
19	Quantity of dilute acid per cell.	11.7 Litres	11.7Liters
20	Over all dimension of each cell (in mm)	145*206*721	145*206*721
21	Distance between the centers of cells when erected	153mm	153mm
22	Weight of cell complete with	48.6 Kgs	48.6 Kgs

	electrolyte		
23	Recommended maximum period of storage before the first charge	12-18 Hrs	12-18 Hrs
24	Internal resistance of the cell.	0.41 mΩ	0.41mΩ
25	Amount and specific gravity of Electrolyte per cell required for first filling	First filling spg 1.220 ± 0.005	First filling spg 1.220 ± 0.005
26	Expected specific gravity of electrolyte at the end of full charge	At full charge 1.240±0.005	At full charge 1.240±0.005
27	Expected specific gravity of electrolyte at the end of discharge at 10-hour rate.	At full discharge 1.160-1.130	At full discharge 1.160-1.130

1. GENERAL TECHNICAL REQUIREMENTS

1.1.. All materials/components used in battery chargers and batteries shall be free from flaws and defects and shall conform to the relevant Indian/IEC standards and good engineering practice.

1.2. **For 220 kV sub-station :**

Lead Acid Battery shall be of conventional type cells shall be supplied in transparent Styrene Acrylo Nitrile (SAN) polymer container boxes (with Lid of opaque SAN) and ample space must be provided below the plate for accumulation of deposit. Spray arrestors shall be provided to prevent loss of acid by spraying during charge. The imported design of tubular type batteries may be offered. The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections. The intercell connector shall be of insulated type.

1.3 The 220 V DC System shall consist of two sets of float cum Boost Chargers of 60 Amps capacity with two sets of 600 AH batteries. Each battery charger shall have a standby float cum-boost chargers in addition to main float cum boost battery charger having same capacity.

The 48 V DC System shall consist of two sets of float cum Boost Chargers of 60 Amps capacity with two sets of 600 AH batteries. Each battery charger shall have a standby float cum-boost chargers in addition to main float cum boost battery charger having same capacity.

Bidder shall ensure following system requirement:

System Voltage	Maximum Voltage during Float operation	Minimum voltage available when no charger working and battery fully discharged upto 1.85V per cell.	Nos of cell
220 Volt	242 Volt	203.5 Volt	110
48 Volt	52.8 Volt	44.4 Volt	24

1.2. Battery

1.2.1. Type

The DC Batteries shall be **Lead-Acid** type and shall be Normal Discharge type. These shall be suitable for a long life under continuous float operations and occasional discharges. The 220 V DC system is unearth and 48 V DC system is + ve earth system.

1.2.2. Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections.

1.2.3. Containers

The container material shall be supplied in transparent Styrene Acrylo Nitrile (SAN) polymer container boxes (with Lid of opaque SAN) and shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28 %. The porosity of the container shall be such as not to allow any gases to escape except through air vent with a vapour trap. The tensile strength of the material of the container shall be such as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigours of transport, storage and handling.

1.2.4. Cell Covers

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

1.2.5. Separators

The design of separators shall ensure that there is no misalignment during normal operation and handling.

1.2.6. Terminal Posts

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

1.2.8. Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.

Nuts and bolts for connecting the cells shall be made of copper. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion.
All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

1.2.9.Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

1.2.10. Battery Bank Stand

All batteries shall be mounted in a suitable single tier wooden stand of teak wood at a convenient height for maintenance. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

1.2.11. Capacity Requirements

When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27° Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

The battery shall be capable of being recharged from the fully exhausted condition (1.75V/cell) within 10 hrs up to 90% state of charge. All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life.

Loss in capacity during storage at an average ambient temperature of 35° Celcius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere hour efficiency shall be better than 90% and watt hour efficiency shall be better than 80%.

1.2.12. Expected Battery Life

The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27° Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected life of 20 years at float operation.

1.2.13. Routine Maintenance of Battery system

For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

a) Torque wrench. Two nos
b) Digital Multimeter with least count of of voltage measurement - 0.01 V
c) Thermometr two nos
d) Hydrometer four nos
e) Rubber syringe
f) One set bridging connector
g) Rubber Hand gloves Four nos

h) Two copies of printed Instruction sheet
i) One pair of spanner
j) PVC sheet stand Insulators
k) Two no acid resisting funnel and jug each

1.2.14. Type Test of Battery

Contractor shall submit type test reports of following tests as per IEC 60896-21 & IEC 60896-22, 2004. Tests shall be conducted in accordance with IEC 60896-2 1 & IEC 60896-22, 2004

1.2.15. Installation and commissioning

1.2.15.1. Manufacturer of Battery shall supervise the installation and commissioning and perform commissioning tests as recommended in O&M manual / or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by Battery manufacturer/ Contractor

1.2.16. Contractor shall be submitted following documents for approval:

a) Data sheet
b) GA of cell and layout drawing
c) Discharge Data for 10 Hour, 8 Hour, 3 Hour, 2 Hour, 1 Hour, 15 Minutes and One Minute indicating capacity factors for end cell voltage of 1.75 V & 1.85 V.
d) Temperature correction factors
e) Installation and commissioning Instructions
f) O & M Manual

1.2.17 The cells on which acceptance tests are carried out shall not be supplied.

1.2.18 The cells shall be accommodated in single tier stands constructed of selected timber and painted with 3 coats of acid proof paint. Necessary paint for this purpose shall be supplied no metal fastening shall be used. The stands shall be supported on insulators to obtain necessary insulation from earth and there shall be insulators between each cell and stand. The price of stand shall be included in the cost of the battery. The following accessories shall be supplied along with batteries and prices for the same shall be quoted separately:

1	One Battery Log Book
2	Four Copies Of Printed Instruction Sheet
3	2 No. Cell Testing digital Voltmeter complete with Leads
4	2 No. Rubber Syringe
5	2 No. of Syringe type Hydro Meter suitable for Specific Gravity Reading.
6	2 No. Thermometer (0- 100 Deg C) With Specific Gravity Scale
7	1 Set of Bridging Connector
8	Anti Sulphuric acid Enamel Paint a) Red Colour In Required Quantity b) Black Colour 2 Litres
9	Battery Stand suitable for accommodating the Cells coated with 3 Coats of anti acid paint.
10	Hard Rubber Cells Insulators in required quantity with 4 No.extra (Spare)
11	P.V.C. Sheet Stand Insulators in required quantity with 4 No.extra (Spare)
12	1 Set of Cell No. Plates With Fixing Pins.
13	1 Pair of Spanners

14	1 No. Acid Resisting Funnel
15	1 No. Acid Resisting Jug Of 2 Litres Capacity
16	Requisite Quantity Of Electrolyte With 10% Extra In Non-Returnable Containers
17	1 Set Of Inter Connectors.
18	Torque wrench – 2 Nos
19	One set of spanners

1.2.19 Installation and commissioning

Manufacturer of Battery shall supervise the installation and commissioning and perform commissioning tests as recommended in O&M manual / or relevant standards. All necessary instruments, material, tools and tackles required for installation, testing at site and commissioning are to be arranged by Battery manufacturer/ Contractor.

1.2.20 **TESTS:**

The batteries shall be tested after manufacture as per the requirements of I.S. 1651:1991 (with latest amendments if any).

22. TECHNICAL SPECIFICATIONS FOR (220 V 600 AH AND 48 V 600 AH) BATTERY CHARGER:

Sr. no.	Particulars	Float 220V-600AH	Boost 220V-600AH	Float 48V600AH	Boost 48V600AH
1	Type	INDOOR	INDOOR	INDOOR	INDOOR
2	Rated AC Input voltage (3Ph 4w, 415V,50Hz +/- 3%, Voltage variation 360-450V)	360 to 450VAC	360 to 450VAC	360 to 450VAC	360 to 450VAC
3	Rated Output Voltage	2.2 Vdc/Cell	2.28dc-2.7Vdc/Cell	2.2 V/Cell	2.28-2.7V/Cell
4	Regulation	1%	1%	1%	1%
5	Ripple	1% without battery	1% without battery	2 mili V sophometeric with battery & 4 mili V without battery in circuit	2 mili V sophometeric with battery & 4 mili V without battery in circuit
6	Currents	61A	120A	61A	120A
7	System output voltage	242Vdc	250 Vdc to 297 Vdc	52.8V	54.7-64.8V
8	MAIN TRANSFORMER Type of connection (Star/Delta)	Star/Delta	Star/Delta	Star/Delta	Star/Delta
9	Single/Double Wound	Double Wound	Double Wound	Double Wound	Double Wound
10	KVA Rating	22 KVA	54 KVA	4.9 KVA	11.8 KVA
11	Method of cooling	Natural Air	Natural Air	Natural Air	Natural Air
12	Whether Taps are provided for primary Volt selection	NO	NO	NO	NO
13	Class of Insulation	F Class	F Class	F Class	F Class
14	Current Density in winding	Max.1.5A/mm sq.	Max.1.5A/mm sq.	Max.1.5A/mm sq.	Max.1.5A/mm sq.
15	Temp. rise above 45 Deg. C.(max. 40 Deg)	Max. 40 Deg. C.	Max. 40 Deg. C.	Max. 40 Deg. C.	Max. 40 Deg. C.
16	Magnetising current at 415V	Max. 3%	Max. 3%	Max. 3%	Max. 3%
17	Rating of the Main Auto TXR.	----------	40Amp	----------	16Amp
18	Type of Control	Auto	Manual	Auto	Manual
19	Type and rating of smoothing filter				
	Inductor	2.2 mH/63 A		2.2mH 62A	
	Capacitor	10000 µF /350V		4700 µF /100V*5	
20	Voltage regulation of Float/ Boost				
	Inherent	1%	1%	1%	1%
	With AVR	1%	1%	1%	1%
21	Efficiency at				
	Full Load (min. 75%)	min. 75%	min. 75%	min. 75%	min. 75%
	Half load (min. 60%)	min. 60%	min. 60%	min. 60%	min. 60%
22	Type, make & rating of Rectifier				

	Current rating	75A	150A	75A	150A
	Peak inverse voltage	1200V	1200V	1200V	1200V
	Inverse voltage surge	1200V	1200V	1200V	1200V
23	Battery charger cubicle				
	a) Thickness of sheet	2 mm	2 mm	2 mm	2 mm
	b) Overall size(W.H.D.)	1700*1600*800		1400*1600*800	
	Total weight	550kg		450kg	
24	Details of Cables & Wires Used in the Charger	1.5/16 sq mm	1.5/16 sqmm	1.5/16 sq mm	1.5/16 sqmm
25	Rating of Dropper Diode (min. 70A/1000V)	min. 75A/1000V	min. 150A/1000V	min. 75A/1000V	min. 150A/1000V

STANDARDS.

1.1 Unless otherwise specified, the equipment shall conform to the latest applicable Indian, IEC, British or USA standards, and in particular to the following standards:-

IS:1651	Specifications For Stationery Cells And Batteries, Lead Acid Type With Tubular Positive Plates
IS:3895	Specification For Rectifier Equipments
IS:9224	Specifications For HRC Fuses
IS:1248	Indication Instruments
IS:2147	Degree Of Protection For Cubicles
IS:375	Specification For Wiring
IS:4540	Mono Crystalline Semi Conductor Rectifier Assemblies And Equipment
IS:6619	Safety Code For Semi Conductor Rectifiers
IS:2026	Transformers
IS:2959	A.C. Contractors For Voltage Not Exceeding 1000 V
IS:4237	General Requirements For Switch Gear In Control Gear For Voltage < 1000 Volts
IS:4064	Air Break Switches And Fuse Units
IS:6005	Code Of Practice For Phosphating
IS:5568	Colour For Ready Mix Paints
IS:2489,5921	Printed Circuit Boards
IS:5578	Guide For Making Insulated Conductors

1.2 CAPACITY & RATING FOR CHARGERS.

The DC system for 220 V DC is unearthed and for 48 V DC is +ve earthed. The Battery Chargers as well as their automatic regulators shall be of static type and shall be compatible with offered Lead Acid batteries. All battery chargers shall be capable of continuous operation at the respective rated load in float charging mode, i.e. Float charging the associated Lead-Acid Batteries at 2.2 Volts per cell while supplying the DC load. The chargers shall also be capable of Boost charging the associated DC Battery at upto 2.6 volts per cell at the desired rate.

Charger shall regulate the float/boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. Necessary temperature sensors shall be provided in mid location of battery banks and shall be wired up to the respective charger for feedback control. The manufacturer shall demonstrate this feature during testing of each charger.

1.3.1. All Battery Chargers shall be provided with facility for both automatic and manual control of output voltage and current. A selector switch shall be provided for selecting the mode of output voltage/current control, whether automatic or manual. When on automatic control mode during Float charging, the Charger output voltage shall remain within +1% to -1% of the set value, for AC input voltage variation of + 10%, frequency variation of +5%, a combined voltage and frequency variation of +10%, and a DC load variation from zero to full load.

1.3.2. All battery chargers shall have a constant voltage characteristics throughout the range (from zero to full load) in the floating mode of the voltage so as to keep the battery fully charged but without harmful overcharge.

1.3.3. All chargers shall have load limiters having drooping characteristic, which shall cause, when the voltage control is in automatic mode, a gradual lowering of the output voltage when the DC load current exceeds the Load limiter setting of the Charger. The Load-limiter characteristics shall be such that any sustained overload or short circuit in DC System shall not damage the Charger, nor shall it cause blowing of any of the Charger fuses. The Charger shall not trip on overload or external short circuit.

1.3.4. Uniform and step less adjustments of voltage setting (in both manual and automatic modes) shall be provided on the front of the Charger panel covering the entire float charging output range specified. Step less adjustments of the Load-limiter setting shall also be possible from 80% to 100% of the rated output current for Charging mode.

1.3.5. During Boost Charging, the Battery Charger shall operate on constant current mode (when automatic regulator is in service). It shall be possible to adjust the Boost charging current continuously over a range of 50 to 100% of the rated output current for Boost charging mode.

1.3.6. The Charger output voltage shall automatically go on rising, when it is operating on Boost mode, as the Battery charges up. For limiting the output voltage of the Charger, a potentiometer shall be provided on the front of the panel, whereby it shall be possible to set the upper limit of this voltage any where in the output range specified for Boost Charging mode.

1.3.7. The Charger manufacturer shall offer an arrangement in which the voltage across the load shall not exceed 110 % during boost charging of the battery and when cell voltage reaches even 2.6 volts. The rating of any diodes used in series with the battery and the load current shall have a minimum 200 % of the rating of maximum load current and also should take into consideration the short time DC load due to simultaneous operation of the CBs/protective relays.

1.3.8. Suitable filter circuits shall be provided in all the chargers to limit the ripple content (Peak to Peak) in the output voltage to 1%, irrespective of the DC load level, when they are not connected to a Battery.The Charger shall have DC earth leakage indicator along with a relaying ckt for extending indication

1.3.9. MCCB

All Battery Chargers shall have 2 Nos. MCCBs on the input side to receive cables from two sources. Mechanical interlock should be provided such that only one shall be closed at a time. It shall be of P2 duty and suitable for continuous duty. MCCB's should have auxiliary contacts for annunciation.

1.3.10. Rectifier Transformer

The rectifier transformer shall be continuously rated, dry air cooled (A.N) and of class F insulation type. The rating of the rectifier transformer shall have 10% overload capacity.

1.3.11. Rectifier Assembly

The rectifier assembly shall be full/half controlled bridge type and shall be designed to meet the duty as required by the respective Charger. The rectifier shall be provided with heat sink having their own heat dissipation arrangements with natural air cooling. Necessary surge protection devices and rectifier type fast acting HRC fuses shall be provided in each arm of the rectifier connections.

1.3.12.Instruments

One AC voltmeter and one AC ammeter alongwith selector switches shall be provided for all chargers. One DC voltmeter and DC ammeter (with shunt) shall be provided for all Chargers. The instruments shall be flush type, dust proof and moisture resistant. The instruments shall have easily accessible means for zero adjustment. The instruments shall be of 1.5 accuracy class. In addition to the above a centre zero voltmeter with selector switch shall also be provided for 220 V chargers for testing purpose.

1.3.13.Air Break Switches

One DC output switch shall be provided in all chargers. They shall be air break type suitable for 500 volts AC/ 250 DC. The contacts of the switches shall open and close with a snap action. The operating handle of the switch shall be insulated from circuit. `ON' and `OFF' position on the switch shall be clearly indicated. Rating of switches shall be suitable for their continuous load. Alternatively, MCCB's of suitable ratings shall also acceptable in place of Air Break Switch.

1.3.14.Fuses

All fuses shall be HRC Link type. Fuses shall be mounted on fuse carriers which are in turn mounted on fuse bases. Wherever it is not possible to mount fuses on carriers, fuses shall be directly mounted on plug-in type base. In such case one insulated fuse pulling handle shall be supplied for each charger. Fuse rating shall be chosen by the Bidder depending on the circuit requirement. All fuses in the chargers shall be monitored. Fuse failure annunciation shall be provided on the failure of any fuse.

.1.3.15. Blocking Diode

Blocking diode shall be provided in the positive pole of the output circuit of each charger to prevent current flow from the DC Battery into the Charger.

1.3.16.Annunciation System

Audio-visual indications through bright LEDs shall be provided in all Chargers for the following abnormalities:

a) AC power failure
b) Rectifier/chargers fuse blown.
c) Over voltage across the battery when boost charging.
d) Abnormal voltage (High/Low)
e) DC earth leakage
f) Any other annunciation if required.

Potential free NO Contacts of above abnormal conditions shall also be provided for common remote indication "CHARGER TROUBLE" in Owner's Control Board. Indication for charger in float mode and boost mode through indication lamps shall be provided for chargers. A potential free contact for float/boost mode shall be provided for external interlocks.
Various alarms as well as the voltages of Chargers shall be suitably integrated in the Substation System.

1.3.17.Name Plates and Marking

The name plates shall be white with black engraved letters. On top of each Charger, on front as well as rear sides, larger and bold name plates shall be provided to identify the Charger. Name plates with full and clear inscriptions shall also be provided on and inside of the panels for identification of the various equipments and ease of operation and maintenance.

1.3.18. Charger Construction

The Chargers shall be indoor, floor-mounted, self-supporting sheet metal enclosed cubicle type. The Contractor shall supply all necessary base frames, anchor bolts and hardware. The Chargers shall be fabricated from 2.0mm cold rolled sheet steel and shall have folded type of construction. Removable gland plates for all cables and lugs for power cables shall be supplied by the Contractor. The lugs for power cables shall be made of electrolytic copper with tin coat. Power cable sizes shall be advised to the Contractor at a later date for provision of suitable lugs and drilling of gland plates. The Charger shall be tropicalised and vermin proof. Ventilation louvers, if provided shall be backed with screens. All doors and covers shall be fitted with synthetic rubber gaskets. The chargers shall have hinged double leaf doors provided on front and on backside for adequate access to the Charger's internals. All the charger cubicle doors shall

be properly earthed. The degree of protection of Charger enclosure shall be at least IP-42 as per IS: 13947 Part I.

1.3.18.1. All indicating instruments, control switches and indicating lamps shall be mounted on the front side of the Charger.

1.3.18.2. Each Charger shall be furnished completely wired upto power cable lugs and terminal blocks and ready for external connections. The control wiring shall be carried out with PVC insulated, 1.5 sq.mm. stranded copper wires. Control terminals shall be suitable for connecting two wires, with 2.5 sq.mm stranded copper conductors. All terminals shall be numbered for ease of connections and identification. Each wire shall bear a ferrule or tag on each end for identification. At least 20% spare terminals shall be provided for control circuits.

1.3.18.3. The insulation of all circuits, except the low voltage electronic circuits shall withstand test voltage of 2 KV AC for one minute. An air clearance of at least ten (10) mm shall be maintained throughout for such circuits, right up to the terminal lugs. Whenever this clearance is not available, the live parts shall be insulated or shrouded.

1.3.19. Painting

All sheet steel work shall be pre-treated, in tanks, in accordance with IS:6005. Degreasing shall be done by alkaline cleaning. Rust and scale shall be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphate coating shall be `Class-C' as specified in IS:6005. Welding shall not be done after phosphating. The phosphating surfaces shall be rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint of shade-692 (smoke grey) of IS:5 shall be applied, unless required otherwise by the Owner. The inside of the chargers shall be glossy white. Each coat of finishing synthetic enamel paint shall be properly staved. The paint thickness shall not be less than fifty (50) microns.

1.3.20. **TESTS**

1.3.20.1. Battery chargers shall conform to all type tests as per relevant Indian Standard. Performance test on the Chargers as per Specification shall also be carried out oneach Charger as per specification. Rectifier transformer shall conform to all type tests specified in IS : 4540 and short circuit test as per IS:2026. Following type tests shall be carried out for compliance of specification requirements:

i) Voltage regulation test
ii) Load limiter characteristics test
iii) Efficiency tests
iv) High voltage tests
v) Temperature rise test
vi) Short circuit test at no load and full load at rated voltage for sustained short-circuit.
vii) Degree of protection test
viii) Measurement of ripple by oscilloscope.
ix) Temperature compensation feature demonstration

1.3.20.2. The Contractor may be required to demonstrate to the OWNER that the Chargers conform to the specification particularly regarding continuous rating, ripple free output, voltage regulation and load limiting characteristic, before despatch as well as after installation at site. At site the following tests shall be carried out :

i) Insulation resistance test
ii) Checking of proper annunciation system operation.

1.3.20.3. If a Charger fails to meet the specified requirements, the Contractor shall replace the same with appropriate Charger without affecting the commissioning schedule of the Sub-station, and without any extra cost to the OWNER.

1.3.20.4. The Contractor shall present for inspection, the type and routine test certificatesfor the following components whenever required by the OWNER.

(i) Switches.
(ii) Relays/ MCCBs

(iii) Instruments.
(iv) DC fuses.
(v) SCR.
(vi) Diodes.
(vii) Condensers.
(viii) Potentiometers.
(ix) Semiconductor
(x) Annunciator.
(xi) Control wiring
(xii) Push buttons and contactors. Makes of above equipment shall be subject to Owner's approval.

Control & monitoring of battery chargers shall be integrated in Sub-station Automation System. A dedicated separate Bay Control Unit shall be provided for this purpose.

****

23. TECHNICAL SPECIFICATION FOR POWER LINE CARRIER COMMUNICATION EQUIPMENTS:-

1.1 SCOPE

This specification covers manufacture, assembly and testing at manufacturer's work, stage inspection, testing, packing and delivery of line carrier communication equipments required on 132 KV line sections. The specifications covers supply of outdoor as well as indoor equipments required for providing, power line carrier communication between two sub-stations. The scope covers supply of multi purpose carrier cabinet with latest technology suitable for speech, tele-protection, signalling, telemetry, and telex / fax transmission.

1.2 LIMITS OF CONTRACTS:

1.2.1 OUTDOOR EQUIPMENTS:-

The contractor's scope of supply shall include the outdoor apparatus required for carrier system such as Wave trap, Coupling capacitor, Line matching unit along with protective device (Drainage coil, surge arrestor & earth switch etc).

1.2.2 INDOOR EQUIPMENTS

The scope of supply shall also include all the indoor equipments required, viz Carrier panel, Protection couplers, Electronic private automatic exchange and Telephones. HF Coaxial cable interconnecting the outdoor and indoor apparatus shall be included in this section.

1.3 REQUIREMENTS:-

The power line carrier communication equipment to be supplied and erected under this contract shall be suitable to provide the following services:-

a) Speech communication between the stations.
b) EHV line protection signal transmission/reception through Carrier equipment.
c) VFT facilities for data communication.

The supplier shall provide Power Line Carrier Cabinet sharp cut-off filter, speech compression & expansion (compander) facility & transit band pass filter. The equipment shall be immune to corona & other noises which are predominantly present in EHV S/Stns. The Carrier cabinet shall work on Amplitude modulation principal however advanced versions working on QAM (Quadrature Amplitude Modulation) shall also be acceptable. The carrier equipment shall support 600 Baud data transmission rate along with speech transmission & 1200 Baud with out speech.

Presently AF coupler unit (carrier protection unit) is not required, however, the Carrier Cabinet should be compatible to be connected with protection coupler working on coded command principle. Coded commands for direct tripping & fixed frequency/combination of frequency commands for permissive trip may be added in future.

1.4 COMMUNICATION SYSTEM:-

Contractor may offer power line carrier equipment according to their standard practice to fulfil the requirement of this specification. The equipment offered should be the single side band fixed frequency type. The equipments shall have full scope for further extension and alteration.

It is to be noted that the existing 132 KV system of the CSPTCL already has a power line carrier communication system, based on the details of the existing equipments and existing frequencies network which will be furnished to successful contractor. The contractor if desired shall be responsible for proposing suitable frequencies for section on which PLC equipments are to be installed. In choosing the frequency for the proposed sections, the contractor shall pay due attention to the frequencies already in use.

For the protection signalling separate carrier frequency is not required. The 4 KHz. AF Band of PLC cabinet shall carry speech from 0- 2 KHz & rest of the portion of band can be utilized for protection signalling data transmission.

The equipment would be used on 132 KV transmission line. For selection of frequency, due consideration should be given to the transposition aspect as the signal attenuation is likely to be substantially affected by transposition of phases and other parameters. The contractor will have to carry out the necessary studies and furnish the required calculations and conclusion drawn

there from for satisfaction of the customer. The details of the transposition shall be furnished to the successful contractors. In any case the frequencies to be finally adopted will be subject to approval by the Government of India and the contractor shall agree to modify the frequencies in accordance with the final requirement without any extra cost. The requirement will have to be complied with, without any extra charges to us even if the approved frequency plan calls for utilisation of fractional frequencies.

1.4.1 **FACILITIES REQUIRED**:-

The communication system shall be used for speech transmission/reception in duplex mode, data transmission & protection signalling. The carrier cabinet will be compatible to be connected with EPAX. The EPAX must support E&M signalling in addition to other facilities. Thus the local subscriber of exchange will be able to make local as well as trunk calls.

1.4.2 **FREQUENCIES TO BE ADOPTED**:- The frequencies to be used shall be chosen from PLC band i.e. 50 - 500 KHz. Higher frequencies can be adopted for smaller sections and lower for longer sections. For this purpose it is obligatory for the contractor to furnish frequencies plan for all sections in the tender.

1.4.3 **COUPLING TO HIGH TENSION LINES**:- For all the line sections covered by this specifications phase to phase coupling shall be adopted. On 132 KV line sections 132 KV class Coupling Capacitors are to be provided by the developer. However, carrier panels LMU with protective device and drainage coil for 132 KV section are included in this specifications.

1.4.4 **MODULATIONS**:- Carrier equipments working on Amplitude modulation technique may be offered however equipments working on QAM & Digital modulation techniques are also acceptable.

1.4.5 **PHYSICAL LAYOUT OF EQUIPMENTS**

The following equipments will be installed in the outdoor switchyard.

i) Wave trap.
ii) Coupling Capacitor
iii) Line Matching Unit along with protective device.

All the remaining equipments viz. Carrier transmitter receiver set, emergency power supply equipment etc., will be installed inside the control building adjacent to switchyard. The lead of coaxial cable connecting the Line Matching Unit and the carrier set will be lead in underground cable ducts. It may be necessary to lay part of the coaxial cable in ducts as well as direct in ground. The cable should thus be suitable to embedded in ground.

The cabinet should be suitable for transmission of speech and data at 1200 Baud. The carrier cabinet should be designed in such manner that programming of AF speech band, pilot, line filter, transmit frequency, & receive frequency is possible on site. The cabinet should have remote loop testing facility.

1.4.6 **STANDARD.**

The PLCC equipments shall comply with the latest issue of I.S. and IEC standard as mentioned below:-

S. No.	Name of equipment	IEC no.	IS no.
1	Wave trap	353	8792
2	Coupling device	481	8793
3	Carrier set	495	8997
4	Protection coupler	834-1 2	---

1.4.7 **POWER LINE CARRIER COMMUNICATION CABINET**:

PLCC terminals shall use amplitude modulation (QAM in case of Digital PLCC panel) and shall have SSB transmission mode. The carrier cabinet shall work on fixed frequency & Duplex mode. The PLCC terminal shall comprise of HF hybrid & high quality, sharp filters & crystal generated highly stable frequency.

The various printed circuit board of carrier set shall be housed in heavy gauge steel (12/14 gauge) indoor cabinet for floor mounting type with adequate arrangements for ventilation and screening of the same to avoid dust getting in and to avoid any adverse effect from moisture during rainy season. The cabinet shall be finished with paints of suitable colour coated inside and outside.

Screw clamp type terminals shall be provided for inter connection wiring. The cabinet shall be suitable for bottom cable entry.

All individual parts of set shall be accessible from the front to permit testing and repair. The front shall have hinged doors, equipped with handles and locks. Necessary testing and indication device shall be provided on the front panel to enable checking of important functions and circuits. The whole circuit shall be mounted on one panel which is hinged at top and bottom of the cabinet. This will facilitate approach to backside of the circuit. The cabinet shall be provided on the outer side with visual and audio alarm indications to announce failure of power supply, absence of carrier signal for both receiver and transmitter etc. the audio alarm would be provided for this purpose which should be audible from 8 metres distance. The carrier set shall be suitable for operation with EPAX i.e. E&M signalling. In addition, two telephone sets shall be provided with each carrier set (one jack telephone, and one four wire telephone), for testing purpose and for carrying on emergency conversion without the help of the associated automatic exchange.

A monitoring and checking system shall be provided on the panel with selector switch to indicate all important levels. (DC, VF, IF and HF). The PLCC terminal should be provided with facility on 2 wire conversation on Express mode with the help of pilot shifting (necessary print for this type of conversation should be provided.

S.No.	Particulars	Description
1.	Operating mode	Single side band with suppressed carrier, with multiple conversion i.e. preferably 3 stage modulation & 4 stage demodulation to suppress noises present in electrical network & maintain high receiver selectivity.
2	Carrier frequency range a. Overall b. Programmable	 40 KHz. To 500 KHz. 50 KHz. To 500 KHz.
3	Nominal band with a. Single channel b. Twin channel	 4 KHz. 8 KHz.
4	Maximum Line Attenuation a. Single Channel b. Twin Channel	 60 dB 54 dB
5	Effective working on the line attenuation excluding line noise level a. Single Channel b. Twin Channel	 35 to 40 dB 30 to 35 dB
6	Nominal output impedance	75 or 125 Ohm unbalanced
7	Return Loss Tolerance in Transition band	$\geq$12 dB
8	Carrier frequency stability	$\leq+$ 5 Hz.
9	Useful A.F. Band width	300 t0 3840 Hz.

1.4.8 **ALLOWABLE ATTENUATION DISTORTION OF A.F. CHANNEL**

A	Broad band repeater, operation 0.3 KHz. to 3.84 KHz.	i. 0.3 to 0.4 KHz. – 0.9/+1.7 dB ii. 0.4 to 3.7 KHz. –0.9/+0.9dB iii. 3.7 to 3.84 KHz. – 0.9/+1.7 dB
B	Broad band repreater operation 0.3 KHz. To 3.6 KHz. (with low pass filter)	i. 0.3 to 0.4 KHz. – 0.9/+1.7 dB ii. 0.4 to 3.7 KHz. –0.9/+0.9dB iii. 3.4 to 3.6 KHz. – 0.9/+1.7 dB
C	Speech band 0.3 to 3.4 KHz. Without compander	Comply with IEC 495
D	Speech band 0.3 to 3.4 KHz. Without compander	Comply with IEC 495

1.4.9 **TELEMETRING BAND**

1.	Tele Control Inputs	Minimum 3 inputs precoupled, independently adjustable 600 ohms
2.	Broad Band repeater operation 0.3 to 3.6 KHz. (with low pass filter)	i. 0.5 to 0.6 KHz. $\leq$3.0 ms. ii. 0.6 to 1.0 KHz. $\leq$1.5 ms. iii. 1.0 to 2.6 KHz. $\leq$0.5 ms. iv. 2.6 to 3.4 KHz. $\leq$1.5 ms. V. 3.4 to 3.6 KHz. $\leq$5.0 ms.
3.	Speech Bands. a) 0.3 KHz to 3.4 KHz. b) 0.3 KHz. T0 2.4 KHz. c) 0.3 KHz. T0 2.0 KHz.	Comply with IEC 495

1.4.10 **FILTER CHARACTERISTICS:-**

1.	Allowable ripple for Band pass, High pass & Low pass filters	+ 0.9 dB/-0.9 db
2	Rejection	$\geq$ 50 dB
3	Filter Frequencies	Programmable
4	Selectivity	$\geq$ 50 dB/120 Hz.
5	Band Stop Attenuation	50 dB
6	Band Pass Attenuation	Flat in a band of $\pm$ 0.9 dB

1.4.11 **COMPANDER CHARACTERISTICS**

It should comply with C.C.I.T.T.-G-162.
HARMONIC DISTORTION: 350 Hz. Speech Signal

1	4- Wire	$\leq$(-) dBm for each component at (-) 3 dBm without attenuation
2	2-Wire	$\leq$ (-) 30 dBm for each component at (-) 3 dBm with compander
3	Tele control signal	$\leq$ 1 % at maximum gain
4	Near & Far end cross talk	$\leq$ (-) 50 dBm
5	Near & Far end cross talk attenuation	$\geq$ 50 dB

1.4.12 **SUPERVISION ALARMS: Should come under following conditions:-**

1.	Loss of Transmitter signal.	
2.	Loss of Receiver signal (2 to 5 dB below the AGC range).	
3.	Low SNR in speech & telecontrol channels	15 dB
4.	Low of Auxiliary supply	
5.	Excessive impulse interference.	

1.4.13 **A.F. MUTING**

1.	Slow Muting Rx signal strength alarm	2 to dB below the AGC range.
2.	Fast Muting alarm for burst noise	Pick up delay < 10 ms at a burst noise level of > O dBmo/SNR <o dB

1.4.14 **R.F. OUTPUT POWER**

1.	Peak envelope power including pilot signal under normal load conditions at c0-axial o/p	40 Watt (+46 dB)
2.	Spurious Signal suppression at the limits of the band width for Single & Twin channel	$\geq$ 60 dB
3.	Harmonic suppression for Single & Twin channel	$\geq$ 80 dB
4.	Suppression of unwanted side bands	$\geq$ 80 dB

1.4.15 **RECEIVER REQUIREMENTS:-**

1.	R.F. sensitivities with reference to test tone level at R.F.I/P	(-) 24 dBm
2.	Image Rejection	$\geq$80 dB
3.	I.F. rejection	$\geq$ 80 dB
4.	A.G.C.	A.F. Output level should remain within $\pm$ 0.5 dB for variation of + 14 dB to (-) 26 dB in R.F. Input level.
5.	A.G.C. Time constant	0.5 dB/Sec For level increase/ decrease
6.	Frequency response equalization range	$\pm$ 6 dB

1.4.16 **TELEPHONE INTERFACES:**

1.	2/4 Wire P.A.X. interface	Should be provided
2.	Remote & Local loop testing facilities for A.F. Signals	Should be provided
3.	2/4 wire Input & output level	Adjustable in steps of 0.25 dB
4.	Input Range-Nominal	(-) 20 dB to + 10 dB in steps of 0.25 dB
5.	Balance referred to ground	$\geq$ 56 dB
6.	Return Losses	$\geq$ 20 dB

1.4.17 **TELECONTROL OUTPUTS**

1.	Telecontrol Output	Minimum 3 nos Decoupled, independently adjustable 600 ohms balances. Programmable as transit filter or Board band outputs.
2.	Nominal Output level	0 dBr, 600 ohms balances.
3.	Output level range (Single Tone)	(-) 20 dBr to + 10 dBr in steps of 0.25 dB across 600 ohms
4.	Maximum Output Level (PEP)	+ 14 dBm across 600 ohms
5.	Balance referred to ground	$\geq$ 56 dB
6.	Return Losses	$\geq$ 20 dB

1.4.18 **ALLOWABLE GROUP DELAY DISTORTION**

1.	Board band repeater operation 0.3 KHz. To 3.84 KHz.	i. 0.5 to 0.6 KHz. $\leq$ 3.0 ms. ii. 0.6 to 1.0 KHz. $\leq$ 1.5 ms. iii. 1.0 to 3.2 KHz. $\leq$ 0.5 ms. iv. 3.2 to 3.7 KHz. $\leq$ 3.0 ms.
2.	Balance referred to ground	$\geq$ 56 dB
3.	Return Losses	$\geq$20 dB

4.	DC Resistance	≥ 2 M Mega-ohms
5.	Speech cutoff frequency adjustable	1.8 KHz. _ 3.4 KHz. In steps of 200 Hz.
6.	Telephony signalling	Pilot Oscillation Keying syste. E.M. Signalling mode.

1.5 GUARANTEED TECHNICAL PARTICULARS FOR TWIN CHANNEL POWER LINE CARRIER COMMUNICATION EQUIPMENT

SN	DESCRIPTION	TECHNICAL PARTICULARS
	Carrier Cabinet	
1	Mode of transmission	Single side band amplitude modulation
2	Carrier frequency range	24 to 500 KHz
3	Nominal carrier frequency band width.	8KHz
4	Oscillator for generating carriers	Crystal controlled oscillator with frequency divider
5	Frequency stability	Less than + /- 5 Hz
6	Effectively transmitted speech frequency band.	300 Hz to 2000 / 2200/ 2400 / 2600 / 2800 / 3000 /3200 / 3400 Hz Upper limit programmable in steps of 200 Hz using plug- in jumpers.
7	Available band for superimposed signals.	Depends on the Speech cut off frequency. With Speech band of 300 Hz to 2000 Hz the available band for superimposed channels is 2160 Hz to 3600 Hz programmable in steps of 60 Hz.
8	Signalling frequency	3780 + /- 30 Hz Pilot frequency is used for signalling (Programmable)
9	HF Power Output	40 watt PEP. Adjustable output power
10	Nominal impedance i) Carrier frequency side ii) V.F. side	75/ 125 Ohms Unbalanced and 150 Ohms Balanced (Optional) 600 Ohms
11	Relative VF levels across 600 Ohms (Balanced) i) 4 wite transit ii) 4 wire receive iii) 2 wire transit iv) 2 wire receive	 -3.5 dBr.(Adjustable using DIP switches from- 20 dBr to +10 dBr) -3.5dBr.(Adjustable using DIP switches from – 20 dBr to +10 dBr) 0dBr.(Adjustable using DIP switches from – 16dBr to + 7 dBr) -7dBr. (Adjustable using DIP switches from – 16 dBr to +7dBr)
12	Details of power supply required.	48V DC (Variation allowed +20%/15%)
13	Power consumption	80 Watts approx. for Twin channel
14	Spurious emissions	As per IEC 495
15	Receiver Sensitivity	-24 dBm referred to the Test Tone level at the RF I / P.
16	Automatic volume control	AF O/P level remains within + / - 0.5 dB for a + /-14/-26dB variation of RF I/P level.
17	Signal to Noise ratio over current carrier channels.	<40 dB
18	Selectivity	70 dB for 300 Hz 100 dB for 4 KHz.
19	Any other technical particulars not mentioned above, but considered necessary may please be also furnished.	-

1.6 BILL OF MATERIAL OF TWIN CHANNEL CARRIER CABINET

Each Carrier cabinet shall consist of the following components:

(1). 01 no. dummy load module.
(2). 01 no. 2 wire telephone for each channel.
(3). 01 no. 4 wire telephone set, push button type for each channel.
(4). 01 no. jack telephone hand set for each channel.
(5). 01 no. 125 ohm load.
(6) Transit band pass filter.
(7) Print puller.
(8) Exhaust fan.
(9) Test meter print.

***

24. COMMUNICATION SYSTEM : 132KV COUPLING CAPACITOR

1.1 SCOPE:

It comprises the design, supply, erection, testing & commissioning of 132 KV Coupling Capacitor.

1.2 STANDARDS:

The 132 KV coupling capacitor shall confirm to the requirements of the latest edition of relevant IEC/IS standard IS 9348/1979.

1.3 TYPE & RATING:-

1.3.1 The 132 KV coupling capacitor shall be of outdoor type, oil filled, pedestal mounted and mechanically strong to withstand stresses due to wind pressure of 150 kg/ sq.mtr. The outer shell will be one piece wet processed porcelain with liberal creepage distance to prevent flash over under the most adverse tropical condition. The 132 KV coupling capacitor shall have the following electromechanical characteristic:

S.No.	Particulars	Value for 132 KV Coupling capacitor
1.	Nominal system voltage	132 KV/√ 3
2.	Highest system voltage	145 KV/ √3
3.	One minute power frequency withstand test voltage (dry)	275 KV
4.	One minute power frequency withstand test voltage (wet)	275 KV
5.	Impulse withstand voltage	650 KV
6.	Rated capacitance	4400 pf + 10% - 5%

1.3.2 The coupling capacitor must confirm to the basic impulse level dry and wet withstand voltage and creepage distances. Sufficient no. of clamps and connectors shall be supplied along with the equipment. The drawings of clamps and connectors shall be approved by CSPTCL. The clamp shall be made of LM9 or LM25 aluminium alloy by gravity die casting process only.

1.3.3 **GUARANTEED TECHNICAL PARTICULARS OF 132 KV COUPLING CAPACITORS**

SN	DESCRIPTION	TECHNICAL PARTICULARS
1	Type	CC: 145/650/50 Single Phase, Outdoor
2	Rated voltage i) Normal (phase to ground) ii) Maxm. (phase to ground)	 (132/√ 3) KV rms (145/√ 3) KV rms
3	Capacitance	4400 pF + 10%, -5%
4	Dry withstand voltage for one minute	275 KV rms
5	Wet withstand voltage for one minute	275 KV rms
6	1.2/50 m sec full wave impulse withstand voltage	650 KV peak
7	Whether suitable for outdoor mounting	Yes
8	Dimension	(i) Height- (ii) Width - Dia
9	Weight	(i) Total weight: (ii) Oil weight :
10	Ambient temperature i) Temp. range over which the unit is capable of maintaining rated data ii) Temp. Range over which the unit will still function	 -25 to +50°C -25 to +50°C

1.4 TECHNICAL SPECIFICATION FOR 132KV WAVE TRAP

1.4.1 **SCOPE** :

It comprises the design, supply, testing, erection & commissioning of suspension type 132 KV WAVE TRAPS.

1.4.2 **STANDARDS** :

The 132 KV wave traps covered under this specification shall confirm to the requirements of the following IEC/IS standard : IEC 353/ IS : 8792- 1978/IS 8793-1978/IS 9859-1981.

1.4.3 **TYPE & RATING:-**

Out door type of wave traps shall be of 0.5 mH 630 A rating for 132 KV system. However, it may be made explicitly clear that the wave traps are suitably designed to block any desired frequency in the range of 50 KHz to 500 KHz by providing suitable tuning pot in such a manner that a minimum resistive component of 570 ohms is available. The tuning pot should be such that with the rating of wave trap 0.5 mH 630 A for 132 kV any frequency between 50 to 500 KHz may be blocked.

1.4.4 The wave traps shall have the following specifications:-

S.No.	Particulars	for 132 kV
1	Maximum Operating voltage of the line on which the line traps are to be used.	145 kv
2	Continuous current rating	630 Amps
3	Instantaneous symmetrical short circuit current capacity	31.5 KA (1 sec.)
4	Tuning range	50-500 KHz
5	Change in resonant frequency due to ambient temperature variation not to exceed.	0.01% per degree C
6	Inductance of main coil.	0.5 mH
7	Change in impedance due to ambient temperature variation not to exceed	0.3% Per degree C
8	Minimum resistive components of Impedance matching within carrier frequency blocking range.	570 Ohms

1.4.5 The wave trap shall be broad band type and suitable for blocking the transmitted and received frequencies of the section concerned where transmit and receive frequencies may be wide apart. The wave trap shall consist of a main coil designed to carry continuously the rated current without exceeding the limit of temperature rise. It should be provided with a protective device and a tuning device. The wave traps shall effectively block the high frequency current but allow the 50 cycle current to pass without losses.

1.4.6 The wave traps shall be of robust in construction with the metal parts made of non-magnetic materials to reduce heating due to induced heavy load and short circuit conditions. Sharp corners shall be avoided on the outer surface of wave traps to minimize corona losses. Insulating material used shall be unaffected by moisture. Suitable bird barrier shall be provided. Suitable surge arrestor shall be provided in the wave trap for protection. The clamps should be suitable for horizontal as well as vertical take off. In the past it is observed that due to failure of clamps the wave trap in service become defective and caused the mal-operation in the system. It is therefore essential that design of clamps should be submitted for our approval. Any modification in the design shall have to be carried out without any extra cost.

1.4.7 The design of wave traps should be robust and maintenance free. The performance of wave traps shall not get affected in the long run even if the same are utilized in polluted atmosphere. All terminal bolts and fasteners used shall be of non magnetic stain less steel to avoid any risk of corrosion. The installation should not be very heavy in weight.

The mounting arrangement i.e. suspension eye bolt shall be provided centrally at the top as well as the bottom of the wave traps.

1.4.8 Blocking bands of wave traps should be written at suitable place on the outside of the traps in bold letters by paint, so that after its installation on gantry, the frequency band can be read out from ground. The paint should be such that it will not fade out at a later stage. To ensure high electrical and mechanical strength, it may be noted that we will prefer wave traps of completely encapsulated design, where the equipment is fully encapsuled in epoxy impregnated fiber glass material. Any other design which may offer better performance would also be acceptable.

1.4. 9 **GUARANTEED TECHNICAL PARTICULARS FOR 132 KV WAVE TRAPS**

S. No.	DESCRIPTION	0.5 mH, 630 Amp 132 KV Wave Trap
1	Type & model	----
2	Manufacturers catalog no.	--
3	Construction	Open coil air cored / Epoxy impregnated
4	Continuous current rating (in Amp)	630 A
5	Inductance in mH	0.5 mH
6	Instantaneous symmetrical short circuit current	40 KA (1 sec.)
7	Resonant frequency range	-----
8	Min. guaranteed resistive component over blocking range	570 Ohm
9	Blocking bands (with suitable strapping)	90-150 KHz & 150-500 KHz
10	Change in resonant frequency due to ambient temp. variation	0.01% /Deg Centigrade
11	Change in impedance due to ambient temp. variation	0.3% /Deg Centigrade
12	Ultimate tensile strength	>Twice the weight of LT + 5000 N.
13	Weight (kg)/ Dimension	Dia: ------, Length: ------- mm, Weight. ----- Kg
14	Material of main coil	Aluminium alloy
15	Type of mounting	Suspension
16	Bird barriers	Provided
17	Corona rings	------
18	Details of protection against lightning	By LA
19	Details of other tech. Particular which are considered essential	---
20	All technical particulars of lightning arrestor and tuning pot.	------

1.5 TECHNICAL SPECIFICATION FOR COUPLING DEVICES SUITABLE FOR PLCC EQUIPMENTS

1.5.1 SCOPE :

It comprises the design, assembly, supply, erection, testing and commissioning of Coupling Devices for PLCCequipments.

1.5.2 STANDARDS :

All the Coupling devices for PLCC equipments shall conform to the requirements of the latest edition of relevant IEC/IS standard as mention below:

SL.	Name of Equipment	IEC NO.	IS NO.
1.	Coupling device	481	8997 & 8998

1.5.3 TYPE & RATING:-

The coupling device in conjunction with coupling capacitor / CVT shall form an electronic band pass filter with uniform characteristics and shall have following features:-

a) It shall match characteristic impedance of 132/220 KV EHV line to impedance of the carrier frequency connection (i.e. coaxial cable).

b) It should be possible to change coaxial cable side impedance simply by changing the straps at site. It should be suitable for 125 Ohms unbalanced, 75 Ohms unbalanced or 150 Ohms balanced as per site requirement.

c) It should be possible to tune coupling device by changing strapping at site to use with coupling capacitor of different values.

d) It shall be possible to use it as phase to ground device and phase to phase device with balancing transformer.

e) Power frequency leakage currents of CVT/CC should be drained to the earth by drainage coil of suitable rating.

f) Voltage surges coming from the power line at the terminal of the coupling device shall be limited by a non linear surge arrester of suitable rating in the primary side. The surge arrester of very good quality should be used. The details of surge arrester giving constructional features, design etc shall be furnished.

g) For direct and efficient earthing of its primary terminal the coupling device shall be equipped with an earthing switch. The coupling device shall be designed such that it shall not be possible to remove the cover before the earthing switch is operated to the earthed position. Further an additional earth switch shall be supplied along with each Coupling Device for earthing of CVT-HT terminals, when the coupling filter units are removed from circuit for maintenance / replacement. The design shall take due regard of requirements for safety in accordance with the Indian Electricity Rules.

1.5.4 Two numbers phase to earth type coupling filters shall be used to achieve phase to phase coupling. Connection between secondaries of the two phase to earth type coupling device shall be through a balancing transformer / hybrid such that reliable communication shall be ensured even when one of the coupled phase is earthed or open circuited on the line side.

1.5.5 Coupling device shall conform to latest IS/ IEC-481 and shall have the following carrier frequency characteristics as applicable to a phase to earth type coupling device.

a)	Nominal line side impedance.	Characteristic impedance of 220/132 Kv line.
b)	Nominal equipment side impedance.	125/75 Ohms (unbalanced) or 150 Ohm balance
c)	Composite loss	Not more than 2 dB
d)	Return loss	Not less than 12dB

e)	Band width	Shall suit the frequency plan
f)	Nominal peak envelope power (for inter modulation product 80 dB down)	Not less than 650 watt.

1.5.6 The coupling device should withstand an insulation voltage of 10KV RMS 50c/s for one minute and impulse withstand voltage (1.2/50 m Secs) of 10 KV.

1.5.7 All the elements of coupling device shall be housed in a weather proof non corrosive box. The general arrangement, weight and dimensional details of box shall be furnished.

1.5.8 Coupling device shall have at least two terminals for carrier equipment connection. The design should be such that a parallel connection in the coupling device will not directly result in any additional attenuation.

1.5.9 GUARANTEED TECHNICAL PARTICULARS FOR COUPLING DEVICES:-

S. N	DESCRIPTION	PARTICULARS
1	Type, model and catalogue number	
2	Whether suitable for mounting outdoor in Switchyard & type of mounting.	Yes/ housed in weather proof non corrosive box to be mounted on structure of CC/CVT
3	Maximum temperature limit for satisfactory operation of coupling device mounted outdoor.	55 Deg Centigrade
4	Nominal Primary side Impedance.	600 Ohms (P-P)
5	Nominal secondary side Impedance.	75/125/150 Ohm unbalanced
6	Composite loss with pass band.	Not more than 2 dB
7	Return loss within pass band.	Better than 12 dB
8	Available bandwidth.	30-500 KHz
9	Nominal Peak envelope power at 50 / 100 KHz	650 Watt
10	Power Frequency impedance between primary terminal and earth terminals of coupling device.	Less than 20 Ohm
11	One minute power frequency insulation level between primary & secondary terminals of coupling device.	10KV rms
12	Impulse (1.2/50 micro-sec.) withstand level between primary and secondary terminals of coupling devices.	10KV peak
13	DRAIN AGE COIL:- a) Continuous current b) Short time current for 0.2 Sec. c) Inductance of drain coil with tolerances (at 50 Hz). d) Impedance at mains frequency.	 1 A (rms) 50 A 50mH $\pm$ 5% Less than 12.56 Ohm
14	SURGE APRESTER:- a) Type model & catalogue number b) Power frequency spark over voltage c) Type of construction d) Maximum permissible arrestor discharge current with 8/20 micro sec. Impulse discharge.	 0.8 KV Moulded non linear register type 5KA peak/as per IS 3070 (Part I) 30 KA peak/ as per IS 3070(Part I)

	e) Maximum permissible short time current (2.2 micro sec.) f) Impulse spark over voltage 1.2/50 micro sec. g) Rated voltage.	3300 V peak/ as per IS 3070(Part I) 800 V rms
15	Earthing switch. Rated voltage / current (normal / short circuit)	With stand voltage is 10KV. 400 A rms continuous 16KA, 1 sec

Co-Axial Cables :- GUARANTEED TECHNICAL PARTICULARS

S. No.	Particulars	Values	Units
1	Manufacturer		
2	Type Number		
3	Characteristic Impedance (To Match Carrier Terminal Output Impedance).	125 / 75	Ohm
4	Conductor Resistance at 20 Deg. C.	38.5 Max.	Ohm/KM
5	Insulation Resistance (Conductor to Braid).	10000 Min.	M Ohms/ KM
6	Tolerance of Characteristic Impedance.	+/- 5%	
7	Rated Capacitance.	34 (Nom.)	pF/Mtr.
8	Attenuation in dB per km.		
I	At 50 KHz	1.6 or less	dB/KM
Ii	At 60 KHz	1.6 or less	dB/KM
Iii	At 300 KHz	3.6 or less	dB/KM
Iv	At 500 KHz	5.1 or less	dB/KM
9	Drawing showing construction of cable offered.	Shall be approved by this office.	
10	Centre Conductor Diameter.	0.80 +/- 0.03	m.m.
11	Diameter at P.E. Thread Wrapped over copper conductor.	1.6 (Nom.)	m.m.
12	P.E. Insulation Thickness.	1.75 (Min.)	m.m.
13	Diameter over insulation.	7.6 (Nom.)	m.m.
14	Thickness of copper braided wire.	0.2 (Nom.)	m.m.
15	Thickness of PVC sheath.	1.2 (Nom.)	m.m.
16	Diameter of G.I. Wire.	0.5 (Nom.)	m.m.
17	Thickness of Final PVC sheath.	1.40 (Nom.)	m.m.
18	Overall Diameter of the cable.	17.0	m.m.
19	Service Voltage.	1500	Volts
20	Maximum Test Voltage.	6.0	KV rms

TELEPHONE CABLES: - GUARANTEED TECHNICAL PARTICULARS:

S. No	Particulars	Armoured 10 Pair jelly filled cable	U/A PVC cable		Drop wire/
			6 pair	2 pair	
1	**Conductor:**				
a	Material with specification	Annealed high conductivity Copper as per IEC:228/ IS:12444	Annealed high conductivity Copper as per IEC:228/IS: 12444	Annealed high conductivity Copper as per IEC:228/IS:12444	Cadmium Copper wire conforming to IS:2665
b	Shape of conductor	Solid round	Solid round	Solid round	Solid round
c	Dia of conductor (mm)	0.6 mm	0.6 mm	0.6 mm	0.91 mm
d	Max. conductor resistance in ohm/km at 20 Deg. C	64 Ω/KM	64 Ω/KM	64 Ω/KM	33.32 Ω/KM
e	Wt. of conductor in Kg/ Km	2.52Kg/KM	2.52Kg/KM	2.52Kg/KM	5.97Kg/KM
2	**Insulation**				
a	Material with specification.	High density polyethylene material conforming to IS:13176:1991	High density polyethylene material conforming to IS:13176:1991	High density polyethylene material conforming to IS:13176:1991	Medium density PE or PVC confirming to TEC:G/ WIR-03/01 Feb'93 & TEC:G/WIR-03/02 July'99
b	Radial thickness of insulation on conductor (mm).	0.35 mm	0.2 mm	0.2 mm	0.85 mm
c	Tolerance on insulation.	$\pm$ 0.02 mm	+ 0.05 & - 0.02 mm	+ 0.05 & - 0.02 mm	
d	Max. dia of insulated conductor (mm)	1. 34 mm	1.1 mm	1.1 mm	2.79 mm
e	Colour coding.	As per TEC Requirement	As per TEC Requirement	As per TEC Requirement	Black
3	**Cabling**				
a	Twisting & laying scheme	As per TEC requirement GR/CUG/01/03 Aug.03	GR/WIR-06/03 March 2002	GR/WIR-06/03 March 2002	N.A.
b	Material of tape used for wrapping.	polythene teraphthalate tape	polythene teraphthalate tape	polythene teraphthalate tape	N.A.
c	Thickness of tape	0.013 mm Min.	0.013 mm Min.	0.013 mm Min.	N.A.
d	Overlap (Min.)	30%	30%	30%	N.A.
4	**Rip Cord**	N.A.	To be Provided	To be Provided	N.A.
5	**Aluminum tape thickness**	0.3 mm	N.A.	N.A.	N.A.
a	Wraping technique (helical/longitudinal)	Longitudinal	N.A.	N.A.	N.A.
b	Overlap min.	6 mm	N.A.	N.A.	N.A.
6	**Sheaths**				
a	Material with	MDPE as per TEC	PVC type -2	PVC type -2	N.A.

	specification.	requirement GR/CUG/01/03 Aug.03	conforming to IS:13176:1991	conforming to IS:13176:1991	
b	Thickness (mm) (min.)	1.5mm	0.65mm	0.5 mm	N.A.
c	**Bedding**	Two close helical lappings of PE or PP Tape with min. 5% overlap shall be provided under Armour			
7	**DST thickness**	Two applications of G.S. Tape of 0.5mm thickness conforming to IS 3975 each applied helically in the same direction with a gap in the first tape of 25 ± 10% of width of the tape and the second tape evenly covering the gap of first tape with an overlap of min. 15%	N.A.	N.A.	N.A.
a	Wraping technique (helical/longitudinal)	Helical	N.A.	N.A.	N.A.
b	Overlap min.	15%	N.A.	N.A.	N.A.
8	**Outer Jacket**				
a	Material with specn.	Low density polyethylene as per TEC requirement GR/CUG/01/03 Aug.03	N.A.	N.A.	N.A.
b	Thickness (mm) (min.)	1.05mm	N.A.	N.A.	N.A.
9	**Electrical Tests**				
a	Insulation resistance between conductor & earth in air at 50 Deg.C	5000 MΩ /Km (Min.)	50 MΩ/Km (Min.)	50 MΩ /Km (Min.)	80 MΩ /Km (Min.)
b	Insulation resistance between conductor & earth in water.	N.A.	5 MΩ/Km	5 MΩ/Km	8 MΩ/Km
c	High Voltage test	3.5 KVDC	2 KV rms	2 KV rms	3 KV DC
d	Spark test	3 KV rms	3 KV rms	3 KV rms	3 KV rms
e	Capacitance	200 pF/Km (Max.)	230 pF/Km	230 pF/Km (Max.)	N.A.

	unbalance between pair to pair.		(Max.)		
f	Capacitance unbalance between pair to ground.	3000 pF/Km (Max.)	N.A.	N.A.	N.A.

***

25. GUARANTEED TECHNICAL PARTICULARS OF UN-ARMOURED COPPER CONTROL CABLES

1	Name of manufacturer						
2	Standard applicable	IS:1554 (Part-I) – 1988 with latest amendments					
3	Rated Voltage	1100 volts					
4	Suitable for earthed or unearthed system	Both					
5	Permissible voltage & frequency variation for satisfactory operation.						
	a. Voltage	±10% than rated voltage at power frequency					
	b. Frequency	50 Hz					
6	Continuous current rating when laid in air in an ambient temp. 50 ºC and for maximum conductor temp. 70 ºC .	Un-armoured number of core	2	4	8	12	19
		Amp.	27	24	17	14	12
7	Rating factor for variation in ambient air temp.(for cables laid direct in Air)						
	Air temp. in deg C	25	30	35	40	45	
	Rating factor	1.25	1.16	1.09	1	0.9	
8	Rating factor for variation in ground temp.(for cables laid direct in ground)						
	Ground temp. in deg C	15	20	25	30	35	40	45
	Rating factor (As per IS:3961: part-II)	1.17	1.12	1.06	1	0.94	0.87	0.79
9	Depth of laying for cables laid directly in this round.	750 mm rating factor 1.00					
10	Rating factor for variation in thermal resistivity of the soil (As per IS:3961-II-1967, Table-8)	Soil thermal resistivity in °C (cm/w) 100 120 150 200 250 300 1.10 1.05 1.00 0.92 0.86 0.81					
11	Current carrying capacity:						
	(a) Short circuit Amp. (RMS)	0.288 KAmps					
	(b) Duration of short circuit	1 sec					
	(c) Conductor temperature allowed for short circuit duty (70 Deg, Centigrade)	160 ^{o}C					
12	Loss tangent at normal frequency	Please furnish					
13	Dielectric constant at normal frequency	Please furnish					
14	Conductor:						
	a. Material	Annealed Copper Class-II					
	b. Normal cross sectional area	2.5 sq.mm / 4 Sq.mm					
	c. Number and diameter of wires	Please furnish					
	d. Received from (Supplier's name)						
15	Insulation:						
	a. Composition of insulation	Type-A:PVC (General purpose) IS:5831-1984					
	b. Thickness of insulation	0.9 mm for 2.5 sqmm, 1.0 mm for 4 sqmm					
	c. Tolerance on thickness of insulation	0.1mm + 0.1 t1 (nominal thickness)					
	d. Approximate diameter of sheath	As per IS					
	e. Specific insulation resistance at 60°C	Please furnish					
	f. Received from (Supplier's name)	Please furnish with drawing					

16	Colour scheme for identification	As per IS
17	Inner sheath	
	a. Material	Unvulcanised Rubber/Thermoplastic material/proofed tape
	b. Extruded or wrapped	wrapped/extruded PVC
	c. Thickness of inner sheath	As per table 4 of IS: 1554 Part-I
	d. Tolerance of thickness of inner sheath	No tolerance
	e. Received from (Supplier's name)	
18	Outer sheath:	
	a. Material	Type ST 1 PVC compound as per IS: 5831-1984.
	b. Calculated diameter over the inner sheath	
	c. Thickness of the outer sheath	As per table 7 column 3 of IS: 1554 Part-I
	d. Tolerance of thickness of outer sheath	As per table 7 column 4 of IS: 1554 Part-I
	Received from (Supplier's name)	Please furnish with drawing
19	Overall diameter of cable over the outer sheath	12 14 16.3 19.5 20.9 24.2
20	Net weight of cable (Kg./Km.)	220 275 485 540 660 950
21	Conductor resistance at 20 º C per Km.	7.41 Ohm/Km. max. for 2.5 sq.mm. 4.61 Ohm/Km. max. for 4 sq.mm
22	Reactance at 50 Hz per Km.	0.107 for 2.5 Sq mm
23	Capacitance at 50 Hz per Km.	1.19 Mfds/Km
24	Insulation resistance at in M ohm Km.	
	i) at 27 deg	$1x10^{13}$
	ii) at maximum operating temperature	$1x10^{10}$
25	volume resistivity in ohm-Cm	
	i) at 27 deg	$1x10^{13}$
	ii) at maximum operating temperature	$1x10^{10}$
26	Conductor temperature corresponding to maximum continuous current	$70^{o}C$
27	Test Voltage	
	a. High voltage test	AC 3 KV (rms) or DC 7.2 KV for five minutes at room temp.
	b. After immersion test voltage	3 KV (rms) raised to 6 KV (rms) within10 sec. For 5 minutes at temp. 60+3oC & 1.2 KV D.C. for 240 hours.
28	Recommended minimum installation radius	15XD
29	Safe pulling force when pulled by pulling eye	50 N/mm^2
30	Cable drum	2C 4C 8C 10C 12 C 19C
	a. The dimension of the cable drum	42x20x12 38x20x10 52x24x14 42x20x12 38x20x10 52x24x14
	b. The approximate weight of the drum	60 40 75 60 40 75
	c. Maximum length per drum for each size of cable	500 M ±5% for each drum. Tolerance for total ordered quantity is ±2%.

SPECIFICATION FOR LT POWER ALUMINIUM XLPE ARMOURED POWER CABLES

1. 3.5 CORE ALUMINIUM XLPE ARMOURED POWER CABLES

No. of cores & cross sectional area	Min.no Of Wires	Thickness of insulation min Nom	Min.Thickness of inner sheath (mm)	Nominal Dimensions of armour Wire(mm)	Min.Thickness of Outer sheathe Wire Armour (mm)	Overall Diameter (Approx.) Wire Armour	(Approx. Net Wt. of Cable Wire Armour (kg/km)	Max.D.C.Resistance at 20 degree C	Max.A.C.Resistance at 70 degree C	Approx reactance at 50 Hz ohms/km	APPROX. Capacitance Mfd/ Km	CURRENT RATINGS	
												Direct in Ground	In Air
												A	A
3.5 C x 120	15/ 12	1.2/ 1.1	0.4	4*0.8	1.72	40.2	2863	0.253	0.33	0.07	0.29	223	257
3.5 C x 240	30/ 15	1.7/ 1.2	0.6	4*0.8	2.2	55.4	5298	0.125	0.16	0.07	0.31	326	399

2. 1 CORE ALUMINIUM XLPE ARMOURED POWER CABLES

No. of cores & cross sectional area	Min. No. of Wires	ARMOURED					Max.D.C.Resistance at 20 Ohms/Km	Max.A.C.Resistance at 70 Ohms/ Km	ARMOURED		CURRENT RATINGS	
		Thickness of PVC Insulation (Nom.) (mm)	Nominal Dimensions of Armour Wire (mm)	Min.Thickness of PVC Outer sheath (mm)	Overall Diameter (Approx.) Wire Armour	Approx. Net Wt. of Cable (kg/km)			Approx. Reactance at 50Hz Ohms/Km	Approx. Capaci-tance mFd/ Km	Direct in Ground	In Air
1C x 240	30	2	1.6	1.4	28.9	1179	0.13	0.162	0.09	0.72	332	433
1C x 300	30	2.1	1.6	1.56	31.5	1421	0.1	0.13	0.09	0.75	376	501

3. 4 CORE ALUMINIUM XLPE ARMOURED POWER CABLES

No. of cores & cross sectional area	Min. of Wires	Thickness of insulation (min.)	Min.Thickness of innersheath (mm)	Nominal Dimensions of Armour Wire (mm)	Min.Thickness of Outer sheathe Wire Armour (mm)	Overall Diameter (Approx.) Wire Armour (mm)	(Approx. Net Wt. of Cable Wire Armour (kg/km)	Max.DC. Resistance at 20 C Ohms/Km	Max.AC. Resistance at 90 C Ohms/Km	CURRENT RATINGS	
										Direct in Ground Amps	In Air Amps
4 C x 16	6	0.7	0.3	1.6	1.4	22.8	862	1.91	2.45	73	70

GUARANTEED TECHNICAL PARTICULARS OF ARMOURED COPPER CONTROL CABLES

1	Name of manufacturer						
2	Standard applicable	IS:7098 (Part-I) – 1988 with latest amendments					
3	Rated Voltage	1100 volts					
4	Suitable for earthed or unearthed system	Both					
5	Permissible voltage & frequency variation for satisfactory operation.						
	a. Voltage	±10% than rated voltage at power frequency					
	b. Frequency	50 Hz					
6	Continuous current rating when laid in air in an ambient temp. 30 ºC.	armoured number of core (4cx10 sqmm copper cable)					04
		Amp.					74
7	Rating factor for variation in ambient air temp.(for cables laid direct in Air)						
	Air temp. in deg C	25	30	35	40	45	
	Rating factor	1.25	1.16	1.09	1	0.9	
8	Rating factor for variation in ground temp.(for cables laid direct in ground)						
	Ground temp. in deg C	15	20	25	30	35	40	45
	Rating factor (As per IS:3961: part-II)	1.17	1.12	1.06	1	0.94	0.87	0.79
9	Depth of laying for cables laid directly in this round.	750 mm rating factor 1.00					
10	Rating factor for variation in thermal resistivity of the soil (As per IS:3961-II-1967, Table-8)	Soil thermal resistivity in °C (cm/w) 100 120 150 200 250 300 1.10 1.05 1.00 0.92 0.86 0.81					
11	Current carrying capacity:						
	(a) Short circuit Amp. (RMS)	1.43 KAmps					
	(b) Duration of short circuit	1 sec					
	(c) Conductor temperature allowed for short circuit duty (70 Deg, Centigrade)	160 ºC					
12	Loss tangent at normal frequency	Please furnish					
13	Dielectric constant at normal frequency	Please furnish					
14	Conductor:						
	a. Material	Annealed Copper Class-II					
	b. Normal cross sectional area	10 sq.mm					
	c. Number and diameter of wires	Please furnish					
	d. Received from (Supplier's name)						
15	Insulation:						
	a. Composition of insulation	Type-A:PVC (General purpose) IS:5831-1984					
	b. Thickness of insulation	1.0 mm for 10 sqmm					
	c. Tolerance on thickness of insulation	0.1mm + 0.1 t1 (nominal thickness)					
	d. Approximate diameter of sheath	As per IS					
	e. Specific insulation resistance at 60°C	Please furnish					
	f. Received from (Supplier's name)	Please furnish with drawing					
16	Colour scheme for identification	As per IS					
17	Inner sheath						

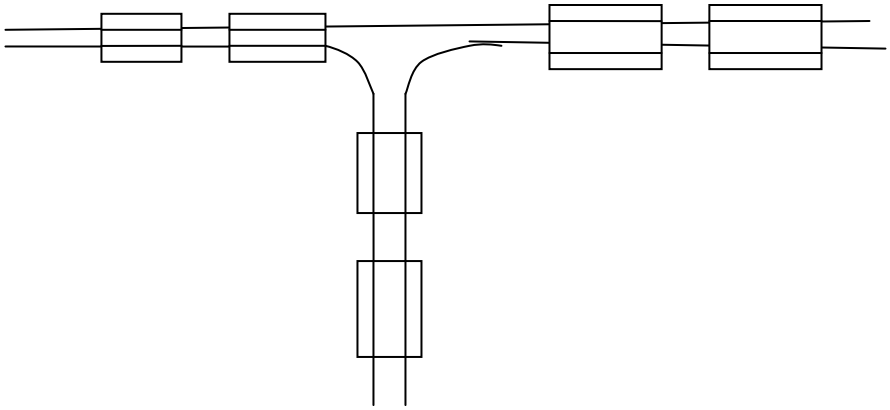
	a. Material	Unvulcanised Rubber/Thermoplastic material/proofed tape
	b. Extruded or wrapped	wrapped/extruded PVC
	c. Thickness of inner sheath	As per table 4 of IS: 1554 Part-I
	d. Tolerance of thickness of inner sheath	No tolerance
	e. Received from (Supplier's name)	
18	Outer sheath:	
	a. Material	Type ST 1 PVC compound as per IS: 5831-1984.
	b. Calculated diameter over the inner sheath	
	c. Thickness of the outer sheath	As per table 7 column 3 of IS: 1554 Part-I
	d. Tolerance of thickness of outer sheath	As per table 7 column 4 of IS: 1554 Part-I
	Received from (Supplier's name)	Please furnish with drawing
19	Overall diameter of cable over the outer sheath	21.4mm+/- 2 mm
20	Net weight of cable (Kg./Km.)	950
21	Conductor resistance at 20 º C per Km.	7.41 Ohm/Km. max. for 2.5 sq.mm. 4.61 Ohm/Km. max. for 4 sq.mm
22	Reactance at 50 Hz per Km.	0.0837 Ohms per KM
23	Capacitance at 50 Hz per Km.	0.31 Mfds/Km
24	Insulation resistance at in M ohm Km.	
	i) at 27 deg	$1x10^{13}$
	ii) at maximum operating temperature	$1x10^{10}$
25	volume resistivity in ohm-Cm	
	i) at 27 deg	$1x10^{13}$
	ii) at maximum operating temperature	$1x10^{10}$
26	Conductor temperature corresponding to maximum continuous current	$70^{o}C$
27	Test Voltage	
	a. High voltage test	AC 3 KV (rms) or DC 7.2 KV for five minutes at room temp.
	b. After immersion test voltage	3 KV (rms) raised to 6 KV (rms) within 10 sec. For 5 minutes at temp. 60+3oC & 1.2 KV D.C. for 240 hours.
28	Recommended minimum installation radius	15XD
29	Safe pulling force when pulled by pulling eye	50 N/mm^2
30	Cable drum	4C
	a. Maximum length per drum for each size of cable	500 M ±5% for each drum. Tolerance for total ordered quantity is ±2%.
31	Armour (a) Material	Galvanised steel round wire/ flat strip as per IS:3975
	(b) Nominal diameter of wire armour & thickness of flat strip (mm)	1.4
	(c) Type	Wire
32	Sequential length marking	Shall be provided on outer sheet of every one meter.

***

26. TECHNICAL SPECIFICATIONS OF CLAMPS, CONNECTORS AND HARDWARES:

1.1 CLAMPS&CONNECTORS:-The drawing & Samples of Clamps, Connectors & Spacers shall be approved by CSPTCL before use in the substation. In the switchyard only ZEBRA conductor has been provided. It should be noted that the requirement is for a minimum of 100 m.m. coverage of the conductor inside the clamp for all clamps. The pad clamp shall have SIX bolts and T clamp shall have 12 bolts. For all types of clamps, the drawings shall be approved by the CSPTCL.

However at high altitude locations eg main 3 phase droppers on HV and LV side of transformer as also for 132 KV line take off either the T clamp should be completely avoided by using long through jumper or wherever essential (at high attitude point) T clamp shall be replaced by a set of PG clamp as shown below point.



The nuts & bolts used in the clamps shall be fine machined screws of reputed make, so that the screws do not become loose during service. Nuts & bolts should be hot dipped galvanized.

For power transformer 40 MVA bushing clamps where an aluminium conductor has to be connected to a copper stud-two separate clamps, one of Copper & other of Aluminium shall be provided with bi-metallic strip joint on the plain pad surfaces of both clamps.

A factor of safety of 1.5 shall be used i.e. clamp for 400 Ampere conductor shall have thickness and area for current at least 600 Amperes.

1.1.1 Clamp Materials:-

The clamps and the connectors shall be made of materials listed below:-

a) For connection ACSR conductors Aluminium alloy casting conforming to designation LM-6 of IS-617. Sand casting is not permitted.

b) For connecting equipment terminals made of Copper or Brass & ACSR conductor, Bi-metallic connectors made from Aluminium Alloy casting conforming to designation A6 of IS 617 with 2 mm thick cast copper liner (1 mm Cu and 1 mm Al) shall be used (for C.T. & P.T. clamps). Clamps for connecting GI shield shall be of malleable Iron casting. Nuts & bolts should be hot dipped galvanized.

1.1.2 TERMINAL CONNECTORS :

The terminal connectors shall meet the following requirements:

i) Terminal connectors shall be manufactured and tested as per IS: 5561.

ii) Terminal connector shall be tested for short circuit current capability test, temperature rise test, corona test etc. The terminal connectors should be manufactured by gravity die-casting process only.Bushing terminals shall be provided with terminal connectors of approved type and size for connection to external parts. Terminal connectors must have been successfully type tested strictly as per IS: 5561. The drawing of terminal connector offered shall have to be got approved by CSPTCL

iii) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off. Compression type of clamps should be supplied.

iv) No part of a clamp shall be less than 12 mm thick.

v) Minimum conductor coverage on the clamp shall be 100mm. Minimum bushing terminal coverage in the clamp shall be 100mm and minimum pad overlap in the clamp shall be 100*100 mm

vi) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.

vii) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm(1 mm Cu and 1 mm Al) shall be integral with aluminium body.

viii) Flexible connectors shall be made from tinned copper/ aluminium sheets.

ix) All current carrying parts shall be designed and manufactured to have minimum contact resistance. The connectors shall be designed for minimum 120% of the maximum current carrying capacity of the ACSR conductor and the temperature rise under these conditions shall not be more than 50% of that of the main conductor.

x) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561

xi) All connections with ACSR conductors shall be bolted type.

1.1.3 TESTS:

Type Tests :

It is essential to furnish following type test reports in respect of Clamps as stipulated in latest version of IS: 5561:

i. Tensile Test
ii. Resistance Test
iii. Temperature rise Test
iv. Short time current Test
v. Dimensional Check
vi. Galvanizing Test, if applicable

Acceptance and Routine Tests :

For Clamps & Connectors following Acceptance & Routine tests shall be conducted:

(A) Acceptance test :

i. Visual check
ii. Tensile Test
iii. Resistance Test
iv. Dimensional Check
v. Galvanizing Test, if applicable

(B) Routine Test :

i. Visual inspection
ii. Dimensional Check.

1.2 SUBSTATION TYPE HARDWARE:-

1.2.1 REQUIRED GUARANTEED STRENGTH OF HARDWARE OF INSULATOR STRINGS:-

The Hardwares and Clamps of 132kV single suspension and double suspension strings suitable for Zebra ACSR and all types of suspension and tension strings suitable for sub-station shall have the ultimate breaking strength of not less than 7,000 kgs. The slipping strength of the suspension clamp shall not be less than 15% and more than 20% of the Conductor strength with which it is to be used. Each individual Hardware component of double suspension and double tension strings such as ball-clevis, socket clevis etc. shall have minimum breaking strength as specified for respective single suspension and tension string respectively.

1.2.2 PARTICULARS OF HARDWARE FITTINGS:

Each substation Hardware fitting shall be complete in all respect and the contractor shall furnish complete drawings and technical particulars of the Hardware fittings comprising items as under:-

i) Single Suspension Hardware Fittings For Zebra/Twin-Zebra for Sub Station:-

The 132KV sub-stations Hardware fittings shall comprise of one Ball Hook, one Socket Clevis Eye Horn holder, one Arcing Horn and one Suspension Clamp suitable for ACSR Zebra Conductor. The Socket Eye and Ball Clevis shall be made of forged steel.

ii) Single Tension Hardware For Twin ACSR Zebra for substation:-

Single Tension Hardware shall comprise of U Clevis, one Ball Link, Socket Clevis, Yoke Plate, two Clevis Eyes and two Tension Clamps of bolted type suitable for ACSR Zebra. U Clevis shall be made of forged steel complete with galvanised steel rivets washer and Phosphorus Bronze/Stainless Steel pins. The Ball fittings shall be made of forged steel in one piece.

iii) Single Tension Hardware for Zebra/Twin Zebra for substation:

The Single Tension Hardware shall comprise of one Anchor Shackle, one Ball link, Socket Clevis and one Tension Clamps of bolted type suitable for respective sizes of Conductor.

iv) Ground wire Assemblies:

The Ground wire tension assembly shall have minimum breaking strength equal to that of the Ground Wire. The slipping strength of the Compression Clamp shall not be less than 95% of the breaking strength of Ground Wire. The Ground wire tension assembly for Substation shall comprise of one bolted type Clamp and one `D' Shackle complete with minor accessories such as bolts, nuts pins etc. The assembly shall be hot dip galvanized and made inherently resistant to the atmosphere corrosion.

v) Ball and Socket Dimensions:

The Ball and Socket for Hardware fittings shall necessarily conform to the dimensions as stipulated in the Indian Standards. The Ball and Socket dimensions of the Hardware sets to be used with 7000 kg and 9100 kg Electro Mechanical strength Disc Insulators shall conform to designation 16mm/16mm-B in accordance with IS:2486(Part-II) or equivalent International Standard.

The minimum breaking and slipping strength of single tension Hardware fitting shall not be less than 7000 kgs. One set of additional nuts (as check nuts) should be provided alongwith the bolts and nuts to fix the tension clamp with the conductor so as to avoid the possibility of relative/looseness due to vibration of strings.

1.2.3 Dimensions & Tolerances:

The dimensions and tolerances of pin balls and socket ends shall conform to IS 2486 Part-II/IEC-120 and shall be checked by the gauge therein after galvanizing.

The bearing surfaces of balls and machined sockets, before galvanizing shall not have surface roughness more than 250 micro inches.

The bearing surface of socket ends shall be uniform about the entire circumference without depressions or high spots. The internal contour of the socket ends shall be concentric with the axis of fittings. The axis of the bearing surface of socket ends shall be coaxial with the axis of fittings with no appreciable tilting.

(i) Socket Fittings:

Socket fittings shall be made of clause IV steel as per IS:2004 or steel of equivalent grade and shall be forged in one piece. They shall be normalized to achieve the minimum breaking strength specified on the respective drawings.

(ii) Security clip for Socket fittings:

Socket fittings shall be provided with R-shaped security clip in accordance with IS:2486 (Part-III) to provide positive locking against unintentional disengagement of socket from the ball of the insulator. The security clip shall be humped to maintain the clip in the locked position and shall have both prongs spread to prevent complete withdrawal from the socket. The clip end shall not project outside the recess of socket when the clip is in locked position.

The hole for the security clip shall be on the side of the socket opposite to the socket opening. The hole for the clip shall be counter sunk. The force required to pull the clip to its unlocked position shall not be less than 50 N or more than 500N. The security clip shall be made of stainless steel of type AISI 302 or 304 or phosphor bronze as per IS:7814.

(iii) Clevis-Eye:

These shall be forged steel of malleable cast iron and shall be complete with galvanised pin with flat washer and split pin of Phosphorus Bronze/Stainless Steel.

(iv) Yoke Plate:

The yoke plates/link plate shall be made of mild steel plate as per IS:226 or equivalent standards. Shearing/cutting of the plates shall be clean without drawn or ragged edges. If the plates are flame cut, mechanical guides shall be used.

Holes shall be cylindrical clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs and all the corners and edges should be rounded off with a radius of at least 3mm.

(v) Sag Adjustment Device

The sag adjustment devices to be provided with double tension hardware fittings shall be of three plate type. The sag adjustment device shall be provided with a safety locking arrangement. Sag adjuster plates shall be made from high qualify mild steel plate as per IS:226. The grain flow shall not be in a direction transverse to the tensile load. Cutting/shearing and drilling of holes shall be similar to those for yoke plate.

The maximum length of the sag adjustment plate from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible and the steps of adjustment shall be clearly indicated in the drawing. An adjustment of 150mm maximum at the interval of 6mm shall be possible with the sag adjustment plate.

1.2.4 IMPORTANT CONDITIONS:

a) All Hardware items shall be complete with minor items such as security clip, bolts, nuts,washer, split pins and inners etc.

b) All ferrous fittings shall be hot dip galvanized, after all machining and fitting has been completed, in accordance with relevant Indian Standard. All Hardware items (other than clamps) and those specified otherwise should be made of Drop Forged Steel. Socket items in forged steel must be forged. The items like Yoke Plate, Arcing Horn, Bolts and Nuts shall be of mild steel and rest of the items shall be of forged steel.

c) All Bolts, Nuts and Screw heads shall have only wide worth standard thread .Bolts head and Nuts shall be hexagonal. The thread in Nuts shall be over tapped after galvanizing and shall be cut before galvanizing. The threads shall not be under cut. The Nuts should be tapped such that they are fit on the bolt threads i.e. these should not have loose fitting.

1.2.5 LENGTH OF STRINGS:

The clearance to the tower steel parts under service conditions of Insulator have been decided on the basis that the overall length of 9 Disc for 132kV line (7000 kgs EMS for single suspension string) will not exceed the length as indicated in the attached drawings. The dimension of the Disc for Ball and Socket type will be 255mm x145mm for 7000 kgs EMS to be used with suspension strings.

1.2.6 GALVANISING:

Hot dip galvanizing shall conform to Indian Standard specification IS-2633 or equivalent International Standard. Galvanising shall be uniform, free from blisters, and shall not peel off due to abrasion, Zinc coating shall be thick enough to withstand 6 one minute dips in Copper Sulphate solution (precee test) for all ferrous parts except for threaded portions which shall withstand atleast 4 one minute dips.

1.2.7 TESTS

The following Type Tests, Stage Tests, Routine Tests and Acceptance Test shall be carried out on power Conductor & Ground wire Hardware fittings.

i) Type Tests

The material offered shall be fully Type Tested as per relevant specification and the contractor shall furnish a set of Type Test reports along with the drawings. These tests must not have been conducted earlier than five years.

ii) Stage Tests:

Stage Tests during manufacturing shall mean those test required to be carried out during the process of manufacturing to ensure quality control such that last product is of the designed quality conforming to the intent of this specification.

iii) Routine Tests:

Routine Tests are those tests, which required to be carried out on each and every finished product so as to check with requirements that are likely to vary during production.

iv) Acceptance Tests:

Acceptance Tests shall mean those tests, which required to be carried out on samples taken from each lot offered for pre-despatch inspection for purposes of acceptance of that lot.

1.2.8 DRAWING AND LITERATURE:

The detailed drawings of each component assembly drawings and descriptive literature of the Hardware assembly shall be submitted. The detailed dimension drawings for each and all-individual Hardware items such as clamps, U Clevis, Socket Eye, Yoke Plate and Socket Clevis etc. shall also be submitted. Test certificates for different tests conducted as per relevant ISS, for all the offered items must also be submitted essentially.

1.2.9 MATERIALS AND WORKMANSHIP:

All the materials shall be of the latest design and conform to the best modern practice adopted in the extra high voltage field.

The design, manufacturing process and quality control of all the materials shall be such as to give maximum factor of safety, maximum possible working load, highest mobility, elimination of sharp edges and corners, best resistance to corrosion and a good finish.

All ferrous parts shall be hot dip galvanised, after all machining has been completed.

Fasteners shall withstand four dips while spring washers shall be guaranteed to withstand at least six dips each lasting one minute under the standard precee test for galvanising. The Zinc coating shall be perfectly adhere, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky while deposits and blisters. The Zinc used for galvanising shall be grade Zn. 99.95 as per IS: 209-1966 or equivalent International Standard. In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blowholes, cracks etc. All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum. No item which would produce high electrical and mechanical stresses in normal working shall have sharp ends or edges, abrasions or projections and shall not cause any damage to the Conductor in any way during erection or during continuous operation. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and no maintain good electrical contact under service conditions. Particular care shall be taken during manufacturing and subsequent handling to ensure smooth surface free from abrasion or dents. The fasteners shall conform to the requirement of IS: 6639-1972 or equivalent International Standard. All fasteners and clamps shall have locking arrangements to guard against vibration loosening.

1.2.10 INSPECTION:

CSPTCL or its representatives shall at all times be entitled to have access to the works and to all places of manufacturing and the successful Contractor/Supplier shall afford all facilities to them for unrestricted inspection of the works, inspection of material, inspection of manufacturing process and for conducting necessary tests as specified herein.

The acceptance of any quantity of material shall in no way relieve the successful Contractor of his responsibility for meeting all the requirement of this specification and shall not prevent subsequent rejection, if such materials are later found to be defective.

1.2.11 DOCUMENTATION & LIST OF DRAWINGS FOR CLAMPS, CONNECTORS, SPACERS AND HARDWARES:

The contractor shall furnish full description, illustrated catalogues and dimensional drawings. The drawing shall include the following information:-

(i) General outline & assembly drawings of all the items /material covered in the specification.
(ii) Dimensions, unit spacings
(iii) Unit mechanical and electrical characteristics as also for the complete assembly/set.
(iv) Weight of each component.
(v) Identification mark.
(vi) Material designation used for different components with reference to Standards.
(vii) Fabrication details such as welds, finishes and coatings
(viii) Manufacturer's catalogue number.
(ix) Brief installation instructions.
(x) Reference of type testing.
(xi) Relevant technical details of significance

Each Clamps & Connectors / Spacers and hardwares shall be marked with the trade mark of the manufacturer and year of manufacturing. Marks shall be forged or stamped with a steel die before galvanizing. The mark shall be distinct, durable and conspicuous

***

27. TECHNICAL SPECIFICATIONS OF 500 KVA, 33/0.415 KV STATION TRANSFORMER:

1.0 **INTENT**

This specification is intended to cover outdoor type oil filled 33/0.415KV, 500KVA Transformers.**The insulation levels of HV windings, HV bushings and clearances shall be suitable for 72.5 KV class**.

2.0 **Scope of Work**

2.1 **Scope of Supply**

Transformers as listed above, with insulating oil, all materials and accessories, and complete in all respects.Gland plates, power cable, lugs, anchor bolts and hardware.Mandatory & optional spares and special maintenance equipments if any.

Scope of Service

The scope includes but is not limited to the following items of work to be performed for all equipment and materials furnished under this section:

a) Design, manufacturing, shop testing, packing & despatch
b) Transportation inclusive of insurance and delivery, FOR site basis
c) Unloading, handling, storing, transportation at site upto foundations, oil filling and treatment, erection, testing and commissioning
d) Civil Works
e) Supply of external cables and termination as required.
f) Fire protection system.

3.0 **General Information**

3.1 All temperature indicators, Buchholz relays and other auxiliary devices shall be suitable for 220 V DC Control supply. All alarm and trip Contacts shall also be suitable for connection in 220V DC Circuits.

3.2 Bidders may specifically note that Purchaser proposes to insist on short circuit test as per Clause 16.11 of IS:2026 (Part-I)-1977 and dielectric test as per IS-2026. Any deviation in this regard shall be sufficient ground for rejection of the bid.

4.0 **TECHNICAL REQUIREMENTS**

4.1 **Core**

The core shall be constructed from high grade, nonaging, cold rolled grain-oriented silicon steel laminations. The maximum flux density in any part of the cores and yoke at normal voltage and frequency shall be such that the flux density at any tap position with 10% voltage variation from the voltage corresponding to the tap shall not exceed 1.9 Wb/sq-m.

4.2 **Windings**

The conductor shall be of electrolytic copper, free from Scalesand burrs.

4.3 **Insulating Oil**

The oil supplied with transformer shall be unused and have the parameters for unused new oil conforming to IS:335 while tested at oil Contractor's premises, No inhibitors shall be used in oil. Ten percent extra oil shall be supplied for topping up after commissioning in nonreturnable containers suitable for outdoor storage.

4.4 **Terminal Arrangement**

a) Bushing terminals shall be provided with suitable terminal connectors of approved type and size for cable/overhead conductors termination of HV side and cable termination on LV side.
b) The neutral terminals of 415V winding shall be brought out on a bushing along with the 415 volt phase terminals to form a 4 wire system for the 415 volt. Additional neutral bushing shall also be provided for earthing.

4.5 **Off Circuit Tap Changing Equipment**

The tap change switch shall be three phase, hand operated for simultaneous switching of similar taps on the three phases by operating an external hand wheel.

4.6 **Marshalling Box**

A metal enclosed, weather, vermin & dust proof marshalling box shall be provided with each transformer to accommodate temperature indicators, terminal blocks etc. It shall have a degree of protection of IP 55 as per IS: 2147.Station transformer Marshalling Box with 2 inlets (one main & one spare) of 800A having MCCB/ACB protection and back up fuses. The Station transformer Marshalling Box shall be provided with 03 Nos 300 Amps outlets with MCCB and back up fuses. Necessary Transducers shall be provided for transmission of voltage, current & other signals to SAS.

4.7**Cable boxes**

Whenever cable connections are required, suitable cable boxes shall be provided and shall be air insulated. They shall be of sufficient size to accommodate Purchaser's cables and shall have suitable removable side/top cover to facilitate cable termination and inspection. Cable boxes shall be dust & vermin proof.

5.0 **Inspection and Testing**

a) The Contractor shall draw up and carry out a comprehensive inspection and testing program during manufacture and commissioning of the transformer. The programme shall be duly approved by the Purchaser.

b) The Contractor shall carryout all type tests and routine tests on the transformers as per relevant standards. Type tests shall be carried out on one transformer of each type and routine tests shall be carried out on all transformers.

6.0 **Inspection**

6.1 **Tank and Accessories**

a) Physical and dimensional check of transformer tank and accessories.

b) Crack detection of major strength weld seams by dye penetration test.

6.2 **Core**

a) Physical inspection and check of quality of varnish, if used.

b) Sample testing of core material for checking specific loss, bend properties, magnestisation, characteristics and thickness.

c) Check on completed core for measurement of iron loss and check for any hot spot by exciting the core so as to induce the designed value of flux density in the core.

d) HV Test

6.3 **Insulating Material**

a) Sample checks for physical properties of the material

b) Check for dielectric strength

c) Check for the reaction of hot oil on insulating material

6.4 **Winding**

a) Sample check on winding conductor for mechanical properties and electrical conductivity and on installation covering.

b) Sample check on insulation paper for pH value, Bursting strength, Electric strength.

6.5 **Assembled Transformer**

a) Check complete transformer against approved outline drawing provision for all fittings, finish etc.

b) Jacking test on all the assembled transformers.

6.6 Oil

All standard tests in accordance with relevant Standards shall be carried out on oil samples taken from the transformer before and after testing of the transformer.

The contractor shall also prepare a comprehensive inspection and testing programme for all bought out sub-contracted items and shall submit the same to the Purchaser for approval. Such programme shall include the following components:

a) Buchholz Relay

b) Winding temperature Indicator

c) Bushings

d) Marshalling Box
e) Tap changer switch
f) Oil temperature indicator

7.0 **Factory Test**

7.1 All standard routine tests in accordance with latest issue of IS : 2026 shall be carried out oneach transformer.

7.2 All the type tests in accordance with latest issues of IS : 2026 shall be conducted ononetransformer of each rating.

7.3 In addition to all type and routine tests, following additional type tests shall also be carriedout on one transformer of each rating as per IS : 2026.

a) Measurement of zero sequence impedance
b) Short circuit test
c) Measurement of acoustic noise level. This shall conform to NEMA standard publication
d) Measurement of capacitance and tan delta of transformer winding.
e) Test on oil samples.

Sequence of testing shall be mutually agreed between Purchaser and Contractor after award.

7.4 All auxiliary equipment shall be tested as per the relevant IS Test Certificates shall besubmitted for bought out items.

7.5 High voltage withstand test shall be performed on auxiliary equipment and wiring aftercomplete assembly.

7.6 Tank Tests:

a) Routine Tests: As per CBIP Manual on Transformers
b) Type Tests:
i) Vacuum Tests: As per CBIP Manual on Transformers
ii) Pressure Test: As per CBIP Manual on Transformers

7.7 In addition to the above, the following checks should be carried out at manufacturer's worksbefore despatch for all transformers:

a) Check for interchange ability of components of similar transformers and for mounting dimensions.
b) Check for proper packing and preservation of accessories like radiators, bushings explosion vent, dehydrating breather, Buchholz relay, conservator etc.
c) Check for proper provision of bracings to arrest the movements of core and winding assembly inside the tank.
d) Test for gas tightness and derivation of leakage rate. To ensure adequate reserve gas capacity during transit and storage.

7.8 The Contractor shall submit a detailed inspection and testing programme for field activities,covering areas right from the receipt of material stage upto commissioning stage as per IS :1886 - Code of practice for installation and maintenance of transformers. The indicative checks and tests are given below.

a) Physical checks on each transformer on receipt at site for any damage or short supply.
b) Tests on oil samples
c) Oil leakage test
d) Physical checks for colour of silica in breather
e) Check for oil level in breather housing, conservator tank, etc.
f) Check for correct operation of all protections and alarms.
g) Insulation Resistance Measurement for Main Winding, control wiring etc.
h) Continuously observe the transformer operation at no load for 24 hours.

8.0 Fittings

The following fittings shall be provided with each transformer covered under this specification.

i) Conservator with drain plug and oil filling hole with blanking plate
ii) Plain oil Gauge
iii) Pressure Relief vent
iv) Pocket on tank cover for Thermometer
v) Valves
vi) Earthing Terminals
vii) Rating & Terminal Marking Plates
viii) Lifting Lugs
ix) Rollers
x) Air Release Plug

The fittings listed above are only indicative and any other fittings which generally are required for satisfactory operation of transformer are deemed to be included.

9.0 **Spare Parts**

9.1 The list of spares for outdoor type transformers covered under this section shall be asspecified in Section-Project

9.2 In addition, the Bidder shall also recommend optional spare parts and maintenance equipment necessary for three(3) years of successful operation of the equipment. The prices of these shall be indicated in respective schedules and these shall not be considered for the purpose of evaluation.

10.0 **Technical Parameters : The insulation levels of HV windings, HV bushings and clearances shall be suitable for 72.5 KV class.**

S.No.	Particulars	Specification
1	Reference of standards	IS 2026/IEC 176
2	Rating	500 KVA
3	Type of winding	Copper wound
4	Service	Outdoor
5	Rated voltage in KV	
	HV Winding	33
	LV Winding	0.415
6	Rated frequency (Hz.)	50
7	Number of phases	3
8	Rated current.	
	H.V	8.75 A
	L.V.	696 A
9	Connection	Dyn 11
10	Type of cooling	ONAN
11	Tap changing equipment	
	Manufacturer	Paragon or equivalent
	LV Variation	+5% to – 5%
	Type	Off circuit bridging
	No. of steps	4 steps, 5 position
12	Guaranteed positive sequence impedance at 75 Deg. C with 100% rating at principal tap	5% tolerance + 10%
13	Temperature rise over an ambient of 50 deg. C	
	Top oil	40 deg. C
	Winding (by resistance method)	45 deg. C

S.No.	Particulars	Specification
14	Guaranteed losses at rated voltage (excluding cooler loss) on principal tap and at rated frequency	
	No load loss	1200W
	Load loss	4800W
	Total loss	6000W
15	Cooler data (Type of cooler)	Pressed steel radiator
16	Withstand time for three phase short circuit at terminals(seconds). NOTE: The transformer is protected by means of DO fuses as such the fault clearance is not rapid. The transformer must be designed with proper supports for LV and HV windings with pre-compressed board/permali wood/filling with resin so as to make the winding immovable	3.0 sec. (Three point zero seconds) supplier must confirm this point
17	No load current at rated voltage and rated frequency Amp.	Less than 2% of full load current
18	Insulation level	
	Separate source power frequency voltage withstand	
	HV Winding(KVrms)	140
	LV Winding(KVrms)	2
	Induced over voltage withstand	
	HV Winding(KVrms)	66
	LV Winding(KVrms)	0.83
	Full wave lightning impulse withstand	
	HV Winding(KVp)	325 KV
	LV Winding(KVp)	--
19	Regulation at full load at 75 deg. C	
	At unit power factor (%)	Please furnish
	At 0.80 power factor (%)	Please furnish
20	Over excitation withstand timer (seconds)	
	120%	1 minute
	150%	3 seconds
21	Proposed method of transformer shipment	By road transport
22	Total quantity of oil	Please furnish
23	Efficiency at 75 deg. C	Please furnish
	At full load (%)	
	At ¼ full load	
	At ½ full load	
24	Approximate dimensions	Please furnish

S.No.	Particulars	Specification
	Tank enclosure(minimum) Note:- The size of tank shall be so decided that a minimum clearance of 75mm is available at every point between live parts and tank. Minimum phase to phase clearance at outer diameter of R&Y, Y&B. HT coils shall be 40mm. This shall be specifically checked at the time of inspection.	
25	Undertaking height	Please furnish
	Approximate weight	Please furnish
	Core & winding (Kg)	
	Tank fittings(kg)	
	Oil (Kg)	
	Total weight (Kg)	Please furnish
26	P.R.V.: The transformer shall be fitted with Pressure Relief Device which will operate at 5 PSI and reset at 1 PSI in addition to explosion vent	Please confirm
27	Tank plate gauge	
	Top & Bottom	Minimum 5mm
	Side plates (with stiffeners)	Minimum 3.5 mm
28	Top of the tank	Slanted to avoid collection of rain water
29	Oil parameters	EHV grade-I as per ISS 335
30	Bushing characteristics HV-72.5 KV	Dry withstand: 140 KV Wet withstand: 140 KV Impulse withstand: 325 KV
31	Material used in Bushing rod	Brass
32	Size of bushing rod	HV 12mm LV 30mm
33	Details of provision for shrinkage of winding	Pre shrinking will be done before final essentially during process
34	Type of transformer tank	Rectangular
35	Arrangement of clamping of winding ends to bushing terminals	Brazing, through multi paper covered leads
36	Bucholz relay	Please confirm

1. The important characteristic of EHV grade transformeroil shall be as under:-

(a) Appearance	The oil shall be clear and transparent and free from suspended matter or sediment
(b) Density at 27^{o} C max.	0.89g/cm^{3}
(c) Kinematic viscosity max. (i) At 27 ^{o} C (ii) Sub-zero temp	 27 cSt. Under consideration
(d) Interfacial tension @ 27 degree min	0.04N/m
(e) Flash point Penskymartn (closed) ,min.	140 degree centigrade
(f) Pour point max.	- 6^{o}C
(g) Neutralization value (total acidity) max.	0.01mg. KOH /g
(h) Corrosive sulfur (in terms of classification of copper strip)	Non corrosive
(i) Electric strength (break-down voltage) e) New untreated oil b) After treatment	 50 kv (RMS) if the value is not attainted the oil shall be treated. 60 kv (RMS)
(j) Dielectric dissipation factor (tan delta)at 90^{o} C max	0.002
(k) Specific resistance (resistivity) i) At 90 ^{o} C min. ii) At 27 ^{o} C min.	 35x10^{12} ohms-cm 1500x10^{12} ohms-cm
(l) Oxidation stability i)Neutralization value after oxidation (max) ii)Total sludge after oxidation (max)	 0.4 KOH/g 0.1 % by weight
(m) Presence of oxidation inhabitor	The oil shall not contain antioxidant additives
(n)Water content (max)	50 ppm, after treatment should be less than 10

2.1 **TYPE TESTS**

Offered station transformer shall be fully type tested as per relevant ISS or any equivalent acceptable International Standard & technical specification. The following type tests shall be carried out on the transformers in accordance with ISS: 2026/1977 as amended from time to time or any equivalent acceptable International Standard:

(i) Short Circuit test
(ii) Lightening Impulse Voltage withstand test.
(iii) Heat run test.
(iv) Loss measurement.

2.2 **ROUTINE TESTS**

Before despatch, completely assembled transformer shall be subjected to the following routine tests & acceptance tests at the manufacturer's works in accordance with the details specified in IS:1180/2026 or any equivalent acceptable International Standards and as detailed below and the contractor shall submit test reports of these for its acceptance : -.

1. Measurement of winding resistance.
2. Ratio, polarity and phase relationships.
3. Impedance voltage.
4. No load loss and No load current.
5. Load loss.
6. Insulation resistance.
7. Separate Source voltage with stand test.
8. Induced over voltage withstand test.

2.3 **ACCEPTANCE TESTS**

1.Physical verification of active parts alongwith weighment of unit.
2. Spill Current measurement test.
3.Test for Magnetic balance shall be conducted by connecting the LV phase by phase to rated phase voltage and measurement of an, bn, cn voltage will be carried out.
4. Test for over fluxing of core.
5. Pressure test performed on one tank.
6. Breakdown voltage test of transformer Oil.
7. Heat run test.

3. **FITTINGS & ACCESSORIES**:- The transformer shall be provided with the following fittings and also complete with first filling of oil:-

1. Rating and terminal marking plate:- The name plate should bear following details:-
   i. Work orders No. and date to be indicated on rating plate.
   ii. Serial no. of transformer to be indicated on rating plate.
   iii. Year of manufacture
   iv. Number of phases
   v. Rated KVA
   vi. Rated Frequency
   vii. Rated voltages
   viii. Rated Currents
   ix. Connection Symbol
   x. % Impedance voltage at rated current (corrected at 75 deg)
   xi. Connection diagram of copper windings.
   xii. Tap position and relative HV/LV voltage.
   xiii. Total Mass
   xiv. Mass & Volume of Insulating oil
   xv. Guaranteed Oil & Winding temp. rise above ambient.

2. HV bushings of 36 KV: 3 Nos.
   LV bushings : 4 Nos. (Bushing should be oil filled non communicating type having their stems sealed at both ends.)
3. Earthing terminals 2 Nos.
4. Tank Lifting lugs 2 Nos.
5. Jacking pads 4 Nos.
6. Silica gel dehydrating breather having minimum 0.5 Kg. Silica gel.
7. Conservator with oil filling cap, drain valve with plug and oil level guage.
8. Pressure release device in addition to Explosion vent with diaphragm.
9. Filter valves (Lower valve to be used as drain valve which should be capable to drain oil completely.
10. Air release device with cap on tank top.
11. 4 Nos. Bi-directional flat rollers with cross channels.
12. Thermometer pocket.
13. Explosion vent.
14. Off-circuit tap changing switch with indicator, handle and locking devices.
15. Terminal connectors for HV & LV bushings (Suitable for Dog conductor & 625 sq.mm Lugs respectively).

4. **TECHNICAL SPECIFICATION FOR 33KV DO FUSE UNITS**

The drop-out fuses (D.O.fuses) shall be expulsion type. This shall be 'D' type and out-door lift off type suitable for manual operation by an operating rod from the ground level.The drop out operation will be angular in vertical plane.

4.1 The DO set unit shall be designed for a normal current rating of 200 Amps. Whereas the rating of fuse unit shall be 15 Amp.The drop out fuses are required with Post Insulators. These shall be suitable for mounting on lattice type structure of CSPTCL's design. The bracket /channel hardware for DO Fuses shall be provided with adequate sizes of nuts, bolts and washer for mounting on the structure. The 33 KV LA shall be provided on the lattice type structure for DO fuse set.

4.2 POST INSULATORS:

Each 33KV DO Fuse Units shall have two Nos. 33KV Post insulator. The insulators shall conform to IS:2544 of 1973 with latest amendment as per this tender specification.

4.3 Rating of fuse base:

Particulars	Description	
Rated Lightning impulse withstand	To earth and between poles	170 KV Peak
	Across the isolating distance of fuse	195 KV Peak base.
Rated one minute power frequency withstand voltage (dry and wet) values	To earth and between poles	75 KV Peak
	Across the isolating distance of fuse	80 KV Peak base
Temperature Rise Limit in Air Above Ambient Temperature (0C):	Brass contacts silver faced	65
	Terminals	50
	Metal parts acting as spring	The temperature shall not reach such a value that elasticity of the metal is changed.

4.4 MAIN CONTACTS:

The main contacts of the D.O.Fuse shall be suitable for heavy duty, properly aligned, made from Brass material. These shall have good finish and smooth surface and shall be silver plated. All the sharp edges shall be rounded off. These contacts shall be so designed to withstand highest short circuit breaking current that may be encountered during service. In nut-shell the contact assembly shall ensure.

i. Electro-dynamic with stand ability during short circuit without any risk of repulsion of contact.

ii. Thermal with stand ability during short circuits.

iii. Constant contact pressure even when the lower parts of the insulator stacks are subjected to tensile stresses due to linear expansion of connected busbar or flexible conductors either because of temperature variation or strong winds.

iv. Proper alignment to ensure smooth operation of D.O.Fuse without adjustment.

4.5 CONNECTORS:

The connectors shall be made from Brass suitable to receive single Zebra conductor. The connectors should be bolted type having 4 bolts & groove to hold the conductor. All brass parts should be silver plated for corrosion resistance and efficient current flow. All ferrous parts should be hot dip galvanized as per the latest version of IS:2633. Nuts and bolts shall conform to IS: 1364 and should be hot dip galvanized. Spring washer should be electro galvanized.

4.6 FLY NUTS:

These shall be provided at both the ends of SRBP tube for tightening the fuse elements. The nut shall be provided with one flat washer of 25mm dia. The arrangement shall be made to ensure that the fuse wire runs centrally inside the SRBP tube after tightening.

4.7 SPRING STRIPS:

The spring strips shall be of phosphore bronze multiline brush type having a high pressure contacts and should retain its tension under minimum continuous service current of 200 Amps at 90 ºC.

4.8 OPERATING HOOKS:

The brass operating hook shall be fixed over the SRBP tube in such a way that the barrel can be removed for replacing the fuse element by operating rod from the ground level.

The drop out fuse units shall operate efficiently. Speed of operation shall not depend on the inclination of the fuse. However, the inclination of the fuse barrel shall be adjusted in such a way that the barrel does not drop by gravitational force.

4.9 D.O.BARRELS:

The D.O. Fuse Barrels shall be made from SRBP and shall conform to BSS:1314. The supplier shall furnish the test certificate for the fuse barrels offered for use in the drop out fuses alongwith each lot offered for inspection to the inspecting officer. The test certificates of SRBP barrel should indicate the following test results:-

i. Dimension:
(a) External dia
(b) Wall thickness
(c) Internal dia

ii. Max. wraping in 12" length of the tube.

iii. Axial electric strength (Proof test in oil at 90ºC at 25KV rms 50 C/S.)
The barrel should with stand this test satisfactorily for one minute

iv. Radial electric strength (Proof test in oil at 90ºC at 19 KV rms 50 C/S.)
The barrel should with stand this test satisfactorily for one minute

v. Surface electric strength (Proof test in air at room temp.(32°C) at 14 KV rms at 50 C/s)
The barrel should withstand this test satisfactorily for one minute.

vi. Water absorption in 14 hours

vii. Resistance to Hot Oil

viii. Cohesion between layers (Proof test)

ix. Machine-ability

4.10 The contractor should indicate the name of manufactures of SRBP tube from where they will purchase the Barrel to make available the above test certificate. The barrels should have the property to resist fire whenever the fuse is blown off. It should not catch fire easily during blowing off of fuse element inside the barrel which causes short time high temperature.

4.11 TESTS:

Type Test Certificate:

The contractor shall furnish the type test certificate of DO Fuses alongwith certified copy of the drawing and other guaranteed technical particulars. The following type test certificate as per ISS:9385 Part-II-1980 (with latest amendment) or any equivalent International Standards must be furnished. The type test should not be older than 5 (five) years and should be performed in the Govt. recognized Lab.

(i) Impulse voltage withstand test,
(ii) H.V. Power Frequency dry / wet withstand test.
(iii) Temperature rise test.
(iv) Breaking Current test.

Alongwith the inspection report of D.O.Fuse Units, the contractor shall invariably furnish Routine Test certificate of DO Fuse barrels & Post Insulator of their manufacturers.

5. STATION SUPPLY:- The LT station supply of the S/S shall be through a 500 KVA 33/0.4KV station transformer connected to the 33 KV bus through a proper DO fuse protection arrangement and a 33 KV isolator. Station transformer Marshalling Box shall have 2 inlets (one main & one spare) of 800A having MCCB protection and back up fuses. The Station transformer Marshalling Box shall have a front door opening and shall be provided with 03 Nos 300 Amps outlets with MCCB and back up fuses. The LT distribution box shall be tested for IP55 for outdoor use. The cable entry shall be from the bottom side of the above distribution box.

The incoming LT supply in the control room shall be through automatic changeover switch so that in case of any trouble in the station transformer alternative supply may be availed from CSPDCL. LT CT Energy Metering arrangement shall be provided on all the incoming supplies by providing Secure Meters Ltd Udaipur make, energy meters having RS45 port on iec 61850/Modbus protocol. A 3 Ph 4 W SEMS make 0.2S class electronic CT operated energy meter shall be provided for recording the substation energy consumption. Necessary metering class LT CTs rated for 800/5 A shall be provided in the ACDB.

28. TECHNICAL SPECIFICATIONS FOR LIGHTING LUMINARIES FOR SWITCH YARD & CONTROL ROOM LIGHTING AND HIGH MAST :

1.1 **SCOPE:**

This specification covers design, manufacture, testing at manufacturer's works, supply and delivery of lighting fixtures and accessories for switch yard and control room lighting.

1.2 **STANDARDS**

1.2.1 The design, manufacture and performance of luminaries shall comply with all currently applicable statutes regulation and safety codes. Nothing should be construed in this specification to relieve the developer of this responsibility.

1.2.2 The lighting luminaries shall conform to the latest applicable IS or IEC standards. Equipment conforming to Indian standards shall also be considered, if offered. Relevant Indian Standards are :-

1.	IS:1913	:	General & Safety requirements for electric lighting fittings.
2.	IS:3287	:	1965: Industrial lighting fitting with plastic Reflector/
3.	IS:1777	:	1978: Industrial Luminaries with metal reflectors.
4.	IS:9974	:	1981: High vacuum sodium vapour lamps (Part 1.2)
5.	IS:8019	:	Vitreous enamelled reflectors for use with illuminating device.
6.	IS:10322	:	Specification for luminaries (Par 1 to 5)
7.	IS:3528	:	Water proof electric lighting fittings.
8.	IS:4012	:	Dust proof electric lighting.
9.	IS:2349	:	Luminaries for street lighting.
10.	IS:1947	:	Specification for street lighting.
11.	IS:5077	:	Specification for decorative lighting cut fits.
12.	IS:1258	:	Specification for Bayonet lamp holders.
13.	IS:3323	:	Lamp holders or tubular fluorescent lamps.
14.	IS:3324	:	Holders for starters for tubular fluorescent lamps.
15.	IS:1534	:	(Part - I) Ballasts or use in fluorescent (Amendment.2) lighting fittings.
16.	IS:1569	:	Capacitors for use in fluorescent.
17.	IS:2215	:	Starter for fluorescent lamps.
18.	IS:2418	:	Part. I Tubular fluorescent lamps.
19.	IS:5133	:	Part. I Steel & cast iron boxes.
20.	IS:2147	:	Degree of protection for switch-gear and control gear.
21.	IS:1034-90	:	Electric Blast
22.	IS:6616-1982	:	Ballast for HPSV lamps.

1.3 GENERAL REQUIREMENT OF OUTDOOR / INDOOR LIGHTING LUMINARIES

a) All AC outdoor fixtures shall be suitable for operation on single phase 2 wire A.C supply.

b) Fixtures shall be designed to have low temperature rise, and suitable heat radiation device the protective glass wind shields shall be fixed at proper distance to avoid localized intensive heat and also cracking due to extreme temperature differential inside and outside the fixtures.

c) The lighting fixture shall be designed for minimum glare. Finishing of fixture shall be such that no bright spots are produced either by direct light source or by reflection.

d) All fixtures shall be complete with accessories like ballasts, power factor improvement capacitors etc. it is desired to mount 3 fixtures on the sub-station structures only and accessories listed above should be fitting assembly. If however, the accessories cannot be accommodated inside, then a separate metal enclosed weatherproof box shall be included in the scope to accommodate these accessories along with a fuse and a set of terminal blocks suitable for loop in and loop out connections. Outdoor type fixtures shall be provided with weather proof and vermin proof boxes.

e) Each fixture shall have a terminal block suitable for loop in loop out and T–off connection by cable, type and size of which shall be specified. The internal wiring should be completed by the manufacturers by means of stranded copper wire of adequate size and terminated on the terminal block.

f) Emergency Lighting:- In case of failure of incoming supply in the Sub-station, emergency DC lighting has to be provided. The above requirement can be met out from DC to AC converter by providing 3 Nos CFL at main control room and one No. each at AC/DC room, Carrier room, AE room, Store room, Battery room etc.

1.4 TECHNICAL PARTICULARS OF LUMINARIES

1.4.1 FLOOD LIGHTING LUMINARIES (2 X 400 WATTS).

Housing	Cast aluminium, MEV treated.
Front clamps	Stainless steel
Mounting bracket	M.S. Hot dip galvanised.
Reflector	High purity aluminium Electrochemically brightened
Gasket	Ethylene propylene
Lamps	400 Watt HPSV

1.4.2 STREET LIGHTING LUMINARIES (1 x 70 Watts)

Housing	Sheet aluminium stove enamelled grey outside and white inside.
Reflector	High purity aluminium sheet chemically brightened & anodised.
Gear Tray	M.S. Painted steel
Toggles	Stainless Steel
Mounting piece	Die cast aluminium MVC treated
Lamp	70 Watt HPSV

1.4.3 INDOOR DECORATIVE MIRROR OPTIC LUMINAIRE FOR 2 x 40 WATT FLUORESCENT LAMP.

Housing	MS CRCA brown stove enamelled.
Gear tray	MS CRCA white stove enamelled.
End plate	High impact polystyrene, wood finish
Mirror Assembly	Aluminium electro chemically brightened anodised.
Lamellae louver Dimensions	Anodised aluminium. Approx. 1320 x 320 x 140 mm.

1.4.4 INDUSTRIAL LUMINAIRE SUITABLE FOR 2 x 40 WATT

Rail	CRCA sheet, stove enamelled white colour.
Reflector	CRCA sheet, stove enamelled outside colour Grey & inside colour white.

1.4.5 **CORROSION PROOF INDUSTRIAL LUMINAIRE FOR 2x40 WATT**

Canopy	Fibre glass reinforced polyester
Gear tray	CRCA sheet, stove enamelled white.
Cover	Acrylic, transparent.

1.4.6 **INDOOR DECORATIVE LUMINAIRE SUITABLE FOR 1x40 WATT FLUORESCENT LAMP:**

Rail	CRCA sheet steel, channel (Grey colour) stove enamelled.
Cover	White stove enamelled.
Diffusers	Plain opal acrylic, light stabilised anti static treated.
End plates	High impact black polystyrene.

1.4.7 **M.S.COMMERICAL RAIL SUITABLE FOR USE WITH SINGLE 40 WATT FLUORESCENT LAMP**

Channel	CRCA sheet steel, stove enamelled, colour grey.
Cover	CRCA sheet steel, stove enamelled, colour white.

1.4.8 **TOP LANTERN TYPE LUMINARIES FOR 1 x 70 WATTS H.P.S.V. LAMPS**

The overall diameter of top shall be 575 m.m. and height 390 m.m. approximately. The Lantern top shall be suitable for 80 m.m. diameter pipe

1.4.9 **HIGH PRESSURE SODIUM VAPOUR LAMPS**

The HPSV lamp of 400 / 70 watts shall be poly crystalline translucent aluminium oxide discharge tube enclosed in a void or tabular outer glass envelope. The inside of lamp shall be coated with uniform layer of diffusing power (applied electro-statically). The discharge tube shall contain an amalgam of Mercury Sodium along with Xenon gas as starter. The outer shall be evacuated.

As per CBIP manual 3.5.1 Good' lighting in a substation is necessary to facilitate normal operation and maintenance activities and at the same time to ensure safety of the working personnel. As per latest IS:3646 (pt. II) "Schedule for values of illumination and Glare Index" recommends values of intensity of illumination. Table below contains the recommended values for different parts of substations.

S. No.	**Particulars**	**Average illumination limiting Glare level 'Lux'**	**limiting Glare level 'Lux' Index "l>**
1	Control rooms Vertical control panels Rear of control panels Control desks Switch houses	 200 to 300 150 300 150	 19 19 19 25
2	Battery room	100	-
3	Carrier room	300	-
4	Offices and reception	300	19
5	Cloak rooms	100	-
6	Workshop/Repair bay	300	25
7	Test room	450	19

S. No.	Particulars	Average illumination limiting Glare level 'Lux'	limiting Glare level 'Lux' Index "l>
8	Outdoor switchyard	20	-
9	Stairs	100	-
10	Corridors	70	16
11	Approach roads	20	-
12	Pathways	20	-
13	Car parks	20	-
14	Conference room	300	19
15	Store room	100	-
16	Cable gallery / floor	70	-
17	AC plant / DG set room	150	-
18	Emergency Lighting	30	-

1.4.10 HIGH MAST:-

The contractor shall provide four numbers 25 meters high Tubular High Mast Lighting. It shall include accessories for high mast including head frame, steel wire rope 6mm dia (7/19 construction),double drum with lantern carriage arrangement carrying luminaries symmetrically in twelve nos fittings around the periphery. Each fitting shall have 2X400W HPSV floodlights.The high mast shall have integral power tool installed at the base apartment for motorised operation of the fittings). Control panel shall be provided at the base. Also, provision of manual movement of fittings shall be provided. The high mast shall be of hot dip galvanised and suitable for wind velocity Wind Zone IV as per IS 875.

***

29. SPECIFICATION FOR SUPPLY OF GALVANISED STEEL STRUCTURES AND EARTHING STEEL, ACDB, DCDB AND MARSHELLING BOX/ JUNCTION BOX. ERECTION, TESTING AND COMMISSIONING OF 220/132/33 KV SUB STATION.

1.0 GALVANISED STEEL STRUCTURES

1.1 SCOPE.

This specification covers following works.

a) Engineering and supply of galvanised fabricated steel structures for gantry and equipments for sub-station as per CSPTCL design & drawing and associated bay work design engineering & supply of earthing steel for Earth mat.

b) Erection of gantry, bus bar, and equipment's structures, stringing of gantry, bus bar and shielding wires, installation of out door / in-door equipments, inter equipment connections using Panther / Zebra ACSR conductors.

c) Installation of cable trays in trenches, laying of control and power cables, construction of earth mat, earthing pits, grounding electrodes and risers.

Note:- The contractor shall have to supply steel structures required for construction of bays at 220/132/33 KV sub-station where ever required. These structures should match standards in all respects.

1.2 STANDARDS.

The steel structures shall conform to the latest edition of the standard as stated hereunder.

a) I.S. 2062 / 226 Specification for structural steel and quality steel.
b) I.S. 802. Use of structural steel in over head transmission line.
c) I.S 806 Code of practice for use of steel tubes.
d) I.S. 808 Specification of rolled steel, channel, beam and angle sections.

1.3 DESIGN REQUIREMENTS:

Following general guide lines shall be followed for verification of design:-

a. For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS 875 Part IV as per CSPTCL drawings.

b. For materials & permissible stresses, IS 802 Part I Section 2 shall be followed in general.

c. Maximum slenderness ratios of leg members, other stressed members and redundant members for compressive force shall be as per IS 802.

d. In order to facilitate inspection & maintenance the structures shall be provided with step bolts not less than 16 mm diameter & 175 mm long spaced not more than 450 mm apart, staggered on faces on one leg extending from about 0.5 metre above ground level to top of the tower. The step bolts shall conform to IS: 10238.

e. All Structures shall be designed for worst condition of dead loads, live loads wind loads etc. as per IS 875 Seismic forces as per IS: 1893, importance factor of 1.5, loads due to deviation of conductor, loads due to un-balanced vertical and horizontal forces, erection loads, short circuit forces. Short Circuit forces shall be calculated considering a fault level of 40 KA IEC: 865 may be followed for evaluation of short circuit forces.

f. Substation gantry structures shall be designed for 2 conditions i.e. Normal condition & Short Circuit Conditions. In both conditions the design will be based on assumption that stringing is done only on one side i.e. all the three phases wire broken on the other side. Factor of safety of 2.0 under Normal conditions & 1.5 under Short Circuit condition shall be taken.

g. Vertical levels of half the span of conductors/ string & the Earth wire on either side of beam shall be taken for design. Weight of man with tools shall be considered as 150 Kg. for design.

h. Terminal / take off gantries shall be designed for a minimum conductor tension of 1 metric tonne per phase for 132 KV or as per requirement whichever is higher. The distance between the terminal gantry & take off tower shall be taken as 200 metres. The design shall also be checked considering ± 30° degree deviation of conductor in both vertical and horizontal planes. For other gantries structural layout requirements shall be adopted.

i. The contractor shall furnish design, drawing, Bill of Material (BoM) of structures on award of contract. The design drawing should clearly indicate sections numbers and sizes of the bolts & details of typical joints, member wise weights & total weight of the structure.

j. There should be provision of connectivity of beam in the last feeder gantries for future beam.

As designing is in the scope of contractor, supply/approval of design & drawing shall not relieve the contractor from his responsibility for :–

i) Observing all the required clearances (phase to phase, phase to earth, sectional clearances & ground clearances) as per tender specifications.

ii) Calculation of force at all the joints/sections and their load carrying capacity shall be as per details of design requirements (e) given above.

iii) In case, the structures not complies with points (i & ii) given above, the contractor shall have to modify/replace the structure as the case may be and agreeable to CSPTCL without any cost implication.

Note: Please note that separate columns for bus bar structures, take off gantries, transformer gantry etc should be provided. In no case common column for take off or other type of gantries and bus bar structures shall be accepted.

1.4 TECHNICAL SPECIFICATIONS FOR ACDB & DCDB PANELS AND MARSHALLING/ JUNCTION BOX

1.4.1 TECHNICAL SPECIFICATION FOR ACDB & DCDB PANELS

SCOPE.

This specification covers the complete design, manufacture, testing, inspection, packing and delivery of the following equipments.

1. 3 phase 415V ACDB
2. 220V DC Board with Metal clad switches
3. 48V DC Board with Metal clad switches

Control & monitoring the ACDB and DCDB shall be integrated in Sub-station Automation System. Separate Bay Control Unit shall be provided for this purpose.

1.4.2 STANDARDS.

Unless otherwise specified, the equipments covered under this specification shall be manufactured, tested and supplied with the guarantee particulars as per the following Indian Standards Specifications.

IS-4237	- General requirements for switch gear & control gear for voltage not exceeding 1000V
IS-2147	- Degrees of protection provided by enclosures for low voltage switch gear and control gear.
IS-375	- Marking and arrangement for switch gear bus bars main connection and aux. wiring
IS-2208	- HRC Cartridge fuse link up to 650V.
IS-1248	- Electrical Indicating Instruments.
IS-1554	- PVC Insulated electrical cables.
IS-2516	- AC circuit breakers.

IS-2705	- Current Transformers.
IS-3156	- Voltage Transformers
IS-4047	Heavy duty Air break switches and composite unit's & fuses for voltage not exceeding 1000V.

1.4.3 **GENERAL REQUIREMENT**

1.4.3.1 AC/DC Boards shall be metal enclosed and floor mounted. Boards shall be provided with metal frame made of structural steel channel section properly drilled for mounting the switchgear. These shall be of single front execution with dimension (H x B x D) approx.2000x 2000 x 400 mm (H x B x D) and having provisions for cable entry from the bottom with removable gland plate. Provision shall also be available for putting labels on the front doors indicating the switchgear designation. Suitable gaskets shall be provided all round the perimeter of covers, gland plates, door etc.

AC/DC Boards shall be divided into distinct vertical sections each comprising of:

i. Individual feeder modules arranged in the multitier formation vertically on both sides of the Bus.
ii. Enclosed vertical busbar running in vertical section in the middle.
iii. Vertical cable alley covering the entire height on the sides.
iv. Metal sheets shall be provided between two adjacent vertical sections running to the full height of the switchgear.

The AC Board shall be provided with incoming supply of 3 phase 4 wire 415 Volts AC through a change over switch rated 800 Amps, so that the incoming to the bus bar can be either taken from the station transformer or from other alternative LT supply. The copper bus bar of the AC board shall be of min. 800A capacity. The AC board shall be designed for fault current of 10 KA on LT side for 3sec. The distribution of single/ 3 phase shall be arranged through MCCM/ACBof 3 no. 3 phase 800 amp, 3 no. 3 phase 200 amp,6 no. 3 phase 100 amp, with separate boxes in ACDB to feed various load points in the sub-station. Further, the ACDB shall be provided with 40 Nos. of 32A outlets with MCB and back up fusesin separate compartments.The ACDBs & DCDBs should have arrangement of physical Isolation through knife switches in addition to the above mentioned features.

1.4.3.2 The 220 volt DC distribution board shall comprise of bus section of bus bars of adequate rating suitable for 220 volt two wire un-grounded supply from the battery charger. The out going circuits shall be 20 in numbers with a rating of 32 Amps for each. There shall be two incomings, one main and one spare each rated 200 Amps. Each incoming/ outgoing bay should be made with 2 no. HRC fuses and 2 pole on/off switch. Separate section box should be provided for each outgoing bay. Heavy duty terminal connectors, stud bolt and nut type, of proper size should be provided.

1.4.3.3 The AC/DC boards shall be metal enclosed and floor mounted. The contractor shall provide metal frame made of structural steel channel section properly drilled for mounting the switchgear. These shall of single front execution with a height not exceed 1600 mm and having provisions for cable entry and exit from the bottom with removable glade plate. HRC fuses of suitable rating shall be provided for DCDB for the protection. No MCCB shall be provided for the protection in DCDB panels.

1.4.3.4 The cabinet shall have cool glades, lungs, heater, plugs, sockets with switch and fuse and one lamp inside with suitable switching arrangements duly wired up for extending supply of 420 volts AC. Suitable metal enclosed plug socket arrangement on side wall of the box shall be provided. All terminal blocks shall be of the 1100 volts grade stud type. **Only copper cable should be used**.

1.4.3.5 Each Distribution board shall have 2 compartments namely-Instruments compartment and Feeder compartment. These compartments shall have doors as described below.

a. For Instrument compartment, one no. door with indicating instruments, indicating lamps, selector switches, nameplate mounted on it.

b. For feeders compartment, one no. inner door with one opening for handle to operate switch fuse unit and four cut outs for outgoing MCBs. One outer door with out cut outs & non breakable transparent sheet shall be provided.

1.4.3.6 Detachable gland plates suitable for receiving the cable shall be provided at the bottom side of Distribution board with glands.

1.4.3.7 Each Distribution Board shall be provided with :-

a. One No.name plate showing the details such as manufacturer's name, Sr. No., rating etc.
b. One no. danger board scripted in Hindi and English
c. One no. flush mounted 96x96mm size ammeter with selector switch
d. One no. flush mounted 96x96mm size voltmeter with selector switch
e. One no. switch fuse disconnector unit with 100 Amp rating
f. 3 nos. LED type phase indication lamps for incoming feeder
g. 3 nos. single phase LTCTs of 10VA and CT ratio 200/5A.

1.4.3.8 The enclosure shall be provided with proper earthing arrangement. Earthing arrangement shall consist of 2 G.I. Bolts of 12 mm (min.) with 2 spring/ plain washers and 2 check nuts.

Two nos. Earthing studs of galvanized M.S. 25 X 6 mm shall be provided for external earth connections at the bottom. These should be complete with plain washer, spring washer, nuts etc. Earthing Bolts must be welded to prevent removal of the same from the cabinet.

1.4.3.9 Stud type Terminal blocks shall be of 1100 V grade box clamp type ELMEX or approved equivalent, not more than two wires shall be connected in one terminal, Spare terminals equal in number to 20% of active terminals shall be provided. All the terminals should be of stud type only.

1.4.4 **MAIN BUS-BARS**

1.4.4.1 The switch gear shall be provided with three phase and a neutral bus bars for AC and two bus bars for DC and shall be suitable for carrying continuous current and short circuit current.

1.4.4.2 All bus bars shall be made of EC grade Copper bars having size not less than 25 x 8 sq. mm. All bus bars, bus taps, and joints shall be insulated by using PVC tapes. In case of DC switchboards, positive and Negative bus bars shall be completely separated from each other by insulating sheet. Separate supports shall be provided for DC bar of each polarity.

1.4.5 TESTS.

1.4.5.1 AC / DC boards shall be subjected to following tests.

a. Temperature rise test on power circuits.
b. Short time current tests on power circuits.
c. Mechanical operation test.
d. Verification of the degrees of protection as per I.S. 2147.
e. Electrical control interlock and sequential operation tests.
f. High voltage test (2000 V for one minute).
g. Verification of wiring as per approved schematic drawing.

1.4.5.2 Type tests and routine tests shall be carried out on all associated equipments as per relevant Indian Standards.

1.4.6 DRAWINGS/ DATA/GTP.

Contractor shall furnish one set of following drawings/data:-

i. Complete assembly drawings of the AC / DC boards showing plan, elevation and typical sectional views and locations of terminal blocks for external wiring connections.
ii. Electrical Single line diagram of the AC / DC boards.
iii. Time- current characteristics curve for each type and rating of MCCBs.
iv Foundation plan showing location of channels sills, anchor bolts etc.
v. Item wise bill of material listing all devices mounted or otherwise furnished indicating manufacturers type.
vi Developed diagram of electrical switches

vii Operation and maintenance manual for individual equipment and complete switchgear.

viii Illustrated literature/write-up for each equipment i.e. CTs, Voltmeter, ammeter, switches, lamps, MCCB etc.,

1.4.7 MOULDED CASE CIRCUIT BREAKERS:

Moulded case circuit breakers (MCCB) shall be quick acting, preferably with a total arc extinction time of not less than 25 milliseconds, trip-free, and should be able to operate satisfactorily under, (i) over load and (ii) short circuit conditions.

MCCB shall be provided with arrangement of separate tripping system for over load and short circuit conditions. For instance, over-load tripping could be provided through a suitably calibrated bimetallic strip and tripping under short circuit conditions could be achieved through a solenoid coil. Any other arrangement of tripping, reliable and sturdy in design, would be acceptable.

In case of AC Boards the MCCB shall be provided with a common trip bar for 3 phase supply, so as to ensure opening of all three phase even when fault occurs in only one phase. Current carrying contact of the MCCB shall be silver plated and sturdy in design. MCCBs should be housed in a heat resistant moulded insulated housing.

Following information regarding MCCBs of various rating shall be furnished:-

i. Make of MCCB offered and experience of the manufacturer.

ii. A copy of type test report in regard to short time current rating of the MCCB.

iii. Complete constructional details of the MCCB illustrated in suitable cross sectional drawings indicating type of housing, type of contacts, type and arrangement of various types of operating mechanism, arrangement of quenching of arc, mounting details etc.

iv. Suitable pamphlet explaining the working of MCCB.

v. MCCB must be type tested as per IS:13947 (Pt- II)/ 1993 / or to any equivalent International Standards / done by CPRI Bhopal, Banglore or ERDA and other recognized and reputable International Laboratory or Institutions.

1.5 TECHNICAL SPECIFICATION FOR MARSHALLING/JUNCTION BOXES.

1.5.1 **SCOPE.**

Suitable size Junction/marshalling boxes shall be provided for the termination of CT, PT, secondary connections. The boxes shall be suitable for outdoor use and tested for IP55. The size should be able to accommodate incoming & out going cables properly. Necessary arrangement shall also be made for the single phase AC supply connection with 1 No. lighting arrangement plus 1 No. 15A plug.

1.5.2 **CONSTRUCTION.**

Junction (Marshalling) boxes shall be made of MS sheet steel of thickness 2.5 m.m. with suitable rubber beading and gaskets to make the box completely water proof and suitable for outdoor installation. Quality gaskets shall be utilized to prevent ingress of rain water inside the box. Suitable mounting arrangements shall be provided for these boxes

i) Boxes shall be suitable for outdoor mounting as stated above and shall be provided with knock-outs both in top and bottom plated for cable/conduit connectors. The box cover should be hinged at one end in addition nuts/bolts shall be provided in all four corners for tightening the box cover. All hardwares used in junction boxes shall be zinc passivated. Junction (Marshalling) boxes shall be of 48 ways (24 terminal blocks) with a dimension (H x W x D) not exceeding 350 x 450 x 250 (H x W x D).

ii) Junction (Marshalling) boxes shall be provided with two earthing terminals and shall be complete with end plate, end clamps, fixing channels (vertically mounted), flange, covers and brass cable glands etc.

iii) Box shall be painted in accordance with the pre-treatment and painting process as per clause '3.0'. . Each box shall be given a coat of read lead primer, one coat of oil primer, followed by two finishing coats of shade 631 of I.S.5 (Light Grey) for exterior and glossy white for the interior surfaces.

iv) Moulded barriers of suitable size shall be provided between terminals to prevent flashover. The terminals shall have a voltage withstand capability of at least 5KV between phase to earth as well as between two adjacent blocks for one minute. Each

junction (marshalling) box shall have provision of addition of one more row terminal blocks in future and each row shall have provision for 5 to 10 terminal blocks, if required.

v) Terminal blocks shall be Elmex/connectwell make and shall be of the disconnectable type only. Please note that non disconnecting type terminal blocks are not required and all such Boxes shall not be accepted. Terminal blocks shall be mounted in 2 rows of 24 ways.

vi) All terminals shall be complete with insulated barriers, terminals, studs, washers, nuts, lock nuts & identification strips and shall have facility for measurement of voltage/current using banana pins

1.5.3 **IMPORTANT DESIGN REQUIREMENTS.**

i) The terminal blocks should necessarily be of disconnecting type only.

ii) The cover of the box should cover the complete surface of the box, so that installation may be water proof. A stopper should be provided so that at the times of opening full load may not come on the hinges.

iii) A small copper strip measuring 450x25x3mm with five nuts should be provided inside the box, so that earthing of five star points of CT secondary could be possible without any difficulty.

iv) Terminal blocks should be numbered serially.

v) Double compression type Brass cable glands, rubber gaskets and Elemex make terminal blocks should be of best quality. Suitable handle type locking arrangement shall be provided for the box. A small circular plate should be provided with each of the cable gland, so that the gland not in use may be closed properly, so as to avoid entry of rain water in the box.

vi) Each type of box shall however have a provision for one additional row of terminals blocks to be added in future. The slotted steel channels of 14 SWG size and each row shall have provision for addition of 10 to 15 terminals blocks if required.

1.5.4 **CABLE ENTRY AND GLANDS.**

In all marshalling boxes cable entry shall be from bottom. The marshalling box shall have **brass** cable glands suitable for different cores, 2.5 mm^2. Copper control cables, which are to be used to connect equipments with control or relay panels. No any cable whether control or power cables should be terminated without using proper size copper lugs of different sizes & should be crimped with correct size crimping tools.

1.5.5 Contractor shall furnish one set of following drawings/data:-

i. Complete assembly drawings of the Junction boxes showing plan, elevation and typical sectional views and locations of terminal blocks for external wiring connections.

ii. Foundation plan showing location of channels sills, anchor bolts etc.

iii. General arrangement drawing of Junction box showing the terminal connectivity mounted.

iv. Itemised bill of material listing all devices mounted or otherwise furnished indicating manufacturers type.

BAY MARSHALLING KIOSKS (BMK):

One no. of bay marshalling kiosk shall be provided for each 220 KV& 132 KV bay and one no. for 2 No. of 33 KV bays.Inaddition to the requirements specified elsewhere in the specification, the bay marshalling kiosk shall have three distinct compartments for the following purpose:-

(i) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum six outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.

(ii) To distribute minimum ten outgoing 240V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers

(iii) 50 Nos.terminal blocks in vertical formation as spare.

(iv) CFL illumination and spaceheater in the kiosk

1.6 INSTALLATION AND ERECTION OF EQUIPMENTS

a) The installation, storage, testing and commissioning of transformer shall be in accordance with I.S. 186 and manufacturer's instructions. All commissioning tests as per manufacturer's specifications shall be carried out.
b) Switch gear and control panel shall be installed in accordance with IS 3072 as per manufacturer's instruction.
c) Induction motor, where ever applicable, shall be installed and commissioned as per IS 900.
d) Battery and battery chargers installation and testing shall be done in strict compliance with manufacturer's instructions.
e) Installation of GI cable trays in trenches and laying of cable shall be carried out as per IS 1255 and as per relevant standards.
f) The earthing system shall be installed as per designed drawing including welding/brazing/ bolting.

1.6 EARTHING OF SUB STATION:-

1.6.1 The Earthing shall be done in accordance with requirements given hereunder. The earth mat design shall be done by the contractor as per IEEE – 80 for the safe step and touch potential. The soil resistivity measurement shall also be done by the contractor. Neutral points of the system of different voltages, metallic parameters & frameworks associated with all current carrying equipments & extraneous networks associated with electric system shall be connected to a single earthing system. Earthing system & lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards & Codes of Practice & Regulations existing in the locality where the system is installed.

a) Code of Practice for Earthing IS: 3043
b) Code of Practice for the protection of building & allied structures against lightning IS: 2309
c) Indian Electricity Rules 1956 with latest amendments.
d) National Electricity Safety Code IEEE – 80.

1.6.2 EARTHING CONDUCTOR LAYOUT:-

a. Earthing Conductors in outdoor areas shall be buried at least 600 m.m. below finished ground level unless stated other wise.
b. Whenever earthing conductor crosses cable trenches, under ground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 m.m. below them and shall be circumvented in case it fouls with equipment / structure foundations.
c. Tap connectors from the earthing grid to the equipment / structure to be earthed, shall be terminated on the earthing terminals of the equipment / structure.
d. Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding / cleating at intervals of 750 m.m. wherever it passes through walls, floors etc. galvanised steel sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.
e. Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 m.m. from the outer boundary of the building.
f. Earthing conductors crossing the road shall be laid 300 m.m. below road or at greater depth to suit the site conditions.

1.6.3 EQUIPMENT & STRUCTURE EARTHING:-

a. Earthing pads shall be provided for the apparatus / equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short

earthing leads (one direct and another through the support structure.) free from kinks and splices.

b. Metallic pipes, conduits and GI cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

c. Metallic conduits shall not be used as earth continuity conductors.

d. Light poles, junction boxes on poles, cable and cable boxes / glands, lock out switches etc, shall be connected to the earthing conductor running alongwith the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points.

e. Earthing conducor shall be burried 2000 m.m. outside the switch yard fence. All gates and every alternated post of the fence shall be connected to earthing grid.

f. All lighting panels, junction boxes, receptable fixtures, conduits etc. shall be grounded in compliance with provisions of I.E. Rules.

1.6.4 SPECIFIC REQUIREMENTS FOR EARTHING SYSTEMS:-

a. Each earthing lead from the neutral of the power transformer shall be directly connected to four pipe electrodes in treated earth pit (as per IS). The connection from transformer neutral to the earthing pits shall be taken through a small cable trench supported on 33 KV pin insulator. The neutral of HV & LV of the transformer shall be connected to 2 Number of earth pits each. All accessories associated with transformer like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.

b. Earthing terminal of each lightning arrester & capacitor voltage transformer shall be directly connected to two pipe electrode, which in turn, shall be connected to station earthing grid.

c. Auxiliary earthing mat comprising of 65 x 8 m.m. G.I. Flats closely spaced (300 m.m. x 300 m.m.) conductors shall be provided at depth of 300 m.m. from ground level below the operating handles of the M.O.M. Box of the Isolators. M.O.M. Boxes shall be directly connected to auxiliary earthing mat.

S. N.	Item	Size of Earthing	Material
1	Main Earthing conductor buried in ground at minimum 600 m.m. below finished ground level	65 x 8 m.m. Flat (as per design requirement. However if design calculations require higher size, the same shall be provided.)	Galvanised Steel
2	Earth Spikes	25 m.m. Diameter 2500 m.m. long, (minimum 100 Nos.)	Galvanised Steel
	Equipment Earthing		
3	40 MVA Transformer	Pipe100m.m.diameter (4 nos pipes per pit.), minimum 3 metres length	Galvanised Steel
4	Other Equipments	100 m.m. diameter 3 meters long (minimum) (Minimum 2 nos pipes per pit)	Galvanised Steel

The earth pits shall be provided as per requirement of 1.5 m x 1.5 m x 3.0 m size. The minimum earth pits to be constructed shall be as given below:-

The contractor shall construct the following earth pits :-

i. 1 no. 2 pipe Earth pit for each 220KV,132KV & 33KV Bus PT/ CVT.

ii. 2 nos.4 pipe Earth Pits for each 40MVA & 160MVA Transformer.

iii. 1 no. 2 pipes Earth Pit for 01 sets of 220KV feeder LAs (3 Nos LAs).

iv. 1 no. 2 pipes Earth Pit for 01 sets of 132KV feeder LAs (3 Nos LAs).

v. 2 nos. 2 pipes Earth Pit for Xmer LAs (independent earth pit for 220KV & 132KV 160MVA Xmer LA) in addition to Sl.No.(ii).

vi. 1 no. 2 pipes Earth Pit for Xmer LAs (independent earth pit for 132KV 40MVA Xmer LA)

vii. 1 no. 2 pipes Earth pit for 33/0.4 KV station transformer

viii. 1 no. 2 pipes Earth Pits for 2 sets of 33KV feeder LAs.

ix. 03 no. 04 pipes Earth pit of size 3.5 x 3.5 x 4 m depth.

x. For 220KV, 132KV, 33KV bus bar, gantry structure & other structures/equipments, the No. of earth pits shall be as per IS.

Apart from the above pits, there shall be a GI earth mat designed with at least 100 Nos, 25mm diameter 2500mm long GI Earth Spikes & 65 x 8 mm GI Flats. All the pits & earth mat shall be interconnected. The spacing of the earth mat grid conductor shall depend upon the soil resistivity of the area and the requirement of safe step and touch potential as per the earth mat design. **In any case, the spacing of the GI Flats shall be at a distance not more than 7X7 meters in 220 KV yard, 132 KV yard and 33 KV yard**.

The combined earth resistance under maximum dry soil conditions shall be **less than 0.5 ohms**. The earth resistance should be taken in presence of engineer-in-charge, EE (MRT) or EE (S/S) of that area. **The earth mat shall be designed as per IEEE 80 -2000 for safe step & touch potential any where in the yard and also on the boundary for a fault current of 40 KA.**

There shall be a Tube Well Boring with associated motor pump & water pipe lines for watering of Earth Pits.

The earth resistance of the earthing mat shall be measured in the presence of engineer-in-charge / EE (S/S) / EE (MRT) of the area.

There shall be a tube well boring with associated motor pump & water pipe line for watering of Earth pits. The combined earth resistance under dry soil conditions shall not be more than 0.5 Ohms under dry weather conditions.

1.6.5 LIGHTNING PROTECTION OF SUB STATION:-

The system of lightening protection of substation switch yard equipment shall be through conventional earth wire installed at adequate height & in adequate numbers to protect the complete switch yard.

1.6.6 EARTH RESISTIVITY TEST:-

This test shall be conducted to determine the Electrical resistivity of soil for designing of grounding system for safe touch & step potential for the entire station area. The specifications for the equipments and other accessories required for performing electrical resistivity test, the test procedure and reporting of field observations shall conform to IS:3043. The test shall be conducted using Wagner's four electrode method as specified in IS:1892, Appendix – B2. The earth resistance test shall be witnessed by engineer-in-charge, EE (MRT) or EE (S/S) of the area. Unless otherwise specified at each test location, the test shall be conducted along two perpendicular directions parallel to the coordinate axis. On each direction a minimum of 8 to 10 readings shall be taken by changing the spacing of the electrodes from an initial small value of 0.5 in upto a distance of 10.0 m. The earth resistance test shall be repeated at multiple suitable locations to assess the average value of the earth resistivity of the switch yard area.

1.6.7 SUPPLY OF EARTHING STEEL:-

The earthing material shall be supplied by the contractor 65x8 mm GI flat :-

a) 25 mm GI round 2,500 m.m. long.

b) MS Plate

The contractor will under take preparation of earthing pits and installation of spikes

30. TECHNICAL SPECIFICATION FOR ACSR "ZEBRA" CONDUCTOR

1.1 Details of Conductor

The ACSRConductor shall generally conform to IS: 398 PART-II, 1996 with latest Amendmentexcept where otherwise specified herein.

The salient parameters of the ACSR Conductor are indicated below.

SN	Particulars	ACSR "ZEBRA" Conductor
a)	Stranding and wire diameter	54/3.18 mm Al +7/3.18 mm steel
b)	Number of Strands	
	Steel core	1
	1st steel layer	6
	1st Aluminium layer	12
	2nd Aluminium layer	18
	3 rd Aluminium layer	24
c)	Sectional area of Aluminium/steel	428.9/ 55.61 sq. mm
d)	Total sectional area	484.50 sq.mm
e)	Overall diameter (mm)	28.62

1.2 Workmanship

All the Aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.

The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

The steel strands shall be hot dip galvanized and shall have a minimum zinc coating as indicated in the STP. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand number of dips in standard Preece test as indicated in STP. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in IEC: 888.

The steel strands shall be pre formed and post formed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid, damages to galvanization during pre-forming and post-forming operation.

1.3 Joints in Wires

AluminiumWires

During stranding, no aluminiumwire welds shall be made for the purpose of achieving the required conductor length.

No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However joints are permitted in the inner layer of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

1.4 Tolerances

The manufacturing tolerances to the extent indicated in the STPshall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor.

1.5 Materials

Physical constant of hard- drawn Aluminium

a) **Resistivity: -** Theresistivity of the aluminium depends upon its purity and its physical condition. However as per the specified value of purity of this specification the maximum value permitted is 0.028264 Ohm.Sq.mm/ meter at 20 ^{0} C and this value has been used for calculation of maximum permissible values of resistance.

b) **Density:-** At a temperature 20 ^{0} C the density of hard drawn aluminium shall be 2.703 g/ cm3.

c) **Constant –Mass temperature Co- efficient of Resistance:-** At a temperature of 20 ^{0} C the constant-mass temperature co-efficient of resistance of hard drawn aluminium measured between two potential points rigidly fixed to the wire, the metal being allowed to expand freely, has been taken as 0.004 per degree Celsius.

d) **Co-efficient of linear expansion**:- The co-efficient of linear expansion of hard drawn aluminum at 0 ^{0} C has been taken as 23.0 x10 $^{-6}$

Hard- drawn Galvanised Steel Wire:-

a) Density:- At a temperature 20 ^{0} C the density of Galvanised Steel wire shall be 7.8 g/ cm3.

b) Co-efficient of linear expansion:- In order to obtain infirmity in calculations a value of 11.5x10 -6 per degree C. may be taken for galvanized steel wire used in ACSR Conductor.

Aluminium

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in ISS, BSS/IEC: 889.

Steel

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the STP and to the relevant standard.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC: 888.

Zinc

The zinc used for galvanizing shall be electrolytic High Grade Zinc of 99.95% purity as per IS:209. It shall conform to and satisfy all the requirements of IS: 209. Galvanizing has to be done hot dip galvanizing process. Natural grease may be applied between the layer of wires (Lithium soap grease corresponding to the Gr.II of IS:7623-1974 its suitable for such application.

1.6 Tests and Standards

Type Tests, Routine and Acceptance tests on ACSR Conductor shall be conducted as per latest relevant standard & tender specification.

Standards

The conductor shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

Sl. No.	Indian Standard	Title	International Standard
1.	IS: 209-1992	Specification for zinc	BS:3436-1986

2.	IS: 398 Part-I - 1996	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC:1089-1991 BS:215-1970
3.	IS:398 Part-II - 1996	Aluminum Conductor Galvanized Steel Reinforced	BS;215-1970 IEC:1089-1991
4.	IS:398 Part-V - 1992	Aluminum Conductor Galvanized Steel-Reinforced For Extra High Voltage (400 KV) and above	IEC:1089-1991 BS:215-1970
5.	IS : 1778-1980	Reels and Drums for Bare Conductors	BS:1559-1949
6.	IS : 1521-1991	Method of Tensile Testing of Steel Wire	ISO 6892-1984
7.	IS : 2629-1990	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
8.	IS : 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles	
9.	IS : 4826-1992	Galvanized Coating on Round Steel Wires	IEC : 888-1987 BS:443-1969
10.	IS : 6745-1990	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433-1969 ISO 1460- 1973
11.	IS : 8263-1990	Method of Radio Interference Tests on High Voltage Insulators	IEC:437-1973 NEMA:107-1964 CISPR
12.		Zinc Coated steel wires for stranded Conductors	IEC : 888-1987
13.		Hard drawn Aluminium wire for overhead line conductors	IEC : 889-1987

1.7 STANDARD TECHNICAL PARTICULARS OF ACSR "ZEBRA" CONDUCTOR

The ACSR ZEBRA CONDUCTOR to be supplied should conform to IS:398 (Part-2) with all the amendments made till to-day. However, important parameters are given below:-

Sl.	**Description**	**Unit**	**Guaranteed Values**
1.0	Raw Materials		
1.1	Steel Wire / Rods		
1.1	Aluminium		
a)	Minimum purity of Aluminium	%	99.50
b)	Maximum copper content	%	0.04
1.2	Steel wires/ rods		
a)	Carbon	%	0.50 to 0.85
b)	Manganese	%	0.50 to 1.10
c)	Phosphorous	%	Not more than 0.035
d)	Sulphur	%	Not more than 0.045
e)	Silicon	%	0.10 to 0.35 (Max.)
1.3	Zinc		
	Minimum purity of Zinc	.%	99.95
2.0 a)	No. of strands Alu./Steel	No.	54/7
b)	Cross section area Alu/Steel. Strands	Sq. mm	7.942/7.942

	Whole Alu./Steel Whole conductor		428.90/55.6 484.50/643.58	
c)	Over all diameter of conductor	mm	28.62	
d)	Laying of strand		Alu	Steel
	Center	No.	NA	1
	First layer	No.	NA	6
	Second layer	No.	12	NA
	Third layer	No.	18	NA
	Fourth layer	No.	24	NA
2.1	Aluminum strands after stranding		54/3.18 mm	
	Diameter			
a)	Nominal	mm	3.18	
b)	Maximum	mm	3.21	
c)	Minimum	mm	3.15	
2.2	Minimum breaking load of strand			
a)	Before stranding	KN	1.29	
b)	After stranding	KN	1.23	
2.3	Maximum resistance of strand at 20 deg. C.	Ohm. per KM.	3.626	
3.0	**Steel strand after stranding**		7/3.18 mm	
2.1	Diameter			
a)	Nominal	mm	3.18	
b)	Maximum	mm	3.24	
c)	Minimum	mm	3.12	
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	10.43	
b)	After stranding	KN	9.91	
3.3	Galvanizing			
a)	Minimum weight of zinc coating per sq.m.	gm	260	
b)	Minimum number of dips that the galvanized strand can withstand in the standard preece test	Nos.	3 dips of one minute	
c)	Min. No. of twists in gauge length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	18	
4.	**Stranded Conductor**			
4.1	UTS of the conductor	kN	130.32 (Min.)	
4.2	Lay length of outer layer	mm	Max	Min
a)	Outer Steel layer	mm	28	13
b)	First Aluminium layer	mm	17	10
c)	Second Aluminium layer	mm	16	10
d)	Third layer	mm	14	10

4.3	DC resistance of the conductor at 20°C when corrected at standard weight Ohm-km whole conductor Strand	ohm/km	0.06868 3.626
4.4	Standard length of the conductor	mtr	1500
4.5	Tolerance on Standard length	%	(+/-) 5
4.6	Direction of lay of outer layer		Right Hand
4.7	Linear mass of the conductor		
	Aluminium	kg/km	1182
	Steel	kg/km	439
a)	Total Standard	kg/km	1621
5.0	Coefficient of linear expansion of complete Conductor per degree celcius	per degree celcius	19.3×10^{-6}
5.1	Calculated final Modulus of elasticity kg/ cm2	GN/ Sq.m	69
5.2	Temp. Variation	0 Deg. / 75 Deg. C	
5.3	Current carrying capacity. at 40 deg. Cent. Ambient and 30 deg. Rise	Amp	740
5.4	Elongation before /after stranding steel strand	%	4/3.5

31. TECHNICAL SPECIFICATION FOR 7/3.66 mm GROUND WIRE

The ground wire will be ISI marked (IS:12776 –2002 with latest amendments) 7/3.66 mm, 95 kg/mm^2 quality galvanised steel stranded wire which will be supplied by the Contractor. The standard Technical Particulars of the ground wire shall be as follows:-

S.No	PARTICULARS	PARAMETERS
1.	Materials	Steel
2.	Stranding	7 / 3.66 m.m.
3.	Weight per K.M.	583 Kg.
	Single wire before stranding	
4.	Diameter of Wire :- (a) Nominal (b) Maximum (c) Minimum	 3.66 m.m. 3.75 m.m. 3.58 m.m.
5.	Tolerance	+ / (-) 2%
6.	Minimum elongation in 100 m.m. length	5 m.m.
7.	Minimum breaking load of strand	10.58 KN
8.	Minimum Tensile Strength	95 Kg / mm^2
9.	D.C. Resistance at 20 ° Celsius	17.15 Ohms / KM
	Stranded wire : Length of Lay :-	
10.	**Nominal**	181mm
11.	Maximum	198 m.m.
12.	Minimum	165 m.m.
13.	Minimum breaking Load	6972 Kg.
14.	Overall diameter	10.98 m.m.
15.	Modulus of elasticity	1.933 x 10^6 kg/ cm^2
16.	Coefficient of linear expansion	11.50 x 10^{-6} per °C
17.	D.C. resistance at 20° C	2.5 Ohms / KM
	Zinc coating	
18.	Minimum Weight of Zinc coating on wire	260 gms./sq. Meter of uncoated wire surface.
19.	No. of one minute dip and half minute dip respectively	3 & 1 respectively
20.	Minimum purity of zinc	99.95%

32. TECHNICAL SPECIFICATION FOR 70 KN, 90 KN & 160 KN DISC INSULATORS (Anti-fog type) AND SOLID CORE POST INSULATORS:-

1.1 70 KN, 90 KN & 160 KN DISC INSULATOR (Anti-fog type)

S. No	Particulars	70 KN	90 KN	160 KN
1.	Type of Insulator (Pin & Cap)	Ball & Socket	Ball & Socket	Ball & Socket
2.	Size and designation of ball and socket with stan0dard to which it will confirm	16 mmB	16mmB	20 mm
		Conforming to IS: 2486 (part-II) 1974		
3.	Dimension			
	a) Porcelain disc diameter mm	255 +/-10	255 +/-10	280+/-13
	b) Unit spacing mm	145 +/-4	145 +/-4	170 +/-5
	c) Creepage distance of single disc (min.) mm	430	430	330
4.	Colour of glaze of the finished porcelain insulator	Brown	Brown	Brown
5	Mechanical values .			
	a) Combined mechanical & electrical strength in KN	70 KN	90 KN	160 KN
	b) Materials used for ball pins.	Forged steel	Forged steel	Forged steel
	c) Grade of material	Class 3A or 4 of IS 2004	Class 3A or 4 of IS 2004	Class 3A or 4 of IS 2004
6	Ultimate tensile stress Kg. Per mm2	63	63	71
7	Yield stress Kg. Per mm2	32.5	32.5	47
8	Hardness test value BHN	175	175	201-255
9	Percentage elongation	(min. 15%)	(min. 15%)	(min. 14%)
10	Whether machine forced	Yes	Yes	Yes
11	Normalising particulars (Temp in C 0)	30-880	30-880	30-880
12	Withstand voltage of single disc			
	a) Dry KV (RMS)	70	70	80
	b) Wet KV (RMS)	40	40	50
13	Impulse voltage 1.2 x 50 Micro sec.	110	110	130
	Positive KV (Peak)	110	110	130
	Negative KV (Peak)			
14	Flash over voltage for the disc. Power frequency :			
	a) Dry KV (RMS)	78	78	75
	b) Wet KV (RMS)	45	45	45
15	Flesh over Impulse voltage 1.2 x 50 Micro sec.			
	a) Positive KV (Peak)	120	120	125
	b) Negative KV (Peak)	120	120	125
16	P.F. Puncher voltage KV (RMS)	120	125	125
17	Min. Corona extinction voltage KV (RMS)	09	09	18
18	Max. RIV at 10 KV (RMS) Micro volts	50	50	50
19	Security clip/ locking device	R TYPE and	R TYPE and	R TYPE and

	a) Type and dimension b) Material c) Standard to which security clip confirmed d) Test values	dimensions as per 2486 Part-IV Stainless steel Guaranteed as per IS 2486 (Part-IV) ---do--	dimensions as per 2486 Part-III) Stainless steel Guaranteed as per IS 2486 (Part-IV) ---do--	dimensions as per 2486 Part-III) Stainless steel Guaranteed as per IS 2486 (Part-IV) ---do--
20	Standard specification to which insulator will confirm	IS- 731 & IS-13305	IS- 731 & IS-13305	IS- 731 & IS-3188
21	Test required	As per IS 731 & IS 3188	As per IS 731 & IS 3188	
22	Inter changeability of disc insulator	Required	Required	
23	Net weight of Insulator unit (Approx.)	5.8	5.8	
24	Packing details i) Type of packing ii) No. of disc in each packing iii) Gross weight of each packing	 Wooden crates 6 42	 Wooden crates 6 42	

1.2 SOLID CORE POST INSULATORS

1. **Scope:**
   This specification covers the complete design, manufacture, testing, inspection, packing and delivery of **solid core insulators for 220KV, 132KV & 33KV** systems as described in preceding para.
2. **Standards:**
3. The rating as well as performance and testing of the isolators shall conform to the latest revisions and amendments of the following standards

Sl. No.	Standard No	Title
1	IS: 2544	Porcelain post insulators for systems with normal voltages greater than 1000 volts
2	IS : 5350	----------do----------

4. **Climatic condition:**
   The equipment to be supplied under this specification shall be suitable for satisfactory operation under the following tropical humid conditions :-

Maximum temperature under hot sun	-	50 degree Centigrade
Minimum temperature of air in shade	-	4 degree Centigrade
Maximum relative humidity	-	95% (sometimes reaches saturation)
Average number of thunderstorm days per annum	-	40 days.
Average number of rainy day per annum	-	90 days.
Average annual rainfall	-	125 Cm.
Maximum wind pressure	-	150 kg/sq.mtr
Altitude above M.S.L.	-	1000 mtrs.

5. **Type and rating:**
   The porcelain shall be sound, free from defects thoroughly vitrified and smoothly glazed. The glaze should be brown in colour. Precautions shall be taken during design & manufacture to avoid the following:
   (a) Stresses due to expansion & contraction which may lead to deterioration,
   (b) Stresses concentration due to direct engagement of porcelain with the metal fitting,

(c) Retention of water in the recesses of metal fittings, and
(d) Shapes which do not facilitate easy cleaning by normal methods.

Cement used shall not cause fracture by expansion or loosening by contraction, and proper care shall be taken to locate correctly the individual parts during cementing. The cement shall not give to chemical reaction with metal fittings, and its thickness shall be as uniform as possible.

All ferrous metal parts, except those of stainless steel, shall be hot-dip galvanized and the uniformity of Zinc coating shall satisfy the requirements of IS:2633-1964.The parts shall be galvanized surface shall be smooth.

The threads of the tapped holes in the post insulators metal fittings shall be cut after giving anti-corrosion protection and shall be protected against rust by greasing or other similar means all other threads shall be cut before giving anti-corrosion protection.The tapped holes shall be suitable for bolts with threads having anti corrosion protection & shall conform to IS:4218(part I to IV).The effective length of thread shall be not less than the nominal diameter of the bolt.

The post insulator unit shall be assembled in a suitable jig to ensure the correct positioning of the top and bottom metal fittings relative to one another. The faces of the metal fittings shall be parallel and at right angles to the axis of the insulator. And the corresponding holes in the top and bottom metal fittings shall be in a vertical plane containing the axis of the insulator.

6. **Principal parameters:**

The principal parameters for the solidcore insulators shall be as given below:

Voltage Class	**220KV**	**132KV**	**33KV**
a) Visible discharge test KV(RMS)	154	105	27
b) Dry one minute power frequency withstand test KV(RMS)	395	275	75
c) Wet one minute power frequency withstand test KV(RMS)	395	275	75
d) Power frequency puncture withstand test on units	1.3 times the actual dry flashover voltage	1.3 times the actual dry flashover voltage	1.3 times the actual dry flashover voltage
e) Impulse voltage withstand test KV(PEAK)	1050	550	170
f) UltimateTorsional strength (KNM)	4	3	3
g) Ultimate bending strength (KN)	8	4	4
h) Ultimate contilever strength	160KN	140KN	80KN
i) Height of the insulator (mm)	2300	1472	508
j) Creepage distance	6125 MM	3625 mm	900 mm
k) Top/ Bottom P.C.D.	127 / 225	127 /184	76/76

7. **Puncture voltage:**

The insulator should be puncture proof.

8. **Markings:**

Each post insulator shall be marked with following:-

a) Name & trade mark of the manufacurer, b) Month & Year of manufacture

9. **Tests:**

9.1 **Acceptance and routine test:**
Each solidcore insulator shall strictly comply with the requirements of all the type tests and shall be subjected to all routine tests stipulated in the relevant standard. All routine tests shall be made prior to despatch in the presence of the representative of the CSPTCL.

9.2 **Type tests:** All the equipments offered should be fully type tested as per the relevant standards IS 2544- 1973& following type test certificates should invariably be produced with tender.

1	Visual examination
2	Verification of dimensions
3	Visible discharge test
4	Impulse voltage withstand test
5	Dry power frequency voltage withstand test
6	Wet power frequency voltage withstand test
7	Temperature cycle test
8	Test for mechanical strength
9	Puncture test (for insulators type-B only)
10	Porosity test
11	Galvanizing test

***

33. TECHNICAL SPECIFICATION FOR TRANSFORMER OIL FILTRATION PLANT

1.1 **SCOPE**

i) The specification provides for design manufacture testing before dispatch and delivery of the Transformer oil filtration plant. The scope covers supply of 1 No. 6000 Liters filtration plant.

ii) Technical specifications

iii) The filtration plants shall be designed such that the oil is first phased through magnetic separator/coarse filter and strainer, followed by heating chamber, filter system and finally to the degassing chamber where it is subjected to vacuum treatment which dehydrates and degasifies the oil completely. The treated oil thus obtained shall be free from all solid impurities, colloidal matter, dissolved gases, water and volatile acids.

1.2 The plant shall be fully mobile mounted on undercarriage with pneumatic tyres. Arrangement for connection to truck or jeep prime mover shall be made depending on plant weight i.e. toeing facility. Automatic brakes shall be provided.

Description of Plant:

a) The plants should be able to remove 99.9 % of particles of 1 to 4 microns.

b) Initial water content should be taken as 80 ppm and initial gas content in the oil should be taken as 10 % with these initial values, the plant should be capable of reducing the water content to 5 ppm or less and gas content should be reduced to 0.2 %.

c) It should be noted that the above reduction in water content and gas content should be achieved in 3 to 5 passes but in any case not exceeding 5 passes.

d) While the Developer may offer his own design, it may be noted that the plant should be capable of producing vacuum not less the 10 torr, in the first pass and in the final passes the plant should produce a vacuum of less the 1 torr. This is the oil to excessive limit.

e) For the above purpose the oil should not be heated beyond 70°C. Thus keeping Maximum temperature limit of 70°C the plant should be capable of reducing water content to less the 5 ppm and gas content to 0.2 % in maximum of 5 passes.

f) Based on the temperature of 70°C contractor should offer heating arrangement. The heaters should be 2 or 3 banks with selectors switch and total capacity of heater should be justified based on the temperature 70°C.

g) The resistivity of oil treated by the filter machine should be above 500×10^{12} ohm /cm to 27° and 13×10^{12} ohm /cm at 90° C. Also the oil should withstand atleast 50 KV for one minute with 13 m.m. spheres 2.5 m.m. apart.

h) The tangent delta of treated oil should be below 0.005 at 90° C. and neutralisation value (total acidity max.) should be 0.03 mg/KOH/gm.

1.3 **FILTERING SYSTEM**:-

i) The developer shall provide filtering system of adequate capacity to ensure that plant offered is capable of producing end results as described under point no. 2 'Description of plant'. In this connection, the following may please be noted.

ii) Filtering system may consist of edge type filter in the form of closely compressed discs of specially treated paper. The oil from filter discs shall enter de-gasification chamber. Edge type filters shall be easily removable for maintenance purpose. For the purpose of cleaning edge type filters separate compressor with provision of air bottle of adequate capacity shall be made. The complete scheme which will form a part of main equipment shall be explained in details.

iii) Arrangements to indicate the pressure of compressed air should be done. Complete scheme for cleaning of filter system alongwith associated accessories shall be explained.

iv) Performance of filter plant design or heating system of the plants to develop designed vacuum shall be guaranteed for all variations in climatic conditions and altitude.

1.4 ACCESSORIES REQUIRED TO BE OFFERED WITH FILTER PLANTS:

i) Gear type input pump with pressure relief valve and flow control valve.
ii) Centrifugal type outlet pump, Vacuum pump of specified rating.
iii) Air compressor complete with storage tank pressure gauge and safety valve.
iv) Separate motors for input pump, output pump, vacuum pump and the air compressor.
v) Heating chamber with heating element.
vi) Two thermostats one on the heater chamber and another in the oil line.
vii) De-gassing chamber with Rasching ring.
viii) Magnetic strainer and preliminary filter on the input side.
ix) 2 Nos solenoid valves on the input and output side.
x) Inlet & outlet oil line valves and one additional valve for re-circulation and connecting the inlet and outlet system as shown in the drawing.
xi) Oil flow indicator on the outlet side.
xii) Pressure gauge on the inlet line and pressure gauge on the pressure tank of air compressor system.
xiii) Vacuum gauge of the required quality.
xiv) Vapour condenser system with condensate tank with required valves.
xv) Two flow switches, one for the low level of the oil and another for high level of oil.
xvi) Drain valves in the heating chamber and outlet line.
xvii) Thermometer range 0 - 150°C.
xviii) Non-return valve for the pump.
xix) Two nos hose pipes each of 15 metres length.
xx) Suitable control panel with mimic diagram.
xxi) Contractors, accessories and arrangements necessary for proper functioning of electrical system.

37. TECHNICAL SPECIFICATION FOR AUTOMATIC DATA LOGGING SYSTEM OF ENERGY METER

This feature is intended for local monitoring of Sub-station para meters on computer screen installed in control room. The objective shall be achieved with the help of customized software and hardware connection to energy meters. The data shall be collected through RS485 port on modbus / 103 / 61850 protocols. The data logging system shall be designed as per compatibility of installed IEDs. The system shall be separated from the one utilized for SAS. The automatic data logging system shall be implemented on the Secure Meters Ltd make 0.2s class meter.

1. **Graphical user interface (GUI) based software on Windows platform.**
2. **Online views** – Tabular and Graphical. The Substation SLD mimic shall be realized on computer screen.
3. **Meter Support** – The software shall acquire data from the Secure Meters Ltd make Premier meters over RS485 MODBUS.
4. **Viewing Online Data-** The software shall provide facility to monitor instantaneous electrical parameters on real time basis and disturbance recording. Online data can be viewed in graphical /tabular formats/substation SLD mimic.
5. **Extraction/Viewing Historical Data -** The load survey data shall be extracted for onward transmission. The software shall provide historical data views for analysis purpose.
6. **Group Definition -** The software shall provide facility for grouping of meters to define virtual meters. This feature shall be used for calculation of total energy consumed by a group of energy meters as well as computation of concurrent maximum demand and power factor for that group of meters.
7. **Alarm Management -** It shall provide User definable alarms for different parameters. These alarms shall be available for system monitoring on real time basis.
8. **E-mail Facility -** The software shall provide daily/weekly data in CSV (comma-separated values or character-separated values) format.
9. **Reports -** The software shall provide various types of reports like min-max, consumption, alarm data, interruption data, meter replacement, demand data, energy loss data etc.
10. **Data Import and Export -** The software shall have facility to import CSV files from a third party application. User should export the meter data to CSV format.
11. **System Architecture -** Single machine (MS Access database)
12. **Computer System Configuration -** Dual Core Processor, SDRAM-6GB, HDD-1000 GB, DVD Drive, Ethernet Card, Serial Ports -2 Nos, USB port, dual power supply, Color 29" LCD Monitor, Operating System – Windows 7, Laser Printer.

Customized reports should be generated. Format for log sheets will be provided by CSPTCL.

36. SUBSTATION AUTOMATION SYSTEM

1.0 GENERAL

1.1 The substation automation system shall be designed, manufactured, tested, installed and commissioned at the substation as per IEC-61850.

1.2 The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipment from Remote Control centre (RCC) as well as from Local Control Centre.

The SAS shall contain the following main functional parts:

- Bay control Intelligence Electronic Devices (IED s) for control and monitoring.
- Station Human Machine Interface (HMI)
- Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- Gateway for remote control via industrial grade hardware (to RCC) through I EC60870-5-1 01 and IEC 60870- 104 protocols.
- Gateway for remote supervisory control (to RSCC), the gateway should be able to communicate with RSCC on IEC 60870-5-101 protocol. The specific protocol to be implemented shall be asper GE's interoperability profile. It shall be the bidder's responsibility to integrate his offered system with existing RSCC system for exchange of desired data. The exact IO point shall be decided during detailed engineering
- Remote HMI.
- Peripheral equipment like printers, display units, key boards, Mouse etc.

1.3. It shall enable local station control via a PC by means of human machine interface (HMI) and control software package, which shall contain an extensive range of supervisory control and data acquisition (SCADA) functions.

1.4. It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. An architecture drawing for SAS is enclosed.

1.5. The communication gateway shall facilitate the information flow with remote control centres. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection, and monitoring functions.

2. System design

2.1 General system design

The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions as given in Section-Project.

The systems shall be of the state-of-the art suitable for operation under electrical environment present in Extra high voltage substations, follow the latest engineering practice, ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The offered SAS shall support remote control and monitoring from Remote Control centres via gateways.

The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training.

The system shall incorporate the control, monitoring and protection functions specified, self-monitoring, signalling and testing facilities, measuring as well as memory functions, event recording and evaluation of disturbance records.

Maintenance, modification or extension of components may not cause a shutdown of the whole substation automation system. Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

Bidder shall offer the Bay level unit (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer), bay mimic along with relay and protection panels and PLCC panels (described in other sections of technical specifications) housed in air-conditioned Bay roomssuitably located in switchyard and Station HMI in Control Room building for overall optimisation in respect of cabling and control room building.

2.2 System architecture

The SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence.

Functions shall be decentralized, object-oriented and located as close as possible to the process.

The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e. in a station and a bay level.

At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands. The IEDs should be directly connected to the switchgear without any need for additional interposition or transducers.

Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fibre-optic cables, thereby guaranteeing disturbance free communication. The fibre optic cables shall be run in G I conduit pipes. Data exchange is to be realised using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure.

(a) The communication shall be made in 1+1 mode, including the links between individual bay IEDs to switch, such that failure of one set of fibre and/or the switch shall not affect the normal operation of the SAS. However it shall generate alarm in SAS. Each fibre optic cable shall have four (4) spare fibres. Two numbers of Ethernet switches shall be used per bay marshalling room and these shall have sufficient numbers of spare ports. Two Numbers BCUs shall be used with each 220 KV. 01 No. BCU shall be used with 132 KV and 33 KV Bay. The BCU and all the major numerical protective relays shall have two nos of Ethernet ports shall support PRP on IEC62439-3 .

At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.

Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e. RCC, station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level. The station level contains the station-oriented functions, which cannot be realised at bay level, e.g. alarm list or event list related to the entire substation, gateway for the communication with remote control centres.

The GPS time synchronising signal (as specified in the section relay & protection) for the synchronization of the entire system shall be provided. A Visual Display Unit shall also be provided along with GPS at local control centre.

The SAS shall contain the functional parts as described in para 1.2 above.

2.3 FUNCTIONAL REQUIREMENTS

The high-voltage apparatus within the station shall be operated from different places:

> Remote control centres
> Station HMI.
> Local Bay controller IED (in the bays)

Operation shall be possible by only one operator at a time.

The operation shall depend on the conditions of other functions, such as interlocking, synchrocheck, etc. (see description in "Bay level control functions").

2.3.1 Select-before-execute

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

2.3.2 Command supervision

Bay/station interlocking and blocking

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.
In addition to software interlocking hardwired interlocking are to be provided for:

(a) Bus Earth switch Interlocking
(b) Transfer Bus interlocking (if applicable)

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.
A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

2.3.3 Run Time Command cancellation

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

2.3.4 Self-supervision

Continuous self-supervision function with self-diagnostic feature shall be included.

2.3.5 User configuration

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.
It shall also be possible to interconnect and derive input and output signals, logic functions, using built-In functions, complex voltage and currents, additional logics (AND-gates, OR gates and timers). (Multi-activation of these additional functions should be possible).
The Functional requirement shall be divided into following levels:

a. Bay (a bay comprises of one circuit breaker andassociated disconnector, earth switches and instrument transformer) Level Functions.
b. System Level Functions

3.1. Bay level functions

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

- Bay control functions **including data collection functionality.**
- Bay protection functions

Separate IEDs shall be provided for bay control function and bay protection function.

3.1.1. Bay control functions

3.1.1.1. Overview

Functions

- Control mode selection
- Select-before-execute principle
- Command supervision:
  - Interlocking and blocking
  - Double command
- Synchrocheck, voltage selection
- Run Time Command cancellation
- Transformer tap changer control (for power transformer bays)
- Operation counters for circuit breakers and pumps
- Air compressor control and runtime supervision
- Operating pressure supervision
- Display of interlocking and blocking
- Breaker position indication per phase
- Alarm annunciation
- Measurement display
- Local HMI (local guided, emergency mode)
- Interface to the station HMI.
- Data storage for at least 500 events
- Extension possibilities with additional I/O's inside the unit or via fibre-optic communication and process bus

3.1.1.2. Control mode selection

Bay level Operation:

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation bay control unit allows the safe operation of all switching devices via the bay control IED.

EMERGENCY Operation

It shall be possible to close or open the selected Circuit Breaker with ON or OFF push buttons even during the outage of bay IED.

REMOTE mode

Control authority in this mode is given to a higher level (Remote Control Centre) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

3.1.1.3. Synchronism and energizing check

The synchronism and energizing check functions shall be bay-oriented and distributed to the bay control and/or protection devices. These features are:

> Settable voltage, phase angle, and frequency difference.

> Energizing for dead line - live bus, live line - dead bus or dead line – dead bus with no synchro-check function.

> Synchronising between live line and live bus with synchrocheck function

Voltage selection

The voltages relevant for the Synchrocheck functions are dependent on the station topology, i.e. on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing is derived from the auxiliary switches of the circuit breakers, the isolator, and earthing switch and shall be selected automatically by the bay control and protection IEDs.

3.1.1.4. Transformer tap changer control

Raise and lower operation of OLTC taps of transformer shall be facilitated through Bay controller IED.

3.1.2. Bay protection functions

3.1.2.1. General

The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices as per section Relay & Protection.

IEDs, shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

Event and disturbance recording function

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. This shall give alarm if 70% memory is full. The disturbance recorder function shall be as per detailed in section C&R

3.2. System level functions

3.2.1. Status supervision

The position of each switchgear, e.g. circuit breaker, isolator, earthing switch, transformer tap changer etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station HMI screen, recorded in the event list, and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.

The switchgear positions shall be indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

The SAS shall also monitor the status of sub-station auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analogue values shall be monitored and recoded through these IED.

3.2.2. Measurements

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz), and the rms values for voltage (U) and current (I) shall be calculated.

The measured values shall be displayed locally on the station HMI and in the control centre. The abnormal values must be discarded. The analogue values shall be updated every 2 seconds. Threshold limit values shall be selectable for alarm indication.

Secure Meters Ltd make Energy meter data shall also be integrated into the Substation System for display of instantaneous values, data logging, data storage and data processing to present the data as customised report. The instantaneous values of V, I, P, Q and F shall be displayed as per SLD in a separate SAS screen. Any deviation in this regard shall be subject to CSPTCL's specific approval.

3.2.3. Event and alarm handling

Events and alarms are generated either by the switchgear, by the control IEDs, or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 ms.

3.2.4. Station HMI

3.2.4.1. Substation HMI Operation:

On the HMI the object has to be selected first. In case of a blocking or interlocking conditions are not met, the selection shall not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction, and the appropriate control execution button shall be pressed in order to close or open the corresponding object.

Control operation from other places (e.g. REMOTE) shall not be possible in this operating mode.

3.2.4.2. Presentation and dialogues

General

The operator station HMI shall be a redundant with hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks or keyboard commands.

The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.

An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from any screen selected by the operator. A Visual Monitoring Unit of size 55 (fifty Five) inches or bigger shall additionally be provided for ease in monitoring at the Control room.

The following standard pictures shall be available from the HMI:

> Single-line diagram showing the switchgear status and measured values (from BCU and Apex energy meter on separate screens)
> Control dialogues with interlocking and blocking details. **This control dialogue shall tell the operator whether the device operation is permitted or blocked and shall indicate the entire interlock sequence of that particular operation.**
> Measurement dialogues
> Alarm list, station / bay-oriented
> Event list, station / bay-oriented
> System status

3.2.4.3. HMI design principles

Consistent design principles shall be adopted with the HMI concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.The object status shall be indicated using different status colours for:

> Selected object under command
> Selected on the screen
> Not updated, obsolete values, not in use or not sampled
> Alarm or faulty state
> Warning or blocked
> Update blocked or manually updated
> Control blocked
> Normal state

3.2.4.4. Process status displays and command procedures

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.

In order to ensure a high degree of security against undesired operation, a "select-before-execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be ableto recognize the selected device on the screen, and all other switchgear shall be blocked. As communication between control centre and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the "execution" of the command the operated switching symbol shall flash until the switch has reached its new position.

The operator shall be in a position to execute a command only, if the switch is not blocked and if no interlocking condition is going to be violated. The interlocking statements shall be checked by the interlocking scheme implemented at bay and station level.

After command execution the operator shall receive a confirmation that the new switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

3.2.4.5. System supervision & display

The SAS system shall be comprehensively self-monitored such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links, and printers at the station level, etc.

3.2.4.6. Event list

The event list shall contain events that are important for the control and monitoring of the substation.The event and associated time (with1 ms resolution) of its occurrence has to be displayed for each event.The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer for at least one month. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

> Position changes of circuit breakers, isolators and earthing devices
> Indication of protective relay operations
> Fault signals from the switchgear
> Indication when analogue measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measurand.
> Loss of communication.

Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

> Date and time
> Bay
> Device
> Function e.g. trips, protection operations etc.
> Alarm class

3.2.4.7. Alarm list

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control centre. The alarm list shall substitute a

conventional alarm tableau, and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. The date and time of occurrence shall be indicated.

The alarm list shall consist of a summary display of the present alarm situation Each alarm shall be reported on one line that contains:

> The date and time of the alarm
> The name of the alarming object
> A descriptive text
> The acknowledgement state.

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, Unacknowledged and cleared, Acknowledged and persistent).

Filters for selection of a certain type or group of alarms shall be available as for events.

3.2.4.8. Object picture

When selecting an object such as a circuit breaker or isolator in the single-line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like

> Type of blocking
> Authority
> Local / remote control
> RSCC / SAS control
> Errors

etc.,shall be displayed.

3.2.4.9. Control dialogues

The operator shall give commands to the system by means of mouse click located on the single-line diagram. It shall also be possible to use the keyboard for command activation. Data entry is performed with the keyboard. Dedicated control dialogues for controlling at least the following devices shall be available:

> Breaker and disconnector
> Transformer tap-changer

3.2.5. User-authority levels

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus etc) within a certain user authorisation group. Each user shall then be given access rights to each group of objects, e.g.:

> Display only
> Normal operation (e.g. open/close of switchgear)
> Restricted operation (e.g. by-passed interlocking)
> System administrator

For maintenance and engineering purposes of the station HMI, the following authorisation levels shall be available:

> No engineering allowed
> Engineering/configuration allowed
> Entire system management allowed

The access rights shall be defined by passwords assigned during the log-in procedure. Only the system administrator shall be able to add/remove users and change access rights.

3.2.6. Reports

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

> Trend reports:

- Day (mean, peak)
- Month (mean, peak)
- Semi-annual (mean, peak)
- Year (mean, peak)

> Historical reports of selected analogue Values:

- Day (at 15 minutes interval)
- Week
- Month
- Year

It shall be possible to select displayed values from the database in the process display on-line. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.Following printouts shall be available from the printer and shall be printed on demand:

i. Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.
ii. Weekly trend curves for real and derived analogue values.
iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.
iv. Provision shall be made for logging information about breaker status like number of operation with date and time indications.
v. Equipment operation details shift wise and during 24 hours.
vi. Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Positions, temperature and status of pumps and fans for transformers.
vii. Printout on adjustable time period as well as on demand system frequency and average frequency.
viii. Reports in specified formats which shall be handed over to successful bidder.
ix. Energy balance report of the 220,132 & 33 KV buses daily and monthly basis from both BCU metering and energy meterof Secure Energy Meter. Formats of specified customised reports for Energy meters shall be provided to the successful bidder.

3.2.7. Trend display (historical data)

It shall be possible to illustrate all types of process data as trends - input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

3.2.8. Automatic disturbance file transfer

All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded (event triggered or once per day) to a dedicated computer and be stored on the hard disc.

3.2.9. Disturbance analysis

The PCbased work station shall have necessary software to evaluate all the required information for proper fault analysis.

3.2.10. IED parameter setting

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters or the activation of parameter sets shall only be allowed after entering a password.

3.2.11. Automatic sequences

The available automatic sequences in the system should be listed and described, (e.g. sequences related to the bus transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences.

3.3. Gateway

3.3.1 Communication Interface

The Substation Automation System shall have the capability to support simultaneous SCADA protocols for communications with multiple independent remote master stations viz IEC 60870-101 and IEC 60870 -104

The Substation Automation System shall have communication ports as follows:

(a) Two ports for Remote Control Centre
(b) Two ports for Regional System Coordination Centre (RSCC)

The communication interface to the SAS shall allow scanning and control of defined points within the substation automation system independently for each control centre. The substation automation system shall simultaneously respond to independent scans and commands from employer's control centres (RCC & RSCC). The substation automation system shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each remote control centre. Also, each control centre's data scan and control commands may be different for different data points within the substation automation system's database.

Hardware capability : It shall havea flexible high performance expandablediscless & fanless plateform . It should be powered by 1 GHz or better processor.It shall have networked time protocol (NTP) & IRIG B format time protocol support. It shall have centralised user authentication .It shall have built in calculative function (Math /logic).It shall have dual redundant hot swappable power supplies ensuring continuous uptime.

3.3.2 Remote Control Centre Communication Interface

CSPTCL will supply communication channels between the Substation Automation System and the remote control centre. The communication channels provided by CSPTCL will consist either of power line carrier, microwave, optical fibre, VSAT or leased line , the details of which shall be provided during detailed Engineering . The contractor shall arrange for necessary software Licences for complete control and monitoring from the Remote Control Centre.

3.3.3 **Interface equipment:**

The Contractor shall provide interface equipment with licensed software and hardware for communicating between between Substation Automation system and Remote control centreand between Substation Automation system and Regional System Coordination

Centre (RSCC) for control and monitoring. However, the communication channels shall be made available for this purpose by the CSPTCL.

In case of PLCC communication, any modem supplied shall not require manual equalization and shall include self-test features such as manual mark/space keying, analogue loop-back, and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. **The modem should be stand alone complete in all respects including power supply to interface the SAS with communication channel.** The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem. All necessary hardware and software shall also be in the scope of bidder except the communication link along with communication equipment between substation control room and Remote Control Centre.

3.3.4 Communication Protocol

The communication protocol for gateway to control centre must be open protocol and shall support IEC 60870-5-101,104 and IEC 61850 for all levels of communication for sub-station automation such as Bay to station HMI, gateway to remote station etc..

4.0 System hardware:

4.1 Redundant Station HMI, HMI View Node, Remote HMI andDisturbance Recorder Work station:

The contractor shall provide redundant station HMI in hot standby mode.

It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components. Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 30% of disk space:

1. Storage of all analogue data (at 15 Minutes interval)and digitaldata including alarm, event and trend data for thirty(30) days,
2. Storage of all necessary software,
3. 1000 GB space for OWNER'S use.

Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

4.1.1 **HMI (Human Machine Interface)**

The VDU shall show overview diagrams (Single Line Diagrams) andcomplete details of the switchgear with a colour display. All event andalarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, decluttering etc.

4.1.2 Visual Display Units/ TFT's (Thin Film Technology)

The contractor shall provide at least four display units, one for station HMI, one for redundant HMI and one for DR work station and a bigger one for easy viewing of station HMI . These shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 29" diagonally in size and capable of colour graphic displays.

The display shall accommodate resolution of 1280 X 1024 pixels or better.

A 55 Inches or bigger size Visual Display LED full HD unit of very good resolution and capable of colour graphics shall be employed for easy viewing of station HMI from anywhere in the control room. The two HMI workstations shall have dual monitor ports

so that the larger 55" Monitor may be connected on any of these as Monitor of station HMI.

4.1.3 Dot Matrix Printer (As per the choice of the CSPTCL)

It shall be robust & suitable for operation with a minimum of 132 characters per line. The printing operation shall be quiet with a noise level of less than 45 dB suitable for location in the control room. Printer shall accept and print all ASCII characters via master control computer unit interface.

The printer shall have in built testing facility. Failure of the printer shall be indicated in the Station HMI. The printer shall have an off line mode selector switch to enable safe maintenance. The maintenance should be simple with provisions for ease of change of print head, ribbon changing, paper insertion etc.

All printers mounted in the control room shall be provided with a separate printer enclosure each. The enclosure shall be designed to permit full enclosure of the printers at a convenient level. Plexiglas windows shall be used to provide visual inspection of the printers and ease of reading. The printer enclosures shall be designed to protect the printers from accidental external contact & each should be removable from hinges at the back and shall be provided with lock at the front.

All reports and graphics prints shall be printed on laser printer. One dot matrix printer shall be exclusively used for hourly log printing.

All printers shall be continuously on line.

i. SERVER/WORK STATION

The server/Industrial PCs shall have following or better specifications ;

Specifications for SCADA servers – Main & standby with OS software

Xeon ®Processor E5504 (2.00GHz, 6MB L3 Cache, 80W,DDR3-800)/Integrated 1x4 MB L3 cache/6 GB(2X2 GB) PC3 10600E PC3-Un-buffered ECC memory/1000GB* 2 Nos SATA 7.2k NHP 3.5" NHP HDD /Embedded NC 107i PCI Express Gigabit Server Adapter/RAID 0,1,0+1/ 460W Non-Hot Plug,Non-redundant Power Supply(70% efficiency)/ Half-Height SATA DVD-ROM Optical Drive/3-1-1 Warranty. DUAL MONITOR PORT.

Specifications for SCADA DATABASE Server –Monitors &OS software

Xeon® Processor E5620(2.40GHz, 12MB L3 Cache ,80W,DDR3-1066, HT ,TURBO (1/1/2/2) /12MB (1X12MB) L3 cache/6GB (3X2GB)PC3-10600R(DDR3-1333)Registered DIMMs/Embedded NC326i PCI Express Dual Port Gigabit Server Adapter/Embedded Smart Array P410i/256MB C t II /(8) SFF SAS/SATA HDD Bays; up gradable to (16) /SATA DVD ROM/(1) 460 Watt Hot –Plug (Redundancy enabled)power supply/3 fans ship standard/5u/3-3-3 Warranty/Keyboard & Optical Mouse/29" TFT Monitor.

HMI Server/Operator Work Station(OWS) & DR PC with Monitor & OS Software

7100 CORE I3 540/4GB DDR3 RAM/320 GB HDD/WIN 7 PROFESSIONAL/DVD WRITER/KEYBOARD & OPTICAL MOUSE/29" TFT MONITOR/3-3-3 WARRANTY/ PCI DUAL PORT LAN CARD

4.1.5 Switched Ethernet Communication Infrastructure:

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS. The bidder shall keep provision of 100% spare capacity for employer use. Each IED of each 220KV , 132 KV & 33 KV yard shall be connected to TwoEthernet switches in Bay Marshalling Room/control roomto communication infrastructure on PRP network protocol.

4.2 Bay level unit

The bay unit shall use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select-before-operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation commands from station HMI and control centre. The bay unit shall have the capability to store all the data for at least 24 hours. Two numbers Ethernet switches shall be provided per Bay control room for redundancy of Ethernet switches.

Two nos. Bay level unit shall be provided for supervision and control of each 220 KV bay and one Number Bay level unit shall be provided for each 132 KV & 33 KV bay (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer). The Bay level unit shall be equipped with analogue and binary inputs/ outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.

The Bay level unit shall meet the requirements for withstandingelectromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

4.2.1 Input/Output (I/O) modules

The I/O modules shall form a part of the bay level unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear. The measured values of voltage and current shall be from the secondaries of instrument transformers. The digital inputs shall be acquired by exception with 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state. There shall be 25 % spare each ofinput and output contacts over and above that utilised for the complete scheme per bay control unit.

4.3 Air-conditioned Bay Marshalling Rooms

The Air-conditioned bay Rooms offered shall house Bay level units, bay mimic, relay and protection panels, PLCC panels etc. as per tender specification. The layout of equipment/panel shall be subject to Owner's approval.A tentative drawing of the bay marshalling room is enclosed with the tender. The Rooms shall be provided with fire alarm system with at least two detectors and it shall be wired to SAS. Two nos physically independent split air conditioners of at least 2T capacity each shall be provided with auto change over scheme. The air conditioner provided in Bay Room shall be controlled and monitored from substation automation system. One additional Room for each voltage level, if required, shall be provided for housing bus bar protection panels at suitable location in switchyard.

4.4 Extendibility in future

Offered substation automation system shall be suitable for extension in future for additional bays. During such requirement, all the drawings and configurations, alarm/event

list etc. displayed shall be designed in such a manner that its extension shall be easily performed by the employer. During such event, normal operation of the existing substation shall be unaffected and system shall not require a shutdown. The contractor shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analogue variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipment which shall be added in future.

5.0 Software structure

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance, modification or an extension of components of any feeder may not force a shut-down of the parts of the system which are not affected by the system adaptation.

5.1.1 Station level software

5.1.1.1 Human-machine interface (HMI)

The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and system configuration. The systemshall be easy to use, to maintain, and to adapt according to specific user requirements. Systems shall contain a library with standard functions and applications.

5.1.2 Bay level software

5.1.1.1 System software

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software along with hardware shall be capable of automatically synchronising with the remaining system without any manual interface. This shall be demonstrated by contractor during integrated system test.

5.1.1.2 Application software

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of a library.

The application software within the control/protection devices shall be programmed in a functional block language.

5.1.1.3 Network Management System:

The contractor shall provide a network management system software for following management functions:

a. Configuration Management
b. Fault Management
c. Performance Monitoring

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR workstation and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any fault in the monitored devices. The NMS shall

(a) Maintain performance, resource usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.
(b) Maintain a graphical display of SAS connectivity and device status.
(c) Issue alarms when error conditions occurs
(d) Provide facility to add and delete addresses and links

5.1.1.4 The contractor shall provide each software in two copies in CD to load into the system in case of any problem related with Hardware/ Communication etc.

6.0 TESTS

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV sub-station equipment installed in sheltered area in the outdoor switchyard and specified ambient conditions:

6.1 Type Tests:

6.1.1 Control IEDs and Communication Equipment:

a. Power Input:

i. Auxiliary Voltage
ii. Current Circuits
iii. Voltage Circuits
iv. Indications

b. Accuracy Tests:

i. Operational Measured Values
ii. Currents
iii. Voltages
iv. Time resolution

c. Insulation Tests:

i. Dielectric Tests
ii. Impulse Voltage withstand Test

d. Influencing Quantities

i. Limits of operation
ii. Permissible ripples
iii. iii. Interruption of input voltage

e. Electromagnetic Compatibility Test:

i. 1 MHZ. burst disturbance test
ii. Electrostatic Discharge Test
iii. Radiated Electromagnetic Field Disturbance Test
iv. Electrical Fast transient Disturbance Test
v. Conducted Disturbances Tests induced by Radio Frequency Field
vi. Magnetic Field Test
vii. Emission (Radio interference level) Test.
viii. Conducted Interference Test

f. Function Tests:

i. Indication
ii. Commands
iii. Measured value Acquisition
iv. Display Indications

g. Environmental tests:

i. Cold Temperature
ii. Dry Heat
iii. Wet heat
iv. Humidity (Damp heat Cycle)
v. Vibration
vi. Bump
vii. Shock

6.2 Factory Acceptance Tests:

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IED's applicable type test certificates shall be submitted. **The manufacturing and configuration phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab. During FAT the entire Sub-station Automation System including complete control and protection system to be supplied under present scope shall be tested for complete functionality and configuration in factory itself. The extensive testing shall be carried out during FAT. The purpose of Factory Acceptance Testing is to ensure trouble free installation at site. No major configuration setting of system is envisaged at site**.

6.3 Integrated Testing;

6.3.1 Hardware Integration Tests:

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests. The vendor specifically demonstrates how to add a device in future in SAS during FAT. The device shall be from a different manufacturer than the SAS supplier

6.3.2 Integrated System Tests:

Integrated system tests shall verify the stability of the hardware and the software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period. The integrated system test shall ensure the SAS is free of improper interactions between software and hardware while the system is operating as a whole.

6.4 Field Tests:

The field tests shall completely verify all the features of SAS hardware and software.

7.0 SYSTEM OPERATION

7.1 Substation Operation

7.1.1 NORMAL OPERATION

Operation of the system by the operator from the remote RCC or at the substation shall take place via industry standard HMI (Human Machine interface) subsystem consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse).

The coloured screen shall be divided into 3 fields :

i) Message field with display of present time and date
ii) Display field for single line diagrams
iii) Navigation bar with alarm/condition indication

For display of alarm annunciation, lists of events etc, a separate HMI View node shall be provided.

All operations shall be performed with mouse and/or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the

command field (i.e. operator prompting). For control actions, the switchgear (i.e. circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys. The switching element selected shall then appear on the background that shall be flashing in a different color. The operator prompting shall distinguish betweenPrompting of indications e.g. fault indications in the switchgear, andprompting of operational sequences e.g. execution of switching operations.

The summary information displayed in the message field shall give a rapid display of alarm/message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described.

Each operational sequence shall be divided into single operation steps which are initiated by means of the function keys/WINDOW command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicated by comments in the message field and must not be executed.

The offer shall include a comprehensive description of the system. The above operation shall also be possible via WINDOWS based system by mouse.

8.0 POWER SUPPLY

Power for the substation automation system shall be derived from substation 220V DC system.

Inverter of suitable capacity shall be provided for station HMI and its peripheral devices e.g. printer etc. In the event of Power failure, necessary safeguard software shall be built for proper shutdown and restart.

9.0 DOCUMENTATION

The following documents shall be submitted for employer's approval during detailed engineering:

(a) System Architecture Drawing
(b) Hardware Specification
(c) Sizing Calculations of various components
(d) Response Time Calculation
(e) Functional Design Document

The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported, and of similar look/feel. All CAD drawings t be provide in "dxf" format.

- List of Drawings
- Substation automation system architecture
- Block Diagram

D e s i g n S p e c i f i c a t i o n a n d Guaranteed availability and reliability

- Calculation for power supply dimensioning
- I/O Signal lists
- Schematic diagrams
- List of Apparatus
- List of Labels
- Logic Diagram (hardware & software)
- Bay Room layout drawing
- GA of Bay Room and GTP

- Control Room Lay-out
- Test Specification for Factory Acceptance Test (FAT)
- Product Manuals
- Assembly Drawing
- Operator's Manual
- Complete documentation of implemented protocols between various elements
- Listing of software and loadable in CD ROM
- Other documents as may be required during detailed engineering

Two sets of hard copy and Four sets of CD ROM containing all the as built documents/drawings shall be provided.

10.0 TRAINING, SUPPORT SERVICES, MAINTENANCE ANDSPARES

10.1 Training

Contractor personnel who are experienced instructors and who speak understandable English shall conduct training. The contractor shall arrange on its own cost all hardware training platform required for successful training and understanding in India. The Contractor shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. These materials shall be sent to Employer at least two months before the scheduled commencement of the particular training course. Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of Employer. Employer reserves the right to copy such materials, but for in-house training and use only. Hands-on training shall utilize equipment identical to that being supplied to Employer.

For all training courses, the travelling (e.g., airfare) and lodging expenses will be borne by the participants.

The schedule, location, and detailed contents of each course will be finalized during Employer and Contractor discussions.

10.2 Computer System Hardware Course

A computer system hardware course shall be offered, but at the system level only. The training course shall be designed to give Employer hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs, and communicate with contract maintenance personnel. The following subjects shall be covered:

(a) System Hardware Overview: Configuration of the systemhardware.

(b) Equipment Maintenance: Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, LANs, routers and printers. Configuration of all the hardware equipments.

(c) System Expansion: Techniques and procedures to expand and add equipment such as loggers, monitors, and communication channels.

(d) System Maintenance: Theory of operation and maintenance ofthe redundant hardware configuration, failover hardware, configuration controlpanels, and failover switches.
Maintenance of protective devices and power supplies.

(e) Subsystem Maintenance: Theory of design and operation, maintenance techniques and practices, diagnostic procedures, and (where applicable) expansion techniques and procedures. Classes shall include hands-on training for the specific.

subsystems that are part of Employer's equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be taught in detail.

(f) Operational Training: Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments. This training shall be provided on Employer equipment, or on similarly configured systems.

10.3 Computer System Software Course

The Contractor shall provide a computer system software course that covers the following subjects:

(a) System Programming: Including all applicable programming languages and all stand-alone service and utility packages provided with the system. An introduction to software architecture, Effect of tuning parameters (OS software, Networksoftware, database software etc.) on the performance of the system.

(b) Operating System: Including the user aspects of the operating system, such as program loading and integrating procedures; scheduling, management, service, and utility functions; and system expansion techniques and procedures

(c) System Initialization and Failover: Including design, theory of operation, and practice

(d) Diagnostics:Including the execution of diagnostic proceduresand the interpretation of diagnostic outputs,

(e) Software Documentation: Orientation in the organization and useof system software documentation.

(f) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.4 Application Software Course

The Contractor shall provide a comprehensive application software courses covering all applications including the database and display building course. The training shall include:

(a) Overview: Block diagrams of the application software and data flows. Programming standards and program interface conventions.

(b) Application Functions: Functional capabilities, design, and major algorithms. Associated maintenance and expansion techniques.

(c) Software Development: Techniques and conventions to be used for the preparation and integration of new software functions.

(d) Software Generation: Generation of application software from source code and associated software configuration control procedures.

(e) Software Documentation: Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.

(f) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.5 Requirement of training:

The contractor shall provide training for two batches for two weeks each for following courses.

S. No.	**Name of Course**
1	Computer System Hardware
2	Computer System Software
3	Application Software

11.0 Maintenance

11.1 Maintenance Responsibility during the Guaranteed Availability Period.

During Guaranteed Availability Period, the Contractor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational.

12.0 RELIABILITY AND AVAILABILITY

The SAS shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

- Mechanical and electrical design
- Security against electrical interference (EMI)
- High quality components and boards
- Modular, well-tested hardware
- Thoroughly developed and tested modular software
- Easy-to-understand programming language for application programming
- Detailed graphical documentation and application software
- Built-in supervision and diagnostic functions
- Security
  - Experience of security requirements
  - Process know-how
  - Select before execute at operation
  - Process status representation as double indications
- Distributed solution
- Independent units connected to the local area network
- Back-up functions
- Panel design appropriate to the harsh electrical environment and ambient conditions
- Panel grounding immune against transient ground potential rise

Outage terms

1) Outage

The state in which substation automation system or a unit of SAS is unavailable for Normal Operation as defined in the clause 7.1 due to an event directly related to the SAS or unit of SAS. In the event, the owner has taken any equipment/ system other than Sub-station Automation System for schedule/forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

2) Actual outage duration (AOD)

The time elapsed in hours between the start and the end of an outage. The time shall be counted to the nearest 1/4th of an hour. Time less than $1/4^{th}$ of an hour shall be counted as having duration of $1/4^{th}$ of an hour.

3) Period Hours (PH)

The number of hours in the reporting period. In a full year the period hour are 8760h (8784h for a leap year).

4) Actual Outage hours (AOH) The sum of actual outage duration within the reporting period

$AOH = \sum AOD$

5) Availability:

Each SAS shall have a total availability of 99.98 % i.e. the ratio of total time duration minus the actual outage duration to total time duration.

12.1 Guarantees Required

The availability for the complete SAS shall be guaranteed by the Contractor. Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole after commissioning of total Sub-station Automation system. The test shall verify the reliability and integrity of all sub-systems. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 1000 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test, the contractor shall rectify the problem and after rectification, the 1000 Hours period start after such rectification. If test object has not been met the test shall continue until the specified availability is achieved.

The contractor has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability criterion, the test is considered to be completed successfully. After that the system shall be taken over by the employer and then the guarantee period shall start.

13.0 Spares

13.1 Consumables:

All consumables such as paper, cartridges shall be supplied by the contractor till the SAS is taken over by the owner. .

13.2 Availability Spares:

In addition to mandatory spares as listed for SAS, the bidder is required to list the spares, which may be required for ensuring the guaranteed availability during the guaranteed availability period. The final list of spares shall form part of scope of supply and accordingly the price thereof shall be quoted by the bidder and shall be considered in the evaluation of the bids. During the guaranteed availability period, the spare parts supplied by the Contractor shall be made available to the Contractor for usage subject to replenishment at the earliest. Thus, at the end of availability period the inventory of spares with the Employer shall be replenished by the Contractor. However, any additional spares required to meet the availability of the system (which are not a part of the above spares supplied by the Contractor) would have to be supplied immediately by the Contractor free of cost to the Employer.

14.0 LIST OF EQUIPMENTS

Quantity of equipments shall be decided by bidder in order to achieve guaranteed reliability and availability as declared by bidder.

Following Minimum Quantity of equipments (but not limited to) shall be supplied;

i) SCADA servers (in Hot-stand by mode) : Two nos with 29 Inch LED Monitor each
ii) SCADA standby server : 1 Nowith 29 Inch LED Monitor
iii) Station HMI and Redundant Station HMI (in Hot-stand by mode HMI): Two nos (OWS 1 and 2) with 29 Inch LED Monitors
iv) Large 55" VDU as specified : 1 no
v) Engg and Disturbance Recorder Work Station with 29 Inch LED Monitor(Maintenance HMI): 1 No

vi) Two nos. Bay level unit shall be provided for supervision and control of each 220 KV bay and one Number Bay level unit shall be provided for each 132 KV & 33 KV bay (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer). (Price of bay Level unit included in Protection panels of Price Annexure B-1, B-2 & B-3)

vii) Each IED of each 220KV, 132 KV & 33 KV yard shall be connected to TwoEthernet switches in Bay Marshalling Room/control roomto communication infrastructure on PRP network protocol.(with 100 % redundant ports or two additional Ethernet switch to ensure redundancy of ports)

viii) Colour Laser Printer – 2 No. (For Reports & Disturbance records)

ix) Dot matrix printers – (one each for Alarms and log sheets)

x) All interface equipment for gateway to RCC and RSCC

xi) Communication infrastructure between Bay level units, Station HMI, Printers, redundant LAN etc. as required

xii) Gateways in Hot- Stand by mode along with two numbers modems each for local and remote ends (RCC and RSCC) also.

xiii) Remote workstation including HMI and along with one printer

xiv) Other equipments as detailed above in SAS section and any other necessary for SAS and not listed.

xv) One No. additional HMI view node (with 29 Inch LED Monitor) are to be provided in the office of Station incharge also.

xvi) 3 KVA or higher size inverters: 2 Nos

xvii) 1 KVA or higher size inverters as per requirement

Any other addition over and above this list of equipments shall be proposed by bidder and decided by CSPTCL as per tender specification in order to achieve guaranteed reliability and availability as declared by bidder.

Basic Monitoring requirements are:

- Switchgear status indication
- Measurements (U, I, P, Q, f)
- Event
- Alarm
- Winding temperature of transformers
- ambient temperature
- Status and display of 415V LT system, 220V & 48V DC system
- Status of display of Fire protection system and Air conditioning system.
- Acquisition of all counters in PLCC panels through potential free contacts from PLCC or independently by counting the receive/send commands.
- Acquisition of alarm and fault record from protection relays
- Disturbance records
- Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.
- Tap-position of Transformer

List of Inputs

The list of input for typical bays is as below:-

Analogue inputs

i) For line

Current R phase,Y phase, B phase

Voltage R-Y phase, Y-B phase, B-R phase

ii) For transformer
Current R phase, Y phase , B phase
WTI
Tap position

iii) For TBC and bus coupler
Current R phase, Y phase,B phase

iv) Common

a) Voltage for Bus-I, Bus-II and Transfer bus wherever applicable
VoltageR-Y phaseY-B phase B-R phase

b) Frequency for Bus-I and Bus-II

c) Ambient temperature (switchyard).

d) LT system
i) Voltage R-Y, Y-B, B-R of Main Switch Boardsection-I
ii) Voltage R-Y, Y-B, B-R of Main Switch Boardsection-II
iii) Voltage R-Y, Y-B, B-R of Diesel Generator
iv) Current from LT transformer-I
v) Current from Diesel Generator
vi) Voltage of 220V DCDB-I
vii) Voltage of 220V DCDB-II
viii) Current from 220V Battery set-I
ix) Current from 220V Battery set-II
x) Current from 220V Battery charger-I
xi) Current from 220V Battery charger-I
xii) Voltage of 48V DCDB-I
xiii) Current from 48V Battery set-I
xiv) Current from 48V Battery charger-I
xv) Voltage R-Y, Y-B, B-R of Main Switch Boardfor external LT supply

Digital Inputs

The list of input for various bays/SYSTEM is as follows:

Line bays

i) Status of each pole of CB, Isolator, Earth switch
ii) CB trouble
iii) CB operation/closing lockout
iv) Pole discrepancy optd
v) Trip coil faulty
vi) LBB optd
vii) Bus bar protn trip relay optd
viii) Main bkr auto recloser operated
ix) Tie/transfer auto recloser operated
x) A/r lockout
xi) Tie/transfer bkr a/r lockout
xii) Direct trip-I/II sent
xiii) Direct trip-I/II received
xiv) Main I/II blocking
xv) Main I/II-Inter trip send
xvi) Main I/II-Inter trip received
xvii) O/V STAGE – I operated
xviii) O/V STAGE – II operated
xix) FAULT LOCATOR FAULTY
xx) MAIN-I/II CVT FUSE FAIL
xxi) MAIN-I PROTN TRIP
xxii) MAIN-II PROTN TRIP
xxiii) MAIN-I PSB ALARM

xxiv) MAIN-I SOTF TRIP
xxv) MAIN-I R-PH TRIP
xxvi) MAIN-I Y-PH TRIP
xxvii) MAIN-I B-PH TRIP
xxviii) MAIN-I START
xxix) MAIN-I/II Carrier aided trip
xxx) MAIN-I/II fault in reverse direction
xxxi) MAIN-I/II ZONE-2 TRIP
xxxii) MAIN-I/II ZONE-3 TRIP
xxxiii) MAIN-I/II weak end infeed optd
xxxiv) MAIN-II PSB alarm
xxxv) MAIN-II SOTF TRIP
xxxvi) MAIN-II R-PH TRIP
xxxvii) MAIN-II Y-PH TRIP
xxxviii) MAIN-II B-PH TRIP
xxxix) MAIN-II start
xl) MAIN-II aided trip
xli) MAIN-I/II fault in reverse direction
xlii) Back-up o/c optd
xliii) Back-up e/f optd
xliv) 220V DC-I/II source fail
xlv) SPEECH CHANNEL FAIL
xlvi) PLCC Protection Channel-I FAIL
xlvii) PLCC Protection Channel-II FAIL

Transformer bays

i) Status of each pole of CB, Isolator, Earth switch
ii) CB trouble
iii) CB operation/closing lockout
iv) Pole discrepancy optd
v) Trip coil faulty
vi) LBB optd
vii) Bus bar protn trip relay optd
viii) REF OPTD
ix) DIFF OPTD
x) OVERFLUX ALARM (MV)
xi) OVERFLUX TRIP (MV)
xii) OVERFLUX ALARM (HV)
xiii) OVERFLUX TRIP (HV)
xiv) HV BUS CVT % FUSE FAIL
xv) MV BUS CVT % FUSE FAIL
xvi) OTI ALARM/TRIP
xvii) PRD OPTD
xviii) OVERLOAD ALARM
xix) BUCHOLZ TRIP
xx) BUCHOLZ ALARM
xxi) OLTC BUCHOLZ ALARM
xxii) OLTC BUCHOLZ TRIP
xxiii) OIL LOW ALARM
xxiv) back-up o/c (HV) optd
xxv) back-up e/f (HV)optd
xxvi) 220v DC-I/II source fail
xxvii) TAP MISMATCH
xxviii) GR-A PROTN OPTD
xxix) GR-B PROTN OPTD
xxx) back-up o/c (MV) optd
xxxi) back-up e/f (MV)optd

Busbar Protection

i) Bus bar main-I trip
ii) Bus bar main-II trip

iii) Bus bar zone-I CT open
iv) Bus bar zone-II CT open
v) Bus transfer CT sup. Optd
vi) Bus transfer bus bar protn optd
vii) Bus protection relay fail

Auxiliary system

i) Incomer-I On/Off
ii) Incomer-II On/Off
iii) 415V Bus-I/II U/V
iv) 415v bus coupler breaker on/off
v) DG set bkr on/off
vi) Alarm/trip signals as listed in Section: DG set
vii) LT transformer-I Bunchholz Alarm & trip
viii) LT transformer-II Bunchholz Alarm & trip
ix) LT transformer-I WTI Alarm & trip
x) LT transformer-II WTI Alarm & trip
xi) LT transformer-I OTI Alarm & trip
xii) LT transformer-II OTI Alarm & trip
xiii) PLCC exchange fail
xiv) Time sync. Signal absent
xv) Alarm/trip signals as listed in Section: Battery and Battery charger
xvi) 220v dc-I earth fault
xvii) 220v dc-II earth fault
xviii) Alarm/trip signals as listed in Section: Fire protection system
xix) Incomer of external power supply ON/OFF.
xx) External power supply transformer Buchholz Alarm & trip.
xxi) External power supply transformer WTI Alarm & trip.
xxii) External power supply transformer OTI Alarm & trip.

The exact number and description of digital inputs shall be as per detailed engineering requirement Apart from the above mentioned digital inputs, minimum of 200 inputs shall be kept for CSPTCL use in future.

Air-Conditioning of Bay Marshalling Room:

The air conditionings system shall be provided in the Bay marshalling Rooms to be used for housing panels having control and protection IEDs for performing sub-station automation and protection functions generally confirm to relevant IS codes. Two nos physically independent split airconditioners of Two tonnes each shall be provided with auto changeover scheme.The changeover scheme shall be presented for approval of CSPTCL. These bayrooms shall be placed in the switchyard area generally unmanned; therefore, the air-conditioning system shall be rugged, reliable, maintenance free and designed for long life.The control and monitoring of the Air conditioning system of Bay Marshalling Romms shall be integrated into Susb Station Automation System.

i Operation:

The air conditioning is required for critical application i.e. for maintaining the temperature for critical sub-station control and protection equipment. To provide redundancy for such critical applications, each bayroom shall be installed with environment control system comprising of two physically indepndent units of air conditioners working in conjunction through a micro processor based controller for desired operation. The system shall be designed for 24 Hours, 365 Days of the year to maintain the inside room temperature for proper operation of the critical equipment. One of the air-conditioner shall be running at a time and on failure of the same or as described hereunder, the other unit shall start automatically. To ensure longer life of the

system, the redundant units shall also be running in cyclic operation through the controller. However, during running of one air-conditioner unit, if inside temperature of the shelter reaches to a predefined (i.e. 32^{o}C), the other unit shall start running to maintain the temperature to specified value (i.e. 23+2^{o}C) and gives alarm for such situation. After achieving this temperature, the other unit shall again shut off.

ii. Sequence of Operation of the Unit:

Suitable arrangement shall be made to operate the unit in the following order. However, the actual operation arrangement shall be finalised during detailed engineering. 1.Evaporator Fan 2. Condenser Fan.3.Compressor

iii. Construction:

The air conditioning unit shall be split type. All components of the units shall be enclosed in a powder coated cabinet and colour of same shall be matched room. The unit shall be assembled, wired, piped, charged with refrigerant and factory tested as a system to ensure trouble free installation and start up. Suitable isolation or other by passing arrangement shall be provided such that any unit/component could be maintained/ repaired without affecting the running standby unit. The maintenance of unit shall be possible from outside the Bayroom.

iv. Required Features of Various Components:

The compressor shall be very reliable, trouble free and long life i.e. hermitically sealed Scroll type of reputed make suitable for operation. Compressor should be installed on vibration isolated mountings or manufacturer's recommended approved mounting. Valve shall be provided for charging/topping up of refrigerant. The bidder shall furnish details of their compressor indicating the MTBF, life of compressor and continuous run time of compressor without failure. The contractor shall also furnish details of all accessories i.e. refrigeration system, evaporator coil, condenser coil, evaporator blower filter, cabinet, indoor supply and return grill etc.

v. The Bay room shall be erected at least 500 mm above the finished ground level with suitable pedestal to avoid any entry of water.

Note:

1. The redundant managed bus shall be realized by high speed optical bus (1 GBPS/100 MBPS as per approval of CSPTCL) using industrial grade components and shall be as per IEC 61850. For 220kV yards, IED for two bays can be housed in one Bay room along with its switches.
2. Inside sub-station, connections shall be ralized as per IEC 61850 protocol.
3. For gateway, it shall communicate with Remote Supervisory Control Centre (RSCC) on IEC 60870-5-101 protocol.
4. The routine to Remote Control Centre (RCC) shal communicate on IEC 60870-5-101 and IEC 60870-5-104 protocol. .
5. The printer as required shall be connected to station bus directly and can be managed either from station HMI, HMI view node or disturbance recorder workstatio**.**

36. TECHNICAL SPCIFICATION FOR AIR CONDITIONING SYSTEM

1.0 GENERAL:-

1.1 This specification covers supply, installation, testing &commissioning of Air conditioning system for the control room building. Air conditioning units for control room building shall be so designed and set to maintain the following inside conditions.

DBT. 24.4º C ± 2 º C

1.2 The following rooms shall be air conditioned –

i) Control room
ii) Bay marshalling rooms

1.3 Air conditioning requirement of rooms indicated above shall be met using split AC units. High wall type split AC units of 2TR capacity each with high wall type indoor evaporator unit shall be used for all rooms.

1.4 **Scope:-**

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

1.5 Fifteen (15) Nos of high wall type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.

1.6 Copper refrigerant piping complete with insulation between the indoor and remote outdoor condensers as required.

1.7 PVC drain piping from the indoor units up to the nearest drain point.

1.8 Power and control cabling between the indoor unit and outdoor unit and earthing.

1.9 MS brackets for outdoor condensing units, condensers as required.

2.0 **Specification for split AC units.**

2.1 The split AC units will be completed with indoor evaporator unit, outdoor condensing units and cordless remote control units.

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

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

2.4 The split AC units shall be Hitachi, Daikin make.

37. TECHNICAL SPECIFICATION FOR VISUAL MONITORING SYSTEM

Visual monitoring system for watch and ward of Substation premises

Visual monitoring system (VMS) for effective watch and ward of sub station premises covering the areas of entire switchyard, Control Room , stores and main gate, shall be provided. The contractor shall design, supply, erect, test and commission the complete system including cameras, Digital video recorder system, mounting arrangement for cameras, cables, LAN Switches, UPS and any other items/accessories required to complete the system. To provide all the necessary licenses to run the system successfully shall be in the scope of contractor .

System with Color IP Cameras for VMS surveillance would be located at variouslocations including indoor areas and outdoor switchyard and as per the direction of Engineer-In Charge. The VMS data partly/completely shall be recorded (minimum for 15 days) and stored on network video recorder.

The number of cameras and their locations shall be decided in such a way that any location covered in the area can be scanned. The cameras shall be located in such a way to monitor at least:

1.The operation of each and every isolator pole of the complete yard (including future scope)
2. All the transformer and reactors (Including future scope)
3.All the entrance doors of control room building and switchyard panel room.
4.All the gates of switchyard.
5.Main Entrance gate
6.All other Major Equipments (such as CB, CT, CVT, SA etc. for present and future)

The cameras can be mounted on structures, buildings or any other suitablemounting arrangement to be provided by the contractor.

1.1 Technical requirements of major equipment of Visual Monitoring System

1.1.1 The Video Monitoring system shall be an integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/automatic operation for best performance

1.1.2 The system should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users.

1.1.3 The system shall use video signals from various types of indoor/outdoor CC colour cameras installed at different locations, process them for viewing on workstations/monitors in the control Room and simultaneously record all the cameras after compression using **H 264**/MPEG 4 or better standard Mouse/Joystick-Keyboard controllers shall be used for Pan, Tilt, Zoom, and other functions of desired cameras.

1.1.4 The System shall provide sufficient storage of all the camera recordings for a period of 15 days or more @ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras. It shall be ensured that data once recorded shall not be altered by any means. The recording resolution and frame rate for each camera shall be user programmable

1.1.5 The surveillance VMS System shall operate on 230 V, 50 Hz single-phase power supply. System shall have back up UPS power supply meeting the power supply need of all the cameras in the stations including those which are installed at gate for a period of 2 hours. The bidder shall submit the sizing calculation for the UPS considering the total load requirement of Video Monitoring System

1.2 **System requirements**

a) System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording.

b) All cameras may be connected through a suitable LAN which shall be able to perform in 220 kV class sub-station environment without fail.

c) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

d) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

e) Facility of Camera recording in HD (1280X720p), D1 , 4CIF , CIF VGA, as well as in any combination i.e. any camera can be recorded in any quality.

f) System to have facility of **100%** additional camera installation beyond the originally planned capacity.

g) In order to optimize the memory, while recording, video shall be compressed using H **264** MPEG-4 or better standard and streamed over the IP network.

h) System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.

i) The offered system shall have facility to export the desired portion of clipping from a specific date/time to another specific date/time) on CD or DVD. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.

j) System shall have provision of WAN connectivity for remote monitoring.

k) The equipment should generally conform to Electro magnetic compatibility requirements for outdoor equipment in EHV switchyards. The major EMC required for Cameras and other equipment shall be as under.

1. Electrical Fast Transient (Level 4) – As per IEC 61000-4-4
2. Damped Oscillatory (1 MHz and 100 KHz) (level 3) – As per IEC 61000-4-12
3. AC Voltage Dips & Interruption/Variation (level 4) – As per IEC 61000-4-12
4. Electrostatic Discharge (Level 4) – As per IEC 61000-4-2
5. Power Frequency Magnetic Field (level 4) – As per IEC 61000-4-8
6. Ripple on DC Power Supply (level 4) – As per IEC 61000-4-17

Type test reports to establish compliance with the above requirement shall be submitted during detailed engineering.

1.2.1 VIDEO SURVEILLANCE APPLICATION SOFTWARE

a) Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of devices such as cameras, videoencoder, Servers, NAS boxes/Raid backup device etc.

b) The software should have inbuilt facility to store configuration of encoders and cameras.

c) The software should Support flexible 1/2/4/8/16/32 Windows Split screen display mode and scroll mode on the PC monitor.

d) The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and color balance of camera, Selection of presets, Video tour selection etc.

e) The software should have user access authority configurable on per device or per device group basis. The system shall provide user activity log with user ID, time stamp, action performed, etc.

f) The users should be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user.

g) It should have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time and camera-wise. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for eachrecording mode for each camera should be possible.

h) The software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.

i) Retrieval: The VMS application should allow retrieval of data instantaneously or any date / time interval chosen through search functionality of the application software. In case data is older than 15 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like DVD's or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system.

j) VMS shall provide the full functionality reporting tool which can provide reports for user login /logoff, camera accessibility report, server health check reports etc.

1.2.2 Network video recorder

The Network Video recorder shall include at least Server (min 3.0 GHZ, 6 GB RAM, 3000GB HDD(min)), RAID 5 ,with suitable configuration along with Colored TFT 29" High resolution monitor, and Internal DVD writer. Windows XP/Vista/7 Prof. or VMS

compatible operating system latest version with hardware like graphic cards, licensed Anti-virus etc.

Further the digital video recorder shall conform to the following requirements:

1. Server Spec Intel Quad Core (or better) 3.0 Ghz(min.) , 8 MB Cache , 6 GB memory or better , with suitable NVIDIA graphics card,3 TB HDD , Raid 5
2. Recording and Display Real-time 25 frames per second perFrame Rate channel , manual select
3. Recording Resolution (PAL): 1280X720 , 704(H) x 586(V) It should be possible to select lower Resolutions
4. Compression Method H.264/MPEG-4 or better and latest Video Motion Detection Standard and built-in (selectable in Capable menu)
6. Monitoring Options Split screen 1, 2, 4 , 8, 16, 32 or more Cameras
7. Playback Options Search, still image capture.
8. Alarm/Event Recording To be provided with built-in external Capable alarm input/ output ports minimum(8 in, 2 out)
9. Network Operation to be provided by using WAN or LANCapable router
10. Remote Internet Viewing Using WAN or LAN router
11. HDD Storage 1GB ~ per hour / channel variable based Consumption on frame speed and resolution settings,as well as compression
12. Operation Triplex operation (simultaneous recording, playback, network operation)

13. Number of Video Channel 32
14. Audio Recording Capable 32
15. Input Voltage 230V AC or equivalent with UPS as aback up for 30 minutes.

1.2.3 VMS Camera

a) The color IP camera for substation shall have PAN, TILT and ZOOM facilities so that it can be focused to the required location from the remote station through a controller. Whereas wireless IP cameras with PTZ controls are required for installation at gates of the CSPTCL premises as per the direction of Engineer-In-Charge.

b) The IP Camera at the main gate can be fixed or PTZ based and shall be used for monitoring entry and exit

c) It should have sufficient range for viewing all the poles of isolators and other equipments with high degree of clarity.

d) The VMS camera shall be suitable for wall mounting, ceiling mounting and switchyard structure mounting.

e) It shall be possible to define at 128 selectable preset locations so that the camera gets automatically focused on selection of the location for viewing a predefined location.

f) The camera should be able to detect motion in day & nightenvironments having light intensity of Color: 0.5 Lux; B&W:0.05 Lux .

g) Housing of cameras meant for indoor use shall be of IP 42 orbetter ratin g whereas outdoor camera housing shall be of IP 66 or better rating. Housing shall be robust and not have the effect of electromagnetic induction in 400KV switchyard.

h) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

i) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

A. Outdoor IP Fixed Megapixel Camera Specifications (For Main Gate)

1. Image Sensor 2-megapixel Progressive ,1 / 3" CMOS/CCDsensor, Minimum illumination 0.1 Lux (or better)
2. Min Luminous 0.5LUX(Color) 0.05Lux(Black)
3. Camera Enclosure Type IP66 Grade
4. Iris/Focus Auto/Manual
5. Video Compression Dual Stream H.264 and MPEG 4 user selectable
6. Support Dual-stream primary/secondary stream, H.264/MPEG 4Optional
7. Video Definition Primary stream:1600x1200,1280x960,1280x720, Secondary stream:800x600,400x288,192x144
8. Video Parameters Brightness, hue, contrast, saturation and image Quality
9. Video Frame Rate PAL: 1-25frames/second NTSC:1-30frames/second
10. Video Compression BR 32Kbit/S - 6Mbit/S
11. Video Output One channel composite Streaming
12. Supported Protocols TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS,ARP, ICMP, POP3, NTP, IPsec, UpnP, RTP, RTCP
13. Operating Temperature-5 ~ +50
14. Operating Humidity 10 ~ 90%

B. Outdoor IP66 PTZ HD Camera Specifications (For Switch Yards)

1. Image sensor1/3 type Solid State Progressive ScanCCD,WDR(High Definition)
2. Security Multiple user access with password protection
3. Effective Pixels **(PAL): Main Stream 1280x720**Sub Stream 640x360 320x280 selectable
4. Compression Dual Stream H.264 and MPEG 4 user selectable
5. Signal System 50 Hz
6. S/N (signal to noise) Better than 50 dB Ratio
7. Electronic Shutter 1/60 ~ 1/10,000 sec. automatic or better
8. Scanning System Progressive/interlace

9. Low Light Sensitivity Color: 0.5 Lux; B&W:0.02 Lux (lux)
10. LensMinimum10x(minimum)opticalinHigh Definition

(**The system shall be able to zoom theimages on the monitor without any distortion to the maximum level of optical zoom)**

11. Lens Size Minimum 4.1~73.8 mm
12. Lens Aperture F1.6(wide)~F2.8(tele), f=4.1~41.0mm, 10X Zoom, Video Auto Focus
    Angle of View Horizontal : 52°(wide) , 2.8°(tele)
13. PTZ Data Transfer Selectable 2400 bps / 4800 bps / 9600 bps Baud/Bit Rates Supported
14. Panning Range Complete 360 degrees (horizontal)
15. Pan Speed Adjustable, 0.1 degrees / second ~ 250degrees / second
16. Tilting Range Minimum 180° Tilt Rotation
17. Tilt Speed Adjustable, 0.1 degrees / second ~ 150degrees / second
18. In Built Storage Camera should have inbuilt storage TF or SDformat for recording and storing Pictures
19. IP Class IP66 Standard
20. Working temperature -0 ~ +50
21. Working Humidity 10 ~ 90%

1.2.4 PTZ-Keyboards

The features of PTZ shall include

- Fully functional dynamic keyboard/joystick controllers.
- Controls all pan , tilt, zoom, iris, preset functions
- Control up to 255 units from a single keyboard
- Many preset options and advanced tour programming
- Compatible with all connected cameras

1. Key Application wired keyboard control operation of PTZ functions for weatherproof dome cameras
2. Pan / Tilt / Zoom SelectableProtocol LanguagesSupported
3. PTZ Data Transfer selectable 1200 bps / 2400 bps /4800 bps/Baud Rates 9600 bpsSupported
4. Additional Features dynamic joystick for smooth camera movements, preset location option for quick access to frequently monitored areas.

The furniture for installing Visual Monitoring System PC/server shall also be supplied.

38. FIRE DETECTION SYSTEM

This system shall be provided for 220 KV sub-stations.

1 Suitable fire detection system using smoke detectors and/or heat detectors shall be provided for the bay marshalling rooms and control room. Fire detectors shall be located at strategic locations in various rooms of the building. The operation of any of the fire detectors/ manual call point should result in the following;

1. A visual signal exhibited in the annunciation panels indicating the area where the fire is detected.
2. An audible alarm sounded in the panel,
3. An external audible alarm sounded in the building, location of which shall be decided during detailed engineering.
4. If the zone comprises of more than one room, a visual signal shall be exhibited on the outer wall of each room.
5. A signal shall be given to air conditioning system for its shut down.

2 Each zone shall be provided with two zone cards in the panel so that systemwill remain healthy even if one of the cards becomes defective.

3 Fire detectors shall be provided on false ceiling in control room and and on ceiling in bay marshalling room. **Coverage area of each smoke detector shall not be more than 60 m^2 and that of heat detectors shall not be more than 40 m^2.**Ionisation type smoke detectors shall be provided in all areas except AHU Room where heat detectors shall be provided. If a detector is concealed, a remote visual indication of its operation shall be provided. Manual call points (Break glass Alarm Stations) shall be provided at strategic locations in the control room building. All cabling shall be done through concealed conduits.

*****

SECTION – II

TECHNICAL SPECIFICATION FOR EHV LINES

TECHNICAL CONDITIONS

TECHNICAL SPECIFICATIONS/CONDITION FOR SUPPLY OF TOWER, FOUNDATION AND FABRICATION FOR CONSTRUCTION OF LINE

1.0 GENERAL INFORMATION AND SCOPE:-This Specification covers the following scope of works:-

(i) Fabrication and supply of G.I. 220KV transmission line towers, including Special crossing towers, Gantry column & beam (wherever applicable) including fasteners, step bolts, hangers, D-shackles etc.
(ii) All types of tower accessories like phase plate, circuit plate (where ever applicable), number plate, danger plate, anti climbing device, Bird guard (where ever applicable).
(iii) Detailed Design engineering for Foundation for different type of tower and casting of foundation for tower footings (wherever applicable).
(iv) Supply of ACSR MOOSE Conductor (54/3.53) Moose, ACSR Zebra Conductor (54/3.18),Ground wire, Disc insulators, Hardware Fittings and Conductor & Earth wire Accessories.
(v) Detailed survey including route alignment, profiling, tower spotting, optimization of tower locations, soil resistively measurement & geotechnical investigation.
(vi) Check survey; Foundation for different type of tower and casting of foundation for tower footings as per approved foundations Design & drawing.
(vii) Erection of towers, tack welding of bolts and nuts including supply and application of zinc rich primer & two coats of enamel paint, tower earthing, fixing of insulator strings, stringing of conductors and earth wires along with all necessary line accessories.
(viii) Testing and commissioning of the erected transmission lines and other items not specifically mentioned in this Specification and / or PBS but are required for the successful commissioning of the transmission line, unless specifically excluded in the Specification.

All measurements for payment shall be in S.I. units, lengths shall be measured in meters corrected to two decimal places. Areas shall be computed in square meters & volume in cubic meters. rounded off to two decimals.

This specification also includes the supply of ACSR Conductor 'Moose' (54/3.53 mm), ACSR Zebra Conductor (54/3.18),Groundwire, Disc insulators, Hardware Fittings and Conductor & Earth wire Accessories, as detailed in the specification. Contractor shall clearly indicate in their offer, the sources from where they propose to procure these materials in appropriate Annexture. The technical description of these items are given in SECTION -IV -B.

All the raw materials such as steel, zinc for galvanizing, reinforcement steel, cement, coarse and fine aggregates for tower foundation, coke and salt for tower earthing etc. are included in the Contractor's scope of supply.

4.0.1 Stringing:-

The entire stringing work of conductor and earth wire for 220 KV line shall be carried out by tension stringing technique. The bidder shall indicate in their offer, the sets of tension stringing equipment he is having in his possession and the sets of stringing equipment he would deploy exclusively which under no circumstance shall be less than the number and capacity requirement indicated in Qualifying Requirements for Bidder. The bidder shall also indicate in the offer, the detail description of the procedure to be deployed for stringing operation for line.
In hilly terrain and thick forest, where deployment of tension stringing machine is not possible, manual stringing may be adopted after getting approval of OWNER site Engineer. The contractor shall deploy appropriate tools / equipments / machinery to ensure that the stringing operation is carried out without causing damage to conductor / earth wire and conductor / earth wire is installed at the prescribed sag-tension as per the approved stringing charts.

SECTION –II:A
TECHNICAL CONDITIONS FOR FOUNDATION & FABRICATION OF TOWER FOR CONSTRUCTION OF LINE.

4.1 **Details of line Material:**

4.1.1 **Electrical System Data for 220 kV line**

S.No.	Particular	Unit	400 KV Line	220 KV Line
1.	Nominal Voltage	kV	400	220
2.	Maximum system voltage	kV	420	
3.	BIL (Impulse)	kV (Peak)	1550	
4.	Power frequency withstand voltage (Wet)	kV (rms)	680	
5.	Switching surge withstand voltage (Wet)	kV (rms)	1050	
6.	Minimum Corona extinction voltage at 50 Hz AC system under dry condition	kV (rms) phase to earth.	320(Min)	
7.	Radio interference voltage at one MHz for phase to earth voltage of 305 KV under dry condition.	Micro Volts	1000 (Max)	

4.2.2 (A) Conductor and earth wire for 400 KV and 220 KV line

Sl. No.	**Description**	**Conductor**	**Conductor**	**Earthwire On one peak**
1.	Type	ACSR 'MOOSE' conductor	ACSR "ZEBRA" Conductor	7/3.66mm GS Earthwire
2.	Stranding and wire diameter			
	Aluminium	54/3.53	54/3.18	-
	Steel	7/3.53	7/3.18	7/3.66
3.	Conductor per phase	2	1	NA
4.	Spacing between conductor of same phase(sub conductor spacing)(mm)	450	-	NA
5.	Configuration	Vertical (for D/C with 8000 mm min. inter phase spacing)	-	One continuously to run horizontally on top of the towers and conductors.
6.	Overall Diameter (mm)	31.77	28.62	10.98
7.	Unit mass (kg/km)	2004	1621	583
8.	Min. UTS (kN)	161.6	130.32	68.4

4.2.2(B) Insulator Strings

Insulator Strings for 400 kV line with twin ACSR MOOSE conductor						**Insulator Strings for 220 kV line with twin ACSR ZEBRA conductor**			
Sl No.	**Particulars**	**Double 'I' Suspension**	**Single 'I' Suspension Pilot**	**Single Tension**	**Double tension**	**Double 'I' Suspension**	**Single 'I' Suspension Pilot**	**Single Tension**	**Double tension**
1.	No of Standard Insulator Disc	2 x 23	1 x 23	1x 24	2 x 24	2 x 13	1x 13	1x14	2 x 14
2.	Size of Disc	280 x 145	280 x 145	280 x 170	280 x 170				

3.	E& M Strength of each disc KN	120	120	160	160				
4.	Pollution	Medium Polluted							
5.	Size and Designation of pin ball shank (mm)	20	20	20	20				
6.	Creepage distance of each disc (mm)	315	315	330	330				

C. Insulator String Hardware (As may be applicable)

a) Anchor Shackle
b) Chain Link
c) Ball Clevis
d) Arcing horn holding plate
e) Yoke plate
f) Socket clevis
g) Arcing horns
h) Corona control ring/grading ring.
i) Clevis Eye
j) Free center type/Armour grip suspension clamp for suspension strings.
k) Compression type dead end clamp for tension string.
l) Sag adjuster for tension string.
m) Balancing weight for pilot string
n) "U" clevis

D. Accessories for Conductor & Earth wire (As may be applicable)

a) Preformed Armour rods
b) Mid Span compression joint
c) Repair Sleeves
d) T-Connector
e) Flexible copper bonds
f) Bundle Spacer
g) Vibration dampers
h) Rigid Spacer
i) Suspension clamp for earth wire.
j) Tension clamp for earth wire.

4.1.3	**Service Condition** Equipment/material to be supplied against this specification shall be suitable for satisfactory continuous operation under conditions as specified below:		
	Maximum ambient temperature (Degree Celsius)	:	50
	Minimum ambient temperature (Degree Celsius)	:	4
	Relative humidity (% range)	:	10-100
	Maximum annual rainfall & snowfall (Cm)	:	as per published Meteorological/ climatologically data

4.1.4 SCOPE:-

a. The successful bidder will supply various types G.I. towers as indicated in price schedule, their extensions and accessories as envisaged for 400KV DCDS LINE & 220KV DCDS LINE. The scope covers supply of drawings of towers, extensions and stub setting templates and drawings of foundations in various types of soil, sag templates, sag tension chart for conductor and ground wire etc. as per drawings provided by CSPTCL.

4.2 TRANSMISSION TOWERS:-

4.2.1 General Description of the Tower

The transmission towers are of self-supporting hot dip galvanized lattice steel type. Designed to carry the line conductors, with necessary insulators, earth wires and all fittings under all loading conditions. The tower shall be fully galvanized using mild steel or/and high tensile steel sections as specified in relevant clause in section-IV. Bolts and nuts with spring washer are to be used for connections.

4.2.2 The towers shall be of the following types:

a) 400 KV Double Circuit (FD-60), 220 KV Double circuit (A-2, A-30, A-60, MD -60)

b) Special towers. (220 KV Double Circuit MD-60)

c) Gantry column and beam.

4.3 CLASSIFICATION OF TOWERS/ TYPE OF TOWERS:

The towers shall be double circuit, self supporting lattice type designed for the specified loading conditions with two peak(flat or horn).

4.3.1 The towers for 400 kV Line & 220 KV line are classified as given below.

Type of Tower	**Deviation Limit**	**Typical Use**
Large Angle & Dead end Tower- "FD-60"	30 deg-60 deg	i) Heavy angle tower to be used for line deviation of 0° degree to 60° degree and also as Dead End tower with single / double tension insulator strings ii) Also to be used for uplift forces resulting from an uplift span upto 300 m under broken wire condition. iii) for river crossing anchoring with longer wind span & 0 deg. Deviation on crossing span side and 0 deg. To 30 deg. Deviation on other side. iv) Dead end with 0 deg. To 15 deg. Deviation both on line side and sub-station side .
Small Angle Tower-"BN-2"	0 deg - 15 deg	i) Small angle tower to be used for line deviation from 0° degrees to 15° degrees with single / Double tension insulator strings. This tower is to be designed for section tower condition also ii) Also to be used for uplift force resulting from an uplift span up to 200 m under broken wire condition. iii) Also to be used for Anti Cascading Condition. iv) To be used as Section Tower at 0 degree.
Medium Angle Tower- "BN-30"	15 deg-30 deg	i) Medium angle tower to be used for line deviation from 0° degrees to 30° degrees with single / Double tension insulator strings. This tower is to be designed for section tower condition also. ii) Also to be used for uplift forces resulting from uplift span up to 200 m under broken wire Condition. iii) Also to be used for anti cascading condition. iv) To be used as section tower at 0 degree deviation.
Large Angle & Dead end Tower- "BN-60"	30 deg-60 deg	i) Heavy angle tower to be used for line deviation of 0° degree to 60° degree and also as Dead End tower with single / double tension insulator strings ii) Also to be used for uplift forces resulting from an uplift span upto 300 m under broken wire condition. iii) for river crossing anchoring with longer wind span & 0 deg. Deviation on crossing span side and 0 deg. To 30 deg. Deviation on other side. iv) Dead end with 0 deg. To 15 deg. Deviation both on line side

Type of Tower	Deviation Limit	Typical Use
		and sub-station side .
Large Angle & Dead end Tower- "MD-60"	30 deg-60 deg	i) Heavy angle tower to be used for line deviation of 0° degree to 60° degree and also as Dead End tower with single / double tension insulator strings with multi circuits. ii) Also to be used for uplift forces resulting from an uplift span upto 300 m under broken wire condition. iii) for river crossing anchoring with longer wind span & 0 deg. Deviation on crossing span side and 0 deg. To 30 deg. Deviation on other side. iv) Dead end with 0 deg. To 15 deg. Deviation both on line side and sub-station side .

STRENGTH FACTOR FOR DESIGNING OF TOWER MEMBERS:

The Strength factor for designing of tower members shall be considered as per clause 17 of IS: 802 (Part-I/ Sec.-1): 2015

4.3.2 Special Towers/Gantry column & beam

The towers which will be specially designed for very long spans which cannot be crossed by normal tower with extensions like Major River crossings etc Shall be treated as special towers. If in any case over head line crossing technically not possible than same voltage level line may cross through single circuit DELTA tower or gantry .The design of Special Towers, single circuit DELTA tower and Gantry column & beam may also be made by contractor in his scope of work.

4.3.3 Extensions

4.3.3.1 The Double Circuit towers are designed so as to be suitable for adding 3M, 6M and 9M body extensions for maintaining adequate ground clearances without reducing the specified factor of safety in any manner for use with Tangent (BN-2), Angle, (BN-30) Angle, (BN-60) angle, (MD-60) angle & Dead End (FD-60) type tower .

4.3.3.2 The drawings of 18 and 25M body extension to tower types FD-60, BN-2, BN-30, BN-60, MD-60 shall be supplied by owner. For Power Line Crossing or any other obstacle, tower types FD-60, BN-2, BN-30, BN-60, MD-60 can be used with 18 and 25 M extensions depending, upon the merit of the prevailing site condition.

If extension more than 25M required for execution of the work the same will be designed by contractor.

4.3.3.3 The towers shall be designed for providing unequal leg extensions also, so that proper optimization of benching / revetment requirement can be done accordingly by the contractor. The towers are designed for unequal leg extensions of 3M, 6M and 9M generally with 3M maximum leg differential and in specific cases with 6m maximum leg differential. In exceptional situations where difference in leg differential does not suit the standard unequal leg extension provisions on the tower mentioned above, then suitable chimney extension shall be provided.

4.3.3.4 All above extension provisions to towers and foundations shall be treated as part of towers and foundations only.

4.4 Span and clearances

4.4.1 Normal Span

The normal ruling span of the line is 400m for 400KV lines & 350M for 220KV lines.

4.4.2 Wind Span

The wind span is the sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span. Wind span for broken wire condition shall be taken 60% of that of Normal condition for all towers.

4.4.3 Weight span

The weight span is the horizontal distance between the lowest point of the conductors on the two spans adjacent to the tower. For spotting of structures, the span limits taken as per under.

3.1(400kV) & (220kV)				
TOWER TYPE	**L /Reliability CONDITION**		**N WIRE/Security CONDITION**	
	MAX (m)	**MIN (m)**	**MAX (m)**	**MIN (m)**
	600	0	360	(-) 300
	525	210	315	105
	525	0	315	(-) 300
	525	0	315	(-) 300

4.4.4 In case of certain locations where actual spotting spans exceed the design spans, cross-arms and certain members of towers are required to be modified / reinforced. In such cases, design & drawings of the modified/reinforced tower and its foundation shall be supplied by the Contractor as per site requirement without any extra cost to the Owner.

4.5 Electrical Clearances

4.5.1 Ground Clearance

The minimum ground clearance from the bottom conductor shall not be less 8840 mm for 400KV lines at the maximum sag conditions i.e at 75° C and still air and normal span of 400 meter as per is: 5613..

a) An allowance of 150 mm has been provided to account for errors in stringing.

b) Conductor creep shall be compensated by over tensioning the conductor at a temperature of 26°C lower than the stringing temperature for ACSR "MOOSE" conductor for 400 kV transmission lines.

c) The minimum ground clearance from the bottom conductor shall not be less than **7015mm for 220KV line** at the maximum sag condition and still air.

d) Conductor creep shall be compensated by over tensioning the conductor at a temperature of 26 deg C lower than the stringing temperature for ACSR Zebra **for 220KV line.**

4.6 STUB SETTING TEMPLATES:

The stub setting templates shall be required for each type of tower and its respective extensions and shall be supplied for each type of tower and its respective extensions. The template shall be of adjustable type i.e. for use with Standard towers as well as extensions. The stub setting templates shall be supply by contractor free of cost.

4.7 WIND LOAD:-

The wind load on conductors, earth wire, towers and insulator strings are as per the recommendations of I.S. 802 (Part-I) -1995 the following parameters are considered for designing:-

i. Wing zones: 4
ii. Basic wind speed: 47 Mtr. Per Second
iii. Terrain category: 2
iv. Reliability level: 1

4.8 TEMPERATURE VARIATION: - The maximum working tension of conductor and ground wire under the uplift conditions shall correspond to the minimum temperature of 0° degree C.
The maximum conductor sag and ground clearance beneath should correspond to the maximum working temperature of 75 degrees C. the maximum ground wire temperature shall be taken as 53° degrees C.

4.9 **BROKEN WIRE CONDITIONS**:- The towers are designed for:-

(a)	Large Angle/ Dead End Tower type FD-60	Any three power conductors broken on the same side and on the same span or any two of the power conductors broken and ground wire broken on the same side and same span whichever combination constitutes the most stringent condition for a particular member, besides Dead End type tower shall be designed for dead end condition i.e. all ground wire & power conductor broken on one side under normal working condition.

(b)	Tangent Tower Type BN-2	Any ground wire broken or one power conductor broken whichever is more stringent for a particular member.
(c)	Small Angle Tower Type BN-30	Any two of power conductors broken on same side and on the same span or any one of the power conductors and ground wire broken on the same side and same span which ever combination is more stringent for a particular member.
(d)	Medium Angle Tower Type BN-60	Any three power conductors broken on the same side and on the same span or any two of the power conductors broken and ground wire broken on the same side and same span whichever combination constitutes the most stringent condition for a particular member, besides Dead End type tower shall be designed for dead end condition i.e. all ground wire & power conductor broken on one side under normal working condition.
(e)	Multi Angle Tower Type MCD-60	Any three power conductors broken on the same side and on the same span or any two of the power conductors broken and ground wire broken on the same side and same span whichever combination constitutes the most stringent condition for a particular member, besides Dead End type tower shall be designed for dead end condition i.e. all ground wire & power conductor broken on one side under normal working condition.

4.10 **MINIMUM THICKNESS:** The minimum thickness of the tower member shall be as per clause 7 of IS: 802 (Part 1, Sec 2) 1992 with latest revision thereof.

4.11 **MAXIMUM LENGTH: -** The maximum length of the members shall not exceed 7.0 meters.

4.12 **PERMISSIBLE STRESSES:-** The permissible stresses in the tower member under tension and compression and in bolts and nuts shall be in accordance with the values given in IS : 802 (Part - I) -1992 with latest revision thereof.

4.12.1 **SLENDERNESS RATIOS**:-

The slenderness ratio for the various tower members shall be in accordance with procedure described in IS: 802 (Part - I/ Sec.-2) 1992 with latest revision thereof.

The allowable limit of stresses for tower members in compression for steel conforming to IS-2062-2006 shall be in accordance with the unit stress curves and unit stress level appended with IS : 802 (Part-I/ Sec.-2)-1992 with latest revision thereof.

4.12.2 **THE EFFECTIVE AREA OF THE ANGLE SECTIONS IN TENSION**:

The net effective area of any tower member in tension shall be as described in IS : 802 (Part - I/ Sec.-2) (1992) with latest revision thereof.

4.12.3 BOLTING & STRESS ON BOLT:

According to IS: 802 (Part - I/ Sec.-2) (1992) with latest revision thereof shall be considered. Not more than two different dia of bolts can be used in one tower if required.

4.12.4 **FRAMING:**

The angle between any two members common to a joint of a trussed frame shall preferably be greater than 20 degree and never less than 15 degree due to uncertainty of struss distribution between two closely spaced members.

4.12.5 **JOINTS :**

The tower should be designed for bolted connections only. The bolts at the joints may be staggered such that the nuts may be tightened with spanners without fouling. The use of gusset- plates shall be kept to a minimum. Wherever possible, members shall be bolted together directly without excessive eccentricity. The thickness of the gusset plate shall be as per IS:802 (Part - I/ Sec.-2) (1992) clause 7 and not be less than 6 mm.

4.13 GALVANISING:-

Fully galvanized towers and stub shall be used for the lines. Galvanising of the member of the towers shall conform to IS:2629 and IS:4759. Post treatment (chromating) recommended as per IS:2629 shall also be carried out after galvanizing. All galvanized members shall withstand tests as per IS:2633. For fasteners the galvanising shall conform to IS:1367 (Part-13). The galvanising shall be done after all fabrication work is completed, except that the nuts may be taped or re-run after galvanising. Threads of bolts and nuts shall have a neat fit and shall be such that they can be turned with finger throughout the length of the threads of bolts and they shall be capable of developing full strength of the bolts. Spring washers shall be electro-galvanized as per Clause 4 of IS:1573.

4.14 MATERIAL OF TOWER STEEL SECTIONS:

The tower members including cross-arms shall be of structural steel quality conforming to I.S.2062: 2006 or latest revision thereof (section as per IEEMA circular). Only structural steel angles sections manufactured according to latest revisions of I.S 808 - The Dimension for hot rolled angle Section and Properties shall be taken into consideration in design of towers.

IS Steel Sections of tested quality of conformity with IS 2062 : 2006 Grade E 250 (Fe 410 W) (Designated Yield Strength. 250 MPa) and/or IS:2062-2006 grade E 350 (Fe 490)(Designated Yield Strength 350 MPa) are to be used in towers, extensions, stubs and stub setting templates. The Contractor can use other equivalent grade of structural steel angle sections and plates conforming to latest International Standards.

Steel plates below 6mm size exclusively used for packing plates/packing washers produced as per IS 1079 -1994 (Grade -0) are also acceptable. However, if below 6mm size plate are used as load bearing plates viz gusset plates , joint splices etc. the same shall conform to IS 2062 : 2006 or equivalent standard meeting mechanical strength/metallurgical properties corresponding to Fe-410 or above grade (designated yield strength not more than 355 MPa), depending upon the type of grade incorporated into design. Flats of equivalent grade meeting mechanical strength/ metallurgical properties may also be used in place of plates for packing plates/ packing washers.Medium and high strength structural steel with known properties confirming to the other national and international standard may also be used subject to the approval of the purchaser.

For designing of towers, preferably rationalized steel sections has been used. During execution of the project, if any particular section is not available, the same shall be substituted by higher section. Any cost on account of the same shall be borne by the Contractor. However, design approval for such substitution shall be obtained from the Owner before any substitution and records of such substitutions shall be maintained by the Contractor.

4.15 FASTENERS: <u>BOLTS AND NUTS AND WASHERS</u>:

The design of the towers and extensions are based on use of HRH mild steel hot dip galvanized bolts (5.6 quality) and nuts (5.0quality). The connections are designed on the basis of use of 16mm dia bolts preferably (if it is necessarily required than Not more than two different dia of bolts can be used in one tower.) The spring washers shall be provided for insertion under all nuts. These washers shall be of steel, electro galvanized, positive lock type and of 3.5mm thickness.

All bolts and nuts shall conform to IS:12427. All bolts and nuts shall be galvanized as per IS:1367 (Part 13)/IS:2629. All bolts and nuts have hexagonal heads and nuts, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS:12427. Bolts should be provided with washer face in accordance with IS:1363, Part-1 to ensure proper bearing.

Nuts should be double chamfered as per the requirement of IS:1363, Part-III. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4mm oversize on effective diameter for size up to M16.

Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm griping of the component parts but no further. It shall be ensured that the threaded portion

of the bolt protrudes not less than 3 mm and not more than 8mm when fully tightened. All nuts shall fir and tight to the point where shank of the bolt connects to the head.

Flat and tapered washers shall be provided wherever necessary. Spring washers shall be provided for insertion under all nuts. These washers shall be steel electro-galvanized.

To avoid bending stress in bolts or to reduce it to minimum, no bolt shall connect aggregate thickness of members more than three (3) times its diameter.

The bolts of 16mm size shall be manufactured by cold/hot forging process and the threads shall be rolled.

The bolts and nuts shall be free from forging and threading defects such as cuts, splits, burrs, bulging, taper, eccentricity, loose fit etc.

The bolts shall be threaded up to standard length only as per relevant Indian Standard and not to full length.

The bolts and nuts shall confirm to IS 1967-1971 Part-III and Part-IV, IS 12427, IS 1363-92, IS 1367Part-XIII with latest amendment.

The spring washers designated as M 16-B suitable for 16mm dia galvanized bolt shall be manufactured out of rectangular section with tolerances as per IS 3063-1994 with latest amendments. The spring steel shall conform to IS- 4072-1975 with latest amendments "Specification for steel for spring washers".

The spring washers after coiling shall be suitably heat treated so as to result in the finished washer having hardness 43 to 50 HRC when tested in accordance with IS 1586- 1968.

The surface of the washers shall be free of scales and burrs. The washers shall be coiled without any kinks (except for the shape with turned-up ends). The ends of the washer shall not abut when the washers are compressed. The ends shall be so served as to prevent tangling.

The approximate weight of 1000 pieces of spring washers suitable for 16mm dia bolt shall be 8.91 kg. in natural black finish as shown in IS 3063-1972 with latest amendments.

The spring washer shall be electro galvanized with chromate passivation. The electro galvanizing of washers should conform to 'severe' grading service conditions incorporated in IS 1573-1986 as "Service Grade No.4", classification Fe Zn 25. The local thickness of zinc coating should be minimum 25 microns and average thickness 38 microns. It should be further suitably heat treated to avoid any danger of hydrogen embitterment.

4.16 STEP - BOLTS:

Each tower will be provided on one of the legs, with step bolts conforming to IS:1363-1992, IS:10238 and IS:1367 (Part-XIII):1983 of not less than 16 m.m. diameter and 175 mm long, spaced not more than 450 m.m. apart and extending from 2.5 meter above the ground level to the top of the tower. For double circuit tower the step bolts shall be fixed on two diagonally opposite legs up to top of the towers. Each step bolt shall be provided with two nuts on one end to fasten the bolt securely to the tower and button head at the other end to prevent the feet from slipping away. The step bolts shall be capable of withstanding a vertical load not less than 1.5 KN

For special towers, where the height of the super structure exceeds 50 meters, ladders along with protection rings shall be provided with the design of tower by the contractor design shall be provided in continuation of the step bolts on one face of the tower from 30 meters above ground level to the top of the special structure. From 2.5m to 30m height of super structure step bolts shall be provided. Suitable platform using 6mm thick perforated chequered plates along with suitable railing for access from step bolts to the ladder and from the ladder to each cross-arm and the ground wire support shall also to be provided. The platform shall be fixed on tower by using counter-sunk bolts.

4.17 DANGER BOARD, NUMBER PLATE, CIRCUIT PLATE AND PHASE PLATES :-

Arrangement shall be provided for fixing of all tower accessories to the tower at a height between 2.5 mtr and 3.5 mtr above the ground level. Danger plates, Number plates, Circuit plates and phase plates shall be supply as per latest IS. and installed by the Contractor:

a) Each tower shall be fitted with a danger plate, number plate, two sets circuit plate and phase plates for double circuit tower.

b) The letters, figures and the conventional skull and bones of danger plates shall conform to IS:2551-1983 and shall be in a signal red on the front of the plate.

c) The corners of the danger and number plate shall be rounded off to remove sharp edges.

d) The letters of number plate shall be red enamelled with white enamelled background.

e) Phase plate: This shall be in set of red, yellow and blue colour .
f) Circuit plate: This may be combined with phase plate.

The drawings for danger board, number plate and phase plates are to be approved by CSPTCL before use. Necessary provision in tower design for fixing of these items shall be made.

4.18 **ANTI-CLIMBING DEVICE WITH BARBED WIRE:-**

Barbed wire type anti climbing device shall be installed by the Contractor for all type of towers. The barbed wire shall conform to IS:278/1978 with latest amendment and shall be type 'A-3'. The barbed wires shall be given chromating dip as per procedure laid down in IS:1340. Barbed wire type anti climbing devices will be used at a height of approximately 3 metres as an anti climbing measure which shall be arranged by the contractor. At every location three layers of barbed wire will be provided each inside and outside the tower in horizontal plane. Spacing between the layers with fixing arrangements shall be provided as per provisions of I.S. 5613 with latest revision thereof. The angle pieces with notches for accommodating barbed wire shall be supplied with the tower members. After the barbed wire is placed in position for the notches, the notch opening shall be welded to avoid the theft of barbed wire and anti corrosive treatment with cold galvanising paint shall be given, as also in the case of the bolts to be welded below bottom cross arm level. Suitable locking arrangements (pad-lock) shall also be provided.

The Barbed wire shall be made of Hot dip Galvanized MS solid wire of size 2.5mm dia (for line wire) and 2.0 mm dia (for point wire). The barbs shall have four points and shall be formed by twisting 2 point wires, each two turns, tightly around both line wires making altogether four complete turns. The wire shall be galvanized by Hot dip process as per IS:2629/1966 (with latest amendment). The galvanized wire shall confirm to the requirement as per IS:4826/1971 with latest amendment in all respect IS:2633/1972 and IS 6745/1972 for testing of uniformity & mass of zinc coating. The zinc coating shall be medium type on line wire and light type on point wire i.e. having zinc coating minimum 110 gm/m² on line wire and 70 gm/m² on point wire.

4.19 **PROVISION OF EARTHING:-**

The provision shall be made in the stub for fixing Galvanized Earthing materials. The stub will be provided with a hole at a distance of 250 m.m. from bottom and at a distance of 500 m.m. below ground level for connection with Galvanized Earthing materials. The hole will be of 17.5 m.m. diameter.

The contractor shall also supply and fix properly the following materials for Galvanized Earthing towers .

Each tower shall be earthed. the tower footing resistance shall not exceed 10 ohms. The Contractor shall measure the tower footing resistance (TFR) of each tower during dry weather after it has been erected and before the stringing of the earth wire. Pipe type earthing and counter poise type earthing shall be done as required in accordance with the following standards:

IS: 3043 Code of practice for Earthing.

IS:5613 Code of practice for Design, Installation and maintenance (Part-II/Section-2) of overhead power lines.

The detailed drawing for pipe & counterpoise type earthing are given in drawing enclosed with this specification for reference. The contractor shall submit the detailed design for approval of Owner before installation of earthing.

For counterpoise type earthing the earthing will vary depending on soil resistivity. For soil resistivity less than 1500 ohms-meter, earthing shall be established by providing 4 lengths of 30m counterpoise wire.

The quoted price shall include fabrication, supply and installation of earthing material including supply of coke, salt etc. In case of counterpoise type earthing the quotation shall be based on 120 mtr of wire per tower.

4.20 Earthing for River Crossing Towers /Pile foundation

Galvanized earthing strip of flat 50 x 6 mm is to be provided in two legs of tower for each location with proper arrangement of connecting these strips by 16mm bolts shall be provided in the stubs. For pile foundation, the strip has to be taken up to scour level along the concrete of pile foundations. Only bolted connections are allowed for connecting this strip to achieve desired length. Contractor shall submit the detailed drawing for approval of Owner before installations

4.21 INSULATOR STRINGS ATTACHMENTS:-

a) For the attachment of suspension Insulator string, a suitable dimensioned swinging hanger on the tower shall be provided so as to obtain specified clearances under respective swinging condition of the strings. The hanger, extensions links, D-Shackles etc. as required and considered in the design of the tower shall

have similar as that of tensile strength of for single/ double suspension string. The design and supply of hanger, D-Shackles, strain plates etc. are also in the scope of Contractor.

b) At tension towers strain plates of suitable dimensions under each cross-arm tip, shall be provided for taking the hooks or D-shackles of the tension insulator strings. To achieve requisite clearances, if the design calls for providing extra D-shackles, link plate etc. before connecting the insulator string the same shall be supplied by the Contractor

4.22 EARTHWIRE CLAMPS ATTACHMENT:-

a) Suspension Clamp:

Earthwire suspension clamps will be supplied by the Contractor. The drawing shall be supplied by the Contractor for Employer's approval. The Contractor shall also supply U bolts / D-shackles, wherever required.

b) Tension Clamp:

Earthwire peaks of tension towers shall be provided with suitable plates to accommodate the shackle of tension clamps. The contractor shall also supply the U-bolts wherever required and take Employer's approval for details of the attachments before the mass fabrication.

4.23 FABRICATION WORKMANSHIP:

Except where here-in-after modified, details of fabrication shall conform to I.S. 802 (Part - II) - or relevant International Standards.

The fabrication of towers shall be done strictly in accordance with the drawing approved by the CSPTCL.

The tower shall be of robust construction.

Normally lap splice shall be used for connecting the members of un-equal size and the inside angles of lap splice shall be rounded at the heel to fit the fillet of the outside angle. All splices shall develop full stress in the members connected through bolts. Butt-joints as well as lap joint splices shall be made as above and as close to the main panel as possible.

Joints shall be designed and detailed to avoid eccentricity as far as possible. The use of gusset plates for joining tower members shall be avoided as far as possible. However, where the connections are such that the elimination of the gusset plates would result in eccentric joints, gusset plates and spacer plates may be used in conformity with modern practice.

The tower structures shall be accurately fabricated to bolt together easily at site without any undue strain on the bolts.

No angle member shall have two leg flanges brought together by closing the angle.

The diameter of the hole shall be equal to the diameter of the bolt plus 1.5 mm.

The structure shall be designed so that all parts shall be accessible for inspection and cleaning. Drain holes shall be provided at all point where pockets of depressions are likely to hold water.

The identical parts shall be made strictly interchangeable. All steel section before any work is done on them shall be carefully levelled, straightened and made true to detailed drawings by methods which will not injure the materials so that when assembled the adjacent matching surface are in close contact throughout. No rough edges shall be permitted in the entire structures. Hammering is not permitted for straightening.

In the entire structures. Hammering is not permitted for straightening.

Cutting may be done by shearing, cropping, flame cutting or sawing. The surface so cut shall be cleaned smooth, reasonably square and free from deformation and distortion.

4.24 DRILLING AND PUNCHING:-

Before any cutting work is started, all steel sections shall be carefully straightened and trued by pressure and not by hammering. They shall again be trued after being punched and drilled.

The holes in the member shall either be drilled or punched with a jig, the former process will be preferred:-

Punching may be adopted for sections up to 12 mm thickness. For thicker sections drilling shall be done.

The holes shall be punched/drilled after bending and related position of these holes shall be maintained with the use of proper templates/jigs and fixtures .

The holes shall be perfectly circular and no tolerance in this respect is permissible. The holes shall be perpendicular to the plate and angle flanges.

Holes must be square with the plates or angles and have their walls parallel.

All burrs left by drills or punch shall be removed completely. When the tower members are in positions, the holes shall be truly opposite to each other. Drilling or ramming to enlarge defective holes shall not be permitted.
The minimum spacings of bolt and edge distance shall be as under :-

For 16 mm dia bolt edge distance of 20 mm from hole centre to rolled or swaged edge and 23mm from hole centre to sheared or flame cut edge, hole centre to hole centre distance minimum 40mm (the hole size being 17.5mm).

The gap between the edges of the connected members in butt joint shall not be more than 6mm and less than 4mm.
The bolt gauge distance in flanges of angle sections shall generally be in accordance with Table XXXI of SF6(1)-1961-ISI " Hand Book for structural Engineers-Structural Steel Sections (Revised)."

4.25 **TOLERANCES:-**

The maximum allowable difference in the diameter of the hole on the two sides of the plate or angle shall not exceed 0.8 m.m. in diameter. The allowable taper in drilled / punched hole shall not exceed 0.8 m.m. on diameter.
The tolerance cumulative or between consecutive holes shall be within +/- 0.5 mm.
The tolerance on the overall length of member shall be within +/- 1.6 mm.
The tolerance on gauge distance shall be within +/- 0.5 mm.

4.26 **MARKING:-**

All members shall be distinctly given punch mark similar to the given in structural drawings. The mark shall be given with marking dies of minimum 18 mm size and this mark shall be legible. Letter FD-2, FD-15, FD-30 and FD-60, which indicate the transmission line and the type of tower shall precede erection mark.

4.27 **GALVANISING PASSIVATION AND PAINTING:**

The tower parts, stubs and pack washers shall be hot dip galvanized. The galvanization shall be done as per requirements of IS 4759 or equivalent International Standard after all fabrication work is completed. The contractor shall also take guidelines from the recommended practices for hot dip galvanizing laid down in IS 2629 or equivalent International Standard while deciding and implementing galvanizing procedure. The mandatory requirements however, are specified herein.

Unless otherwise specified the fabricated tower parts and stubs shall have a minimum overall zinc coating of 610gms per sq.m. of surface except for plates below 5mm which shall have Zinc coating of 460 gms per sq.m of surface. The average zinc coating for sections 5mm & above shall be maintained as 87 microns and that for sections below 5mm shall be maintained as 65 microns.

The zinc coating shall be adherent, reasonably uniform, smooth, continuous and free from imperfections such as black/bare spots, ash rust strains, bulky white deposits/wet storage strains and blisters.

The surface preparation for fabricated tower parts and stubs for hot dip galvanizing shall be carried out a indicated herein below:

(i) **Degreasing & Cleaning of Surface**: Degreasing and cleaning of surface, wherever required, shall be carried out in accordance with clause 4.1 of IS 2629-1985 or equivalent International Standard. After degreasing the article shall be thoroughly rinsed. However, if acidic degreasers are used rinsing is not required.

(ii) **Pickling**: pickling shall be done using either hydrochloric or sulphuric acid as recommended at clause 4.3 of IS 2629-1985 or equivalent International Standard. The actual concentration of the acids and the time duration of immersion shall be determined by the Contractor depending on the nature of material to be pickled. Suitable inhibitors also shall be used with the acids to avoid over pickling. The acid concentration, inhibitors used, and maximum allowable iron content shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program.

(iii) **Rinsing**: After pickling, the material shall be rinsed, preferably in running water to remove acid traces, iron particles or any other impurities from the surface. Two rinse tanks are preferable, with water cascading from the second tank to the first to ensure thorough cleaning. Wherever single tank is employed, the water shall be periodically changed to avoid acid contamination, and removal of other residue from the tank.

(iv) **Fluxing**: The rinsed article shall be dipped in a solution of zinc ammonium chloride, The concentration and temperature of the flux solution shall be standardized by the contractor depending on the article to be galvanized and individual circumstances. These shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program. The specific gravity of the flux solution shall be periodically monitored and controlled by adding required quantity of flux crystals to compensate for drag-out losses. Free acid content of the flux solution also shall be periodically checked and when it is more than two (2) grams of free acid per litre of the solution, it shall be neutralized. Alternatively, Ph value should be monitored periodically and maintained between 5.0 to 5.5.

(v) **Drying**: When dry galvanizing is adopted the article shall be thoroughly dried after fluxing. For the purpose of drying, the contractor may use hot plate, air oven or any other proven method ensuring complete drying of the article after fluxing and prior to dipping in the molten zinc bath. The drying process shall be such that the article shall not attain a temperature at which the flux shall get decomposed. The article thus dried shall be galvanized before the flux coating picks up moisture from the atmosphere or the flux layer gets damaged or removed from the surface. The drying procedure, time duration, temperature limits, time lag between fluxing, drying, galvanizing etc shall form part of plant standard to be formulated and submitted to Purchaser along with Quality Assurance Program.

(vi) **Quality of Zinc**: Any one or combination of the grades of zinc specified in IS 209 or IS 13229 or equivalent International Standard shall be used for galvanizing. The contractor shall declare the grade(s) of zinc proposed to be used by them for galvanizing. The molten metal in the zinc bath shall contain minimum 98.5 % zinc by mass. It shall be periodically measured and recorded. Zinc aluminium alloy shall be added as per IS 2629 or equivalent International Standard.

(vii) **Dipping Process**: The temperature of the galvanizing bath shall be continuously monitored and controlled. The working temperature of the galvanizing bath shall be maintained at 450+/- 10 degree C. The article should be immersed in the bath as rapidly as possible without compromising on safety aspects. The galvanizing bath temperature, immersion angle & time, time duration of immersion, rate of withdrawal etc. shall be monitored and controlled depending upon the size, shape, thic KNess and chemical composition of the article such that the mass of zinc coating and its uniformity meets the specified requirements and the galvanized surface is free from imperfections and galvanizing defects.

(viii) **Post Treatment**: The article shall be quenched in water. The quench water is to be changed / drained periodically to prevent corrosive salts from accumulating in it. If water quenching is not done then necessary cooling arrangements should be made. The galvanized articles shall be dipped in chromating solution containing sodium dichromate and sulphuric acid or chromic acid base additive at a predetermined concentration and kept at room temperature to retard while rust attack. The temperature of the chromate solution shall not exceed 65 degree C. The articles shall not be stacked immediately after quenching and dichromating. It shall be ensured that the articles are dry before any further handling operation.

(ix) **Storing, Picking and Handling**: In order to prevent while rust formation sufficient care should be exercised while storing handling and transporting galvanized products. The articles shall be stored in an adequately ventilated area. The articles shall be stored with spacers in between them and kept at an inclination to facilitate easy drainage of any water collected on the articles. Similar care is to be taken while transporting and storing the articles at site.

The Contractor shall prepare a detailed galvanizing procedure including Flow Chart with control parameters and all plant standards as required above and submit to PURCHASER for approvals as part of Quality Assurance Plan.

4.28 Standards

The design, manufacturing, fabrication, galvanizing, testing, erection procedure and materials used for manufacture and erection of towers, design and construction of foundations shall conform to the following

Indian Standards (IS)/International Standards which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification

The material and services covered under these specifications shall be performed as per requirements of the relevant standard code referred hereinafter against each set of equipment and services. Other internationally acceptable standards which ensure equal or higher performance than those specified shall also be accepted.

Sl. No.	**Indian Standard**	**Title**	**International Standard**
1.	IS:209-1992	Specification for Zinc	ISO/R/752 ASTM B6
2.	IS 278-1991	Galvanized Steel Barbed wire	ASTM A131
3.	IS 800-1991	Code of Practice for General Building Construction in Steel	CSA 6.1
4(a).	IS:802(Part 1) Sec 1-1995 Sec 2-1992	Code of Practice in Overhead Transmission Line Tower : Materials, loads and Permissible Stress Section- 1: Materials and loads Section-2 : Permissible stresses.	ASCE 52 IEC 826 BS 8100
4(b).	IS:802(Part 2)-1990	Code of Practice for use of structural steel in Overhead Transmission Line : Fabrication, Galvanizing, inspection & Packing	ASCE 52
4(c).	IS:802(Part 3)-1990	Code of Practice for use of structural steel in Overload Transmission Line: Tower testing	ASCE 52 IEC 652
5.	IS:808-1991	Dimensions for Hot Rolled Steel Beam, Column, Channel and Angle Sections.	
6.	IS:875-1992	Code of Practice for Design Loads (other than Earthquakes) for Buildings and Structures.	
7.	IS:1363-1990	Hexagon Nuts (size range M5 to M36)	
8.	IS:1367-1992	Technical Supply Conditions for Threaded Steel/ Fasteners	
9.	IS:1477-1990	Code of practice for Painting of Ferrous Metals in Buildings: Part-I: Pre-treatment Part-II: Painting.	
10.	IS:1573-1991	Electro-Plated Coatings of inc on iron and Steel	
11.	IS:1852-1993	Rolling and Cutting Tolerances of Hot Rolled Steel Products	
12.	IS-1893-1991	Criteria for Earthquake Resistant Design of Structures	IEEE 693
13.	IS:2016-1992	Plain Washers	ISO/R887 ANSIB18-22.1
14.	IS:2062-2006	Steel for general structural purposes	
15.	IS:2074-1992	Ready Mixed Paint. Air Drying, Oxide. Zinc Chrome, Priming Specification.	
16.	IS:2551-1990	Danger Notice Plates	
17.	IS:2629-1990	Recommended Practice for Hot Dip Galvanising of iron and steel.	
18.	IS:2633-1992	Method of Testing Uniformity of Coating of Zinc Coated Articles	ASTM A123 CSA G164
19.	IS:3043-1991	Code of Practice for Earthing	
20.	IS:3063-1994	Single coil Rectangular section Spring Washers for Bolts, Nuts Screws	DIN-127

Sl. No.	Indian Standard	Title	International Standard
21.	IS:3757-1992	High Strength Structural Bolts	
22.	IS:4759-1990	Specification for Hot zinc coatings on structural steel and other Allied products	
23.	IS:5369-1991	General Requirements for Plain Washers	
24.	IS:5613-1993	Code of Practice for Design installation and Maintenance of Overhead Power LinesSection-1: Design Part 2, Section-2: Installation and Maintenance	
25.	IS:6610-1991	Specification for Heavy Washers for Steel structures	
26.	IS:6623-1992	High Strength Structural Nuts	
27.	IS:6639-1990	Hexagon Bolts for Steel Structure.	ASTM A394 ASTM A90
28.	IS:6745-1990	Method for Determination of weight of Zinc coated iron and Steel Articles.	ASTM A90
29.	IS:8500-1992	Specification for Weldable Structural Steel (Medium & High Strength Qualities)	
30.	IS:10238-1989	Step Bolts for Steel Structures	
31.	IS:12427-1988	Bolts for Transmission Line Towers	
31.	IS:12427-1988	Indian Electricity Rules.	
31.	Publication No. 19(N)/700	Regulation for Electrical Crossing of Railway Tracks	

4.29 <u>TECHNICAL SPECIFICATION FOR G.I. NUTS & BOLTS</u>:-

This specification of G.I.Nuts & Bolts covers the Manufacture, testing at manufacturer's works, supply and delivery of G.I. Nuts & Bolts as referred above. The Technical specification contained in this section are for the guidance of the bidder Any deviation from purchaser specification will be considered on their related merits or performance, efficiency, durability and overall economy consistent with the purchaser's requirements hereinafter stipulated.

a. IS SPECIFICATION FOR G.I. NUTS & BOLTS:-

S.No	Particulars	Relevant IS No.
1	IS Specification of BIS for all GI Nut Bolts	IS:12427-1988
2	Minimum sharing strength of bolts (kg per mm sq.)	IS:12427-1988
3	Minimum ultimate tensile strength of Bolts	IS:1367
4	Value of Hardness test: (i) Rock well hardness test (ii) Brinell hardness test	IS:1367
5	Indian standard for bolts & nuts dimensions	IS:12427-1988 and any latest revision thereof for property class 5.6/5
6	Indian standard for threading dimension of bolts & nuts	IS:1367-1967 including IS-1367 (Part-XIII) 1983 & any latest revision thereof and IS:4218 (Part-V) 1978.
7	Indian Standard for hot dip galvanizing	IS:1367 Part-XIII, 1983
8	Indian Standard for test of bolts & nuts	IS:1367-1967 and any latest amendment thereof.
9	Designation of standard for raw material for bolts & nuts.	IS:2062 Gr.A with latest amendment

b. GUARANTEED TECHNICAL PARTICULARS FOR GI NUTS AND BOLTS.

S. No	Description	Dimensions (in mm) 16 mm bolts, Property class 5.6
1	Nominal diameter	16.00

1)	1) Maximum diameter of Unthreaded shank	16.7
	ii) Minimum diameter of unthreaded shank.	15.3
3.	Width Across flats Nom/Max./Min.	24.00/24.00/23.16
4.	Width Across corner	26.17
5.	Thickness of bolt head (Max. / Min.)	10.75/9.25
6.	Pitch	2.00
7.	Length of thread	23.00
8.	Zinc coating thickness	Minimum 54 microns.
9.	Mass of coating	Minimum 375g/m^2
10.	Minor diameter. A) Before plating Max/ Min. B) After plating Max.	13.508 /13.204
11.	Nut Thickness Max. / Min.	15.9 / 14.1
12.	Across flat width of nut Max./ Min.	24.00 / 23.16
13.	Across corner width of nut Min.	26.17

NOTE:- The bolts of above specification with different lengths of 35, 40, 45, 50, 55, 60, 65 mm with 50% thread.

c. IS SPECIFICATION OF G.I. STEP BOLTS

S.No.	Particulars	Relevant IS No.
1	IS Specification of BIS for GI Step Bolts	IS:10238(2001) and Nuts IS:1363, Pt.III(1992)
2	Minimum ultimate tensile strength of Bolts	IS:1367
3	Value of Hardness test: (i) Rock well hardness test (ii) Brinell hardness test	IS:1367
4	Proof load test	IS:1367-2001
5	Indian standard for bolts & nuts dimensions	IS:10238-1982 and any latest revision thereof
6	Indian standard for threading dimension of step bolts & nuts	IS:4218 (Part-V) - 1978 & any latest revision thereof
7	Indian Standard for hot dip galvanizing step bolts & nuts	IS:1367 Part-XIII, 1983 & IS:2629
8	Indian Standard for test of step bolts & nuts	IS:1367-1967 and any latest amendment thereof.
9	Designation of standard for raw material for step bolts & nuts.	IS:2062 Gr.A with latest amendment

NOTE:- (i) The bolts of above specification with different lengths of 35,40,45,50,55, 60, 65,70, 75, 80 * 85mm with 50% thread. HDG.I. Nuts & Bolts shall confirm to IS:12427–1988 & IS:1367 overall any latest inclusion in amendment thereof and IS:4218 Part-V-1978. The raw material used for manufacturing of HD G.I. Nuts & Bolts shall confirm to standard fixed by Bureau of Indian Standards and in respect of GI Nuts & Bolts. The hot dip galvanizing and other parameters shall confirm to IS:1367 part-13, 1983 with latest amendments thereof. The process adopted for manufacturing of GI Nuts & Bolts shall be head line process.

(ii) The Step Bolts size 16x175mm shall be confirming to IS-10238 (2001) and all technical requirements as stated in the relevant IS.

(iii) The material offered shall be of the best quality and work-manship. The relevant parameters must satisfy the technical particulars laid down by Bureau of Indian Standard for Hot Dip Galvanized Nuts & Bolts.

d. GUARANTEED TECHNICAL PARTICULARS FOR GALVANIZED SPRING WASHER FOR TRANSMISSION LINE

S.No	Particulars	
1.	ISS number to which spring washer will conform.	IS:3063
2.	ISS to which electro galvanized washer will conform	IS:1573
3.	ISS for tests regarding dimensions and strength etc.	IS:3063
4.	ISS for test for electro galvanising of washer.	IS:1573
5.	ISS for raw material of washers.	IS:4072
6.	Ultimate tensile strength.	700 N/m^2
7.	Hardness of finished washers in HRC after heat treatment as per Rock well hardness test.	43 – 50 HRC
8.	The free height of washers:- i) After having compressed flat for compression of 52,200N for 16mm size. ii) After compression and removal of pressure and repeated 20 times in quick succession.	 5.95 mm 5.95 mm
9.	Method of testing for electro galvanising.	As per IS:1573
10.	Thic KNess of zinc coating in microns.	38 average, 25 min
11.	Result of twist test.	Passes
12.	Dimension, indicating tolerance of single coil Rectangular section spring washers with flat ends: i) Inside diameter basic tolerance. ii) Maximum outside diameter. iii) Breadth of washers basic tolerance. iv) Thic KNess of washers basic tolerance. v) Weight of spring washers (kg/1000 Nos. pieces)	 16.2 ± 0.8mm 27.4 mm 5 ± 0.2 mm 3.5 ± 0.2mm 8.91 kg. approx. as per IS:3063

NOTE: Spring washer should be suitable for use with 16 mm bolts and nuts conforming to IS:1363 and electro galvanising should be as per IS:1573 service condition "3" i.e. minimum thic KNess of 25 microns and average thic KNess of 38 microns.

4.30 **CLASSIFICATION OF FOUNDATIONS:**

The foundation shall depend upon the type of soil, sub-soil water level and the presence of surface water which have been classified as follows and as per CBIP Manual publication No.268.

S.No	Name of soil	Remarks
1	Normal dry Soil.	To be used for locations where normal dry, cohesive or non-cohesive soils are met.
2	Wet	To be used for locations:- (a) Where sub-soil water is met at 1.5 Meter or more below the ground level. (b) Which are in surface water for long periods with water penetration not exceeding one meter below the ground level e.g. the paddy fields..
3	Partially submerged	When water table is at a depth between 1.5m and 0.75m below ground level and when the soil is normal and cohesive.
4	Fully submerged	When water table is within 0.75m below ground and soil is normal and cohesive.
5	Black cotton	When soil is cohesive having inorganic clay exceeding 15% and characterised by high shrinkage and swelling property. Where top layer of black cotton soil exceeds 50% and extends upto full depth or is followed by good soil and where top layer is good soil upto 50% of the depth but the lower layer is a black cotton soil. For designing purpose the soil is to be considered as Submerged.
6	Partial Black Cotton	When the top layer of soil up to 1.5 mtr is Black Cotton and thereafter it is normal dry cohesive soil.
7	Soft	To be used at locations where decomposed or fissured rock, hard

	rock/Fissured Rock	gravel, kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used at these locations.
8	Submerged Fissured Rock	Where fissure rock is encountered with subsoil water within 0.75m or below 0.75 m from G.L. (Top layer may be either a good soil or black cotton soil)
9	Hard rock	In locations where chiselling, drilling and blasting is required for excavation, hard rock type foundations are to be used where hard rock encountered at 1.5 m or less below ground level.
10	Sandy Soil	Sandy soil with clay content upto 5%

The foundation design for tower mentioned in clause No.4.3.1, 4.3.3.1, and 4.3.3.2 will be supplied only for above soils.

In addition to the above, depending of the site conditions, other types of foundations may be introduced suitably for following type of soils for which the design will be submitted by the contractor without any extra cost to the Board:-

(i) Intermediate conditions under the above classifications to effect more economy, or

(ii) For locations in hilly and special rocky areas.

(iii) For locations where special foundation (well type, pile type or any other type) are necessitated , the proposal for this shall be submitted by the contractor based on the detailed soil investigations and approval for the same shall be obtained from the Purchaser

4.31 LOADS ON FOUNDATIONS:

The foundations shall withstand the ultimate loads on the superstructure with strength factor 1.1 as specified in this specification, for the full footing reactions along the stub angle slopes obtained from the structural stress analysis.

The reactions on the footing shall be composed of the following types of loads for which they shall be required to be checked:-

Maximum tension or uplift

Maximum compression or down thrust,

Maximum horizontal shear or side thrust.

The additional weight of concrete in the footing below ground level over the earth weight and full weight of concrete above the ground level in the footing and embedded steel parts will also be taken into account adding to the down thrust.

4.32 <u>STABILITY ANALYSIS</u> :-

The following primary types of soil resistances shall be assumed to act in resisting the loads imposed on the footings in earth:

<u>Resistance against uplift: -</u> The uplift loads will be assumed to be resisted by weight of earth in an inverted frustum of a conical pyramid of earth on the footings pad whose sides make an angle equal to the angle of repose of the earth with the vertical in average soil. The weight of concrete embedded in earth and that above the ground will also be considered for resisting the uplift. In case where the frustum of earth pyramids of two adjoining legs super impose each other, the earth frustum will be assumed truncated by a vertical plane through the centre line of the tower base.

<u>Resistance against down thrust: -</u> The down thrust loads combined with the additional weight of concrete above earth will be resisted by bearing strength of the soil assumed to be acting on the total area of the bottom of the footings. Additional movement due to side thrust shall also be considered while calculating bearing capacity as per CBIP Manual (Publication No.268).

<u>Resistance against side thrust :-</u> The bidder shall describe in detail the methods followed by them to check the stability of foundations for horizontal shears or side thrusts along with the relevant references (CBIP Manual publication No.268) in support of their contentions.

In addition to the strength design, stability analysis of the foundation shall be done to check the possibility of failure by over turning, up-rooting, sliding and tilting of the foundation.

4.33 **PROPERTIES OF EARTH :-** The following properties of earth under various conditions would be assumed for foundations:-

S. No.	PARTICULARS	ANGLE OF EARTH FRUSTUM (DEGREES)	UNIT WT. OF SOIL (KG/CUM)	LIMIT BEARING CAPACITY (KG./SQ. M.)
1	Normal dry soil	30	1440	25,000
2	Wet soil due to presence of sub soil water/surface water	15	940	12500
3	Black cotton soil			
a)	In Dry Portion	0	1440	12,500
b)	In Wet Portion	0	940	12,500
4.	Sandy Soil			
a)	With Clay content 0.5%	10	1440	25,000
b)	With Clay content 5-10%	20	1440	25,000
5.	Fissured Rock/Soft Rock (With undercut)			
a)	In Dry Portion	20	1700	62,500
b)	In Wet Portion	10	940	62,500
6.	Normal Hard Dry Soil (Murrum) with Undercut	30	1600	40,000
7.	Hard Rock	30	1700	125000

Note:

(i) Where clay content is more than 10% but less than 15%, the soil will be classified as Normal Dry Soil.

(ii) Angle of Earth shall be taken with respect to vertical.

4.34 **PROPERTIES OF CONCRETE:-**

The cement concrete used for foundations shall be Nominal Mix Concrete of Grade M-20 having 1:1.5:3 nominal mix ratio with 20 mm coarse aggregate for chimney portion and 40mm aggregates for pyramid or slab portion. The quantity of cement to be used per cubic meter shall be as per CPWD specification (DSR). All the properties of concrete regarding its strength under compression, tension, shears, punching and bending etc. as well as workmanship, will conform to IS: 456.

a) The Portland Cement used in concrete shall conform to 33 grade (IS:269) or 43 grade (IS:8112) or 53 grade (IS:12269).

b) The Pozzolena used in concrete shall confirm to IS:1489. The curing time of pozzolena cement will be decided at the time of execution of the work under the contract based on the certificate form a reputed laboratory which will be obtained and submitted by the Contractor.

Concrete aggregates shall confirm to IS:383.

The water used for mixing concrete shall be fresh, clean and free from oil, acids & alkalise, organic materials or other deleterious substances. Potable water is generally preferred.

4.35 **Reinforcement:-** Reinforcement shall confirm to IS:432 from MS bars and hard drawn steel wires and to IS:1139 and IS:1786 for deform and cold twisted bars respectively. Thermo mechanically treated (TMT) bars (equivalent grade) in place of cold twisted bars are also acceptable. All reinforcement shall be clean and free from loose mill scales, dust, loose rust and coats of paint, oil or other coatings, which may destroy or reduce bond. Contractor shall supply, fabricate and place reinforcement to shapes and dimensions as indicated or as required to carry out the intent of drawings and Specifications.

4.36 **R.C.C. FOUNDATIONS:-**

The R.C.C. foundations shall be in accordance with IS: 456-2000 or any revision/modification thereof, employing the same properties of materials, permissible stresses and mode of design as specified therein, when adoption of R.C.C. foundation results in overall economy over ordinary cement concrete foundation, Such foundations will not be permitted in pyramid forms and instead suitable steps of square slabs, each not less than 150 mm thick shall be adopted. The thickness of the bottom slab in touch with the base earth shall not be less than 300 mm. Further, suitable length of the stub shall be embedded in and covered by the foundation slabs so that adequate bond strength may develop for transferring the full design loads through concrete to the foundation slabs.

4.37 **FOUNDATION DEPTH:** The total depth of foundations below the ground level shall not be less than 1.5 M. To maintain inter-changeability of stubs for the same type of tower, the depth of each type of foundations for each type of tower shall be equal except for foundation in hard rock. However, the maximum depth of foundation for all type of tower, except special crossing structures**,** shall not be more than 3.5 metre below the ground level.

4.38 **CONTRACTOR'S LIABILITY:-**The contractor shall ensure that the specification of materials and workmanship of all towers actually supplied conform strictly to the towers which have successfully under gone the tests. In case, any deviation is detected the Contractor shall replace such defective towers free of cost to the CSPTCL. All expenditure incurred in erection to and fro transportation; any other expenditure or losses incurred by the CSPTCL on this account shall be fully borne by the Contractor. No extension in delivery time shall be allowed on this account.

4.39 **STANDARDS:** The manufacturing, fabrication, Galvanising, testing, erection procedure and materials used for manufacture and erection of towers and construction of foundations shall conform to the Indian Standards (IS) which shall mean latest revisions, with amendments / changes adopted and published Unless specifically stated otherwise in the specification.

The material and services covered under these specifications shall be performed as per requirements of the relevant IS standards against each set of equipment and services.

4.40 **FINAL DRAWING DETAILS:**

The CSPTCL shall signify his approval or otherwise of the drawings submitted by the Bidder within a reasonable time generally not exceeding 30 days from the date of receipt of such drawings. Within 30 days of the receipt by the Contractor of the notification by the Board of his approval of such drawings, ten sets along with reproducible tracing of the drawings as approved shall be submitted to the Board by the contractor.

4.41 **DEPARTURE FROM SPECIFICATIONS TECHNICAL CONDITIONS:** In case of deviation from any of the requirements of the specifications, the same may be brought out clearly in annexure-16, otherwise it will be presumed that all the technical conditions of our specifications are acceptable to the Bidder.

4.42 **QUANTUM OF WORK**:

The quantities indicated in price schedules are based on preliminary assessment and are provisional. Thus, the quantities of towers and extensions etc. assumed are only provisional as also the number of location in various types of soils, The quantities of various work indicated are also provisional and may vary depending on actual type of soil / conditions encountered in the field depending on survey and approved profile. The work is to be completed as per actual site conditions and on same prices as offered and on similar terms and conditions.

However for offering tender prices the quantum of work given in Annexure-1 & 2 may be assumed.

SECTION-II-B
TECHNICAL SPECIFICATIONS

SECTION-II-B-(i)

1. Technical Description of ACSR (54/3.53) "MOOSE" and Zebra Conductor

1.1 **Details of Conductor**

1.1.1 The ACSR Conductor shall generally conform to IEC: 1089/ IS: 398 except where otherwise specified herein.

1.1.2 The salient parameters of the ACSR Conductor are indicated below.

SN	Particulars	ACSR MOOSE Conductor	ACSR ZEBRA Conductor
a)	Stranding and wire diameter	54/3.53mmAl +7/3.53 mm steel	54/3.18 mm. Al+7/3.18 mm Steel
b)	Number of Strands		
	Steel core	1	1
	1st steel layer	6	6
	1st Aluminium layer	12	12
	2nd Aluminium layer	18	18
	3rd Aluminium layer	24	24
c)	Sectional area of Aluminium	528.5	428.9/55.61 sq.mm.
d)	Total sectional area	597.0	484.50 sq.mm.
e)	Overall diameter (mm)	31.77	28.62

1.1.3 Standard Technical Particulars

1.1.3.1 The Standard Technical Particulars (STP) of the ACSR conductor are enclosed at Annexure-B of this section. The values indicated in the STP are the minimum and/or maximum values required to be met by the Supplier.

1.2 Workmanship

1.2.1 All the Aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions, etc., after drawing and also after stranding.

1.2.2 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (protusion of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

1.2.3 The steel strands shall be hot dip galvanized and shall have a minimum zinc coating as indicated in the STP. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections and shall withstand number of dips in standard Preece test as indicated in STP. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in IEC: 888.

1.2.4 The steel strands shall be preformed and post formed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid, damages to galvanization during pre-forming and post-forming operation.

1.3 Joints in Wires

1.3.1 Aluminium Wires

1.3.1.1 During stranding, no aluminium wire welds shall be made for the purpose of achieving the required conductor length.

1.3.1.2 No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However joints are permitted in the inner layer of the conductor unavoidably broken during stranding provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

1.3.1.3 Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

1.3.2 Steel Wires

There shall be no joint of any kind in the finished wire entering into the manufacture of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

1.4 Tolerances

The manufacturing tolerances to the extent indicated in the STP shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor.

1.5 Materials

1.5.1 Aluminium

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC: 889.

1.5.2 **Steel**

1.5.3 The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the STP.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC: 888.

1.5.4 Zinc

The zinc used for galvanizing shall be electrolytic High Grade Zinc of 99.95% purity as per IS209. It shall conform to and satisfy all the requirements of IS:209.

1.6 Standard Length

1.6.1 The standard length of the conductor shall be as indicated in the STP. .

2.0 Tests and Standards

Tests on ACSR Conductor shall be conducted as per latest relevant standard & tender specification.

2.1 Type Tests

The following tests shall be conducted once on a sample / samples of conductor as **per latest relevant standard & tender specification.**

a)	DC resistance test on stranded conductor	As per Annexure-A
b)	UTS test on stranded conductor	
c)	Radio interference voltage test (dry)	
d)	Corona extinction voltage test (dry)	

2.2 **Acceptance Tests:-** Acceptance Tests on **ACSR Conductor** shall be conducted by owner representative at works site of manufacturer as per provision in **latest relevant standard and tender specification.**

a)	Visual and dimensional check on drum	As per Annexure-A
b)	Visual check for joints scratches etc. and length meas conductor by rewinding	
c)	Dimensional check on steel and aluminum strands	
d)	Check for lay-ratios of various layers	
e)	Galvanizing test on steel strands	
f)	Torsion and Elongation tests on steel strands	
g)	Breaking load test on steel and Aluminium strands	
h)	Wrap test on steel & Aluminium strands	IEC : 888 & 889

i)	DC resistance test on Aluminium strands	IEC : 889
j)	Procedure qualification test on welded joint of Aluminium str	Annexure-A
k)	Barrel Batten strength test	Annexure-A

Note : All the above tests except (j) shall be carried out on Aluminum and steel strands after stranding only.

2.3 **Routine Test**

a)	Check to ensure that the joints are as per Specification
b)	Check that there are no cuts, fins etc., on the strands.
c)	Check that drums are as per Specification
d)	All acceptance test as mentioned above to be carried out on each coil/ drum (as applicable)

2.3.1 Packing

2.3.1.1 The conductor shall be supplied in non-returnable, strong, wooden drums provided with lagging of adequate strength, constructed to protect the conductor against all damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Supplier shall be responsible for any loss or damage during transportation handling and storage due to improper packing. The drums shall generally conform to IS:1778, except as otherwise specified hereinafter.

2.3.1.2 The drums shall be suitable for wheel mounting and for letting off the conductor under a minimum controlled tension of the order of 5 KN.

2.3.2 **Marking**

Each drum shall have the following information stenciled on it in indelible ink along with other essential data :

(a) Contract/Award letter number.
(b) Name and address of consignee.
(c) Manufacturer's name and address.
(d) Drum number
(e) Size of conductor
(f) Length of conductor in meters
(g) Arrow marking for unwinding
(h) Position of the conductor ends
(i) Distance between outer-most Layer of conductor and the inner surface of lagging.
(k) Barrel diameter at three locations & an arrow marking at the location of the measurement.
(l) Number of turns in the outer most layer.
(m) Gross weight of drum after putting lagging.
(n) Tear weight of the drum without lagging.
(o) Net weight of the conductor in the drum.

The above should be indicated in the packing list also.

2.4 **Standards**

2.4.1 The conductor shall conform to the following Indian/International Standards, which shall mean latest revisions, with amendments/changes adopted and published, unless specifically stated otherwise in the Specification.

2.4.2 In the event of the supply of conductor conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Supplier and those specified in this document will be provided by the Supplier to establish their equivalence.

Sl. No.	**Indian Standard**	**Title**	**International Standard**
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS: 398 Part-I - 1996	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC:1089-1991 BS:215-1970
3.	IS:398 Part-II - 1996	Aluminum Conductor Galvanized Steel Reinforced	BS;215-1970 IEC:1089-1991
4.	IS:398 Part-V - 1992	Aluminum Conductor Galvanized Steel- Reinforced For Extra High Voltage (400 KV) and above	IEC:1089-1991 BS:215-1970
5.	IS : 1778-1980	Reels and Drums for Bare Conductors	BS:1559-1949
6.	IS : 1521-1991	Method of Tensile Testing of Steel Wire	ISO 6892-1984
7.	IS : 2629-1990	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
8.	IS : 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles	
9.	IS : 4826-1992	Galvanized Coating on Round Steel Wires	IEC : 888-1987 BS:443-1969
10.	IS : 6745-1990	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433-1969 ISO 1460 - 1973
11.	IS : 8263-1990	Method of Radio Interference Tests on High Voltage Insulators	IEC:437-1973 NEMA:107-1964 CISPR
12.		Zinc Coated steel wires for stranded Conductors	IEC : 888-1987
13.		Hard drawn Aluminum wire for overhead line conductors	IEC : 889-1987

ANNEXURE-A

3. Tests on Conductor

3.1 UTS Test on Stranded Conductor

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5 m length between fixing arrangement suitably fixed on a tensile testing machine. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to 100% of the UTS of conductor and held for one minute. The Conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and this value shall be recorded.

3.2 Corona Extinction Voltage Test:

The sample assembly with each conductor of 5 m length shall be strung as per the configuration shown in the Table below.

Line Configuration	No of conductor samples per Bundle	Spacing (mm)	Maximum Height of the conductor above ground (m)
400kV with twin ACSR MOOSE	Two	450	8.84

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than that indicated in the STP. There shall be no evidence of corona on any part of the samples. The test should be conducted without corona control rings. However, small corona control rings may be used to prevent corona in the end fittings. The voltage should be corrected for standard atmospheric conditions.

3.3 Radio Interference Voltage Test:

Under the conditions as specified under (1.2) above, the conductor samples shall have radio interference voltage as indicated in the standard technical particulars enclosed at Annexure-B of this section. This test may carried out with corona control rings and arcing horns. The test procedure shall be in accordance with IEC-437

3.4 D.C. Resistance Test on Stranded Conductor

On a conductor sample of minimum 5m length two contact-clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge or digital ohm-metre of sufficient accuracy by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C as per IS:398. The resistance corrected at 20^0C shall conform to the requirements indicated in the STP.

3.5 Chemical Analysis of Aluminium and Steel

Samples taken from the Aluminium and steel ingots/coils/strands shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this Specification.

3.6 Visual and Dimensional Check on Drums

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification.

3.7 Visual Check for Joints, Scratches etc.

Conductor drums shall be rewound in the presence of the Owner. The Owner shall visually check for scratches, joints etc. and that the conductor generally conform to the requirements of this Specification. Five percent (5%) to ten percent (10%) drums from each lot shall be rewound in the presence of the Owner's representative. The actual quantity will be discussed and mutually agreed to by the Supplier & Owner in the Quality Assurance Programme.

3.8 Dimensional Check on Steel and Aluminium Strands

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

3.9 Check for Lay-ratios of Various Layers

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

3.10 Procedure Qualification test on welded Aluminium strands:- Two Aluminium wire shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the breaking strength of individual strands.

3.11 Chemical Analysis of Zinc :- Samples taken from the zinc ingots shall be chemically/ spectrographically analyzed. The same shall be in conformity to the requirements stated in the Specification.

3.12 **Galvanizing Test:-** The test procedure shall be as specified in IEC : 888. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

3.13 **Torsion and Elongation Tests on Steel Strands :- T**he test procedures shall be as per clause No. 10.3 of IEC : 888. In torsion test, the number of complete twists before fracture shall not be less than that indicated in the STP. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

3.14 **Check on Barrel Batten strength of Drums:-** The details regarding barrel batten strength test will be discussed and mutually agreed to by the Supplier & Owner in the Quality Assurance Programme.

Annexure-B

(i) STANDARD TECHNICAL PARTICULARS OF ACSR MOOSE CONDUCTOR

Sl.	Description	Unit	Guaranteed Values
1.0	Raw Materials		
1.1	Steel Wire / Rods		
1.1	Aluminium		
a)	Minimum purity of Aluminium	%	99.50
b)	Maximum copper content	%	0.04
1.2	Steel wires/ rods		
a)	Carbon	%	0.50 to 0.85
b)	Manganese	%	0.50 to 1.10
c)	Phosphorous	%	Not more than 0.035
d)	Sulphur	%	Not more than 0.045
e)	Silicon	%	0.10 to 0.35 (Max.)
1.3	Zinc		
a)	Minimum purity of Zinc	.%	99.95
2.0	Aluminum strands after stranding		54/3.53mm
2.1	Diameter		
a)	Nominal	mm	3.53
b)	Maximum	mm	3.55
c)	Minimum	mm	3.51
2.2	Minimum breaking load of strand		
a)	Before stranding	KN	1.57
b)	After stranding	KN	1.49
2.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.002921
3.0	**Steel strand after stranding**		7/3.53mm
2.1	Diameter		
a)	Nominal	mm	3.53
b)	Maximum	mm	3.59
c)	Minimum	mm	3.47
3.2	Minimum breaking load of strand		
a)	Before stranding	KN	12.63
b)	After stranding	KN	11.99

Sl.	Description	Unit	Guaranteed Values
3.3	Galvanising		
a)	Minimum weight of zinc coating per sq.m.	gm	250
b)	Minimum number of dips that the galvanized strand can withstand in the standard preece test	Nos.	2 dips of one minute & 1 dip of half minute

c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16	
4.	**Stranded Conductor**			
4.1	UTS of the conductor	kN	161.20 (Min.)	
4.2	Lay length of outer steel layer	mm	Max	Min
a)	Outer Steel layer	mm	18	16
b)	12 wire Aluminium layer	mm	14	12
c)	18 wire Aluminium layer	mm	13	11
d)	24 wire Alumimium Layer	mm	12	10
4.3	DC resistance of the conductor at 20°C when corrected atstandard weight Ohm-km	ohm/km	0.05552	
4.4	Minimum corona Extinction Voltage (line to phase) under Dry condition	kV (rms)	320	
4.5	RIV at 1 Mhz at 305 Amp (line to phase) under Dry condition	Micto Volts	Below 1000	
4.6	Standard length of the conductor	m	1800	
4.7	Tolerance on Standard length	%	(+/-) 5	
4.8	Direction of lay of outer layer		Right Hand	
4.9	**Linear mass of the conductor**			
	Aluminium	kg/km	1463	
	Steel	kg/km	539	
a)	Total Standard	kg/km	2002	
b)	Minimum	kg/km	1969	
c)	Maximum	kg/km	2040	
5.0	Coefficient of linear expansion of Conductor per degree celcius	per degree celcius	19.3×10^{-6}	
5.1	Calculated finalModulus of elasticity kg/ cm2 $\times 10^{+6}$	kg/ cm2	$0.686 \times 10^{+6}$	
5.2	Temp. Variation	0 Deg. / 75 Deg. C		
5.3	Current carrying capacity. at 40 deg. Cent. Ambient and 30 deg. Rise	Amp	830 Amp	

(ii) STANDARD TECHNICAL PARTICULARS OF ACSR ZEBRA CONDUCTOR

The ACSR ZEBRA CONDUCTOR to be supplied should confirm to IS:398 part-II with all the amendments made till to-day. However, important parameters are given below for :-

Sl.	**Description**	**Unit**	**Guaranteed Values for ACSR Zebra**
1.0	Raw Materials		
1.1	Steel Wire / Rods		
1.1	Aluminium		
a)	Minimum purity of Aluminium	%	99.50
b)	Maximum copper content	%	0.04
1.2	Steel wires/ rods		
a)	Carbon	%	0.50 to 0.85

b)	Manganese	%	0.50 to 1.10	
c)	Phosphorous	%	Not more than 0.035	
d)	Sulphur	%	Not more than 0.045	
e)	Silicon	%	0.10 to 0.35 (Max.)	
1.3	Zinc			
a)	Minimum purity of Zinc	.%	99.95	
2.0 a)	No. of strands Alu./Steel	No.	54/7	
b)	Cross section area iv) Alu/Steel. Strands v) Whole Alu./Steel vi) Whole conductor	Sq. mm	 7.942/7.942 428.90/55.6 484.50/643.58	
c)	Over all diameter of conductor	mm	28.62	
d)	Laying of strand		Alu.	Steel
	vi) Center	No.	NA	1
	vii) First layer	No.	NA	6
	viii) Second layer	No.	12	NA
	ix) Third layer	No.	18	NA
	x) Fourth layer	No.	24	NA
2.1	Aluminum strands after stranding		54/3.18 mm.	
	Diameter			
a)	Nominal	mm	3.18	
b)	Maximum	mm	3.21	
c)	Minimum	mm	3.15	
2.2	Minimum breaking load of strand			
a)	Before stranding	KN	1.29	
b)	After stranding	KN	1.23	
2.3	Maximum resistance of 1 m length of strand at 20 deg. C.	Ohm Sq. per Mtr.	0.03626	
3.0	**Steel strand after stranding**		7/3.18	
2.1	Diameter			
a)	Nominal	mm	3.18	
b)	Maximum	mm	3.24	
c)	Minimum	mm	3.12	
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	10.43	
b)	After stranding	KN	9.91	
3.3	Galvanising			
a)	Minimum weight of zinc coating per sq.m.	gm	260	

b)	Minimum number of dips that the galvanized strand can withstand in the standard preece test	Nos.	3 dips of one minute	
c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	18	
4.	**Stranded Conductor**			
4.1	UTS of the conductor	kN	130.32	
4.2	Lay length of outer layer	mm	Max	Min
a)	Steel layer	mm	28	13
b)	First Aluminium layer	mm	17	10
c)	Second Aluminium layer	mm	16	10
d)	Third layer	mm	14	10
4.3	DC resistance of the conductor at 20°C when corrected at standard weight Ohm-km ii) Whole conductor iii) Strand	Ohm /km	0.06868 3.626	
4.4	Standard length of the conductor	m	1500	
4.5	Tolerance on Standard length	%	(+/-) 5	
4.6	Direction of lay of outer layer		Right Hand	
4.7	**Linear mass of the conductor**			
	Aluminium	kg/km	1182	
	Steel	kg/km	439	
a)	Total Standard	kg/km	1620	
5.0	Coefficient of linear expansion of Conductor per degree celcius i) Aluminium ii) Steel	per degree celcius	19.3x10^-6	
5.1	Calculated final Modulus of elasticity kg/ cm2	kg/ cm2 GN/Sq. M	69	
5.2	Temp. Variation	0 Deg./75 Deg.C		
5.3	Current carrying capacity. at 40 deg. Cent. Ambient and 30 deg. Rise	Amp	740	
5.4	Elongation before stranding steel strand	%	4/3.5	

(SECTION-II-B-ii) (a)

TECHNICAL SPECIFICATION OF GROUND WIRE

1. Galvanized Steel Earth wire

Details of Earthwire

The galvanized steel earth wire shall generally conform to the specification of ACSR core wire as mentioned in IS:398 (Part-II)-1976 except where otherwise specified herein.

The basic details of the earth wire for are tabulated below:

Sl.No.	Description	Unit	400 KV lines	220 KV
1.	Stranding & Wire diameter	mm	7/3.66 (steel)	7/3.66 (steel)
2.	Strands Steel Core Outer steel layer	 No. No.	 1 (one) 6 (six)	 1 (one) 6 (six)
3.	Total sectional area	Sq. mm.	73.65	73.65

Other technical details are furnished in the section–I of this Specification.

2 Workmanship

All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.

The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use .

The steel strands shall be hot dip galvanized and shall have minimum Zinc coating after stranding, as stipulated in Cl. 2.0 of this section of the Specification. The zinc coating shall be smooth, continuous, of uniform thic KNess, free from imperfections. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation B498-M.

The steel strands shall be preformed and post formed in order to prevent spreading of strands while cutting of composite earth wire. Care shall be taken to avoid damage to galvanization during performing and post forming operation.

To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

3. Joints in Wires

There shall be no joint of any kind in the finished steel wire strand entering into the manufacture of the earth wire. There shall be no strand joints or strand splices in any length of the completed stranded earth wire.

4. Tolerances

The manufacturing tolerance to the extent of the limits as stipulated in Clause 2.0, Table 1 of this section of the Specification only shall be permitted in the diameter of the individual steel strands and lay length of the earth wire:

5. Materials

Steel :- The steel wire strands shall be drawn from high carbon steel rods and the chemical composition shall conform to the requirements as stipulated in Clause 2.0, Table 1 of this section of the Specification.

Zinc :- The zinc used for galvanizing shall be electrolytic High Grade Zinc and shall conform to the requirements of IS:209.

6 Standard Length :- The standard length of the earth wire shall be as stipulated in Clause 2.0, Table 1 with the specified tolerance on standard length.

7 Standard technical Particulars :- The standard Technical Particulars to be adhered by the contractor/ manufacturer are furnished in below:

TABLE – 1 (7/3.66 mm Galvanized Steel Earth wire)

Sl. no.	Description	Unit	Standard Values
1.0	**Raw Materials**		
1.1	**Steel wires / rods**		
a)	Carbon	%	Not more than

Sl. no.	Description	Unit	Standard Values
			0.55
b)	Manganese	%	0.40 to 0.90
c)	Phosphorous	%	Not more than 0.04
d)	Sulphur	%	Not more than 0.04
e)	Silicon	%	0.15 to 0.35
1.2	**Zinc**		
a)	Minimum purity of Zinc satisfy IS:209	%	99.95
2.0	**Steel strands**		7/3.66 mm
2.1	**Diameter (Tolerance +/- 2 %)**		
a)	Nominal	mm	3.66
b)	Maximum	mm	3.75
c)	Minimum	mm	3.57
2.2.	**Minimum breaking load of strand**		
a)	After stranding	KN	10.58
2.3	**Galvanizing**		
a)	Minimum weight of zinc coating per sq.m. after stranding	Gms.	275
b)	Minimum number of dips that the galvanized strand can withstand in the standard preece test	Nos.	3 dips of 1 minute and one dip of ½ minute
c)	Minimum number of twists in a gauge length equal to 100 times diameter of wire which the strand can withstand in the torsion test, after stranding	Nos.	18

3.0	**Stranded Earth wire**		
	Total cross section area	Sq.mm	73.65
3.1	UTS of Earth wire	KN/kg	68 .4(min.)/6972
3.2	Lay length of outer steel layer		
a)	Standard	mm	181
b)	Maximum	mm	198
c)	Minimum	mm	165
3.3	Maximum DC resistance of earth wire at 20^0 C	Ohm/km	2.5
3.4	Standard length of earth wire	M	2000
3.5	Tolerance on standard length	%	±5
3.6	Direction of lay for outside layer		Right hand
3.7	Linear mass		
a)	Standard	Kg/km	583
b)	Maximum	Kg/km	600
c)	Minimum	Kg/km	552
3.8	Overall diameter	mm	10.98 mm
3.9	Modulus of elasticity	kg/ cm^2	1.933×10^6
4.0	Coefficient of linear expansion	per □ C	11.50×10^{-6}
4.1	D.C. resistance at 20□ C	Ohms / KM	2.5

8. Tests and Standards

Tests on Eathwire shall be conducted as per latest relevant standard & tender specification.

8.1 Type Tests on Earthwire:

The following tests shall be conducted once on a sample:		
a)	UTS test	: As per Annexure - A
b)	DC resistance test	: As per Annexure - A

8.2- **Acceptance Tests :--** Acceptance Tests on Earthwire shall be conducted by owner representative at works site of manufacturer as per provision in latest **relevant standard and as per tender specification.**

Acceptance Tests on Earthwire		
a)	Visual and dimensional check on drum	: As per Annexure - A
b)	Visual check for joints scratches etc. and lengths of earthwire	: As per Annexure - A
c)	Dimensional check	: As per Annexure - A
d)	Lay length check	: As per Annexure - A
e)	Galvanising test	: As per Annexure - A
f)	Torsion test	: As per Annexure - A
g)	Elongation test	: As per IS:398 (Part-II)
h)	Wrap test	: As per IS:398 (Part-II)
i)	DC resistance test	: As per IS:398 (Part-II)
j)	Breaking load test	: As per IS:398 (Part-II)
k)	Chemical Analysis of steel	: As per Annexure - A
Routine Tests on Earthwire		
a)	Check for correctness of stranding	: As per Annexure - A
b)	Check that there are no cuts, fins etc. on the strands.	: As per Annexure - A
c)	Check that drums are as per Specification.	: As per Annexure - A
Tests During Manufacture Earthwire		
a)	Chemical analysis of zinc used for galvanising	: As per Annexure - A
b)	Chemical analysis of steel	: As per Annexure - A

8.3 Standards

The earth wire shall conform to the following Indian/ International Standards, which shall mean latest revisions, amendments/changes adopted and published, unless otherwise in the Specification.

Sl. No	**Indian Standard**	**Title**	**International Standard**
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS: 398-1990	Specification for Aluminium Conductors for Overhead Transmission Purposes	IEC:1089-1991 BS:215-1970
3.	IS:398-1998 Part-II	Aluminum Conductor Galvanized Steel Reinforced	BS;215-1970 IEC:1089-1991
4.	IS :398-1996 Part-IV	Aluminum Alloy stranded conductor	BS-3242-1970 ASTM 8399M86 IEC:1089-1991
5.	IS:398-1992 Part-V	Aluminum Conductor Galvanized Steel-Reinforced For Extra High Voltage (400 KV) and above	IEC:1089-1991 BS:215-1970
6.	IS : 1778-1997	Reels and Drums for Bare Conductors	BS:1559-1949
7.	IS : 1521-1991	Method of Tensile Testing of Steel Wire	ISO 6892-1984
8.	IS : 2629-1990	Recommended Practice for Hot Dip Galvanizing of Iron and Steel	
9.	IS : 2633-1992	Method of Testing Uniformity of Coating on Zinc Coated Articles	
10.	IS : 4826-1992	Galvanized Coating on Round Steel Wires	IEC : 888-1987 BS:443-1969
11.	IS : 6745-1991	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433-1969 ISO 1460 - 1973

12.	IS : 8263-1991	Method of Radio Interference Tests on High Voltage Insulators	IEC:437-1973 NEMA:107-1964 CISPR
13.	IS : 9997-1991	Aluminium Alloy Redraw Rods	IEC 104 - 1987
14.		Zinc Coated steel wires for stranded Conductors	IEC : 888-1987
15.		Hard drawn Aluminium wire for overhead line conductors	IEC : 889-1987

ANNEXURE-A

9. **Tests on Earth wire**

UTS Test

Circles perpendicular to the axis of the earth wire shall be marked at two places on a sample of earth wire of minimum 5 m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate up to 50% of UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter the load shall be increased at steady rate to 100% of UTS and held for one minute. The earth wire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

10. D.C. Resistance Test

On a earth wire sample of minimum 5m length two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially at zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20^0C. The resistance corrected at 20^0C shall conform to the requirements of this Specification.

11. Chemical Analysis of Zinc

Samples taken from the zinc ingots shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in the Specification.

12. Chemical Analysis of Steel

Samples taken from the steel ingots/coils/strands shall be chemically,/spectrographically analysed. The same shall be in conformity to the requirements stated in this Specification.

13. Visual and Dimensional Check on Drums and its barrel strength test.

The drums shall be visually and dimensionally checked to ensure that they conform to the requirements of this Specification. The details regarding barrel strength test will be discussed and mutually agreed to by Contractor and Owner in the quality assurance programmed.

14. Visual Check for Joints, Scratches etc. and Length of Earth wire

Ten percent drums from each lot shall be rewound in the presence of the Owner. The Owner shall visually check for scratches, joints etc. and see that the earth wire generally conforms to the requirements of this Specification. The length of earth wire wound on the drum shall be measured with the help of counter meter during rewinding.

15. Dimensional Check

The individual strands shall be dimensionally checked to ensure that they conform to the requirement of this Specification.

16. Lay Length Check

The lay length shall be checked to ensure that they conform to the requirements of this Specification.

17. Galvanizing Test

The test procedure shall be as specified in IS:4826- 1979. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

18. Torsion Test

The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case test sample length is less or more than 100 times the stranded diameter of the strand the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number.

****

SECTION-II-B(ii) (b)

TECHNICAL SPECIFICATIONS FOR
OPGW AND ASSOCIATED HARDWARES

(1) INTRODUCTION and GENERAL INFORMATION:

The Tender Document describes the technical specifications for Supply of OPGW & its associated hardware & fittings are being procured by the CSPTransCL as a part of the **Tender No. TR-16/55.**

This Specification describes the functional and performance requirements of the OPGW Cable and its associated hardware & fittings.

1.1 Scope

The scope of the this specification includes Design, engineering, manufacturing, testing, supply, loading, transportation, unloading, and erection of **(a) OPGW Cable (b) Associated hardware & fittings and In-line Splice enclosure** on LILO of 400KV DCDS Raita (Raipur)-Jgdalpur transmission line upto 400kV Dhamtari S/Stn.:

1.2 General Requirements

This specification defines the design, performance and testing requirements for supply of OPGW cable & its associated hardware & fittings.

The Contractor is encouraged to offer standard products and designs. However, the Contractor must conform to the requirements and provide any special equipment necessary to meet the requirements stated herein.

The Bidder's proposal shall address all functional and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification without further necessity for inquiries.

The Bidder's proposal shall clearly identify all features described in the specifications or in any supporting reference material that will not be implemented; otherwise, those features shall become binding as part of the final contract.

An analysis of the functional and performance requirements of this specification and/or design, and engineering may lead the Contractor to conclude that additional items (hardware/software) are required that are not specifically mentioned in this specification. The Contractor shall be responsible for providing at no added cost to the **CSPTransCL**, all such additional items. Such materials shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items (hardware/ software) in their proposal.

OPGW cable & associated hardware & fittings shall be designed to operate in varying environments. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture, lightning & short circuit, vibration and electro-magnetic interference etc.

1.3 Contractor Responsibilities and Obligations

The Contractor shall be responsible for design, engineering, manufacturing, testing for acceptance, supply, loading, transportation, unloading, transit insurance, delivery at site for supply of OPGW cable & its associated hardware & fittings.

The Contractor's obligations include, but are not limited to, the following:

1) Provide OPGW cabling that meets the functional and performance requirements of this specification.
2) Engineering and design specific to each location including review of, and conformance with local environmental and earthing requirements.
3) Testing and documentation for OPGW cable & its associated hardware & fittings.
4) Design of the mechanical assemblies and accessories, including vibration dampers required for installation of all overhead fibre cable.
5) Factory acceptance testing of all equipment provided.
6) Conduct type tests and provide documented evidence of satisfactory Type Test performance to the Employer.
7) Detailed descriptions of the Contractor's obligations, in relation to individual items of hardware, software, functions and services, are delineated in other sections of this specification.

1.4 Applicable Standards

The following standards and codes shall be generally applicable to the equipment and works supplied under this Contract:

(1) American Society for Testing and Materials ASTM-B415, ASTM-D1248, ASTM D 3349.
(2) ITU-T/CCITT Recommendations G.650, G.652, G.653, G.655
(3) Institute of Electrical and Electronics Engineers IEEE-812, 1138-1994, IEEE-524, IEEE-828 & 830.
(4) Electronic Industries Association, EIA-455-3, 455-31B, 455-32, 455-91, 455-78, 455-59, 455-80, 455-169, 455-81, EIA RS 598
(5) International Electrotechnical Commission standards, IEC -1396 and IEC - 1089.
(6) International Electrotechnical Commission standards, IEC 793-1, 793-2, 794-1, 794-2, IEC-529, , IEC 60794-1-2 , IEC 60794-4-10

Specifications and codes shall be the latest version, inclusive of revisions, which are in force at the date of the contract award. Where new specifications, codes, and revisions are issued during the period of the contract, the Contractor shall attempt to comply with such, provided that no additional expenses are charged to the CSPTRANSCL .

In the event the Contractor offers to supply material and/or equipment in compliance to any standard other than Standards listed herein, the Contractor shall include with their proposal, full salient characteristics of the new standard for comparison.

1.5 References

(1) CIGRE Guide for Planning of Power Utility Digital Communications Networks
(2) CIGRE Optical Fibre Planning Guide for Power Utilities
(3) CIGRE New Opportunities For Optical Fibre Technology in Electricity Utilities

(4) CIGRE guide to fittings for Optical Cables on Transmission Lines.

(2) SPECIFICATIONS AND FUNCTIONAL DESCRIPTION OF FIBRE OPTIC CABLE:

This section describes the functional & technical specifications for supply of OPGW cable & its associated hardware & fittings.

2.1 Fibre Optic Cabling

2.1.1 General

The Contractor shall supply 12 fibre (DWSM) OPGW fibre optic cable. The cable length requirement is indicated in the appendices.

All optical fibre cabling including fibre itself and all associated installation hardware shall have a minimum guaranteed design life span of 25 years.

Required Optical Fibre Characteristics

The characteristics of optical fibre to be provided under this specification are as follows.

Physical Characteristics

Dual-Window Single mode (DWSM), G.652 telecommunication grade optical fibres shall be provided in fibre optic cables. DWSM optical fibres shall meet the requirements defined in Table 2-1(a).

Attenuation

The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.05 dB/km. The attenuation coefficient between 1285 nm and 1330 nm, shall not exceed the attenuation coefficient at 1310 nm by more than 0.05 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.10 dB. The fibre attenuation characteristics specified in Table 2-1(a) shall be "guaranteed" fibre attenuation of any & every fibre reel.

Table 2-1(a)
DWSM Optical Fibre Characteristics

Fibre Description:	Dual-Window Single-Mode
Mode Field Diameter:	8.6 to 9.5 μm (± 10% of the nominal value)
Cladding Diameter:	125.0 μm ± 2 μm
Mode field concentricity error	≤ 1.0μm at 1310 nm
Cladding non-circularity	≤ 2%
Cable Cut-off Wavelength λ_{cc}	≤□ □ 1260 nm
1550 nm loss performance	As per G.652
Proof Test Level	≥100 kpsi
Attenuation Coefficient:	@ 1310 nm ≤ 0.35 dB/km @ 1550 nm ≤ 0.23dB/km

Table 2-1(a)
DWSM Optical Fibre Characteristics

Chromatic Dispersion; Maximum: **Zero Dispersion Wavelength:** **Zero Dispersion Slope:**	20 ps/(nm x km) 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm 1300 to 1324nm -0.093 ps/(nm^{2}xkm) maximum
Polarization mode dispersion coefficient	≤□ 0.5 ps/km^½
Temperature Dependence:	Induced attenuation ≤ 0.05 dB (-60ºC - +85 ºC)
Bend Performance:	@ 1310 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.05 dB/km @ 1550 nm (75±2 mm dia Mandrel), 100 turns; Attenuation Rise ≤ 0.10 dB/km @ 1550 nm (32±0.5 mm dia Mandrel, 1 turn; Attenuation Rise ≤ 0.50 dB/km

Fibre Optic Cable Construction

Overhead Fibre Optic Cables shall be OPGW (Optical Ground Wire). The design of cable shall account for the varying operating and environmental conditions that the cable shall experience while in service.

EHV Transmission Line- Earthwire/Conductor Details

Details of maximum spans, voltage levels and the relevant characteristics of the earthwire/conductor required for design of OPGW cable shall be considered same as given in **tender specification Section IV A & B.**

Optical Fibre Identification

Individual optical fibres within a fibre unit, and fibre units shall be identifiable in accordance with EIA/TIA 598 or IEC 60304 or Bellcore GR-20 colour-coding scheme.

Buffer Tube

Loose tube construction shall be implemented. The individually coated optical fibre(s) shall be surrounded by a buffer for protection from physical damage during fabrication, installation and operation of the cable. The fibre coating and buffer shall be strippable for splicing and termination. Buffer tubes shall be filled with a water-blocking gel.

Optical Fibre Strain

The fibre optic cable shall be designed such that the optical fibres experience no strain under all loading conditions defined in IS 802. No fibre strain condition shall apply even after a 25 year cable creep.

For the purpose of these specifications, the following definitions shall apply:

- *Maximum Working Tension (MWT)* is defined as the maximum cable tension at which there is *no fibre strain*.
- The *no fibre strain* condition is defined as fibre strain of less than or equal to 0.05%, as determined by direct measurements through IEC/ ETSI (FOTP) specified optical reflectometry techniques.
- The *Cable strain margin* is defined as the maximum cable strain at which there is no fibre strain.
- The cable *Maximum Allowable Tension (MAT)* is defined as the maximum tension experienced by the Cable under the worst case loading condition as defined in IS 802.

- The cable *max strain* is defined as the maximum strain experienced by the Cable under the worst case loading condition as defined in IS 802.
- The cable *Every Day Tension (EDT)* is defined as the maximum cable tension on any span under normal conditions viz at 32 °C and no wind.
- The *Ultimate /Rated Tensile Strength (UTS/* RTS/ breaking strength) is defined as the maximum tensile load applied and held constant for one minute at which the specimen shall not break.

While preparing the Sag-tension charts for the OPGW cable the following conditions shall be met:

- The Max Allowable Tension (MAT) / max strain shall be less than or equal to the MWT/ Strain margin of the cable.
- The sag shall not exceed the earth wire sag in all conditions.
- The Max Allowable Tension shall also be less than or equal to 0.4 times the UTS of OPGW. However, Max Allowable Tension up to 0.5 times the UTS of OPGW may be accepted, subject to no fibre strain.
- The 25 year creep at 25% of UTS (creep test as per IEEE 1138) shall be such that the 25 year creep plus the cable strain at Max Allowable Tension (MAT) is less than or equal to the cable strain margin.
- The everyday tension (EDT) shall not exceed 20% of the UTS for the OPGW cable.

The Sag-tension chart indicating the maximum tension, cable strain and sag shall be calculated for the following conditions as specified in IS 802:1977/1995:

a. 53 ^{o}C, no wind, no ice
b. 32 ^{o}C, no wind, no ice
c. 0 ^{o}C, no wind, no ice
d. 32 ^{o}C, full wind, no ice
e. 0 ^{o}C, 2/3rd / 36% of full wind (IS 802:1977/1995)

The above cases shall be considered for the spans from 100 m to max. span length in the range of 50 m spans. The full wind load shall be considered as the design wind load as per relevant IS 802 version and the sag-tension chart shall be submitted accordingly.

2.1.3.5 Cable Materials

The materials used for optical fibre cable construction, shall meet the following requirements:

Filling Materials

The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC-60794-1-F-5.

The filling compound used shall be a non-toxic homogenous waterproofing compound that is free of dirt and foreign matter, nonhygroscopic, electrically nonconductive and non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

The filling compound shall remain stable for ambient temp. between -20°C and +65°C and shall not drip, flow or leak with age or at high temperatures during short duration lightning strikes and short circuit currents The filling compound shall meet the requirements of "Seepage of Filling Compound test" as per EIA/TIA 455-81.

The waterproofing filling materials shall not affect fibre coating, colour coding, or encapsulant commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

Metallic Members

When the fibre optic cable design incorporates metallic elements in its construction, all metallic elements shall be electrically continuous.

Marking, Packaging and Shipping

This section describes the requirements for marking, packaging and shipping the overhead fibre optic cable.

(a) Drum Markings: Each side of every reel of cable shall be permanently marked in a minimum of 1 cm high white lettering with the vendors' address, the Employer's destination address, cable part number and specification as to the type of cable, length, number of fibres, a unique drum number & segment no., factory inspection stamp and date.

(b) Cable Drums: All optical fibre cabling shall be supplied on sturdy, corrosion resistant, steel drums suitable for long periods of storage and re-transport & handling provided with lagging of adequate strength, constructed to protect the cabling against all damage and displacement during transit, storage and subsequent handling during installation. Both ends of the cable shall be sealed as to prevent the escape of filling compounds and dust & moisture ingress during shipment and handling. Spare cable caps shall be provided with each drum as required.

There shall be no factory splices allowed within a continuous length of cable. Only one continuous cable length shall be provided on each drum. The lengths of cable to be supplied by the contractor on each drum shall be between 4-5kms. However length of cable higher than 5 kms, if required, may also be supplied in single drum. Same shall be discussed & finalised during the detailed engineering.

Optical Ground Wire (OPGW)

OPGW cable construction shall comply with IEEE-P1138 and IEC publication 1396. The cable provided shall meet both the construction and performance requirements such that the ground wire function, the optical fibre integrity and optical transmission characteristics are suitable for the intended purpose.

The composite fibre optic overhead ground wire shall be made up of buffered optical fibre units embedded in a water tight aluminium/aluminium alloy/stainless steel protective central fibre optic unit surrounded by concentric-lay stranded metallic wires in single or multiple layers. However, other material may be accepted subject to meeting the cable type-testing requirements as specified in the technical specifications. The dual purpose of the composite cable is to provide the electrical and physical characteristics of conventional overhead ground wire while providing the optical transmission properties of optical fibre.

Central Fibre Optic Unit

The central fibre optic unit shall be designed to house and protect multiple buffered optical fibre units from damage due to forces such as crushing, bending, twisting, tensile stress and moisture. The central fibre optic unit and the outer stranded metallic conductors shall serve together as an integral unit to protect the optical fibres from degradation due to vibration and galloping, wind and ice loadings, wide temperature variations, lightning and fault current, as well as environmental effects which may produce hydrogen. The central fibre optic unit may include an aluminium tube and/or channelled aluminium rod.

Basic Construction

The cable construction shall conform to the applicable requirements of Technical Specification, applicable clauses of IEC 1089 related to stranded conductors and Table 2.2(a) OPGW Mechanical and Electrical Characteristics. In addition, the basic construction shall include bare concentric-lay-stranded metallic wires with the outer layer having left hand lay. The wires may be of multiple layers with a combination of various metallic wires within each layer. The direction of lay for each successive layer shall be reversed.

Breaking Strength

The rated breaking strength of the completed OPGW shall be taken as no more than 90 percent of the sum of the rated breaking strengths of the individual wires, calculated from their nominal diameter and the specified minimum tensile strength.

The rated breaking strength **shall not include the strength of the optical unit**. The fibre optic unit shall not be considered a load bearing tension member when determining the total rated breaking strength of the composite conductor.

Electrical and Mechanical Requirements

Table 2-2(a) provides OPGW Electrical and Mechanical Requirements for the minimum performance characteristics. Additionally, the OPGW mechanical & electrical characteristics shall be similar to the electrical & mechanical characteristics of the (7/3.66) GI earthwire. The earthwire parameters are listed in tender specification Section –IV B –Part (ii). For the purposes of determining the appropriate Max Working Tension limit for the OPGW cable, IS 802:1995 and IS 875: 1987 shall be applied. However the OPGW sag & tension charts shall be based on IS 802. For the OPGW cable design selection and preparation of sag tension charts, the limits specified in this section shall also be satisfied. The Bidder shall submit sag-tension charts for the above cases with their bids.

Table 2.2(a)
OPGW Electrical and Mechanical Requirements

(1)	**Everyday Tension at 32ºC, no wind:**	≤ 20% of UTS of OPGW
(2)	**D.C. Resistance at 20ºC:**	< 1.0 ohm/Km
(3)	**Short Circuit Current:**	≥6.32 kA for 1.0 second

Operating conditions

Since OPGW shall be located at the top of the EHV transmission line support structure, it will be subjected to Aeolian vibration, Galloping and Lightning strikes. It will also carry ground fault currents. Therefore, its electrical and mechanical properties shall be the same or similar as those required of conventional ground wire as listed in tender specification Section –IV B –Part (ii).

Installation Hardware

The scope of supply of the optical cable includes the assessment, supply and installation of all required fittings and hardware. The Contractor shall determine the exact requirements of all accessories required to install and secure the OPGW.

The OPGW hardware fittings and accessories shall follow the general requirements regarding design, materials, dimensions & tolerances, protection against corrosion and markings as specified in §4.0 of EN 61284: 1997 (IEC 61284). The shear strength of all bolts shall be at least 1.5 times the maximum installation torque. The Contractor shall provide the OPGW hardware & accessories drawing & Data Requirement Sheets (DRS) document for all the assemblies & components. However, DRS format of assemblies has been enclosed in the appendices. All component reference numbers, dimensions and tolerances, bolt tightening torques & shear strength and ratings such as UTS, slip strength etc shall be marked on the drawings.

The fittings and accessories described herein are indicative of installation hardware typically used for OPGW installations and shall not necessarily be limited to the following:

(a) Suspension Assemblies: Preformed armour grip suspension clamps and aluminum alloy armour rods/ reinforcing rods shall be used. The suspension clamps shall be designed to carry a vertical load of not less than 25 KN. The suspension clamps slippage shall occur between 12kN and 17 kN as measured in accordance with type test procedures specified in APPENDIX A,.

The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pins, etc. The total drop of the suspension assembly shall not exceed 150 mm (measured from the centre point of attachment to the centre point of the OPGW).

(b) Dead End Clamp Assemblies: All dead end clamp assemblies shall preferably be of the performed armoured grip type and shall include all necessary hardware for attaching the assembly to the tower strain plates. Dead end clamps shall allow the OPGW to pass through continuously without cable cutting. The slip strength shall be rated not less than 95% of the rated tensile strength of the OPGW.

(c) Clamp Assembly Earthing Wire: Earthing wire consisting of a 1500 mm length of aluminium or aluminium alloy conductor equivalent in size to the OPGW shall be used to earth suspension and dead end clamp assemblies to the tower structure. The earthing wire shall be permanently fitted with lugs at each end. The lugs shall be attached to the clamp assembly at one end and the tower structure at the other.

(d) Structure Attachment Clamp Assemblies: Clamp assemblies used to attach the OPGW to the structures, shall have two parallel grooves for the OPGW, one on either side of the connecting bolt. The clamps shall be such that clamping characteristics do not alter adversely when only one OPGW is installed. The tower attachment plates shall locate the OPGW on the inside of the tower and shall be attached directly to the tower legs/cross-members without drilling or any other structural modifications.

(e) Vibration Dampers: Vibration dampers type 4R Stockbridge or equivalent, having four (4) different frequencies spread within the Aeolian frequency bandwidth, shall be used for suspension and tension points in each span. The Contractor shall determine the exact numbers and placement(s) of vibration dampers through a detailed vibration analysis as specified in appendices. Vibration damper clamps shall be made of aluminium or aluminium alloy, shall support the dampers during installation and shall maintain the dampers in position without damage to the OPGW and without causing fatigue. Armour or patch rods made of aluminium or aluminium alloy shall be provided as required to reduce clamping stress on the OPGW. The vibration damper body shall be hot-dip galvanized mild steel/cast iron or shall be permanent mould cast zinc alloy.

In-Line Fibre Optic Splice Enclosures

All in-line splices shall be encased in In-Line Fibre Optic Splice Enclosures. Suitable splice enclosures shall be provided to encase the optical cable splices in a protective, moisture and dust free environment. In line splice enclosures shall comply to ingress protection class IP 66 or better. The splice enclosures shall be designed for the storage and protection of a minimum of 16/08 optical fibre splices and equipped with sufficient number of splice trays for splicing all fibres in the cable. In-line splice enclosures shall be suitable for outdoor use with each of the cable types provided under this contract. Splice enclosures shall be appropriate for mounting on EHV transmission towers above anti-climb guard levels at about 10 metres from the ground level and shall accommodate pass-through splicing.

9. INSPECTION & TESTING REQUIREMENTS

This section describes the specific requirements for inspection & testing requirement for supply of OPGW cable & its associated hardware & fittings.

9.1 General

All materials furnished and all work performed under this Contract shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the Employer.

The entire cost of testing type test, factory acceptance test, routine tests, production tests and other test during manufacture specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/Employer's representative.

9.2 Testing Requirements

Following are the requirements of testing for supply of OPGW Cable:

1. Type Testing
2. Factory Acceptance Testing

9.3 Type Testing

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification.

9.3.1 Type Test Samples

The Contractor shall supply equipment/material for sample selection only after the Quality Assurance Plan has been approved by the Employer. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance Plan. The Contractor shall submit for Employer approval, the type test sample selection procedure. The selection process for conducting the type tests shall ensure that samples are selected at random. For optical fibres/ Fibre Optic cables, at least three reels/ drums of each type of fibre/ cable proposed shall be offered for selection. For FO cable installation hardware & fittings at least ten (10) samples shall be offered of which at least three samples shall be selected by the Employer's representative. For In line Splice enclosures and other equipment at least three samples shall be offered, of which one sample shall be selected.

9.3.2 List of Type Tests

The list of required type tests is given in APPENDIX A.

9.4 Factory Acceptance Tests (FAT)

Factory acceptance tests shall be conducted on randomly selected final assemblies of a Fibre Optic Cable & associated hardware & accessories to be supplied. Factory acceptance testing shall be carried out on overhead fibre optic cable (OPGW) & FO cable hardware fittings & accessories, splice enclosures and all other items for which price has been identified separately in the Price bid Schedules.

9.4.1 Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the Employer shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. In case any of the selected samples fail, the failed sample is rejected and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected. Physical inspection shall be carried out on 100% basis for all the equipment/items offered.

For the FO cable hardware fittings & accessories, the minimum sampling rate, and batch acceptance criteria shall be as defined in IS 2486.

Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Employer reserves the right to require the Contractor to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a report is made and remedial actions taken, as applicable.

9.4.2 Production Testing

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

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

10. VENDOR LIST FOR OPGW CABLE AND OPGW ASSOCIATED HARDWARE & FITIINGS

List of approved vendor for supply of OPGW CABLE & OPGW ASSOCIATED HARDWARE FITIINGS are as under.The bidders are required to submit the GTP / Drawings etc. from the vendor for approval.

Sl. No.	**Item(s)**	**Name of Sub-vendor**
1	"OPGW " Cable	Sub- vendor shall be manufacturer of OPGW who has been manufacturing OPGW for the last three (3) years and at least 500 km of OPGW manufactured by such manufacturer shall have been in satisfactory operation on 400 kV or higher voltage EHV transmission lines for at least two(2) years as on the date of opening of Bids. Vender who have already supplied similar OPGW cable to M/s PGCIL and the same is in satisfactory operation on 400 kV or higher voltage EHV transmission lines for at least three (3) years as on the date of opening of Bids. (Proof of supply & performance certificate for successful operation form last three years should be submitted)
2	OPGW Associated Hardware & fittings	Sub- vendor shall be manufacturer of OPGW ASSOCIATED HARDWARE & FITIINGS who has been manufacturing OPGW ASSOCIATED HARDWARE & FITIINGS for the last three (3) years and by such manufacturer shall have been in satisfactory operation on 400 kV or higher voltage EHV transmission lines for at least two(2) years as on the date of opening of Bids. Vender who have already supplied similar OPGW ASSOCIATED HARDWARE & FITIINGS to M/s PGCIL and the same is in satisfactory operation on 400 kV or higher voltage EHV transmission lines for at least three (3) years as on the date of opening of Bids. (Proof of supply & performance certificate for successful operation form last three years should be submitted)

APPENDIX A

TYPE TESTING / FACTORY ACCEPTANCE TESTING PROCEDURES / REQUIREMENTS

Wherever the referenced test procedures or the technical specifications call for visual inspection for damage, the test report shall include a full description of observed status of the sample. (Visually inspected samples shall also be colour photographed and copies of colour photographs shall be included in type test report)

B-1 Type Tests for Optical Fibres

The type tests listed below in table B-1.1 shall be conducted on DWSM fibres. The tests specific to the cable type are listed in subsequent sections.

Table B-1.1
Type Tests For Optical Fibres

S.No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
2	Attenuation Variation with Wavelength	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
3	Attenuation at Water Peak	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
4	Temp. Cycling (Temp dependence of Attenuation)		EIA/TIA 455- 3A, 2 cycles
5	Attenuation With Bending (Bend Performance)		EIA/TIA 455- 62A
6	Mode Field dia.		EIA/TIA 455-164A/167A/174
7	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A
8	Cladding Diameter		EIA/TIA 455-176
9	Point Discontinuities of attenuation		EIA/TIA 455-59
10	Core -Clad concentricity error		EIA/TIA 455-176
11	Fibre Tensile Proof Testing		EIA/TIA 455-31B

B-2 Type Tests For OPGW Cables

The type tests to be conducted on the OPGW cable are listed in table B-2.1: Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table B-2.1
Type tests for OPGW Cable

S.NO.	Test Name	Test Description	Test Procedure	
1	Water Ingress Test	IEEE 1138 Section 4.1.1.1	IEEE 1138, Section 5.1.1.1 (IEC 794-1-F5 /EIA/TIA 455-82B) : Test duration : 24 hours	
2	Seepage of filling compound	IEEE 1138 Section 4.1.1.2	IEEE 1138 Section 5.1.1.2 (EIA/TIA 455-81B)	Preconditioning period : 72 hours. Test duration : 24 hours.
3	Short Circuit Test	IEEE 1138 Section 4.1.1.3 Or	IEEE 1138 Section 5.1.1.3	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. A suitable temperature sensor such as thermocouple shall be used to monitor and record the temperature inside the OPGW tube in addition to monitoring & recording the temperatures between the strands and between optical tube and the strand as required by IEEE 1138. Test shall be conducted with the tension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the test.
		IEC 60794-1-2 (2003) Method H1		Initial temperature during the test shall be greater than or equal to ambient field temperature. However, maximum temperature recorded on any component of OPGW cable shall not exceed the Short Circuit transient peak temperature guaranteed by the Contractor during design.
4	Aeolian Vibration Test	IEEE 1138 Section 4.1.1.4	IEEE 1138 Section 5.1.1.4	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The vibration frequency and amplitude shall be monitored and recorded continuously. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring. Test shall be conducted with the tension/suspension clamps proposed to be supplied. The cable and the clamps shall be visually inspected for mechanical damage and photographed after the

Table B-2.1
Type tests for OPGW Cable

S.NO.	Test Name	Test Description	Test Procedure	
				test.
5	Galloping test	IEEE 1138 Section 4.1.1.5	IEEE 1138 Section 5.1.1.5	Test shall be conducted with the tension/suspension clamps proposed to be supplied. The cable and clamps shall be visually inspected for mechanical damage and photographed after the test. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.
6	Cable Bend Test	Procedure 2 in IEC:794-1-E11		The short-term and long-term bend tests shall be conducted in accordance with Procedure 2 in IEC:794-1-E11 to determine the minimum acceptable radius of bending without any increase in attenuation or any other damage to the fibre optic cable core such as bird caging, deformation, kinking and crimping.
7	Sheave Test	IEEE 1138 Section 4.1.1.6 Or IEC 60794-1-2 (2003) Method E18B	IEEE 1138 Section 5.1.1.6	Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The Sheave dia. Shall be based on the pulling angle and the minimum pulley dia employed during installation. All fibres of the test cable sample shall be spliced together in serial for attenuation monitoring.
8	Crush Test	IEEE 1138 Section 4.1.1.7	IEEE 1138 Section 5.1.1.7 (IEC 794-1-E3/ EIA/TIA 455-41B)	The crush test shall be carried out on a sample of approximately one (1) metre long in accordance with IEC:794-1-E3. A load equal to 1.3 times the weight of a 400-metre length of fibre optic cable shall be applied for a period of 10 minutes. A permanent or temporarily increase in optical attenuation value greater than 0.1 dB change in sample shall constitute failure. The load shall be further increased in small increments until the measured attenuation of the optical waveguide fibres increases and the failure load recorded along with results.
9	Impact Test	IEEE 1138	IEEE 1138, Section	The impact test shall be carried out

Table B-2.1
Type tests for OPGW Cable

S.NO.	Test Name	Test Description	Test Procedure	
		Section 4.1.1.7	5.1.1.7 (IEC 794-1-E4/ EIA/TIA 455-25B)	in accordance with IEC:794-1-E4. Five separate impacts of 0.1-0.3kgm shall be applied. The radius of the intermediate piece shall be the reel drum radius ± 10%. A permanent or temporary increase in optical attenuation value greater than 0.1 dB/km change in sample shall constitute failure.
10	Creep Test	IEEE 1138 Section 4.1.1.8	IEEE 1138 Section 5.1.1.8	As per Aluminium Association Method , the best-fit straight line shall be fitted to the recorded creep data and shall be extrapolated to 25 years. The strain margin of the cable at the end of 25 years shall be calculated. The time when the creep shall achieve the strain margin limits shall also be calculated.
11	Fibre Strain Test	IEEE 1138 Section 4.1.1.9	IEEE 1138 Section 5.1.1.9	
12	Strain Margin Test	IEEE 1138 Section 4.1.1.10	IEEE 1138 Section 5.1.1.10	
13	Stress strain Test	IEEE 1138 Section 4.1.1.11	IEEE 1138 Section 5.1.1.11	
14	Cable Cut-off wavelength Test	IEEE 1138 Section 4.1.1.12	IEEE 1138 Section 5.1.1.12	
15	Temperature Cycling Test	IEEE 1138 Section 4.1.1.13	IEEE 1138 Section 5.1.1.13	
16	Corrosion (Salt Spray) Test	EIA/TIA 455-16A		
17	Tensile Performance Test	IEC 794-1-E1 / EIA/TIA 455-33A	The test shall be conducted on a sample of sufficient length in accordance with IEC:794-1-E1. The attenuation variation shall not exceed 0.05 dB/kM up to 90% of RTS of fibre optic cable. The load shall be increased at a steady rate up to rated tensile strength and held for one (1) minute. The fibre optic cable sample shall not fail during the period. The applied load shall then be increased until the failing load is reached and the value recorded.	

Table B-2.1
Type tests for OPGW Cable

S.NO.	Test Name	Test Description	Test Procedure
18	Fault Current/ lightning Test	IEEE Std. 4-1978 or	Tension equal to 20% of the OPGW RTS shall be applied to a sample with minimum length of 15 m of cabled fibres and two separate 4/10 micro second current impulses each having a peak value of 150 KA and a negative polarity shall be applied through a 1 cm gap. The attenuation during the tests shall be continuously measured. After the tests the same shall be visually inspected. Any increase in optical waveguide fibres attenuation measured at 1550 nm shall constitute failure. Fibre attenuation shall be continuously monitored and recorded through a digital data logging system or equivalent means. The tensile performance test shall be repeated on the sample subjected to the lightning arc test.
		IEC 60794-1-2(2003)	The cable construction shall be tested in accordance with Method H2
19	DC Resistance Test	On a fibre optic cable sample of minimum 1 metre length, two contact clamps shall be fixed with a predetermined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The tests shall be repeated at least five times and the average value recorded after correcting at 20□ C.	

B-3 Type Test on OPGW Cable Fittings

The type tests to be conducted on the OPGW Cable fittings and accessories are listed below:

B-3.1 Mechanical Strength Test for Suspension/Tension Assembly

Applicable Standards : IS : 2486 / IEC : 61284 :1997.

Suspension Assembly
The armour rods /reinforcement rods are assembled on to the approved OPGW using the Installation Instructions to check that the assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:
The suspension assembly shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased and held for one minute for the test rig to stabilise. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. The angle between the cable, the Suspension Assembly and the horizontal shall not exceed 16^{o}. This load shall then be removed in a controlled manner and the Protection Splice disassembled. Examination of all the components shall be made and any evidence of visual deformation shall be documented.

Part 2:

The Suspension clamp shall then be placed in the testing machine. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Suspension Assembly and held for one minute for the Test Rig to stabilise and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.

Tension Assembly
The Tension Assembly is correctly fitted and is the same that will be carried out during installations.
Part 1:
The tension assembly (excluding tension clamp) shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased at a constant rate and held for one minute for the test rig to stabilise. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. This load shall then removed in a controlled manner and the Tension Assembly disassembled. Examination of the Tension Dead-End and associated components shall be made and any evidence of visual deformation shall be documented.

Part 2:
The Tension Dead-End and associated components shall then be reassembled and bolts tightened as before. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Tension Assembly and held for one minute for the Test Rig to stabilise and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.
Acceptance Criteria for Tension/Suspension Assembly:

- No evidence of binding of the Nuts or Deformation of components at end of part 1 of Test.
- No evidence of Fracture at the end of one minute at the minimum failure load during Part 2 of the Test.

Any result outside these parameters shall constitute a failure.

B-3.2 Clamp Slip Strength Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length fibre optical cable shall be fixed in the clamps. Once the Suspension Clamp has been assembled, the test rig is tensioned to 1 kN and the position scale on the recorder 'zeroed'. The test rig is then tensioned to 2.5 kN and the relative positions of the Reinforcing Rods, Armour Rods and Suspension Clamp shall be marked by a suitable means to confirm any slippage after the test has been completed. The relative positions of the helical Armour Rods and associated Reinforcing Rods at each end shall be marked and also 2 mm relative position between clamp body and Armour Rods shall be marked on one side. The load shall be increased to 12 kN at a loading rate of 3 kN/min and held for one minute. At the end of this one minute period, the relative displacement between clamp body and the armour rods shall be observed. If the slippage is 2 mm or above, the test shall be terminated. Otherwise, at the end of one minute the position of the clamp body and 2 mm. relative position between clamp body and armour rods shall be marked on the other side. After the one minute pause, the load shall be further increased at a loading rate of 3 kN/min, and recording of load and displacement shall continue until either the relative Position displacement between clamp body and armour rods reaches more than 2 mm.or the load reaches the maximum slip load of 17 kN. On reaching either of the above values the test is terminated. Visual examination of all paint marks shall be recorded, and a measurement of any displacement recorded in the Table of Results.

Acceptance Criteria:

The Suspension Clamp has passed the Slip Test if the following conditions are met

- No slippage* shall occur at or below the specified minimum slip load.

* Definition of no slippage in accordance with IEC 61284:1997 :- Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the cable as a result of the test itself are not regarded as slippage.

- Slippage shall occur between the specified maximum and minimum slip load of 12 - 17 kN.
- There shall be no slippage of the Reinforcing Rods over the cable, and no slippage of the Armour Rods over the Reinforcing Rods.
- The relative movement (i.e. more than 2 mm between Armour Rods & Clamp body) between minimum 12 kN and maximum slip 17 kN, shall be considered as slip.
- The Armour Rods shall not be displaced from their original lay or damaged**.

** Definition of no damage in accordance with convention expressed in IEC 61284 : 1997 no damage, other than surface flattening of the strands shall occur.

Any result outside these parameters is a failure.

B-3.3 Slip Strength Test of Tension Clamp

Tension clamps shall be fitted on a 8 m length of fibre optic cable on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load shall gradually be applied up to 20 % of the RTS of OPGW . Displacement transducers shall be installed to measure the relative movement between the OPGW relative to the Reinforcing Rods and Tension Dead -End relative to Reinforcing Rods. In addition, suitable marking shall be made on the OPGW and Dead-End to confirm grip. The load shall be gradually increased at a constant rate up to 50 % of the UTS and the position scale of the recorder is zeroed. The load shall then gradually increased up to 95 % of the UTS and maintained for one minute. After one minute pause, the load shall be slowly released to zero and the marking examined and measured for any relative movement.

Acceptance Criteria:

- No movement* shall occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Dead-End assembly.
- No failure or damage or disturbance to the lay of the Tension Dead-End, Reinforcing Rods or OPGW.

* Definition of no movement as defined in IEC 61284: Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the conductor as a result of the test itself are not regarded as slippage.

Any result outside these parameters shall constitute a failure.

B-3.4 Grounding Clamp and Structure Mounting Clamp Fit Test

For structure mounting clamp, one series of tests shall be conducted with two fibre optic cables installed, one series of tests with one fibre optic cable installed in one groove, and one series of tests with one fibre optic cable in the other groove. Each clamp shall be installed including clamping compound as required on the fibre optic cable. The nut shall be tightened on to the bolt by using torque wrench with a torque of 5.5 kgm or supplier's recommended torque and the tightened clamp shall be held for 10 minutes. After the test remove the fibre optic cable and examine all its components for distortion, crushing or breaking. Also the fibre optic cable shall be checked to ensure free movement within the core using dial callipers to measure the diameter of the core tube. The material shall be defined as failed if any visible distortion, crushing, cracking or breaking of the core tube is observed or the fibre optic cable within the core tube is not free to move, or when the diameter of the core tube as measured at any location in the clamped area is more than 0.5 mm larger or smaller of the core diameter as measured outside the clamped area.

B-3.5 Structure Mounting Clamp Strength Test

The clamp and mounting assembly shall be assembled on a vertical 200 mm x 200 mm angle and a short length of fibre optic cable installed. A vertical load of 200 kg shall be applied at the end of the mounting clamp and held for 5 minutes. Subsequently, the load shall be increased to 400 kg and held for 30 seconds. Any visible distortion, slipping or breaking of any component of the mounting clamp or assembly shall constitute failure.

B-3.6 Type Test on Vibration Damper

B-3.6.1 Dynamic Characteristic Test:-

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Critical Aeolian Vibration frequency band as determined through vibration analysis of undamped OPGW.. The damper assembly shall be vibrated vertically with a ±1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at 0.5 mm to determine following characteristics with the help of suitable recording instruments.

(a) Force Vs frequency
(b) Phase angle Vs frequency
(c) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the Aeolian vibration frequency-band between the lower and upper dangerous frequency limits determined by the vibration analysis of fibre optic cable without dampers.

The above dynamic characteristics test shall be conducted on five dampers. The variations between the samples tested shall conform to the sample test limits.

B-3.6.2 Vibration Analysis

The vibration analysis of the fibre optic cable shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis.

(a) The analysis shall be done for single fibre optic cable without armour rods. The tension shall be taken as max Permissible Every Day Tension (20% of UTS), for a span ranging from 100 m to 1100 m.
(b) The self damping factor and flexural stiffness (EI) for fibre optic cable shall be calculated on the basis of experimental results. The details to experimental analysis with these data shall be furnished.
(c) Examine the Aeolian Vibration level of the fibre optic cable with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.
(d) From vibration analysis of fibre optic cable without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.

(e) From vibration analysis of fibre optic cable with damper(s) installed at the recommended location, the dynamic strain level at the clamped span extremities, damper attachment point and the antinodes on the fibre optic cable shall be determined. In addition to above damper clamp vibration amplitude and antinodes vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment point, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

B-3.7 Vibration Damper Clamp Slip and Fatigue Tests

B-3.7.1 Test Set Up

The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fibre optic cable shall be tensioned at 15 kN and shall not be equipped with protective armour rods at any point.

Constant tension shall be maintained within the span by means of lever arm arrangement. After the fibre optic cable has been tensioned, clamps shall be installed to support the fibre optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fibre optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

B-3.7.2 Clamp Slip Test

The vibration damper shall be installed on the test span. The damper clamp, after tightening with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 kN parallel to the axis of fibre optic cable for a minimum duration of one minute shall not slip, i.e., the permanent displacement between fibre optic cable and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased until the clamp starts slipping. The load at which the clamp slips shall not be more than 5 kN.

B-3.7.3 Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than ±25/f mm where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test, if resonance shift is observed, the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned herein above shall be repeated after fatigue tests without retorquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from fibre optic cable and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristics of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The fibre optic cable under clamp shall also be free from any damage.

For purposes of acceptance, the following criteria shall be applied:

(i) There shall not be any frequency shift by more than ±2 Hz for frequencies lower than 15 Hz and ±3 Hz for frequencies higher than 15 Hz.

(ii) The force response curve shall generally lie within guaranteed % variation in reactance after fatigue test in comparison with that before fatigue test by they Supplier.

(iii) The power dissipation of the damper shall not be less than guaranteed % variation in power dissipation before fatigue test by the Supplier. However, it shall not be less than minimum power dissipation which shall be governed by lower limits of reactance and phase angle indicated in the envelope.

B-4 Type Tests for In Line Splice Enclosures

Following Type tests shall be demonstrated on the In Line Splice Enclosure(s) (Splice Enclosure/Box) . For certain tests, lengths of the fibre optic cable shall be installed in the splice box, and the fibres must be spliced and looped in order to simulate conditions of use. The attenuation of the fibres shall be measured, during certain tests, by relevant Fibre Optic Test Procedures (EIA/TIA 455 or IEC 794-1 procedures).

B-4.1 Temperature Cycling Test

FO cable is installed in the splice enclosure and optical fibres spliced and looped. The box must be subjected to 5 cycles of temperature variations of -40°C to +65°C with a dwell time of at least 2 hours on each extreme.

Fibre loop attenuation shall be measured in accordance with EIA 455-20/ IEC 794-1-C10. The variation in attenuation shall be less than ±0.05dB. The final humidity level, inside the box, shall not exceed the initial level, at the closing of the box.

B-4.2 Humid Heat test

The sealed splice enclosure, with fibres spliced and looped inside, must be subjected to a temperature of +55°C ±2°C with a relative humidity rate of between 90% and 95% for 5 days. The attenuation variation of the fibres during the duration of the test shall be less than ±0.05dB, and the internal humidity rate measured, less than 2% .

B-4.3 Rain Withstand Test

The splice enclosure with optical fibres cable installed and fibres spliced fixed, shall be subjected to 24 hours of simulated rain in accordance with IEC 60 testing requirements. No water seepage or moisture shall be detected in the splice enclosure. The attenuation variation of the fibres after the test shall be less than ±0.05dB.

B-4.4 Vibration Test

The splice enclosure, with fibres united inside, shall be subjected to vibrations on two axes with a frequency scanning of 5 to 50 Hz. The amplitude of the vibrations shall be constant at 0.450mm, peak to peak, for 2 hours, for each of the vibrations' axes. The variation in attenuation, of the fibres, shall be less than ±0.05dB. The splice enclosure shall be examined for any defects or deformation. There shall be no loosening or visible damage of the FO cable at the entry point.

B-4.5 Bending and Torsion test

The splice enclosure, with fibres spliced inside, shall be firmly held in place and be subjected to the following sequence of mechanical stresses on the cable:

a)3 torsion cycles of ±180° shall be exercised on the cable. Each cycle shall be less than one minute.

b)3 flexure cycles of the cable, of ±180° with one cycle less than one minute.

The variation in the attenuation, of the fibres, shall be less than ±0.05dB. The cables connection ring shall remain securely fixed to the box with the connection maintained firmly. No defects/fissures shall be noted on the joint ring or on the splice enclosure

B-4.6 Tensile test

The splice enclosure with cable fixed to the boxes shall be subjected to a minimum tension of 448 N for a period of two minutes. No fissure shall be noted in the connections or on the box.

B-4.7 Drop Test

With 2 lengths of 10 metres of cable fixed to the box, it shall be dropped five times from a height of 11 metres. There shall be no fissure, at all, of the box, and the connections shall remain tight. The test shall be carried out in accordance with procedure described in IEC-68-2-32.

B-5 Factory Acceptance Tests On Fibre Optic Cables

As specified in technical specifications, the Factory acceptance tests shall be conducted on random sampling of fibre optic cable to be supplied for the present procurement, prior to any shipment.

B-5.1 FAT On Fibre : Optical Acceptance Tests

The Optical acceptance tests listed in table B-5.1 below are applicable for the fibres of all types of Fibre Optic Cables i.e. OPGW and approach cable to be supplied. The listed tests follow testing requirements set forth in IEEE standard 1138 section 4.2.2.1 and section 5.2.2.1. The referenced sections specify the detailed test description. The acceptance norm shall be as specified in the above mentioned IEEE standards unless specified otherwise in the technical specifications.

Table B-5.1
Factory Acceptance Tests for Fibres of all FO cables: Optical Tests

S.No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation Coefficient	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
2	Point Discontinuities of attenuation	AS per Section-02 of TS, Volume II	EIA/TIA 455-59
3	Attenuation at Water Peak	AS per Section-02 of TS, Volume II	EIA/TIA 455- 78A
4	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A
5	Core – Clad Concentricity Error		EIA/TIA 455-/176
6	Cladding diameter		EIA/TIA 455-176
7	Fibre Tensile Proof Testing		EIA/TIA 455-31B

The test reports for the above tests for all types of the fibres carried out by the Fibre Manufacturer and used in the OPGW cables and approach cable shall be shown to the inspector during OPGW cable FAT and shall be submitted along with the OPGW cable FAT report.

B-5.2 Factory Acceptance Test On OPGW Cable

The factory acceptance tests for OPGW cable specified below in Table B-5.2 follow the requirements set forth in section 4.1.2 and section 5.1.2 of IEEE standard 1138. The FAT shall be carried out on 10% of offered drums in each lot as specified in technical specifications and the optical tests shall be carried out in all fibres of the selected sample drums. The Rated Tensile Strength test shall be carried out on one sample in each lot.

Table B-5.2
Factory Acceptance Tests On OPGW
Applicable standard: IEEE 1138

S. No.	Factory Acceptance Test on Manufactured OPGW
1	Attenuation Co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Rated Tensile Strength
5	Lay Length Measurements

B-5.3 Factory Acceptance Test On OPGW Fittings

The factory acceptance tests for OPGW Fittings as specified below in Table B-5.3. The sampling plan shall be as per IS 2486:

Table B-5.3
Factory Acceptance Tests On OPGW Fittings

S. No.	Factory Acceptance Test

Suspension Assembly	
1	UTS/Mechanical Strength of the assembly
2	Clamp Slip Test
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Mechanical strength of each component
Tension Assembly	
5	Clamp Slip Strength test
6	Visual Material verification and dimensional checks as per approved DRS/Drawings
7	Mechanical strength of each component
Vibration Damper	
8	Galvanising test on damper, masses and messenger wires
9	Damper response (resonant frequencies)
10	Clamp Slip test
11	Strength of messenger wires
12	Mass pull off test
13	Visual Material verification and dimensional checks as per approved DRS/Drawings
Structure Mounting Clamp	
14	Clamp fit test
15	Clamp Strength test
16	Visual Material verification and dimensional checks as per approved DRS/Drawings

B-5.4 Factory Acceptance Test on In Line Splice Enclosures

The factory acceptance tests for In Line Splice Enclosures as specified below in Table B-5.4:

Table B-5.4
Factory Acceptance Tests on In Line Splice Enclosures

S. No.	Factory Acceptance Test
1	Visual check Kit Quantities and Specific Component Number for each component of In Line Splice Enclosure and dimensional checks against the approved drawings.

APPENDIX B

DATA REQUIREMENT SHEETS

The DRS forms have been included for the major items, however, the DRS for each item along with sufficient details shall be submitted

The following sets of Data Requirement Sheets are required to be filled up by the bidders to aid in the evaluation process. The response shall be brief and to the point and shall be supported by the printed product description and other literature. The same DRS format duly filled and the relevant drawings shall also be submitted during the detailed engineering along with the relevant technical brochures.

DRS Form 1

DATA REQUIREMENTS SHEETS for
OVERHEAD FIBRE OPTIC CABLE

OPTICAL GROUND WIRE (OPGW):

Manufacturer: _____ Part #:_____	
CABLE CONSTRUCTION	

Seq	**Parameter:**	**Unit:**	**Particulars:**
1	Fibre ManufacturerDual Window Single-Mode:		
2	No. of FibresDual Window Single-Mode:	each	
3	Buffer Type:		
4	Buffer Tube Diameter:	mm	
5	Buffer Tube material		
6	No. of Buffer Tubes:	each	
7	No. of Fibers per Tube:	each	
8	Identification/numbering of individual tubes:		
9	No. of empty tubes (If any):	each	
10	Filling material:		
11	Filling material compliant with technical specifications?	Yes/No	
12.	Strength member(s):		
13.	Binding yarn/ tape:		
14	Describe Central Core Design:		
15	20% Aluminum Clad steel wire Diameter: Number:	 mm each	
16	Aluminum alloy wires Diameter: Number:	 mm each	
17	Aluminum tube inner diameter:	mm	
18	Aluminum tube outside diameter:	mm	
19	Cable Diameter: (nominal ± deviation)	 mm	
20	Cable cross-section area (Nominal):	mm^2	
21	Cable cross-section area (Effective):	mm^2	

22	Fully Compliant with IEEE P1138:	Yes/No	
23	**Mechanical Properties of Cable**		
24	Max. breaking load/ Ultimate Tensile Strength (UTS):	kN	
25	Fibre strain margin:	%	
26	Zero fibre strain up to load	kN	
27	Weight:	kg/km	
28	Crush strength:	kg/mm	
29	Equivalent Modulus of elasticity:	KN/mm^2	
30	Minimum Bending Radius without microbending:	mm	
31	Maximum Bending Radius: Short Term: Long Term (Continuous):	mm	
32	Tensile proof test (Screening) level:	KN/mm^2	
33	Maximum permissible tensile stress:	KN/mm^2	
34	Permissible CTS. tensile stress:	KN/mm^2	
35	Maximum sag at maximum temperature and design span with no wind:	mm	
36	Everyday tension , no wind:	% of UTS	
37	Maximum tension at Every day condition with full wind pressure of .....Kg/m^2 on full projected are, 400 meter span:	Kg	
	Thermal Properties of Cable		
38	Coefficient of linear expansion:	per °C	
39	Coefficient of expansion		
	Cladding: Core:	per °C per °C	
40	Nominal operating temperature range:	°C	

41	SC current transient peak temperature:	°C	
42	Maximum allowable temperature for lightning strike:	°C	
	CABLE SPOOL and DRUM		
43	Available length per spool Maximum: Nominal:	m	
44	Size of drum:	m	
45	Weight of empty drum:	kg	
46	Weight of drum with cable: spooled	kg	
47	Will drum length scheduling be practiced to match transmission line span lengths?	Yes/No	
48	Describe Drum materials:		
49	Describe cable end capping and protection against abrasion etc.:		
	INSTALLATION		
50	Splice Loss: Maximum: Average:	 dB dB	
51	Operating Temperature Range:	°C	
52	Rated Isoceraunic No.		
53	Expected Cable Life:	Years	
54	Installation rate per team:	km/day	
55	No. of persons per team:	no.	
56	Max. possible span for specified operating conditions:	m	
57	Midspan sag at 0°C with no wind loading:	mm	
58	Midspan sag at max temp. with no wind loading:	mm	
59	Midspan sag at max temp. and wind loading	mm	
60	Cable swing angles: Worst Case: Everyday:		
61	Describe Installation method(s):		

Sag tension chart parameters like sag and tension at various spans and applicable wind and ice load conditions shall be submitted along with the DRS. The cable parameters like coefficient of liner expansion, modulus of elasticity shall also be indicated.

DRS Form 2

DATA REQUIREMENTS SHEETS for OPTICAL FIBRE

DUAL-WINDOW SINGLE MODE (DW-SM)

OPTICAL PARAMETERS

Seq	Parameter:	Unit:	Particulars:
1.	Fiber manufacturer(s)/Type:		
2.	Fiber production method:		
3.	Attenuation Coefficient@ 1310 nm: @ 1550 nm:	dB/km dB/km	
4.	Attenuation Variation with Wavelength (±25 nm):	dB/km	
5.	Attenuation at water peak:	dB/km	
6.	Point discontinuity @ 1310nm: @ 1550nm:	dB dB	
7.	Temperature dependence (induced attenuation):	dB	
8.	Nominal Mode Field Diameter @ 1310 nm: @ 1550 nm:	μm	
9.	Mode Field Diameter Deviation @ 1310 nm: @ 1550 nm:	μm	
10.	Mode field non-circularity:	%	
11.	Chromatic Dispersion Coefficient @ 1310 (1288-1339) nm: @ 1310 (1271-1360) nm: @ 1550 nm:	ps/nm.km	
12.	Zero dispersion wavelength:	nm	
13.	Zero dispersion Slope:	$ps/nm^2.km$	
14.	Cutoff wavelength:	nm	
15.	Refractive Index:		

16.	Refractive Index profile:		
17.	Cladding Design:		
18.	Numerical aperture:		

PHYSICAL and MECHANICAL PROPERTIES

Seq	Parameter:	Unit:	Particulars:
19.	Bend Performance: (37.5 mm radius, 100 turns) @1310 nm & @ 1550 nm (16mm radius, 1 turn) @1550 nm	dB dB	
20.	Core Diameter(nominal ± deviation):	µm	
21.	Core non-circularity:	%	
22.	Cladding Diameter (nominal ± deviation):	µm	
23.	Core- Clad concentricity Error:	µm	
24.	Cladding noncircularity:	%	
25.	Fibre cut-off wavelength	µm	
26.	Protective Coating type & material Primary: Secondary:		
27.	Protective Coating Diameter (nominal ± deviation):	µm	
28.	Protective Coating removal method:		
29.	Coating Concentricity	µm	
30.	Polarisation mode dispersion coefficient	ps/km$^{\wedge 1/2}$	
31.	Proof test level	kpsi	
32.	Colour coding scheme compliant with EIA/TIA 598 or IEC 60304 or Bellore GR-20.	Yes/No	
33.	Colouring material compliant with technical specs?	Yes/No	

DRS Form 3-A

DATA REQUIREMENTS SHEETS for HARDWARE AND ACCESSORIES

Suspension Clamp Assembly:

Manufacturer: _____
Part #: _____

ITEM	DESCRIPTION	UNIT	PARTICULARS
1.	Minimum vertical Strength	kN	
2.	Maximum Slip Strength	kN	
3.	Minimum Slip Strength	kN	
4.	Length (nominal)	mm	
5.	Weight (nominal)	kg	
6.	Total Drop (maximum) including shackles	mm	
7.	Tightening torque (nominal)	Nm	
8.	Details of Armour Rod Set		
	a) No. of rods per clamp		
	b) Direction of Lay		
	c) Overall length	mm	
	d) Diameter of each Rod	mm	
	e) Tolerances (i) Diameter of each rod (ii) Length of each rod	 □±% □±%	
	f) Material of manufacture		
	g) UTS of each Rod	kN	
	h) Weight	kg	
	Details of Protection Splice Set (Reinforcing Rods)		
	i) No. of rods per clamp		
	j) Direction of Lay		
	k) Overall length	mm	
	l) Diameter of each Rod	mm	
	m) Tolerances (i) Diameter of each rod (ii) Length of each	 □±% □±%	
	n) Material of manufacture		
	o) UTS of each Rod	kN	
	p) Weight	kg	

DRS Form 3-B

DATA REQUIREMENTS SHEETS for HARDWARE AND ACCESSORIES

Dead End Clamp Assembly:

Manufacturer: _____
Part #: _____

ITEM	DESCRIPTION	UNIT	PARTICULARS
1.	Minimum Slip Load	kN	
2.	Length (nominal)		
	a) Reinforcing Rods	mm	
	b) Dead end	mm	
3.	Weight (nominal)		
	a) Reinforcing Rods	kg	
	b) Dead end	kg	
4.	Breaking strength (minimum)	kN	
5.	Wire Size		
	a) Reinforcing Rods	mm	
	b) Dead end	mm	

DRS Form 3-C

DATA REQUIREMENTS SHEETS for HARDWARE AND ACCESSORIES

Vibration Damper:

Manufacturer: _____
Part #: _____

ITEM	DESCRIPTION	UNIT	PARTICULARS
i	Total Weight	Kg	
ii	Weight of each Damper	Kg	
iii	Material of Damper Weight		
vi	Clamp Material		
v	Clamp bolt tightening torque	Nm	
vi	Clamp bolt material		
vii	Messenger Cable Material		
i	No. of Strands in Messenger Cable		
ii	Breaking Strength of Messenger Cable	kN	
iii	Resonance Frequencies		
	a) First Frequency	Hz	
	b) Second Frequency	Hz	
	c) Third Frequency	Hz	
	d) Fourth Frequency	Hz	
iv	Minimum Slip Strength of Damper Clamp		
	a) Before Fatigue Test	kN	
	b) After fatigue Test	kN	

DRS Form 3-D

DATA REQUIREMENTS SHEETS for
OPGW HARDWARES and ACCESSORIES

Down Lead Clamp /Fastening Clamp

Manufacturer: _____
Part : _____

ITEM	DESCRIPTION	Unit:	Particulars:
1.	Material:		
2.	Suitable for OPGW (range):	mm	
3.	Tightening torques	Nm	
4.	Vertical load	kN	
5.	Filler details:		
(a)	Material		
(b)	diameter:	mm	
6.	Tower attachment arrangement		

DRS Form 4

DATA REQUIREMENTS SHEETS for
In Line Splice Enclosures

Manufacturer: _____
Model _____

Seq	Parameter:	Unit:	Particulars:
1.	Dimensions H * W * D:	cm	
2.	Weight:	Kg	
3.	Colour and Finish:		
4.	Cable Glanding & Fixing:		
5.	Construction materials & Gauge:		
6.	Locking arrangements:		
7.	Installation Clearances: Front Access: Rear Access: Top * Bottom * Sides:	cm	
8.	IP Protection	Class	
9.	Total number of optical couplings:	ea	
10.	Provision of pass through splicing:	Yes/No	
11.	Whether filled with suitable encapsulant	Yes/No	
12.	Method(s) for mounting with the tower:		

Optical Fibre Cable Accommodations

13.	Cable Glanding:		
14.	Maximum number of cables that can be accommodated:	each	
15.	Diameter(s) of cables that can be accommodated:		

16. Describe Cable entries :

DRS Form 4 (Continued)

DATA REQUIREMENTS SHEETS for
In Line Splice Enclosures

Seq	Parameter:	Unit:	Particulars:
Cable Termination Splice Accomodations:			
17.	Details of Splice Trays:		
	Dimension:		
	Material/Gauge:		
	Weight:	kg	
	Colour & Finish:		
	Method of mounting:		
18.	Maximum number of splice trays:	ea	
19.	Number of splices per tray:	ea	
20.	Provision of Splice organisors:		
21.	Do splice trays require a separate enclosure? If so:	Yes/No	
	Manufacturer:		
	Dimensions H * W * D:	cm	
	Weight:	Kg	
	Colour and Finish:		
	Method(s) of Mounting:		
	Construction materials & Gauge:		
	Locking arrangements:		
22.	Installation Clearances Front Access: Rear Access: Top * Bottom * Sides: Excess length of fibre service loops	m	

SECTION- II B- (iii)
TECHNICAL SPECIFICATIONS OF INSULATOR

1.1 Technical Description of Disc Insulators

Details of Disc Insulators

The Insulator strings shall consist of Standard discs for a three phase, 50 Hz, effectively earthed 400KV transmission systems in a moderately polluted atmosphere. The discs shall be cap and pin, ball and socket type.

The size of disc insulator, minimum creepage distance, the number to be used in different type of strings, their electromechanical strength and mechanical strength of insulator string along with hardware fittings shall be as follows :

A) For 400 KV Transmission Line with twin bundle ACSR 'MOOSE' Conductor

Sl. No.	Type of string	Size of disc insulators (mm)	Minimum creep age distance of each disc (mm)	No. of disc	Electro-mechanical strength of insulator disc(KN)	Mechanical strength of insulator string along with Hardware fittings (KN)
1.	Single 'I' Suspension	255*145 or 280x145	315	1 x 23	120	120
1.1	Double 'I' suspension	255*145 or 280x145	315	2x23	120	2x120
2.	Single suspension Pilot	255*145 or 280x145	315	1 x 23	120	120
3.	Single Tension	280x170	330	1 x 24	160	160
4.	Double Tension	280x170	330	2 x 24	160	2 x 160

Pin and Cap

Pin and Cap shall be designed to transmit the mechanical stresses to the shell by compression and develop uniform mechanical strength in the insulator. The cap shall be circular with the inner and outer surfaces concentric, of such design that it will not yield or distort under load conditions.

The pin ball shall move freely in the cap socket but without danger of accidental uncoupling during erection or in position. The design of the disc should be such that stresses due to expansion or contraction in any part of the insulator shall not lead to deterioration.

Security clip

Security clip for use with ball and socket coupling shall be of R-shaped hump type which shall provide positive locking of the coupling as per IS:2486-(Part-Ill)/IEC : 372. The legs of the security clips shall be spread after installation to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances shall locking device allow separation of insulator units or fittings.

The hole for the security clip shall be countersunk and the clip shall be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energised conditions. The force required to pull the security clip into its unlocked position shall not be less than 50N (5 kg) or more than 500N (50 kg).

Ball and Socket Designation

The dimensions of the balls and sockets shall be of 20 mm designation for 120 KN & 160 KN disc insulators in accordance with the standard dimensions stated in IS:2486(Part II)/IEC:120.

Dimensional Tolerance of Insulator Disc (Standard)

It shall be ensured that the dimensions of the disc insulators are within the limits specified below :

a)	Diameter of Disc (mm)			
		Standard	Maximum	Minimum
	120 KN Disc	255/280	266/293	244/267
	160 KN Disc	280	293	267
b)	Ball to ball spacing between discs			
		Standard	Maximum	Minimum
	120 KN Disc	145	149	141

	160 KN Disc	170	175	165

Interchangeability

The disc insulators inclusive of the ball and socket fittings shall be of standard design suitable for use with the hardware fittings of any make conforming to relevant Indian/International Standards.

Corona And RI Performance

All surfaces must be clean, smooth, without cuts, abrasions or projections. No part shall be subjected to excessive localized pressure. The metal parts shall be so designed and manufactured that it shall not generate any Radio Interference beyond specified limit and not produce any noise generating corona under the operating conditions.

Maintenance

The disc insulators offered shall be suitable for employment of hot line maintenance techniques so that the usual hot line operations can be carried out with ease, speed and safety.

Bidders shall indicate the methods generally used in the routine hot and dead line maintenance of EHV Lines for which similar disc insulators have been supplied by them. Bidders shall also indicate the recommended periodicity of such maintenance.

Materials

Porcelain

The porcelain used in the manufacture of shells shall be sound, free from defects thoroughly vitrified and smoothly glazed.

Glaze

The finished porcelain shall be glazed in brown colour. The glaze shall cover all exposed parts of the insulator and shall have a good lustier, smooth surface and good performance under the extreme weather conditions of a tropical climate. It shall not crack or chip by ageing under the normal service conditions. The glaze shall have the same coefficient of expansion as of the porcelain body throughout the working temperature range.

Cement

Cement used in the manufacture of the insulator shall not cause fracture by expansion or loosening by contraction. The cement shall not give rise to chemical reaction with metal fittings and its thic KNess shall be as small and uniform as possible. Proper care shall be taken to correctly centre and locate individual parts during cementing.

Pins and Caps

Pins and Caps shall be made of drop forged steel and malleable cast iron/spheriodal graphite iron/drop forges steel respectively, duly hot dip galvanized and shall not be made by jointing, welding, shrink fitting or any other process from more than one piece of material.

Security Clips

Security clips shall be made of good quality stainless steel or phosphor bronze as per IS:1385.

Workmanship

All the material shall be of the latest design and conform to the best modern practices adopted in the extra high voltage field. Suppliers shall offer only such insulators as are guaranteed by him to be satisfactory and suitable for 400 KV Transmission lines and will give continued good service.

The design, manufacturing process and material control at various stages shall be such as to give maximum working load, highest mobility, best resistance to corrosion, good finish and elimination of sharp edges and corners to limit corona and radio interference.

The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

Metal caps shall be free from cracks, seams, shrinks, air holes, burrs and rough edges. All surfaces of the metal parts shall be perfectly smooth with no projecting points or irregularities which may cause corona. All load bearing surfaces shall be smooth and uniform so as to distribute the loading stresses uniformly.

All ferrous parts shall be hot dip galvanized to give a minimum average coating of Zinc equivalent to 600 gm/sq.m. and shall be in accordance with the requirement of IS:2629 and shall satisfy the tests mentioned in IS:2633. The zinc used for galvanizing shall be of Grade Zn 99.95 as per IS:209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters.

Before ball fittings are galvanized, all die flashing on the shank surface of the ball shall be carefully removed without reducing the dimensions below the design requirements.

The design of the insulators shall be such that the shell shall not engage directly with hard metal. The design shall also be such that when units are coupled together there is no contact between the shell of one unit and metal of the next adjacent unit. The design of the shell ribs shall be such that the security clip of the insulator can be engaged and disengaged easily with hot stick without damaging the shell ribs.

Insulator units after assembly shall be concentric and co-axial within limits as permitted by the relevant Indian Standards.

Equipment Marking

Each insulator disc unit shall be legibly and indelibly marked with the trade mark of the manufacturer, name of CSPTCL and month & year of manufacture. The guaranteed combined mechanical and electrical strength shall be indicated in kilo Newton followed by the word ' KN' to facilitate easy identification and to ensure proper use.

For porcelain insulator, the marking shall be on porcelain. The marking shall be printed, not impressed and shall be applied before firing. For toughened glass insulators the marking shall be on the metal parts.

One 10 mm thick ring or 20 mm thick spot of suitable quality of paint shall be marked on the cap of each insulator porcelain disc of particular strength for easy identification of the type of insulator. The paint shall not have any deteriorating effect on the insulator performance. Following codes shall be used as identification mark :

For 120 KN disc/ long rod unit : Yellow
For 160 KN disc / long rod unit : Green
For 70 KN disc / long rod unit : XXXX

Bid Drawings

The Bidder shall furnish full description and illustration of the material offered.

2. (A) Standard Technical Particulars for insulator & insulator strings for 400KV Transmission line :-

Standard Technical Particulars for Standard Disc Insulators

The Disc Insulators to be supplied should confirm to IS:731(1971) with all the amendments made till to-day and as per technical particulars indicated herein. In addition to this magna spray flux test on the metallic portion of disc insulators should also confirm to standard prescribed for insulators. Please note, apart from acceptance test, mechanical tests as per IEC-383 is compulsory for acceptance of supply.

However, the standard technical particulars of disc insulators shall be as follows:-

Sl.	Description	Unit	Standard Technical Particular value		
			70 Kn Disc Insulator	120 KN Disc Insulator	160 KN Disc Insulator
1.0	**General**				
a)	Type of Insulator (Pin & Cap)			Ball & Socket	Ball & Socket
b)	Size and Designation of pin ball shank	mm		20 as per IS 2486/ IEC 120	20 as per IS 2486/ IEC 120
2.0	**Dimensions**				
a)	Diameter of disc	mm		255/ 280	280
b)	Tolerance on Diameter	± mm		11/13.0	13.0
c)	Ball to ball spacing between Disc	mm		145.0	170.0
d)	Tolerance on spacing	± mm		4.0	5.0
e)	Minimum nominal creepage distance of single disc	mm		315.0	330.0
3.0	**Materials**				
a)	Colour of glaze of finished porcelain insulator			Brown	Brown
4.0	Mechanical values . d) Electromechanical Strength of disc	KN		120	160

Sl.	Description	Unit	Standard Technical Particular value		
			70 Kn Disc Insulator	**120 KN Disc Insulator**	**160 KN Disc Insulator**
	in KN e) Materials used for ball pins. Grade of material			Forged steel Class 3A or 4 of IS 2004	Forged steel Class 3A or 4 of IS 2004
5.0	**Minimum electrical values**				
a)	Power frequency flashover voltage of (dry)	KV (rms)		75.0	78
b)	Power frequency flashover voltage of (Wet)	KV (rms)		45.0	48
c)	Impulse flashover test voltage 1.2 x 50 µs positive (Dry)	KV (peak)		115.0	120
d)	Impulse flashover test voltage 1.2 x 50 µs negative (Dry)	KV (peak)		120.0	125
e)	Power frequency withstand voltage of (dry)	KV (rms)		70.0	72
f)	Power frequency withstand voltage of (Wet)	KV (rms)		40.0	42
g)	Impulse withstand test voltage 1.2 x 50 µs positive (Dry)	KV (peak)		110.0	115
h)	Impulse withstand test voltage 1.2 x 50 µs negative (Dry)	KV (peak)		110.0	115
i)	Steepness of impulse voltage (steep wave front test)	KV/us		2500.0	2500.0
6.0	Power frequency puncture voltage	KV (rms)		120.0	125.0
7.0.	Minumum Visible discharge voltage of single disc (dry)	KV (rms)		18.0	18.0
8.0	Maximum RIV at 1 MHZ and 10 KV AC (rms) voltage of single disc	Micro-volts		50.0	50.0
9.0	Eccentricity of disc				
a)	Max. radial run out	mm		7.65/8.84	8.4
b)	Max. axial run out	mm		10.2/11.2	11.2
10.0	**Galvanising**				
a)	Minimum mass of zinc coating	Gm/ sq.m.		600	600
b)	Minimum no. of one minute dips in the standard preece test	Nos.		6 dips	6 dips
c)	Minimum purity of zinc used for galvanising	%		99.95	99.95
11.0	Security clip/ locking device e) Type and dimension f) Material g) Standard to which security clip confirmed			R TYPE and dimensions as per 2486 Stainless steel Guaranteed as per IS 2486 (Part-IV)	R TYPE and dimensions as per 2486 Stainless steel Guaranteed as per IS 2486 (Part-IV)
12	Standard specification to which insulator will confirm			IS- 731 & IEC 60383	IS- 731 & IEC 60383

Standard Technical Particulars of insulator strings with Standard Disc Insulators alongwith hardware fittings for 400 KV transmission line with Twin ACSR MOOSE conductor :-

Sl.. No.	Description	Unit	Standard Technical Particular value

			Single 'I' Suspension string	**Single Suspension Pilot string**	**Single Tension string**	**Double Tension string**
			1 x 23	**1 x 23**	**1 x 24**	**2 x 24**
1.0	Power frequency withstand volt-age of string with arcing horns, corona control rings/grading rings under wet condition	KV (rms)	680	680	680	680
2.0	Switching withstand voltage (dry)					
a)	Positive	KV(Peak)	1050	1050	1050	1050
b)	Negative	KV (peak)	1050	1050	1050	1050
3.0	Impulse withstand voltage (dry)					
a)	Positive	KV(Peak) KV (peak)	1550	1550	1550	1550
b)	Negative		1550	1550	1550	1550
4.0	Impulse flashover voltage (dry)					
a)	Positive	KV (Peak)	1615	1615	1615	1615
b)	Negative	KV (Peak)	1615	1615	1615	1615
5.0	Minimum corona extinction voltage under dry condition	KV (rms)	320	320	320	320
6.0	RIV at 1 MHZ when string is energised at 305 KV (rms) under dry condition	Micro volts	1000 (max.)	1000 (max.)	1000 (max.)	1000 (max.)
7.0	Mechanical strength of complete insulator string alongwith hardware fittings	KN	120	120	160	2 x 160
8.0	Maximum voltage distribution across any disc of line to earth voltage	%	9	9	10	10

Standard Technical Particulars of insulator strings with Standard Disc Insulators alongwith hardware fittings for 400 KV transmission line with Twin ACSR Zebra conductor :-

Sl.. No.	**Description**	**Unit**	**Standard Technical Particular value**			
			Single 'I' Suspension string	**Single Suspension Pilot string**	**Single Tension string**	**Double Tension string**
			1 x 23	**1 x 23**	**1 x 24**	**2 x 24**
1.0	Power frequency withstand volt-age of string with arcing horns, corona control rings/grading rings under wet condition	KV (rms)	680	680	680	680
2.0	Switching withstand voltage (dry)					
a)	Positive	KV(Peak)	1050	1050	1050	1050
b)	Negative	KV (peak)	1050	1050	1050	1050
3.0	Impulse withstand voltage (dry)					
a)	Positive	KV(Peak) KV (peak)	1550	1550	1550	1550
b)	Negative		1550	1550	1550	1550
4.0	Impulse flashover voltage (dry)					
a)	Positive	KV (Peak)	1615	1615	1615	1615
b)	Negative	KV (Peak)	1615	1615	1615	1615
5.0	Minimum corona extinction voltage	KV (rms)	320	320	320	320

Sl.. No.	Description	Unit	Standard Technical Particular value			
			Single 'I' Suspension string	**Single Suspension Pilot string**	**Single Tension string**	**Double Tension string**
			1 x 23	**1 x 23**	**1 x 24**	**2 x 24**
	under dry condition					
6.0	RIV at 1 MHZ when string is energised at 305 KV (rms) under dry condition	Micro volts	1000 (max.)	1000 (max.)	1000 (max.)	1000 (max.)
7.0	Mechanical strength of complete insulator string alongwith hardware fittings	KN	120	120	160	2 x 160
8.0	Maximum voltage distribution across any disc of line to earth voltage	%	9	9	10	10

2. (B) Standard Technical Particulars for insulator & insulator strings for 220KV transmission line

(1) DISC INSULATORS:-

S.No.	Particulars	70 KN	90 KN	160 KN
1.	**Type of Insulator (Pin & Cap)**	**Ball & Socket**	**Ball & Socket**	**Ball & Socket**
2.	Size and designation of ball and socket with standard to which it will confirm	16 mmB Conforming 1974	16mmB to	20 mmB IS: 2486 (part-II)
3.	Dimension a) Porcelain disc diameter mm b) Unit spacing mm c) Creepage distance of single disc (min.) mm	 255 +/-10 145 +/-4 320	 255 +/-10 145 +/-4 320	 280 +/-13 170 +/-5 330
4..	Colour of glaze of the finished porcelain insulator	Brown	Brown	Brown
5	Mechanical values . 1. Combined mechanical & electrical strength in KN 2. Materials used for ball pins. 3. Grade of material	 70 KN Forged steel Class 3A or 4 of IS 2004	 90 KN Forged steel Class 3A or 4 of IS 2004	 160 KN Forged steel Class 3A or 4 of IS 2004
6	Ultimate tensile stress Kg. Per mm2	63	63	71
7	Yield stress Kg. Per mm2	32.5	32.5	47
8	Hardness test value BHN	175	175	201-255
9	Percentage elongation	(min. 15%)	(min. 15%)	(min. 14%)
10	Whether machine forced	Yes	Yes	Yes
11	Normalising particulars (Temp in C 0)	30-880	30-880	30-880
12	Withstand voltage of single disc c) Dry KV (RMS) d) Wet KV (RMS)	 70 40	 70 40	 75 45
13	Impulse voltage 1.2 x 50 Micro sec. a) Positive KV (Peak) b) Negative KV (Peak)	 110 110	 110 100	 130 130
14	Flesh over voltage for the disc. Power frequency : c) Dry KV (RMS)	 78	 78	 80

	d) Wet KV (RMS)	45	45	50
15	Flesh over Impulse voltage 1.2 x 50 Micro sec. a) Positive KV (Peak) b) Negative KV (Peak)	 120 120	 120 120	 140 140
16	P.F. Puncher voltage KV (RMS)	120	125	130
17	Min. Carona extinction voltage KV (RMS)	09	09	18
18	Max. RIV at 10 KV (RMS) Micro volts	50	50	50
19	Security clip/ locking device h) Type and dimension i) Material j) Standard to which security clip confirmed k) Test values	R TYPE and dimensions as per 2486 Part-IV Stainless steel Guaranteed as per IS 2486 (Part-IV) ---do--	R TYPE and dimensions as per 2486 Part-III) Stainless steel Guaranteed as per IS 2486 (Part-IV) ---do--	R TYPE and dimensions as per 2486 Part-III) Stainless steel Guaranteed as per IS 2486 (Part-IV) ---do--
20	Standard specification to which insulator will confirm	IS- 731 & IS-3188	IS- 731 & IS-3188	IS- 731 & IEC-383
21	Test required	As per IS 731 & IS 3188	As per IS 731 & IS 3188	As per IS 731 & IS 3188
22	Inter changeability of disc insulator	Required	Required	Required
23	Net weight of Insulator unit (Approx.)	5.8	5.8	8.5
24	Packing details i) Type of packing ii) No. of disc in each packing iii) Gross weight of each packing	 Wooden crates 6 42	 Wooden crates 6 42	 Wooden crates 5 54

(2) INSULATOR STRINGS WITH HARDWARE FITTINGS:

The complete insulator string including Hardware fittings shall have the following characteristics:-

S. No.	Characteristics	Single/Double Suspension		Single/Double Tension	
		220 kV	132 kV	220 kV	132 kV
1	**No. of Standard Discs**	**1x13 2x13**	**1x9 2x9**	**1x14 2x14**	**1x10 2x10**
2	**Nominal diameter of discs**	**255**	**255**	**280**	**255**
3	**Power frequency Withstand voltage (wet) kV (rms)**	**460**	**280**	**490**	**300**
4	**Lighting impulse withstand voltage (dry)(kVp)**	**1200**	**800**	**1200**	**800**
5	**Switching surge Withstand voltage (Dry & wet) (kVp)**	**900**	**350**	**900**	**350**
6	**Mechanical failing Load (kgf)**	**7000/ 14000**	**7000/ 14000**	**16500/ 33000**	**9000/ 18000**
7	**Pollution**	**Moderately polluted**		**Moderately polluted**	
8	**No deformation load (kgf)**	**4690/ 9380**	**4690/ 9380**	**11055/ 25610**	**6030/ 12060**
9	**Corona Extinction voltage (KV rms)**	**176**	**-**	**176**	**-**

The Insulator string Hardware fittings and Ground wire assemblies shall comply and conform to the above requirement.

BALL & SOCKET DIMENSIONS:- **The Ball and Socket for Hardware fittings shall necessarily conform to the dimensions as stipulated in the Indian Standards. The Ball and Socket dimensions of the Hardware sets to be used with 7000 kg and 9100 kg Electro Mechanical strength Disc Insulators shall conform to designation 16mm/16mm-B in accordance with IS:2486(Part-II) or equivalent International Standard. The Ball and Socket dimension of Hardware to be used with 16,500 kg Electro Mechanical strength disc insulator shall conform to designation 20mm in accordance with IS-2486:(Part-II) or equivalent International Standard. The Bidder shall offer full detail of locking device in accordance with IS 2486:(Part-III) or equivalent International Standard along with test reports, gauges and adherence to Standards for Tests on Locking Devices in line with IS:2486 (Part-IV) or equivalent International Standard.**

3. **Tests and Standards**

Tests on Disc insulator shall be conducted as per latest relevant standard & tender specification.

3.1 **Type Tests**

The following type tests shall be conducted on a suitable number of individual standard disc insulators or complete strings:

3.2 **On unit disc Insulators**

a)	Verification of dimensions	:As per IEC :60383
b)	Thermal mechanical performance test	:As per ISS
c)	Power frequency voltage withstand and flashover test under (i) dry & (ii) wet condition	:As per IEC : 60383
d)	Impulse voltage withstand and flashover test (dry)	:As per IEC : 60383
e)	Visible Discharge test (dry)	:As per IS:731, Cl. 10.2
f)	RIV test (dry)	:As per IEC:60437
g)	Residual strength Test	:As per Annexure-A
h)	Steep wave front Test	:As per Annexure-A
i)	Impact Test	:As per Annexure-A

On the complete Disc Insulator String with Hardware Fittings

a)	Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition	:As per IEC : 60383
b)	Switching surge voltage withstand test under wet condition	:As per IEC: 60383
c)	Impulse voltage withstand test under dry condition	:As per IEC : 60383
d)	Impulse voltage flash over test under dry condition	:As per IEC : 60383
e)	Voltage distribution test	:As per Annexure-A
f)	Corona and RIV test under dry condition	:As per Annexure-A
g)	Mechanical Strength test	:As per Annexure-A

h)	Vibration test	:As per Annexure-A
i)	Power-Arc Test	:As per Annexure-A

Type tests specified under Clause 5.1.1 and 5.1.2 for 400 KV lines shall not be required to be carried out if a valid test certificate is available for a similar design, i.e., tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO/IEC vide 25/17025 or EN 45001 by the National accreditation body of the country where laboratory is located). The test reports submitted shall be for the tests conducted within last 5 (five) years prior to date of bid opening.

In case the test have been conducted earlier than the above stipulated period or in the event of any discrepancy in the test report (i.e., any test not applicable due to any design/manufacturing change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specifications), the tests shall be conducted by the Supplier at no extra cost to the Owner.

3.3 **Acceptance Tests**

For Disc Insulators

a)	Visual examination		:As per IEC : 60383
b)	Verification of dimensions		:As per IEC : 60383
c)	Temperature cycle test		:As per IEC : 60383
d)	Galvanising test		:As per IEC : 60383
e)	Mechanical performance test		:As per IEC:60575Cl 4.0
f)	Test on locking device for ball and socket coupling		:As per IEC:60372
g)	Eccentricity test		:As per IEC:60383
h)	Residual Strength Test		:As per IEC:797 Clause 4.4 & 4.5
i)	Metallurgical		:As per ISS
	i)	Grain size	
	ii)	Inclusion rating	
	iii)	Chemical analysis	
	iv)	Microstructure	
j)	IR Measurement		:As per ISS
k)	Impact Test		:As per ISS
l)	Steep Wave front test		:As per ISS
m)	Thermal Mechanical performance test		:As per ISS
o)	Electro-mechanical strength test		:As per ISS
p)	Porosity test		:As per ISS
q)	Puncture test		:As per IEC : 60383

3.4 **Packing and Marking**

All insulators shall be packed in strong seasoned wooden crates. The gross weight of the crates along with the material shall not normally exceed 200 Kg to avoid handling problem.

3.5 **Standards**

The insulator strings and its components shall conform to the following lndian/ International Standards which shall mean latest revision, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.
In the event of supply of insulators conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the standards proposed by the Bidder and those specified in this document will be provided by the Supplier to establish equivalence.

Sl. No.	**Indian Standard**	**Title**	**International Standard**
1.	IS:209-1992	Specification for zinc	BS:3436
2.	IS:406-1991	Method of Chemical Analysis of Slab Zinc	BS:3436
3.	IS:731-1991	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V	BS:137- (I&II) IEC:60383
4.	IS:2071 Part (I) – 1993 (Part(II)- 1991 Part(III)- 1991	Methods of High Voltage Testing	IEC:60060-1
5.	IS:2486 Part- I-1993 Part- II-1989 Part-III-1991	Specification for Insulator fittings for Overhead Power Lines with a nominal voltage greater than 1000V General Requirements and Tests Dimensional Requirements Locking Devices	 BS:3288 IEC:60120 IEC:60372
6.	IS:2629-1990	Recommended Practice for Hot, Dip Galvanisation for iron and steel	ISO-1461 (E)
7.	IS:2633-1992	Testing of Uniformity of Coating of zinc coated articles	
8.	IS:3188-1988	Dimensions for Disc Insulators	IEC:60305
9.	IS:6745-1990	Determination of Weight of Zinc Coating on Zinc coated iron and steel articles	BS:433-1969 ISO:1460-1973
10.	IS:8263-1990	Methods of RI Test of HV insulators	IEC:60437 NEMA Publi-cation No.07/ 1964/ CISPR
11.	IS:8269-1990	Methods for Switching Impulse test on HV insulators	IEC:60506
12.		Thermal Mechanical Performance test and mechanical performance test on string insulator units	IEC: 60575
13.		Salt Fog Pollution Voltage Withstand Test	IEC:60507
14.		Residual Strength of String Insulator Units of Glass or Ceramic Material for Overhead Lines after Mechanical Damage of the Dielectric	IEC:60797
15.		Guide for the selection of insulators in respect of polluted conditions	IEC:60815
16.		Tests on insulators of Ceramic material or glass or glass for overhead lines with a nominal voltage greater than 1000V	IEC:60383
17.		Characteristics of string insulator units of the long rod type	IEC : 60433
18.		Standard Test Method for Autoclave Expansion of Portland Cement	ASTM C151-93-a
19.		American National Standard for Insulators wet process porcelain and toughened glass suspension type	ANSI C29-2-1992

4. Tests on Complete Strings with Hardware Fittings

4.1 Voltage Distribution Test (For Disc Insulator strings only)

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed 6.5 % for suspension & tension insulator strings for 765 KV line and 9% for suspension insulator strings and 10% for tension insulator strings for 400 KV lines.

4.2 Corona Extinction Voltage Test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 KV (rms) line to ground under dry condition for 400 KV line. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC: 383.

4.3 RIV Test (Dry)

Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305 KV line to ground under dry condition for 400 KV line. The test procedure shall be in accordance with IS:8263/IEC : 437.

4.4 Mechanical Strength Test

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to, remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

4.5 Vibration Test

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 metres. In the case of suspension string a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and four sub-conductors (each tensioned at 43 KN for 400 KV line) shall be secured with clamps. The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point, nearest to the string, shall be measured and the same shall not be less than $1000/f^{1.8}$ where f is the frequency of vibration in cycles/sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware shall be examined for looseness, fatigue failure and mechanical strength test. There shall be no deterioration of properties of hardware components and insulators after the vibration test. The insulators shall be subjected to the following tests as per relevant standards :

	Tests Percentage of	Percentage of units to be tested
		Disc insulators
a)	Temperature cycle test followed by mechanical performance test	60
b)	Puncture test/steep wave front test	40

4.6 Power - Arc Test

This test shall be performed on the complete string in accordance with IEC Technical Report IEC : 61467-1997 with the following test series :

Test circuit	Short circuit current	Number and duration of test
B	$I_n = I_{sys} = 40$ KA	Two of $t_n = 0.2$s and one of $t_n = 0.5$s

The acceptance criteria after the completion of test series shall be following.

a) Insulator separation not permitted.
b) Burning/melting of metal components, breakage of insulator sheds, glaze removal are permitted.
c) The complete insulator string alongwith its hardware fitting excluding arching horn, corona control ring/grading ring shall withstand 80% of UTS.

4.7 Steep Wave Front Test (For Disc Insulator only)

Test following test shall be performed on 10 insulator units in case of disc insulators selected at random from the lot offered for selection of sample for type test.

a) Each insulator unit shall be subjected to five successive positive and negative impulse flashovers with a wave having minimum effective rate of rise of 2500 KV per microseconds.
b) Each unit shall then be subjected to three dry power frequency voltage flashovers.

4.8 Acceptance Criteria

An insulator shall be deemed to have met the requirement of this test if, having been successfully subjected to the ten impulse flashovers, the arithmetic mean of the three subsequent dry/power frequency voltage flashover values equals or exceeds 95% of the rated dry power frequency flashover voltage.

An insulator shall be deemed to have failed to meet the requirement of above testing if,

(a) It has not flash over when the oscillogram or peak voltage indicator shows a marked reduction in voltage.

or

(b) Any one of the subsequent three dry power frequency voltage flashover value is less than 80% of the value specified.

Failure of any one unit either in the steep wave front or subsequent low frequency voltage test shall cause for testing on double number of units.

4.9 **Hydraulic Internal Pressure Test on Shells (only for Disc Insulator)**

The test shall be carried out on 100% shells before assembly. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

4.10 **Thermal Mechanical Performance Test**

Thermal Mechanical Performance Test shall be performed in accordance with IEC-60383-1 Clause 20 with the following modifications :

(1) The applied mechanical load during this test shall be 70% of the rated electromechanical or mechanical value.
(2) The acceptance criteria shall be
  (a) X greater than or equal to R + 3S.
  Where
  X = Mean value of the individual mechanical failing load.
  R = Rated electro-mechanical / mechanical failing load.
  S = Standard deviation.
  (b) The minimum sample size shall be taken as 20 for disc insulator units and 5 units for long rod units.
  (c) The individual electromechanical failing load shall be at least equal to the rated value. Also puncture shall not occur before the ultimate fracture.

4.11 **Electromechanical/Mechanical Failing Load Test**

This test shall be performed in accordance with clause 18 and 19 of IEC 383 with the following acceptance

(i) X greater than or equal to R + 3S

Where
X = Mean value of the electro-mechanical/mechanical/ failing load.
R = Rated electro-mechanical / mechanical failing load.
S = Standard deviation.

(ii) The minimum sample size shall be taken as 20 for disc insulators units and 5 for long rod units. However, for larger lot size, IEC 591 shall be applicable.

(iii) The individual electro-mechanical/mechanical failing load shall be at least equal to the rated value. Also electrical puncture shall not occur before the ultimate fracture.

4.12 **Residual Strength Test (For Disc Insulators only)**

The above test shall be performed as per clause 4.4 and 4.5 of IEC 797 preceded by the temperature cycle test, on both glass and porcelain disc insulators. The Sample size shall be 25 and the evaluation of the results and acceptance criteria shall be as per clause No. 4.6 of IEC:797.

4.13 **IR Measurements**

IR measurement shall be carried out by the instrument operating at 1 KV DC. IR value when measured under fair weather condition, shall not be less than 50 M-ohm.

4.14 **Impact Test**

The Impact Test shall be carried out in accordance with ANSI-C-29.2 Clause 8.2.8 with the following modification.

The breaking point of the pendulum shall be so adjusted that, when released the copper nose will strike the outer rim of the shell or the most protuded rim of the shell squarely in a direction parallel to the axis of the unit and towards the cap.

The test specimen shall receive an impact of 7 N-m for 120 KN Disc & 10N-m for 160 KN & 210 KN Disc by releasing the pendulum.

4.15 **Tests on All components (As applicable)**

4.16 **Chemical Analysis of Zinc used for Galvanizing**

Samples taken from the zinc ingot shall be chemically analysed as per IS:209-1979. The purity of zinc shall not be less than 99.95%.

4.17 **Tests for Forgings**

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programmed.

4.18 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic, particle inspection for castings will be as per the internationally recognised procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Supplier and Owner in Quality Assurance Programme.

4.19 Autoclave Test

For cement used in the assembly of the insulators six samples from different batches shall be tested in accordance with ASTM C-151. The cement shall have an expansion less than 0.12%.

SECTION-II (B) - (iv)

TECHNICAL SPECIFICATION OF HARDWARE FITTING ASSESORIES FOR CONDUCTOR AND ASSESORIES FOR EARTH WIRE

1.0 Technical Description of Hardware Fittings

1.1 Detail s of Hardware Fittings

1.1.1 The hardware fittings shall be suitable for use with Disc insulators having ball and socket fittings. The hardware fittings shall be as per the specification and shall be supplied suitable for twin bundle ACSR moose conductor attaching to hanger/ strain plate fixed on tower. Each hardware fitting shall be supplied complete in all respects and shall include the following hardware parts:

1.1.2 Suitable arcing horn as specified in clause 1.7 hereinafter.

1.1.3 Suitable yoke plates for suspension and tension hardware fitting for the twin bundle moose conductor arrangement complying with the specifications given hereinafter.

1.1.4 Corona control rings/grading ring with fittings for attachment to line side yoke plate.

1.1.5 Sag adjustment plate for double tension hardware fittings for 400kV (twin bundle conductor) line **and turn buckle for single tension hardware fittings .**

1.1.6 Suspension and dead end assembly to suit conductor size as detailed in clause 1.12, 1.13 and 1.14 hereinafter.

1.1.7 Provisions for attaching balancing weights on the line side yoke plate of single suspension pilot hardware fittings .

1.1.8 Other necessary fittings viz D-shackles, eye links, extension links, ball clevis, socket clevis, clevis eye, U clevis and chain link etc. to make the hardware fittings complete.

1.2 Dimensions of Insulator String Along with Hardware Fitting

The various limiting dimensions of the insulator strings along with hardware fittings shall be as per the specification drawings enclosed in section of drawings of this specification.

1.3 Corona and RI Performance

Sharp edges and scratches on all the hardware fittings shall be avoided. All surfaces must be clean, smooth, without cuts and abrasions or projections. The

Contractor must give suitable assurance about the satisfactory corona and radio interference performance of the materials offered by them.

1.4 Maintenance

1.4.1 The hardware fittings offered shall be suitable for employment of hot line maintenance technique so that usual hot line operations can be carried out with ease, speed and safety. The technique adopted for hot line maintenance shall be generally bare hand method & hot stick method. The Bidder should clearly establish in the bid, the suitability of his fittings for hot line maintenance.

1.4.2 The line side yoke plate shall have a notch & a working hole of suitable size. The design of corona control rings/grading ring shall be such that it can be easily replaced by employing hot line maintenance technique.

1.5 Designation

1.5.1 Ball and Socket Designation

The dimensions of the ball and socket shall be of 20mm wherever 120 and 160 KN insulator are used . The designation should be in accordance with the standard dimensions stated in IS 2486(Part-II)/IEC:120. The dimensions shall be checked by the appropriate gauge after galvanising only.

1.6 Security Clips and Split Pins

1.6.1 Security clips for use with ball and socket coupling shall be R-shaped, hump type which provides positive locking of the coupling as per IS:2486(Part-III)/ IEC : 372. The legs of the security clips shall be spread after assembly in the works to prevent complete withdrawal from the socket. The locking device should be resilient, corrosion resistant and of suitable mechanical strength. There shall be no risk of the locking device being displaced accidentally or being rotated when in position. Under no circumstances the locking devices shall allow separation of fittings.

1.6.2 The hole for the security clip shall be countersunk and the clip should be of such design that the eye of clip may be engaged by a hot line clip puller to provide for disengagement under energised conditions. The force required to pull the security clip into its unlocked position shall not be less than 50 N (5 kg) or more than 500 N (50 kg).

1.6.3 Split pins shall be used with bolts & nuts.

1.7 Arcing Horn/Intermediate Arcing Horn

The arcing horn / Intermediate Arcing Horn shall be either ball ended rod type or tubular type.

The air gap shall be so adjusted to ensure effective operation under actual field conditions.

The arcing distance between arcing horn and corona control rings / grading ring shall be 3050 mm under nominal dimension of insulator for insulator string with disc insulator.

1.8 **Yoke Plates**

The strength of yoke plates shall be adequate to withstand the minimum ultimate tensile strength as specified in the bid drawings.

The plates shall be either triangular or rectangular in shape as may be necessary. The design of yoke plate shall take into account the most unfavorable loading conditions likely to be experienced as a result of dimensional tolerances for disc insulators as well as components of hardware fittings within the specified range. The plates shall have suitable holes for fixing corona control rings/grading ring/arcing horn. All the corners and edges should be rounded off with a radius of atleast 3 mm. Design calculations i.e. for bearing & tensile strength, for deciding the dimensions of yoke plate shall be furnished by the bidder. The holes provided for bolts in the yoke plate should satisfy shear edge condition as per Clause No. 8.10 of IS:800-1984..

1.9 **Corona Control Rings/Grading Ring**

1.9.1 The Corona control rings/grading ring shall be provided with hardware fittings and shall be of such design that it should cover at least one disc insulator in disc insulator strings so that they will reduce the voltage across the insulator units. It shall also improve corona and radio interference performance of the complete insulator string along with hardware fittings.

1.9.2 The corona control rings/grading ring shall be made of high strength heat treated aluminium alloy tube of minimum 2.5 mm wall thickness. If mild steel brackets are used then the brackets shall not be welded to the pipe but shall be fixed by means of bolts and nuts on a small aluminium plate attachment welded to the pipe. The welded center of the corona control ring/grading ring shall be grinded before buffing. Alternately, Aluminium tube/flats of suitable dimensions welded to the corona control rings/grading rings may be used for connection to yoke plate.

1.9.3 The Corona control rings/grading ring should have a brushed satin finish and not a bright glossy surface. No blemish should be seen or felt when rubbing a hand over the metal.

1.9.4 Bidder may quote for grading ring with armour grip suspension assembly. The grading ring shall be of open type design with a gap of 125 mm. The open ends shall be suitably terminated. The outside diameter of the tube shall be 60 mm . The ends of grading ring tube shall be sealed with welded aluminium cap duly buffed.

1.10 **Sag Adjustment Plate .**

1.10.1 The sag-adjustment plate to be provided with the double tension hardware fitting shall be of three plate type. The sag adjustment plate shall be provided with a safety locking arrangement. The device shall be of such design that the adjustment is done with ease, speed and safety.

1.10.2 The maximum length of the sag adjustment plate from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible and the steps of adjustment shall be clearly indicated in the drawing. An adjustment of 150 mm minimum at the interval of 6 mm shall be possible with the sag adjustment plate.

1.10.3 Design calculations for deciding the dimensions of sag adjustment plate shall be furnished by bidder. The hole provided for bolts should satisfy shear edge condition as per Clause No.8.10 of IS:800-1984.

1.11 **Turn Buckle**

1.11.1 The turn buckle is to be provided with single tension hardware fitting. The threads shall be of sufficient strength to remain unaffected under the specified tensile load.

1.11.2 The maximum length of the turn buckle from the connecting part of the rest of the hardware fittings shall be 520 mm. The details of the minimum and maximum adjustment possible shall be clearly indicated in the drawing. An adjustment of 150 mm minimum shall be possible with turn buckle.

1.12 **Suspension Assembly**

1.12.1 The suspension assembly shall be suitable for ACSR MOOSE conductor.

1.12.2 The suspension assembly shall be armour grip suspension clamp type ; except for Pilot insulator string for which only suitable Envelope type suspension clamp shall be used.

1.12.3 The suspension clamp along with standard preformed armour rods set shall be designed to have maximum mobility in any direction and minimum moment of inertia so as to have minimum stress on the conductor in the case of oscillation of the same.

1.12.4 The suspension clamp along with standard preformed armour rods/armour grip suspension clamp set shall have the slip strength between 20 to 29 KN.

1.12.5 The suspension assembly shall be designed, manufactured and finished to give it a suitable shape, so as to avoid any possibility of hammering between suspension assembly and conductor due to vibration. The suspension assembly shall be smooth without any cuts, grooves, abrasions, projections, ridges or excrescence, which might damage the conductor.

1.12.6 The suspension assembly/clamp shall be designed so that it shall minimise the static & dynamic stress developed in the conductor under various loading conditions as well as during wind induced conductor vibrations. It shall also withstand power arcs & have required level of Corona/RIV performance.

1.12.7 The magnetic power loss shall not be more than that stipulated in the Standard Technical Particulars.

1.12.8 **Armour Grip Suspension Clamp**

1.12.8.1 The armour grip suspension clamp shall comprise of retaining strap, support housing, elastomer inserts with aluminum reinforcements and AGS preformed rod set.

The housing supports and housing straps should provide positive stop closure. AGS unit should have low rotational inertia, strut action of the Armour Cage, resilient cushioning of the neoprene insert, immunity from high compressive and flexural stress and wide area support. Manufacturer is required to guarantee minimum fatigue life of the AGS units and this would be established under actual tests on tensioned Conductor span. The manufacturer is required to guarantee minimum 40 years life of the complete AGS units including Neoprene cushioning and this should be established under actual test on a tensioned Conductor span**.**

1.12.8.2 Elastomer insert shall be resistant to the effects of temperature up to 85^{O}C, Ozone, ultraviolet radiations and other atmospheric contaminants likely to be encountered in service. The physical properties of the elastomer shall be of approved standard. It shall be electrically shielded by a cage of AGS performed rod set. The elastomer insert shall be so designed that the curvature of the AGS rod shall follow the contour of the neoprene insert.The Elastomer used with AGS unit must be capable of withstanding desired long out-door performance including the variation of temperature from 0^{0}C to 85^{0}C. The Bidder will have to provide certificate from reputed manufacturers that the Elastomer being supplied by them is suitable for AGS fitting and must have tensile strength of 2000 PSI and minimum ultimate elongation 300%.

1.12.8.3 The Preformed Rods Set, suitable for ACSR MOOSE conductor, shall be used to minimise the stress developed in the sub-conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from the suspension clamp as a result of unbalanced conductor tension in adjacent spans and broken wire condition. It shall also withstand power arcs. chafing and abrasion from suspension clamp and localized heating effect due to magnetic power losses from suspension clamps as well as resistance losses of the conductor.

The helical Preformed Rods Set required for AGS assembly shall be made of Aluminium alloy of HE 20 grade as per IS-6051/1970 or equivalent International Standard duly heat treated and shall be suitable to wrap a desired size of Conductor. The tensile strength of the retaining rod material should not be less than 50,000 PSI). The minimum slipping strength of the complete fitting shall not be less than 15% and more than 20% of the UTS of the cable on which it is to be used. The Clamp shall be in 2 parts made of Aluminium and will have inner profile matching with the profile of Armour rod. This Clamp should be made by drop forging process. AGS assembly should be provided with the forged steel socket eye to match with the suspension string and should have UTS not less than 120KN.

1.12.8.4 The preformed rods set shall have right hand lay and the inside diameter of the helics shall be less than the outside diameter of the conductor to have gentle but permanent grip on the conductor. The surface of the rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

1.12.8.5 The pitch length of the rods shall be determined by the Bidder but shall be less than that of the outer layer of conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristic wholly independent of the skill of linemen.

1.12.8.6 The length of the AGS preformed rods shall be such that it shall ensure sufficient slipping strength and shall not introduce unfavorable stress on the conductor under all operating conditions. However the length of AGS preformed rods shall not be less than 2535 $\pm$ 25 mm and diameter shall be 9.270 $\pm$ 0.10 mm . The tolerance in length of the rod in complete set should be with in 13 mm between the longest and shortest rod . The end of rod shall be parrot billed.

1.12.8.7 The number of rods in each set shall be twelve (12). Each rod shall be marked in the middle with paint for easy application on the line.

1.12.8.8 The rod shall not loose their resilience even after five applications.

1.12.8.9 The conductivity of each rod of the set shall not be less than 40% of the conductivity of the International Annealed Copper Standard (IACS).

1.13 **Envelope Type Suspension Clamp**

The seat of the envelope type suspension clamp shall be smoothly rounded & suitably curved at the ends. The lip edges shall have rounded bead. There shall be at least two U-bolts for tightening of clamp body and keeper pieces together. Hexagonal bolts and nuts with split-pins shall be used for attachment of the clamp.

1.14 **Dead end Assembly**

1.14.1 The dead end assembly shall be suitable for ACSR MOOSE conductor & ACSR Zebra Conductor.

1.14.2 The dead end assembly shall be compression type with provision for comprising jumper terminal at one end. The angle of jumper terminal to be mounted should be 30° with respect to the vertical line. The area of bearing surface on all the connections shall be sufficient to ensure positive electrical and mechanical contact and avoid local heating due to I^2R losses. The resistance of the clamp when compressed on Conductor shall have resistively less than 75% of the resistance of equivalent length of Conductor.

1.14.3 Die compression areas shall be clearly marked on each dead-end assembly designed for continuous die compressions and shall bear the words 'COM PRESS FIRST' suitably inscribed near the point on each assembly where the compression begins. If the dead end assembly is designed for intermittent die compressions it shall bear identification marks 'COMPRESSION ZONE' AND 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compressions and knurling marks showing the end of the zones. The letters, number and other markings on the finished clamp shall be distinct and legible. The dimensional tolerances of the cross section of Aluminium and steel dead end; for dead end assembly for ACSR MOOSE conductor shall be as table given below and stipulated in the Standard Technical Particulars.

Sr. No	Item (For ACSR MOOSE conductor)	Dimension before compression		Dimension after compression	
		Inner dia. (mm)	Outer dia. (mm)	Corner to corner width (mm)	Face to faca width (mm)
1	Aluminum dead end	34 ± 0.5	54 ± 1	53 ± 0.5	46 ± 0.5
	Steel dead end	11.1 ± 0.2	21 ± 0.5	20.2 ± 0.5	17.5 ± 0.5

Sr. No	Item (For ACSR Zebra conductor)	Dimension before compression		Dimension after compression	
		Inner dia. (mm)	Outer dia. (mm)	Corner to corner width (mm)	Face to faca width (mm)
1	Aluminum dead end	34 ± 0.5	54 ± 1	53 ± 0.5	46 ± 0.5
	Steel dead end	11.1 ± 0.2	21 ± 0.5	20.2 ± 0.5	17.5 ± 0.5

1.14.4 The assembly shall not permit slipping of, damage to, or failure of the complete conductor or any part there of at a load 95% of the ultimate tensile strength of the conductor.

1.15 **Fasteners : Bolts, Nuts and Washers**

a. All bolts and nuts shall conform to IS 12427. All bolts and nuts shall be galvanized as per IS: 1367 (Part 13)/ IS 2629. All bolts and nuts shall have hexagonal heads, the heads being forged out of solid truly concentric, and square with the shank, which must be perfectly straight.

b. Bolts up to M16 and having length up to 10 times the diameter of the bolt should be manufactured by cold forging and thread rolling process to obtain good and reliable mechanical properties and effective dimensional control. The shear strength of bolt for 5.6 grade should be 310 MPa minimum as per IS 12427. Bolts should be provided with washer face in accordance with IS 1363 (Part-1) to ensure proper bearing.

c. Nuts should be double chamfered as per the requirement of IS:1363 Part-III. It should be ensured by the manufacturer that nuts should not be over tapped beyond 0.4 mm oversize on effective diameter for size up to M16.

d. Fully threaded bolts shall not be used. The length of the bolt shall be such that the threaded portion shall not extend into the place of contact of the component parts.

e. All bolts shall be threaded to take the full depth of the nuts and threaded enough to permit the firm gripping of the component parts but no further. It shall be ensured that the threaded portion of the bolt protrudes not less than 3 mm and not more than 8 mm when fully tightened. All nuts shall fit and tight to the point where shank of the bolt connects to the head.

f. Flat washers and spring washers shall be provided wherever necessary and shall be of positive lock type. Spring washers shall be electro-galvanized. The thickness of washers shall conform to IS 2016:1967.

g. The Bidder shall furnish bolt schedules giving thickness of components connected. The nut and the washer and the length of shank and the threaded portion of bolts and size of holes and any other special details of this nature.

h. To obviate bending stress in bolt, it shall not connect aggregate thickness more than three time its diameter.

i. Bolts at the joints shall be so staggered that nuts may be tightened with spanners without fouling.

j. To ensure effective in-process Quality control it is essential that the manufacturer should have all the testing facilities for tests like weight of zinc coating, shear strength, other testing facilities etc, in-house.

k. Fasteners of grade higher than 8.8 are not to be used and the minimum grade of bolt shall be 5.6.

1.16 **Materials**

The materials of the various components shall be as specified hereunder. The Bidder shall indicate the material proposed to be used for each and every component of hardware fittings stating clearly the class, grade or alloy designation of the material, manufacturing process & heat treatment details and the reference standards.

1.16.1 The details of materials for different component are listed as in Table-I

TABLE-1 : (Details of Materials)

Sl. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
1.	Security Clips	Stainless Steel/ Phospher Bronze	-	AISI 302 or 304-L/ IS-1385	
2.	Arcing Horn	Mild Steel Rod/ Tube Type	Hot dip galvanized	As per IS-226 or IS-2062	
3.	Ball Fittings, Socket, all shackles links cleves	Class-IV Steel	Drop forged & normalized Hot dip galvanized	As per IS: 2004	
4.	Yoke Plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
5.	Sag Adjustment plate	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
6(a).	Corona Control ring/ Grading ring	High Strength Al. Alloy tube (6061/ 6063/1100 type or 65032/ 63400 Type)	Heat treated	ASTM-B429 or as per IS	Mechanical strength of welded joint shall not be less than 20 KN
6(b).	Supporting Brackets & Mounting Bolts	High Strentgth Al Alloy 7061/ 6063/ 65032/ 63400 Type) or Mild Steel	Heat treated Hot dip galvanized	ASTM-B429 or as per IS:226 or IS:2062	
7.	Turn Buckle	Class-II Steel	Forged hot dip galvanized	IS:2004	
8(a).	Free centre type clamp/ Envelope type Clamp: Clamp Body, Keeper Piece	High Strength Al. Alloy 4600/ LM-6 or 6061/ 6063	Casted or forged & Heat treated	IS:617 or ASTM-B429	

TABLE-1 : (Details of Materials)

Sl. No.	Name of item	Material treatment	Process of Standard	Reference	Remarks
8(b)	Envelope type Clamp: Cotter bolts/ Hangers, Shackles, Brackets	Mild Steel	Hot dip galvanized	As per IS-226 or IS-2062	
8(c)	Envelope type	Stainless Steel	Forged & & Heat	AISI 302 or 304-L	

	Clamp: U Bolts	or High Strength Al alloy 6061/ 6063 or 65032/ 63400	treated	ASTM-B429	
9.	P. A. rod	High strength Al alloy type 6061/65032 or equivalent	Heat treatment during manufacturing	ASTM:B429	Min. tensile strength of 35 kg/mm2
10.	AGS clamp (a) Supporting house	High strength corrosion resistant Al. alloy LM6, 4600 or equivalent 6061/65032	Cast/forged heat treated.	IS:617 or equivalent	
	(b) Al insert and retaining strap	High strength Al alloy type 6061 or equivalent	Forged and Heat treated	ASTM:B429	
	(c) Elastomer cushion	Moulded on Al reinforcement			
11(a).	Dead End Assembly: Outer Sleeve	EC grade Al of purity not less than 99.50%			
11(b).	Steel Sleeve	Mild Steel	Hot Dip Galvanized	IS:226/IS-2062	

Note : Alternate materials conforming to other national standards of other countries also may be offered provided the properties and compositions of these are close to the properties and compositions of material specified. Bidder should furnish the details of comparision of material offered viz a viz specified in the bid or else the bids are liable to be rejected.

1.17 **Workmanship**

a. All the equipment shall be of the latest design and conform to the best modern practices adopted in the Extra High Voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for 400 KV transmission lines and will give continued good performance.

b. The design, manufacturing process and quality control of all the materials shall be such as to give the specified mechanical rating, highest mobility, elimination of sharp edges and corners to limit corona and radio-interference, best resistance to corrosion and a good finish.

c. All ferrous parts including fasteners shall be hot dip galvanized, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanized. The bolt threads shall be undercut to take care of the increase in diameter due to galvanising. Galvanising shall he done in accordance with IS 2629:1985/ IS 1367 (Part 13) and shall satisfy the tests mentioned in IS 2633: 1986.

d. Before ball fittings are galvanized. all die flashing on the shank and on the bearing surface of the ball shall be carefully removed without reducing the dimensions below the design requirements.

e. The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash rust, stains, bulky white deposits and blisters. The zinc used for galvanising shall be Zinc of any grade in IS 209:1992 ingot (fourth revision) or IS 13229:1991.

f. Pin balls shall be checked with the applicable “GO” gauges in at least two directions. one of which shall be across the line of die flashing, and the other 90^{o} to this line. "NO GO" gauges shall not pass in any direction.

g. Socket ends, before galvanising, shall be of uniform contour. The bearing surface of socket ends shall be uniform about the entire circumference without depressions of high spots. The internal contours of socket ends shall be concentric with the axis of the fittings as per IS:2486/IEC : 120.

h. The axis of the bearing surfaces of socket ends shall be coaxial with the axis of the fittings. There shall be no noticeable tilting of the bearing surfaces with the axis of the fittings.

i. In case of casting, the same shall be free from all internal defects like shrinkage, inclusion, blow holes, cracks etc. Pressure die casting shall not be used for casting of components with thickness more than 5 mm.

j. All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum.

k. No equipment shall have sharp ends or edges, abrasions or projections and cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating

surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under service conditions.

l. All the holes shall be cylindrical, clean cut and perpendicular to the plane of the material. The periphery of the holes shall be free from burrs.

m. All fasteners shall have suitable corona free locking arrangement to guard against vibration loosening.

n. Welding of aluminium shall be by inert gas shielded tungsten arc or inert gas shielded metal arc process. Welds shall be clean, sound, smooth, uniform without overlaps, properly fused and completely sealed. There shall be no cracks, voids incomplete penetration, incomplete fusion, under-cutting or inclusions. Porosity shall be minimised so that mechanical properties of the aluminium alloys are not affected. All welds shall be properly finished as per good engineering practices.

1.18 **Bid Drawings**

1.18.1 The Bidder shall furnish full description and illustrations of materials offered.

1.18.2 Fully dimensioned drawings of the complete insulator string hard wares and their component parts showing clearly the following arrangements shall be furnished along with the bid. Weight, material and fabrication details of all the components should be included in the drawings.

(i) Attachment of the hanger or strain plate.
(ii) Suspension or dead end assembly.
(iii) Arcing horn attachment to the string as specified in clause 1.7 of this technical Specification.
(iv) Yoke plates
(v) Hardware fittings of ball and socket type for inter connecting units to the top and bottom Yoke plates.
(vi) Corona control rings/grading ring attachment to conductor and other small accessories.
(vii) Links with suitable fittings.
(viii) Details of balancing weights and arrangements for their attachment in the single suspension pilot insulator string.

1.18.3 All drawings shall be identified by a drawing number and contract number. All drawings shall be neatly arranged. All drafting & lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions & dimensional tolerances shall be mentioned in mm.

The drawings shall include :

(i) Dimensions and dimensional tolerance.
(ii) Material, fabrication details including any weld details & any specified finishes & coatings. Regarding material designation & reference of standards are to be indicated.
(iii) Catalogue No.
(iv) Marking
(v) Weight of assembly
(vi) Installation instructions
(vii) Design installation torque for the bolt or cap screw.
(viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts.
(ix) The compression die number with recommended compression pressure.
(x) All other relevant terminal details.

1.18.4 After placement of award, the Contractor shall submit fully dimensioned drawing including all the components to the Owner for approval. After getting approval from the Owner and successful completion of all the tests, the Contractor shall submit more copies of the same drawings to the Owner for further distribution and field use at Owner's end.

2.0 Accessories for ACSR 'MOOSE' Conductor

2.1 General

2.1.1 This portion (under clause 2.0) details the technical particulars of the accessories for ACSR MOOSE Conductor..

2.2 Mid Span Compression Joint

2.2.1 Mid Span Compression Joint shall be used for joining two lengths of conductor. The joint shall have a resistively less than 75% of the resistivity of equivalent length of conductor. The joint shall not permit slipping off, damage to or failure of the complete conductor or any part there of at a load less than 95% of the ultimate tensile strength of the conductor.

2.2.2 The joint shall be made of steel and aluminium sleeves for jointing the steel core and aluminium wires respectively. The steel sleeve should not crack or fail during compression. The steel sleeve shall be hot dip galvanized. The aluminium sleeve shall have aluminium of purity not less than 99.5%. The dimensions and dimensional tolerances of mid span compression joint shall be as per Standard Technical Particulars and as below.

Sr. No	**Item** (Mid span joint for ACSR MOOSE conductor)	**Length** (mm)	**Dimension before compression**		**Dimension after compression**	
			Inner dia. (mm)	Outer dia. (mm)	Corner to corner width (mm)	Face to face Width (mm)
1	Aluminium	735 ± 5	34 ± 0.5	54 ± 1	53 ± 0.5	46 ± 0.5
2	Sreel	250 ± 5	11.1 ± 0.2	21 ± 0.5	20.2 ± 0.5	17.5 ± 0.5

2.3 T-Connector

T-Connector of compression type shall be used for jumper connection at transposition tower. It shall be manufactured out of 99.5% pure aluminium and shall be strong enough to withstand normal working loads. The T-connector shall have a resistivity across jumper less than 75% resistivity of equivalent length of conductor. The T-connector shall not permit slipping off, damage to or failure of complete conductor. The welded portions shall be designed for 30 kN axial tensile load. Leg sleeve of T-connector should be kept at an angle of 15 deg. from vertical and horizontal plane of the conductor in order to minimise jumper pull at the welded portion. The dimensions and dimensional tolerances of T-connector shall be as per Standard Technical Particulars and as below.

Sr. No	**Item** (T- Connector for ACSR MOOSE conductor)	**Length** (mm)	**Dimension before compression**		**Dimension after compression**	
			Inner dia. (mm)	Outer dia. (mm)	Corner to corner width (mm)	Face to face Width (mm)
1	T- Connector	400 ± 5	34 ± 0.5	54 ± 1	53 ± 0.5	46 ± 0.5

2.4 Repair Sleeve

Repair Sleeve of compression type shall be used to repair conductor with not more than two strands broken in the outer layer. The sleeve shall be manufactured from 99.5% pure aluminium and shall have a smooth surface. The repair sleeve shall comprise of two pieces with a provision of seat for sliding of the keeper piece. The edges of the seat as well as the keeper piece shall be so rounded that the conductor strands are not damaged during installation. The dimensions and dimensional tolerances of repair sleeve shall be as per Standard Technical Particulars and as below

Sr. No	**Item** (Repair sleeve for ACSR MOOSE conductor)	**Length** (mm)	**Dimension before compression**		**Dimension after compression**	
			Inner dia. (mm)	Outer dia. (mm)	Corner to corner width (mm)	Face to face Width (mm)
1	Repair sleeve	300 ± 5	34 ± 0.5	54 ± 1	53 ± 0.5	46 ± 0.5

2.5 Vibration Damper

2.5.1 Vibration dampers of 4R-stockbridge type with four (4) different resonances spread within the specified aeolian frequency band width corresponding to wind speed of 1 m/s to 7 m/s shall be used at suspension and tension points on each conductor in each span along with bundle spacers to damp out aeolian vibration as mentioned herein after.

2.5.2 Alternate damping systems or "Dogbone" dampers offering equivalent or better performance also shall be accepted provided the manufacturer meets the qualifying requirements stipulated in the

Specifications. Relevant technical documents to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid.

2.5.3 One damper minimum on each side per Conductor/Sub-conductor for suspension points and two dampers minimum on each side per conductor/sub-conductor for tension points shall be used for ruling design span of 400 meters

2.5.4 The clamp of the vibration damper shall be made of high strength aluminium alloy of type LM-6. It shall be capable of supporting the damper and prevent damage or chaffing of the conductor during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the conductor without damaging the strands or causing premature fatigue failure of the conductor under the clamp. The clamp groove shall be in uniform contact with the conductor over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or other materials which could cause damage to the conductor when the clamp is installed. Clamping bolts shall be provided with self locking nuts and designed to prevent corrosion of threads or loosening in service.

2.5.5 The messenger cable shall be made of high strength galvanized steel/stain less steel with minimum strength of 135 Kg/sqmm. It shall be of preformed and post formed quality in order to prevent subsequent droop of weight and to maintain consistent flexural stiffness of the cable in service. The no of stand in the massanger cable shall be 19. The messenger cable other than stainless steel shall be hot dip galvanized in accordance with the recommendations of IS:4826 for heavily coated wires.

2.5.6 The damper mass shall be made of hot dip galvanized mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkage, inclusions and blow holes etc. The surface of the damper masses shall be smooth.

2.5.7 The damper clamp shall be casted over the messenger cable and offer sufficient and permanent grip on it. The messenger cable shall not slip out of the grip at a load less than the mass pull-off value of the damper. The damper masses made of material other-than zinc alloy shall be fixed to the messenger cable in a suitable manner in order to avoid excessive stress concentration on the messenger cables which shall cause premature fatigue failure of the same. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion. The damper mass made of zinc alloy shall be casted over the messenger cable and have sufficient and permanent grip on the messenger cable under all service conditions.

2.5.8 The damper assembly shall be so designed that it shall not introduce radio interference beyond acceptable limits.

2.5.9 The vibration damper shall be capable of being installed and removed from energised line by means of hot line technique. In addition, the clamp shall be capable of being removed and reinstalled on the conductor at the designated torque without shearing or damaging of fasteners.

2.5.10 The contractor must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 KN and 5 KN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.

2.5.11 The magnetic power loss of vibration damper shall not have more than 1 watt at 600 amps. 50 Hz AC per sub conductor when installed on twin bundle conductor.

2.5.12 The vibration analysis of the system, with and without damper and dynamic characteristics of the damper as detailed under Annexure-A, shall have to be submitted. The technical particulars for vibration analysis and damping design of the system are as follows:

Sl. No.	**Description**	**Technical particulars**
		400 kV (twin bundle moose conductor) line
1.	Span length in meters	
i)	Ruling design span	400 meters
ii)	Maximum span	1100 meters
iii)	Minimum span	100 meters

2.	Configuration	Double circuit twin bundle conductor per phase in vertical configuration
3.	Tensile load in each sub-Conductor at temperature of 0 deg. C and still air	As per sag tension calculations.
4.	Armour rod used	Standard Preformed armour rods/ AGS
4.	Maximum permissible dynamic strain	+/- 150 micro strains

2.5.13 The damper placement chart for spans ranging from 100m to 1100m shall be submitted by the Bidder. Placement charts should be duly supported with relevant technical documents and sample calculations.

2.5.14 The damper placement charts shall include the following

(1) Location of the dampers for various combinations of spans and line tensions clearly indicating the number of dampers to be installed per conductor per span.

(2) Placement distances clearly identifying the extremities between which the distances are to be measured.

(3) Placement recommendation depending upon type of suspension clamps (viz Free center type/Armour grip type etc.)

(4) The influence of mid span compression joints, repair sleeves and armour rods (standard and AGS) in the placement of dampers.

2.6 Bundle Spacer

2.6.1 Armour grip bundle spacers shall be used to maintain the spacing of 450 mm for 400 kV line twin bundle conductor between the two sub-conductors of each bundle under all normal working conditions.

2.6.2 Spacers offering equivalent or better performance shall also be accepted provided offer meets the qualifying requirements stipulated in the Specification.

2.6.3 The offer shall include placement charts recommending the number of spacers per phase per span and the sub span lengths to be maintained between the spacers while installing on the twin bundle conductors.

2.6.3.1 The placement of spacers shall be in such a way that adjacent sub spans are sufficiently detuned and the critical wind velocity of each sub span to avoid clashing of sub conductors. The placement shall ensure bundle stability under all operating conditions.

2.6.3.2 The placement chart shall be provided for spans ranging from 100 m to 1100m. The number of spacers recommended for a ruling design span of 400m shall however be seven with no sub-span greater than 70m and no end sub-span longer than 40m.

2.6.3.4 The Bidder shall also furnish all the relevant technical documents in support of their placement charts along with the bid.

2.6.4 Jumpers at tension points shall be fitted with spacers so as to limit the length of free conductor to 3.65 m and to maintain the sub conductor spacing of 450 mm for 400 kV (twin) line**. Bidder shall quote for rigid spacer for jumper**. It shall meet all the requirements of spacer used in line except for its vibration performance. Spacers requiring retaining rods shall not be quoted for jumpers.

2.6.5 The spacer offered by the Bidder shall satisfy the following requirements.

2.6.5.1 Spacer shall restore normal spacing of the sub conductors after displacement by wind, electromagnetic and the electrostatic forces under all operating conditions including the specified short circuit level without permanent deformation damage either to conductor or to the assembly itself. They shall have uniform grip on the conductor

2.6.5.2 For spacer requiring retaining rods, the retaining rods shall be designed for the specified conductor size. The preformed rods shall be made of high strength, special aluminium alloy of type 6061/65032 and shall have minimum tensile strength of 35 kg/sq.mm. The ends of retaining rods should be ball ended. The rods shall be heat-treated to achieve specified mechanical properties and give proper resilience and retain the same during service.

2.6.5.3 Four number of rods shall be applied on each clamps to hold the clamp in position. The minimum diameter of the rods shall be 7.87 $\pm$ 0.1 mm and the length of the rods shall not be less than 1100 mm.

2.6.5.4 Where elastomer surfaced clamp grooves are used, the elastomer shall be firmly fixed to the clamp. The insert should be forged from aluminium alloy of type 6061/65032. The insert shall be duly heat treated and aged to retain its consistent characteristics during service.

2.6.5.5 Any nut used shall be locked in an approved manner to prevent vibration loosening. The ends of bolts and nuts shall be properly rounded for specified corona performance or suitably shielded.

2.6.5.6 Clamp with cap shall be designed to prevent its cap from slipping out of position when being tightened.

2.6.5.7 The clam grooves shall be in uniform contact with the conductor over the entire surface, except for rounded edges. The groove of the clamp body and clamp cap shall be smooth and free of projections, grit or other material. which cause damage to the conductor when the clamp is installed.

2.6.5.8 For the spacer involving bolted clamps, the manufacturer must indicate the clamp bolt tightening torque to ensure that the slip strength of the clamp is maintained between 2.5 kN and 5 kN. The clamp when installed on the conductor shall not cause excessive stress concentration on the conductor leading to permanent deformation of the conductor strands and premature fatigue failure in operation.

2.6.5.9 Universal type bolted clamps, covering a range of conductor sizes, will not be permitted.

2.6.5.10 No rubbing, other than that of the conductor clamp hinges or clamp swing bolts, shall take place between any parts of the spacer. Joint incorporating a flexible medium shall be such that there is no relative slip between them.

2.6.5.11 The spacer shall be suitably designed to avoid distortion or damage to the conductor or to themselves during service.

2.6.5.12 Rigid spacers shall be acceptable only for jumpers.

2.6.5.13 The spacer shall not damage or chafe the conductor in any way which might affect its mechanical and fatigue strength or corona performance.

2.6.5.14 The clamping system shall be designed to compensate for any reduction in diameter of conductor due to creep.

2.6.5.15 The spacer assembly shall not have any projections, cuts, abrasions etc. or chattering parts which might cause corona or RIV.

2.6.516 The spacer tube shall be made of aluminium alloy of type 6061/65032. If fasteners of ferrous material are used, they shall conform to and be galvanized conforming to relevant Indian Standards. The spacer involving ferrous fasteners shall not have magnetic power loss more than **one watt at 600 Amps 50 Hz alternating current per sub conductor.**

2.6.5.17 Elastomer, if used, shall be resistant to the effects of temperature up to 95 deg.C, ultraviolet radiation and other atmospheric contaminants likely to be encountered in service. It shall have good fatigue characteristics. The physical properties of the elastomer shall be of approved standard.

2.6.5.18 The spacer assembly shall have electrical continuity. The electrical resistance between the sub-conductor across the assembly in case of spacer having elastomer clamp grooves shall be suitably selected by the manufacturers to ensure satisfactory electrical performance and to avoid deterioration of elastomer under all service conditions.

2.6.5.19 The spacer assembly shall have complete ease of installation and shall be capable of removal/reinstallation without any damage.

2.6.5.20 The spacer assembly shall be capable of being installed and removed from the energised line by means of bare hand/ hot line technique.

2.7 Material and Workmanship

2.7.1 All the equipment shall be of the latest proven design and conform to the best modern practice adopted in the extra high voltage field. The Bidder shall offer only such equipment as guaranteed by him to be satisfactory and suitable for transmission line application of the rated voltage with bundle conductors and will give continued good performance.

2.7.2 The design, manufacturing process and quality control of all the materials shall be such as to achieve requisite factor of safety for maximum working load, highest mobility, elimination of sharp edges and corners, best resistance to corrosion and a good finish.

2.7.3 All ferrous parts shall be hot dip galvanized, after all machining has been completed. Nuts may, however, be tapped (threaded) after galvanising and the threads oiled. Spring washers shall be electro galvanized as per grade 4 of IS-1573-1970. The bolt threads shall be undercut

to take care of increase in diameter due to galvanising. Galvanising shall be done in accordance with IS:2629/IS-1367 (Part-13) and satisfy the tests mentioned in IS-2633. Fasteners shall withstand four dips while spring washers shall withstand three dips. Other galvanized materials shall have a minimum overall coating of Zinc equivalent **to 600 gm/sq.m** and shall be guaranteed to withstand at least six dips each lasting one minute under the standard Preece test for galvanising unless otherwise specified.

2.7.4 The zinc coating shall be perfectly adherent, of uniform thickness, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The zinc used for galvanising shall be of grade Zn.99.95 as per IS:209.

2.7.5 In case of castings, the same shall be free from all internal defects like shrinkage, inclusion, blow holes. cracks etc.

2.7.6 All current carrying parts shall be so designed and manufactured that contact resistance is reduced to minimum and localised heating phenomenon is averted.

2.7.7 No equipment shall have sharp ends or edges, abrasions or projections and shall not cause any damage to the conductor in any way during erection or during continuous operation which would produce high electrical and mechanical stresses in normal working. The design of adjacent metal parts and mating surfaces shall be such as to prevent corrosion of the contact surface and to maintain good electrical contact under all service conditions.

2.7.8 The fasteners shall conform to the requirements of IS:6639. All fasteners and clamps shall have corona free locking arrangement to guard against vibration loosening.

2.8 Compression Markings

Die compression areas shall be clearly marked on each equipment designed for continuous die compressions and shall bear the words 'COMPRESS FIRST' 'suitably inscribed on each equipment where the compression begins. If the equipment is designed for intermittent die compressions, it shall bear the identification marks 'COMPRESSION ZONE' and 'NON-COMPRESSION ZONE' distinctly with arrow marks showing the direction of compression and knurling marks showing the end of the zones. The letters, number and other markings on finished equipment shall be distinct and legible

2.9 Bid Drawings

2.9.1 The Bidder shall furnish detailed dimensioned drawings of the equipments and all component parts. Each drawing shall be identified by a drawing number and Contract number. All drawings shall be neatly arranged. All drafting and lettering shall be legible. The minimum size of lettering shall be 3 mm. All dimensions and dimensional tolerances shall be mentioned in mm.

2.9.2 The drawings shall include

(i) Dimensions and dimensional tolerances
(ii) Material. fabrication details including any weld details and any specified finishes and coatings. Regarding material, designations and reference of standards are to be indicated.
(iii) Catalogue No.
(iv) Marking
(v) Weight of assembly
(vi) Installation instructions
(vii) Design installation torque for the bolt or cap screw
viii) Withstand torque that may be applied to the bolt or cap screw without failure of component parts
(ix) The compression die number with recommended compression pressure.
(x) All other relevant technical details

2.9.3 Placement charts for spacer and damper

2.9.4 The above drawings shall be submitted with all the details as stated above along with the bid document. After the placement of award. the Contractor shall again submit the drawings to the owner for approval. After owner's approval and successful completion of all type tests, more sets of drawings shall be submitted to owner for further distribution and field use .

3.0 G.S. Earth wire Accessories

3.1 General

This portion Specify the details of the technical particulars of the accessories for Galvanized Steel Earth wire.

3.2 **Mid Span Compression Joint**

Mid Span Compression Joint shall be used for joining two lengths of earth wire. The joint shall be made of **mild steel with aluminium encasing**. The steel sleeve should not crack or fail during compression. The Brinnel Hardness of steel should not exceed the value as stipulated in the Standard Technical Particulars. The steel sleeve shall be hot dip galvanized. The aluminium sleeve shall have aluminium of purity not less than 99.5%. Filler aluminium sleeve shall also be provided at the both ends. The joints shall not permit slipping off, damage to or failure of the complete earth wire or any part thereof at a load not less than 95% of the ultimate tensile strength of the earth wire. The joint shall have resistivity less than 75% of resistivity of equivalent length of earth wire. The dimensions and the dimensional tolerances of the joint shall be as stipulated in the Standard Technical Particulars. .

Sr. N	**Item** (mid spa compression join for G.S. Eart wire)	**Dimension before compression**			**Dimension after compression**		
		Length (mm)	Inner dia. (mm)	Outer dia. (mm)	**Length** (mm)	Corner to corner width (mm)	Face to face Width (mm)
1	Aluminium sleeve	400 ± 5	22 ± 0.5	32 ± 0.5	430 (Appro.	29.4 ± 0.5	25 ± 0.5
2	Steel sleeve	230 ± 5	11.5 ± 02	21 ± 0.5	265 (Appro.)	20.2 ± 0.5	17.5 ± 0.5
3	Filler aluminiur sleeve	60 ± 5	11.5 ± 02	21 ± 0.5	-	-	-

3.3 **Vibration Damper**

3.3.1 Vibration dampers of 4R-Stockbridge type with four (4) different frequencies spread within the specified aeolian frequency band-width corresponding to wind speed of 5m/s to 7 m/s shall be used for suspension and tension points on each earth wire in each span to damp out aeolian vibrations as mentioned herein after.

3.3.2 Alternate damping systems or "Dog bone" dampers offering equivalent or better performance also shall be acceptable provided the manufacturer meets the qualifying requirements stipulated in the Specifications. Relevant technical documents to establish the technical suitability of alternate systems shall be furnished by the Bidder along with the bid.

3.3.3 One damper minimum on each side per earth wire at suspension points and two dampers on each side per earth wire at tension points shall be used for ruling design span of 400 meters.

3.3.4 The clamp of the vibration damper shall be made of aluminium alloy. It shall be capable of supporting the damper during installation and prevent damage or chaffing of the earth wire during erection or continued operation. The clamp shall have smooth and permanent grip to keep the damper in position on the earth wire without damaging the strands or causing premature fatigue failure of the earth wire under the clamp. The clamp groove shall be in uniform contact with the earth wire over the entire clamping surface except for the rounded edges. The groove of the clamp body and clamp cap shall be smooth, free from projections, grit or materials which could cause damage to the earth wire when the clamp is installed. Clamping bolts shall be provided with self locking nuts designed to prevent corrosion of the threads or loosening during service.

3.3.5 The messenger cable shall be made of high strength galvanized steel/stainless steel with a minimum strength of 135 Kg/sq.mm. It shall be of preformed and post formed quality in order to prevent subsequent droop of weights and to maintain consistent flexural stiffness of the cable in service. The number of standards in the messenger cable shall be 19. The messenger cable ends shall be suitably and effectively sealed to prevent corrosion.

3.3.6 The damper mass shall be made of hot dip galvanized mild steel/cast iron or a permanent mould cast zinc alloy. All castings shall be free from defects such as cracks, shrinkages, inclusions and blow holes etc. The inside and outside surfaces of the damper masses shall be smooth.

3.3.7 The vibration analysis of the system, with and without damper, dynamic characteristic of the damper as detailed under Annexure-A, shall have to be submitted by the Bidder along with his bid. The technical particulars for vibration analysis and damping design of the system are as follows:-

Sl.o.	Description	Technical particulars
1.	Span length in meters	
i)	Ruling design span	400 meters
ii)	Maximum span	1100 meters
iii)	Minimum span	100 meters
2.	Tensile load in Conductor at temperature of deg. C and still air	As per sag tension calculations.
3.	Maximum permissible dynamic strain	+/- 150 micro strains

3.3.8 The damper placement chart for spans ranging from 100 m to 1100 m shall be submitted by the Bidder. All the placement charts should be duly supported by relevant technical documents.

3.3.9 The damper placement charts shall include the following :

(1) Location of the dampers for various combinations of spans and line tensions clearly indicating number of dampers to be installed per earth wire per span.

(2) Placement distances clearly identifying the extremities between which the distances are to be measured.

(3) Placement recommendation depending upon type of suspension clamps

(4) The influence of mid span compression joints in the placement of dampers.

3.4 **Flexible Copper Bond**

The flexible copper bond shall be circular in cross-section of minimum 34 sq.mm equivalent copper area and not less than 500 mm in length. It shall consist of 259 wires of 0.417 mm dia. tinned copper conductor. It shall be laid up as 7 stranded ropes, each of 37 bunched wires. The tinning shall be as per relevant Indian Standard. Two tinned copper connecting lugs shall be press jointed to either ends of the flexible copper cable. One lug shall be suitable for 12 mm, dia. bolt and the other for 16 mm dia bolt. The complete assembly shall also include one 16 mm dia., 40 mm long HRH MS Bolt hot dip galvanized with nut and lock washer.

3.5 **Suspension Clamp**

3.5.1 At all suspension towers, suitable suspension clamps shall be used to support the required earth wire. The clamps shall be of either free center type and shall provide adequate area of support to the earth wire. The groove of the clamp shall be smooth, finished in an uniform circular or oval shape and shall slope downwards in a smooth curve to avoid edge support and hence to reduce the intensity of bending moment on earth wire.

3.5.2 There shall be no sharp point in the clamps coming in contact with earth wire. There shall not be any displacement in the configuration of the earth wire strands nor shall the strands be unduly stressed in final assembly during working conditions.

3.5.3 The clamping piece and the clamp body shall be clamped by at least two U-bolts lock nut with washer on each of its limbs. Suspension clamps shall be provided with inverted type U-bolts. One limb of the U-bolt shall be long enough to accommodate the lug of the flexible copper bond.

3.5.4 The Contractor shall supply all the components of the suspension assembly including shackles, bolts, nuts, washers, split pin etc. The total drop of the suspension assembly from the center point of the attachment to the center point of the earth wire shall not exceed 150 mm. The design of the assembly shall be such that the direction of run of the earth wire shall be same as that of the conductor.

3.5.5 The complete assembly shall be guaranteed for slip strength of not less than 12 KN and not more than 17 KN . the breaking strength of the assembly shall not be less than 25 kN.

3.6 Tension Clamp

3.6.1 At all tension towers suitable compression type tension clamps shall be used to hold 7/3.66 mm galvanized steel earth wire. Anchor shackle shall be supplied which shall be suitable for attaching the tension clamp to strain plates.

3.6.2 The clamps shall have adequate area of bearing surface to ensure positive electrical and mechanical contact and shall not permit any slip to the earth wire under working tension and vibration conditions. The angle of jumper terminal to be mounted should be 30 deg. with respect to the vertical line.

3.6.3 The clamps shall be made of mild steel with aluminum encasing. The steel should not crack or fail during compression. The Brinnel hardness of steel sleeve shall not exceed 200. The steel sleeve

shall be hot dip galvanized. The aluminum encasing shall have aluminum of purity not less than 99.5%. Filler aluminum sleeve shall also be provided at the end.

3.6.4 The complete assembly shall be so designed as to avoid undue bending in any part of the clamp and shall not produce any hindrance to the movements of the clamps in horizontal or vertical directions.

3.6.5 The slip strength of the assembly shall not be less than 95% of the ultimate strength of the earth wire.

3.6.6 The clamps shall be complete with all the components including anchor shackle, bolts, nuts, washers, split pin, jumper arrangement etc.

3.7 Material and Workmanship

Same as Clause 2.7 of this section

3.8 **Compression Marking**

Same as Clause 2.8 of this section

3.9 **Bid Drawings**

Same as Clause 2.9 of this section

4.0 Standard Technical Particulars

4 (A) Standard Guaranteed Technical Particulars of Hardware Fittings and Accessories for Conductor & Earthwire for 400 kV Transmission Line with twin ACSR MOOSE Conductor and 7/3.66 mm GS Earthwire are furnished below:

4.1	**SUSPENSION HARDWARE FITTINGS FOR TWIN ACSR 'MOOSE' CONDUCTOR**			
Sl	**Description**	**Unit**	**Particulars / Value**	
			Double 'I'	**Single 'I' Pilot**
			AGS clamp	**Envelope clamp**
1.	Maximum magnetic power loss of suspension assembly at sub conductor current of 600 amperes, 50Hz AC	Watt	4	8
2.	Slipping strength of suspension assembly (clamp torque Vs slip curve shall be enclosed)	kN	20-29	
	Ball & socket dimension	mm	20	
3.	Particulars of standard/AGS Standard / AGS preformed armour rod set for suspension assembly			
	a) No. of rods per set	No.	12	NA
	b) Direction of lay		Right Hand	NA
	c) Overall length after fitting on conductor	mm	2235	NA
	d) Diameter of each rod	mm	9.27	NA
	e) Tolerance in			NA
	i) Diameter of each rod	±mm	0.10	NA
	ii) Length of each rod	±mm	25	NA
	iii) Difference of length between the longest and shortest rod in a set	±mm	13	NA
	g) Type of Aluminium alloy used for manufacture of PA rod set		6061/ 65032	NA
	h) UTS of each rod	Kg/mm^2 (Min)	35	NA
4.	**Particulars of Elastomer (For AGS Clamp only)**			
	a) Type of elastomer		Chloroprene / Neoprene	NA
	b) Shore hardness of elastomer		65 - 80	NA
	c) Temperature range for which elastomer is designed	°C	Upto 85°C	NA
	d) Moulded on insert		Yes	NA
5.	Mechanical Strength of Suspension fitting (excluding suspension clamp)	KN	240	120
6.	Mechanical Strength of suspension clamp.		70 70	70
7.	Purity of Zinc used for galvanising	%	As per IS:209 / IS 13229	
8.	Min. No. of dips in standard preece test the ferrous parts can withstand	No	a) Fasteners : 4 dips of 1 min b) Spring washers : 3 dips of 1 min c) All others : 6 dips of 1 min	
	Anchor, shackle, ball link & shocket eye		Forged steel HSD	
	Nuts, bolts & washers		Galvanized MS	
	Security clip		R- type made of SS/PB	
	Spring washer		Electro Galvanized spring steel	

4.2	**TENSION HARDWARE FITTINGS TWIN ACSR MOOSE CONDUCTOR**			
Sl.	**Description**	**Unit**	**Particulars / Value**	
			Single Tension	**Double Tension**
1.	Mechanical Strength of Tension fittings (excluding dead end clamp)	kN	160	320
2.	Type of Dead End assembly		Compression	
3.	Compression Pressure	MT	100	
4.	Maximum electrical resistance of dead end assembly as a percentage of equivalent length of Conductor	%	75	
5.	Slip strength of dead end assembly	kN	153.2	
6.	Purity of Zinc used for galvanising	%	As per IS:209 / IS 13229	
7.	Min. No. of dips in standard preece test the ferrous parts can withstand.	Nos	a) Fasteners : 4 dips of 1 min b) Spring washers : 3 dips of 1 min c) All others : 6 dips of 1 min	

4.3 Mid span compression Joint for ACSR MOOSE Conductor				
Sl.	**Description**	**Unit**	**Particulars/ Value**	
			Aluminium Sleeve	Steel Sleeve
1.	**Material of Joint**		Aluminium of purity 99.5%	Mild Steel(Fe-410, IS:2062)
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	From 100 to 200	
3.	Weight of Zinc coating for steel sleeve	gm/m^2	610	
4.	**Dimension of sleeve Before compression**		Aluminum sleeve	Steel sleeve
i)	Inside diameter	mm	34.00 ± 0.5	11.10 ± 0.2
ii)	Outside diameter	mm	54.00 ± 1.0	21.00 ± 0.5
iii)	Length	mm	735 ± 5	250 ± 5
5.	**Dimensions of Sleeve after compression**		Aluminum sleeve	Steel sleeve
i)	Outside dimension(Corner to corner)	mm	53.00 ± 0.5	20.20 ± 0.5
ii)	Outside dimension (face to face)	mm	46.00 ± 0.5	17.50 ± 0.5
iii)	Length	mm	785 (approx)	286 (approx)
6.	Slip strength	KN	153.2	
7.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75	
8.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320	
9.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000	

4.4 Repair sleeve for ACSR MOOSE Conductor			
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	**Material**		Aluminium of minimum purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
i)	Inside diameter	mm	34.00 ± 0.5
ii)	Outside diameter	mm	54.00 ± 1.0
iii)	Length	mm	300.00 ± 5.0
3.	**Dimensions of Aluminum Sleeve after compression**		
i)	Outside dimension(Corner to corner)	mm	53.00 ± 0.5
ii)	Outside dimension (face to face)	mm	46.00 ± 0.5
iii)	Length	mm	330.00(Approx.)
4.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
5.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000

4.5 Vibration Damper for ACSR MOOSE CONDUCTOR			
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	Type of Damper		4R-Stockbridge type
	Suitable for conductor size daimeter	mm	31.77
2.	Materials of components		
	a) Damper masses		Cast iron/mild steel/Zinc alloy duly hop dip galvanized
	b) Clamp		Aluminum alloy 4600
	c) Messenger cable		High tensile strength galvanized steel
3.	Number of strands in stranded messenger cable	Nos.	19
4.	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm^2	135
5.	Slip strength of stranded messenger cable (mass pull off)	kN	5
6.	Slipping strength of damper clamp		
	(a) Before fatigue test	kN	2.5
	(b) After fatigue test	kN	2
7.	Resonance frequencies range	Hz	5 to 40
8	Maximum magnetic power loss per vibration damper in watts for 600 Amps, 50 Hz AC	watt	1
9	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
10	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000
11	Minimum fatigue strength of damper in cycle	cycle	10 million cycle
12	Amplitude of fatigue test at the highest resonant frequency	m.m.	+ 1 m.m.
13	Percentage variation in reactance after fatigue test in comparison with that . before fatigue test	%	+/-40 (Maximum)
14	Percentage variation in power dissipation after fatigue test in comparison with that before fatigue test	%	+/-40 (Maximum)

4.6 RIGID SPACER FOR JUMPER FOR ACSR MOOSE CONDUCTOR (TWIN BUNDLE MOOSE)			
Sl	**Description**	**Unit**	**Particulars / Value**
1	**Type of spacer**		**Armour grip type**
2.	Material of components		
	(a) Clamp		Al Alloy IS:4600 or Equivalent
	(b) main Body		Al Alloy 6063/63400
3	Manufacturing process of component parts.		
	a) Clamp		Die- cast
	b) main Body		Aluminum extrusion
4	Maximum ultimate tensile strength of spacer		
	a) Compressive load	KN	14
	b) Tensile load	KN	7
5	Slipping strength of spacer clamp	KN	2.5
6	Maximum magnetic power loss per spacer in watts for 600 Amps, 50 Hz AC	watt	1
7	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
8	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000
9	Elastomer (*if used*)		
	(a) Shore hardness		65 - 80
	(b) Temp. range for which designed	°C	Up to 95°C

4.7 BUNDLE SPACER FOR TWIN ACSR MOOSE CONDUCTOR			
Sl	**Description**	**Unit**	**Particulars / Value**
1	**Type of spacer**		**ARMOUR GRIP TYPE**
2.	Material of components		
	(a) Insert		Al. Alloy IS:6061/65032
	(b) main Body		Al. Alloy IS: 6063/63400/6061/65032
	(c) Retaining rod		Al . Alloy IS:6061/65032
3	Manufacturing process of component parts.		
	(a) Insert		Forged
	(b) main Body		Aluminum extrusion
	(c) Retaining rod		Head treatment during manufacturing
4	**Retaining rod**		
	No of retaining rod used for each spacer	No	8
	Diameter	mm	7.87 $\pm$ 1
	Length	mm	1100
5	Maximum ultimate tensile strength of spacer		
	a) Compressive load	KN	14
	b) Tensile load	KN	7
6	Slipping strength of spacer clamp		
	(a) Before vibration test	KN	2.5
	(b) After vibration test	KN	2
7	Minimum corona Extinction voltage kV	kV	320

	(rms) under dry condition				
8	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000		
9	Elastomer (*if used*)				
	(a) Type		Chloroprene/Neoprene		
	(b) moulded on insert		Yes		
	(c) Shore hardness		65 to 80		
	(d) Temp. range for which designed	°C	Up to 95°C		
	(e) thickness of inser	mm	5		
10	Slipping strength of spacer clamp	kN	**Clamp type**	**Longitudnal Load (KN)**	**Maxm Slip permitted (mm)**
			Metal – Metal Bolted	6.5	1
			Rubber loaded	2.5	2.5
			Preformed rod	2.5	12

4.8 T-connector for ACSR MOOSE Conductor			
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	**Material**		Aluminium of purity 99.5%
2.	**Dimension of Aluminum sleeve Before compression**		
	i) Inside diameter	mm	34.00 ± 0.5
	ii) Outside diameter	mm	54.00 ± 1.0
	iii) Length	mm	400.00 ± 5.0
3.	**Dimensions of Aluminum Sleeve after compression**		
	i) Outside dimension(Corner to corner)	mm	53.00 ± 0.5
	ii) Outside dimension (face to face)	mm	46.00 ± 0.5
4.	Axial tensile strength of welded portion of T-connector	KN	30
5.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare conductor.	%	75
6.	Minimum corona Extinction voltage kV (rms) under dry condition	kV	320
7.	Maximum Radio Interference Voltage at 1 MHz for phase to earth voltage of 305 kV (rms) under dry condition	Micro Volts	1000

4.9 Mid span compression Joint for 7/3.66 mm GS Earthwire				
Sl.	**Description**	**Unit**	**Particulars/ Value**	
			Aluminium / Filler . Sleeve	Steel Sleeve
1.	**Material of Joint**		Aluminium of minimum purity 99.5%	Mild Steel(Fe-410, IS:2062)
2.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	From 100 to 200	
3.	Weight of Zinc coating	gm/m^2	600	

4.	**Dimension of sleeve Before compression**				
			Aluminium Sleeve	Steel Sleeve	Alu filler sleeve
i)	Inside diameter	mm	22.00 ± 0.5	11.50 ± 0.2	11.50 ± 0.2
ii)	Outside diameter	mm	32.00 ± 0.5	21.00 ± 0.5	21.00 ± 0.5
iii)	Length	mm	400 ± 5	230 ± 5	60 ± 5
5.	**Dimensions of Sleeve after compression**				
			Aluminium Sleeve	Steel Sleeve	
i)	Outside dimension(Corner to Corner)	mm	29.40 ± 0.5	20.20 ± 0.5	
ii)	Outside dimension (face to face)	mm	25.00 ± 0.5	17.50 ± 0.5	
iii)	Length	mm	430 (approx)	265 (approx)	
6.	Slip strength	KN	65		
7.	Maximum resistance of the compressed unit expressed, as percentage of the resistance of equivalent length of bare Earthwire	%	75		

4.10	**Flexible Copper Bond for 7/3.66 mm GS Earthwire**		
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	Stranding		37/7/0.417
2.	Cross sectional area	Sq.mm	35.4
3.	Minimum copper equivalent area	Sq.mm	34
4.	Length of copper cable	mm	500 + 5
5.	Material of lugs		Tinned copper
6.	Bolt Size		
	i) Diameter	mm	16
	ii) Length	mm	40

4.11	**Vibration Damper for 7/3.66 mm GS Earthwire**		
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	Type of Damper		4R-Stockbridge type
	Suitable for conductor size daimeter	mm	10.98
2.	Materials of components		
	a) Damper masses		Cast iron/mild steel/Zinc alloy duly hop dip galvanized
	b) Clamp		Aluminum alloy 4600
	c) Messenger cable		High tensile strength galvanized steel
3.	Number of strands in stranded messenger cable	Nos.	19
4.	Minimum ultimate tensile strength of stranded messenger cable	Kg/mm^2	135
5.	Slip strength of stranded messenger cable (mass pull off)	kN	2.5
6.	Slipping strength of damper clamp		
	(a) Before fatigue test	kN	2.5
	(b) After fatigue test	kN	2
7.	Resonance frequencies range	Hz	10 to 60
8.	Percentage variation in reactance after fatigue test in comparison with that . before fatigue test	%	+/-40 (Maximum)
9.	Percentage variation in power dissipation	%	+/-40 (Maximum)

	after fatigue test in comparison with that before fatigue test		

4.12	**Suspension Clamp for 7/3.66 mm GS Earthwire**		
Sl.	**Description**	**Unit**	**Particulars/ Value**
1.	**Material of components**		
	(a) Shackle		Forged Steel
	(b) Clamp Body & Keeper		Malleable cast iron / SGI
	(c) U- Bolt		Mild Steel
2.	Total Drop (Maximum)	mm	150
3.	Breaking Strength (Minimum)	kN	25
4.	Slipping Strength	kN	12 to 17

4.13	**Tension Clamp for 7/3.66 mm GS Earthwire**				
Sl.	**Description**	**Unit**	**Particulars/ Value**		
1.	**Material of components**				
	(i) Anchor Shackle		Forged Steel		
	(ii) Compression Clamp				
	a) Steel Sleeve		Mild Steel		
	b) Aluminium sleeve		Aluminium of purity 99.5%		
	c) Aluminium Filler sleeve		Aluminium of purity 99.5%		
3.	Range of Hardness of the steel sleeve (Brinnel hardness)	BHN	120-200		
4.	**Dimension of sleeve Before compression**				
			Aluminium Sleeve	Steel Sleeve	Alu filler sleeve
i)	Inside diameter	mm	22.00 ± 0.5	11.50 ± 0.2	11.50 ± 0.2
ii)	Outside diameter	mm	30.00 ± 0.5	21.00 ± 0.5	21.00 ± 0.5
iii)	Length	mm	245 ± 5	205 ± 5	25 .0
5.	**Dimensions of Sleeve after compression**				
			Aluminium Sleeve	Steel Sleeve	
i)	Outside dimension(Corner to Corner)	mm	29.40 ± 0.5	20.20 ± 0.5	
ii)	Outside dimension (face to face)	mm	25.00 ± 0.5	17.50 ± 0.5	
6.	Slip strength	KN	65		
7.	Minimum Breaking strength of assembly (excluding clamp)	KN	70		
8.	Compression Pressure	Ton	100		

4 (A) Standard Guaranteed Technical Particulars of Hardware Fittings and Accessories for Conductor & Earthwire for 400 kV Transmission Line with twin ACSR MOOSE Conductor and 7/3.66 mm GS Earthwire are furnished below:

4(A) .1 **SINGLE SUSPENSION HARDWARE FOR PANTHER, ZEBRA ACSR CONDUCTOR WITH PREFORMED ARMOUR RODS**

S.No.	**ITEM**	**PANTHER**	**ZEBRA**
1.	Type of clamp	AGS type	AGS type
2.	Ball & socket dimension	16mm	16mm
3.	Suitable for conductor size	ACSR Panther with amour rods	ACSR Zebra with amour rods
4.	Breaking strength	7000 kg.	7000 kg.
5	Tension clamp & keeper	Alu.alloy GDC	Alu.alloy GDC

6.	Anchor. Shackle. Ball Link & socket Eye	Forged steel HDG	Forged steel HDG
7.	Bolts, nuts & washers	Galvanised MS	Galvanised MS
8.	Security clip	R type made of SS/PB	R type made of SS/PB
9,	Spring Washer	Electro galvanised spring steel	Electro galvanised spring steel
10.	Galvanising standard	IS:2633	IS:2633
11.	Standard reference	2486 part-I,II & III	2486 part-I,II & III
12.	Arcing Horn	MS Flat 25x6	Steel tube type
13.	Preformed Armour rods	As per standard in No. & size.	As per standard in No. & size.

The 132 / 220 KV double suspension hardware set suitable for Panther / Zebra conductor shall consist of following items:-

S.No	ITEM	Qty / Set	Material
1	Ball Hook	1	Forged Steel
2	Socket Clevis	3	Forged Steel
3	Yoke Plate	2	Mild Steel
4	Ball Clevis	2	Forged Steel
5	Arcing Horn	1	M.S. Flat / Steel tube
6	Clevis eye	1	Forged Steel
7	Suspension clamp AGS type	1	Aluminium Alloy
8	Pre formed armour rod	1 Set	Aluminium Alloy

AT TENSION LOCATIONS : 14 disc single tension string with 160 KN E&MS disc insulators will be used with compression type dead end clamp.

4(A) 2 SINGLE TENSION HARDWARE COMPRESSION TYPE SUITABLE FOR PANTHER, ZEBRA & EARTHWIRE :-

Single tension string Hardware shall comprise of one `D' Shackle, one Ball Link, one Forged Steel Socket, Socket Clevis Horn holder, one line side Arcing Horn and one Tension Clamp of compression type having before and after compression dimensions strictly as mentioned below:-

S.NO	ITEM	ZEBRA	EARTHWIRE
1.	Type of clamp	Compression type	Compression type
2.	Suitable for conductor size	ACSR Zebra	7/3.66mm Groundwire
3.	Breaking strength	16500 kg.	7000 kg,
4.	Tension clamp jumper	Ex-Alu.alloy	Forged steel
5.	Steel sleeve, anchor shackle, ball link socket eve	Forged steel HDG	Forged steel HDG
6.	Bolts, nuts and washers	Galvanised MS	Galvanised MS
7.	Security clip	'R' type made of SS/PB	--
8.	Spring washer	Electro galvanised spring wheel	Electro galvanised spring wheel
9.	Galvanised Standard	IS:2633	IS:2633
10.	Standard reference	2486, part – I,II & III	2486, part – I,II & III
11.	Arcing Horn	Steel tube type	--
12.	Standard Length of hardware set without pin and D shackle arrangement	539 mm	285 mm
13.	Diameter of aluminium tube before compression: a) Inner dimension	31mm	--

	b) Outer dimension	48 mm	
14.	Diameter of aluminium tube after compression:- a) Across Flat b) Across Corner	 40 mm 46 mm	
15.	Diameter of steel tube before compression:- a) Inner dimension b) Outer dimension	 9.95 mm 20.8 mm	 11.5 mm 21.2 mm
16.	Diameter of steel tube after compression. a) Across Flat b) Across Corner	 17.5 mm 20.2 mm	 17.5 mm 20.2 mm
17.	Length of sleeve (Steel/Al.) a) Before compression b) After compression	 241/711 2/763	 230 262
18.	Conductivity	Equal to ACSR Zebra	Equal to groundwire
19.	Weight of hardware	As per ISS	As per ISS

In the case of railway / road / river / other transmission line crossing, double suspension / double tension insulators strings will be used with their hardwares and fittings.

4(A) .3 **DOUBLE TENSION HARDWARE FOR PANTHER & ZEBRA ACSR CONDUCTOR COMPRESSION TYPE:-**

BALL & SOCKET dimensions:- The ball and socket dimensions of double tension hardware for Panther ACSR Conductor which will be used with 90KN disc insulator & for Zebra ACSR Conductor with 160 KN disc insulator shall conform to dimension 16mm B& 20 mm B.

The double tension string of 132 KV and 220 KV line shall have ultimate breaking strength of not less than 9100 kg and 16500 kg respectively. Individual items of the fittings which will be subjected to tension shall also have ultimate breaking strength of not less than 9100 kg and 16500 kg. The compression clamp shall have a minimum slipping strength of not less than 95% of breaking strength of conductor with which it is used.

CONDUCTIVITY:- The entire fitting or part thereof shall have the conductivity equivalent to length of conductor.

All the ferrous parts should be hot dip galvanised as per IS 2633 and nut bolt should be galvanised as per IS 5358.

132 KV / 220 KV DOUBLE TENSION HARDWARE for ACSR Panther and Zebra shall comprise of following items:-

S.No	**ITEM**	**Qty / Set**	**Material**
1	"U" clevis	2	Forged Steel
2	Chain Link	1	Forged Steel
3	Yoke Plate	2	M.S. Plate
4	Ball Clevis	2	Forged Steel
5	Socket Clevis	2	Forged Steel
6	Clevis eye	1	Forged Steel
7	Arcing Horn	1	M.S. Flat / Steel tube
8	Compression tension clamp assembly complete	1	Extruded Al. & Forged Steel.

4(A) .4 **CONDUCTOR ACCESSORIES**:

(A) Armour Grip Suspension Clamp (AGS):

AGS fitting shall consist of 2 Neoprene Halves, a set of Helical rods made of Aluminium alloy, two Aluminium halves casting having inner profile matching with the profile of the Armour rod cage and jointed by supporting strap made of Aluminium alloy.

The Bidder should give complete data on the reduction of the dynamic stresses of the Conductor at the point of AGS support compared to that of bare clamp used with preformed types of Armour rods.
The Bidder will be required to prove the comparative performance in regard to the dynamic flexural stress pattern on the vibrating Conductor on the tensioned span with actual tests on the AGS unit compared to the normal bare clamp with Armour rods. Suitable curves should be furnished along with the bid for the same and also actual reports on the stress/ strain determinations. The Bidder should give the guaranteed value of the power loss of the AGS units offered by them supported by a test certificate of any reputed laboratory of the country. Suitable curves should be furnished along with the bid for the power loss due to AGS unit as well as with the conventional envelope type of Suspension Clamps.

The housing supports and housing straps should provide positive stop closure. AGS unit should have low rotational inertia, strut action of the Armour Cage, resilient cushioning of the neoprene insert, immunity from high compressive and flexural stress and wide area support. Manufacturer is required to guarantee minimum fatigue life of the AGS units and this would be established under actual tests on tensioned Conductor span. The manufacturer is required to guarantee minimum 40 years life of the complete AGS units including Neoprene cushioning and this should be established under actual test on a tensioned Conductor span.

The rubber used with AGS unit must be capable of withstanding desired long out-door performance including the variation of temperature from 0^0C to 75^0C. The Bidder will have to provide certificate from reputed manufacturers that the rubber being supplied by them is suitable for AGS fitting and must have tensile strength of 2000 PSI and minimum ultimate elongation 300%.

The helical retaining rods required for AGS assembly shall be made of Aluminium alloy of HE 20 grade as per IS-6051/19 or equivalent International Standard duly heat treated and shall be suitable to wrap a desired size of Conductor. The tensile strength of the retaining rod material should not be less than 50,000 PSI and the electrical conductivity should not be less than 40% (IACS). The minimum slipping strength of the complete fitting shall not be less than 15% and more than 20% of the UTS of the cable on which it is to be used. The Clamp shall be in 2 parts made of Aluminium and will have inner profile matching with the profile of Armour rod. This Clamp should be made by drop forging process. AGS assembly should be provided with the forged steel socket eye to match with the suspension string and should have UTS not less than 7,000 Kgs.

IT IS ESSENTIAL FOR THE BIDDER TO HAVE SUITABLE HEAT TREATMENT FACILITIES FOR ALUMINIUM ALLOY WIRES IN THE ARMOUR GRIP SUSPENSION UNITS. FORMED ROD BASED ITEMS WILL NOT BE ACCEPTABLE FROM MANUFACTURERS WHO DO NOT HAVE NECESSARY TECHNOLOGY FOR DEVELOPMENT OF ADEQUATE RESILIENCE, ELONGATION UTS AND TWIST TEST FACILITIES BACKED WITH PROPER HEAT TREATMENT SYSTEMS. SUCH OFFERS MAY BE TREATED AS NON-RESPONSIVE.
(B) The AGS Preformed Armour rods set suitable for ACSR Zebra/Panther conductor(as the case may be) shall be used to minimize the stress developed in a conductor due to different static and dynamic loads because of vibration due to wind, slipping of conductor from suspension clamp as a result of unbalance conductor tension in adjacent span and broken wire

condition. It shall be made of Aluminium alloy of HE 20 grade as per IS-6051/19 duly heat-treated. The aluminium alloy wires (pre heat treated) for manufacturing of Armour rods can also be used, however bidder should submit the test certificates in support of their claim for using pre heat-treated wires. It shall also withstand power arcs; chafing and abrasion from suspension clamp and localized heating effects due to resistance losses of the conductor.

The pitch length of the rods shall be determined by the supplier but shall be less than that of the outer layer of ACSR conductor and the same shall be accurately controlled to maintain uniformity and consistently reproducible characteristics wholly independent of the skill of lineman.

The preformed armour rod sets shall have right hand lay and the inside diameter of the helices shall be less than the outside diameter of the conductor to grip the same tightly. The surface of the armour rod when fitted on the conductor shall be smooth and free from projections, cuts and abrasions etc.

The length of each rod shall be as per drawing enclosed. The tolerance in length of each rod shall be +/- 25mm. The tolerance in length of the rods in completed sets should be within 13 mm between the longest and shortest rod. The ends of the armour rod shall be parrot billed.

The number of armour rods in each set shall be 11/12. The each rod shall be marked in the middle with paint for easy applications on the line.

The armour rod shall not loose their resilience even after five applications. The conductivity of each rod of the set shall not be less than 40% of the conductivity of International Annealed Copper Standard (IACS). The minimum tensile strength of armour rod should be 35 Kg per sq.mm.

Mid span joints, Repair Sleeves, Flexible Copper Bond etc. should be used as per transmission line practice & latest revision of I.S.S.

(C) STANDARD PARTICULARS FOR MID SPAN JOINTS:-

S.No	**Description**	**Panther ACSR**	**Zebra ACSR**	**Earthwire**
1	Type of hardware	Compression	Compression	Compression
2	Breaking strength	100% of UTS of conductor	100% of UTS of conductor	100% of UTS of earthwire
3	Conductivity	Equal to ACSR Panther	Equal to ACSR zebra	Equal to earthwire
4	Dimensions before & after compression			
	Aluminium Joint :- a) Overall Dia before compression (i) Inner dimension (ii) Outer dimension b) Dimension after compression:- (i) Across Flat (ii) Across corner	 23 38 32 37	 31 48 40 46	 - -
	Steel Joint :- a) Overall Dia before compression (i) Inner dimension (ii) Outer	 9.35 18	 9.95 20.8	 11.5 21

	dimension b) Dimension after compression:- (i) Across Flat (ii) Across corner	 15.1 17.4	 17.5 20.2	 17.5 20.2
5	The material from which following is made of			
	Al. Sleeve	Extruded 99.5% pure Aluminium	Extruded 99.5% pure Aluminium	-
	Steel Sleeve	HDG Steel	HDG Steel	HDG Steel
6	Standard weight	As per IS with tolerance	As per IS with tolerance	As per IS with tolerance
7	Length of aluminium sleeves before and after compression m.m. Length of steel sleeves before and after compression m.m.	610 / 660 mm 203 /233 mm	711 /775 mm 241 / 280	-
8	Reference	IS 2121	IS 2121	-

(D) STANDARD PARTICULARS OF REPAIR SLEEVES OF PANTHER ZEBRA AND EARTHWIRE

S.No	**Description**	**Zebra ACSR**	**Earthwire**
1	Breaking strength of cable with sleeve compressed	100% of UTS	100% of UTS
2	Conductivity of cable with sleeve compressed	Equal to conductor	Equal to earthwire
3	Dimensions before and after compression (flat to flat).	48 / 40 mm	20.8 / 17.5 mm
4	Length of sleeve before & after compression	279/310	254/280
5	The material from which sleeve is made	Extruded Aluminium	HDG Steel
6	Weight of repair sleeve	0.60 kg	

(E) VIBRATION DAMPER FOR PANTHER, ZEBRA & EARTHWIRE :-

Vibration dampers (4-R type) shall be used for Conductors & Groundwires.

S.No	**Item**	**Zebra**	**Earthwire**
1	Type	4 – R type	4 – R type
2	Suitable for conductor size	28.62 mm	10.98 mm
3	Material used for clamp	Alu. Alloy GDC as per IS 617	Alu. Alloy GDC as per IS 617
4	Messenger table	High tensile steel stranded galvanised wire	High tensile steel stranded galvanised wire
5	Damper weights	5.0 kg	1.8 kg.

6	Slipping strength	500 Kg	500 Kg
7	Natural frequency of damper	9.2, 15.8, 26.6, 36.8 Hz.	14.3, 20.4, 27, 33.9, 42.6 Hz.
8	No. Of clamps required per span length of 250M, 300M, 350M, 400M, 300 M & 500 M	Upto 400 M, 2 dampers per span; and upto 500 M, 4 dampers per span	Upto 400 M, 2 dampers per span; and upto 500 M, 4 dampers per span
9	Minimum fatigue strength of damper in cycle	10 million cycle	10 million cycle
10	Amplitude of fatigue test at the highest resonant frequency	+ 1 m.m.	+ 1 m.m.
11	Slip strength of clamp	500 kg	250 kg
12	Clamping torque	8 kg-mtr	4 kg-mtr
13	Maximum dynamic strain on the conductor with the damper at clamping points	Less than 150 micro strains	Less than 150 micro strains
14	Standard to which material will be manufactured and tested	IS 98 / 1980	IS 98 / 1980
15	Magnetic power loss in watts	Below 1 watt per damper	Below 1 watt per damper

MISCELLANEOUS ITEMS: Enamelled number plates, phase plates and danger board, bolts and nuts, spring washers, pack washers and other tower accessories like 'D" shackle, hanger and fasteners shall be provided with the tower gantry. Drawing of Anti-climbing devices (including barbed wire) for Gantry shall be submitted by contractor for approval of CSPTCL. No extra payment will be made for this.

5.0	**Tests and Standards**
5.1	**Type Tests**
5.1.1	**On the complete Disc Insulator String with Hardware Fittings**
	(a) Power frequency voltage withstand test with corona control rings/grading ring and arcing horns under wet condition, Switching surge voltage withstand test under wet condition ,Impulse voltage withstand test under dry condition, Impulse voltage flashover test under dry condition **: As per IEC:383** (b)Voltage distribution test, Corona and RIV test under dry condition, Mechanical Strength test , Vibration test, Power Arc Test : **As per Annexure-A**
5.1.2	**On Suspension Hardware Fitting only**
	Magnetic power loss test for suspension assembly, Clamp slip strength Vs torque test for suspension clamp, Mechanical strength Test, Ozone Test on elastomer: **As per Annexure-A**
5.1.3	**On Tension Hardware Fitting only**
	(a) Electrical resistance test for dead end Assembly, Heating cycle test for for dead end Assembly, Slip strength test for dead end assembly: **As per Annexure-A**
	(b)Mechanical strength test: : **As per Annexure-A**

5.1.4	**Mid Span Compression Joint for Conductor and Earthwire**
	(a) Electrical resistance test, Heating cycle test **:As per IS:2121 (Part-II)**
	(b)Chemical analysis of materials , Slip strength test, Corona extinction voltage test (dry), Radio interference voltage test (dry**): As per Annexure-A**
	Note: Heating cycle test Tests , Corona extinction voltage test (dry), Radio interference voltage test (dry**)** are not applicable for Mid Span Compression Joints for earthwire.
5.1.5	**Repair Sleeve for Conductor**
	Chemical analysis of materials, Corona extinction voltage test (dry), Radio interference voltage test (dry**): As per Annexure-A**
5.1.6	**T-Connector for Conductor**
	(a) Chemical analysis of materials, Axial tensile load test on welded portion, Corona extinction voltage test (dry), Radio interference voltage test (dry**): As per Annexure-A**
	(b)Electrical resistance test, Heating cycle test**:As per IS:2121 (Part-II), Clause 6.5 & 6.6**
5.1.7	**Flexible Copper Bond**
	Slip strength test **: As per Annexure-A**
5.1.8	**Vibration Damper for Conductor and Earthwire**
	(a) Chemical analysis of materials, Dynamic characteristics test , Vibration analysis, Clamp slip test, Fatigue tests, Magnetic power loss test, Corona extinction voltage test (dry), Radio interference voltage test (dry**): As per Annexure-A**
	(B)Damper efficiency test : **As per IS:9708**
	Note: , Corona extinction voltage test (dry), Radio interference voltage test (dry & Damper efficiency test are not applicable for Vibration Damper for earthwire.
5.1.9	**Bundle Spacer for Line**
	Chemical analysis of materials, Clamp slip test, Vibration test (Vertical Vibration , Longitudinal Vibration, Sub span oscillation), Magnetic power loss test (if applicable), Tension-compression Test, Corona extinction voltage test (dry), Radio interference voltage test (dry), Ozone test**) : As per Annexure-A**
5.1.1	**Rigid Spacer for jumper (For Quad & twin bundle conductor line)**
	Chemical analysis of materials, Clamp slip test, Magnetic power loss test (if applicable) Tension-compression Test, Corona extinction voltage test (dry), Radio interference voltage test (dry) **: As per Annexure-A**
5.1.1	**On Earthwire Suspension clamp Assembly**
	Chemical analysis of materials, Clamp slip strength Vs torque test for suspension clamp, Mechanical strength Test **: As per Annexure-A**
5.1.1	**On Earthwire Tension clamp Assembly**
	Chemical analysis of materials, Mechanical strength test (excluding clamp), Slip strength test for tension assembly, Electrical resistance test for tension clamp **: As per Annexure-A**

5.1.13 All the type test given in 5.1.1 above shall be conducted on Single 'I' suspension and Double Tension insulator string along with hardware fittings as applicable. The test specified given under Clause No. 5.1.1 except Vibration test, Power Arc Test shall be conducted on Single suspension Pilot insulator string and Single Tension insulator string along with hardware fittings:-

5.1.14 Type tests specified above shall not be required to be carried out if a valid test certificate is available for a similar design, i.e., tests conducted earlier should have been conducted in accredited laboratory (accredited based on ISO/IEC guide 25/17025 or EN 45001 by the National Accreditation body of the country where laboratory is located) or witnessed by the representative (s) of OWNER or Utility. The test reports submitted shall be for the tests conducted within the last 5 (five) years prior to the date of Bid opening.

In case the tests have been conducted earlier than the above stipulated period or in the event of any discrepancy in the test report (i.e., any test report not applicable due to any design / manufacturing change including substitution of components or due to non compliance with the requirement stipulated in the Technical Specification) the tests shall be conducted by the Contractor at no extra cost to the Owner.

5.2	**Acceptance Tests**
5.2.1	**On Both Suspension and Tension Hardware Fittings**
	Visual Examination, Verification of dimensions, Galvanising/Electroplating test : **As per IS:2486-(Part-I)**
	Mechanical strength test of each component (excluding corona control rings grading ring and arcing horn), Mechanical Strength test of welded joint, Chemical analysis, hardness tests, grain size, inclusion rating & magnetic paricle inspection for forgings/castings **: As per Annexure-A** Mechanical strength test for corona control rings/ grading ring and arcing horn: A**s per BS:3288-(part-I)**
	Test on locking device for ball and socket coupling : A**s per IEC:372 (2)**
5.2.2	**On Suspension Hardware Fittings only**
	Clamp Slip strength Vs Torque test for suspension clamp, Shore hardness test of elastomer cushion for AG suspension clamp : As per Annexure-A
	Bend test for armour rod set, Resilience test for armour rod set, Conductivity test for armour rods set: As per IS:2121(Part-I), Clause 7.5,7,10 & 7.11
5.2.3	**On Tension Hardware Fittings only**
	Slip strength test for dead end assembly : As per IS:2486 (Part-I) Clause 5.4
5.2.4	**On Mid Span Compression Joint for Conductor and Earthwire**
	Visual examination and dimensional verification : As per IS:2121 (Part-II), Clause 6.2, 6.3 7 6.7
	Galvanising test, Hardness test: As per Annexure-B
5.2.5	**T-Connector for Conductor**
	Visual examination and dimensional verification : As per IS:2121 (Part-II)
	Axial tensile load test for welded portion : As per Annexure-A
5.2.6	**Repair Sleeve for Conductor**
	Visual examination and dimensional verification : As per IS:2121(Part-II) Clause 6.2, 6.3
5.2.7	**Flexible Copper Bond**
	Visual examination and dimensional verification : As per IS:2121(Part-II) Clause 6.2, 6.3
	Slip strength test : As per annexure-A
5.2.8	**Vibration Damper for Conductor and Earthwire**
	Visual examination and dimensional verification : As per IS:2121(Part-II) Clause 6.2, 6.3 7 6.7
	Galvanising test, Verification of resonance frequencies, Clamp slip test, Clamp bolt torque test, Strength of the messenger cable, Mass pull off test, Dynamic characteristics test : As per Annexure-B
5.2.9	**Bundle Spacer for line / Rigid spacer for Jumper**
	Visual examination and dimensional verification : As per IS:2121(Part-II) Clause 6.2, 6.3 7 6.7
	Galvanising test, Movement test (except for spacer jumpers), Clamp slip test , Clamp bolt torque test, Compression-tension test, Assembly torque test, Hardness test for elastomer , UTS of straning rod(if applicable) : As per Annexure-B
5.2.10	**Earthwire Tension Clamp Assembly**
	Visual examination and dimensional verification : As per IS:2121(Part-II)
	Galvanising test, Slip strength test for tension clamp, Mechanical strength test on each component (excluding clamp, Hardness test : As per Annexure-A
5.2.11	**Earthwire Suspension Clamp Assembly**
	Visual examination and dimensional verification : As per IS:2121(Part-II)
	Galvanising test, Clamp slip strength test, Mechanical strength test on each component (excluding clamp) : As per Annexure-A
5.3	**Routine Tests**
5.3.1	**For Hardware Fittings**

	a)	Visual examination	IS:2486-(Part-I)
	b)	Proof Load Test	: As per Annexure-A
5.3.1	**For conductor and earthwire accessories**		
	a)	Visual examination and dimensional verification	: As per IS:2121(Part-II) Clause 6.2, 6.3 7 6.7
5.4	**Tests During Manufacture on all components as applicable**		
	a)	Chemical analysis of Zinc used for galvanising	IS:2486-(Part-I)
	b)	Chemical analysis mechanical metallographic test and magnetic particle inspection for malleable castings	: As per Annexure-A
	c)	Chemical analysis, hardness tests and magnetic particle inspection for forging	: As per Annexure-A

5.5 Testing Expenses

5.5.1 All testing shall be arranged by the contractor **at no extra cost to the Owner**. No payment shall be made by the CSPTCL in the account of testing for the type test, acceptance test, routine test, etc. to the contractor.

5.5.2 For type tests which involve the tests on the complete insulator string with hardware fittings, the Contractor of hardware fittings shall supply the necessary number of sets of hardware fittings at the place of testing free of cost.

5.5.3 In case of failure in any type test, the Bidder whose material has failed is either required to modify the design of the material & successfully carryout all the type tests as has been detailed out in Clause 5.1 of this specification or to repeat that particular type test at least three times successfully at his own expenses. In case of failure of the complete string in any type test, the manufacturer whose product has failed in the test shall get the test repeated at his cost.

5.5.4 The entire cost of testing for type test, acceptance and routine tests and tests during manufacture specified herein shall be treated as included in the quoted Price.

5.5.5 In case of failure in any type test, repeat type tests are required to be conducted, then, all the expenses for deputation of Owner's representative/ Inspector deputation or ₹ 5000.00 whichever is higher shall be deducted from the contract price. Also if on receipt of the Contractor's notice of testing, the Owner's representative/Inspector does not find 'material to be ready for testing the expenses incurred by the Owner for deputation or ₹ 5000.00 whichever is higher shall be deducted from contract price.

5.6 **Sample Batch For Type Testing**

5.6.1 The Contractor shall offer material for sample selection for type testing only after getting Quality Assurance Programme approved by the Owner. The Contractor shall offer at least three times the quantity of materials required for conducting all the type tests for sample selection. The sample for type testing will be manufactured strictly in accordance with the Quality Assurance Programme approved by the Owner.

5.6.2 Before sample selection for type testing the Contractor shall be required to conduct all the acceptance tests successfully in presence of Owner's representative.

5.7 **Inspection**

5.7.1 The Owner's representative shall at all times be entitled to have access to the works and all places of manufacture, where the material and/or its component parts shall be manufactured and the representatives shall have full facilities for unrestricted inspection of the Contractor's, sub-Contractor's works raw materials. manufacturer's of all the material and for conducting necessary tests as detailed herein.

5.7.2 The material for final inspection shall be offered by the Contractor only under packed condition as detailed in clause 5.8 of this part of the Specification. The engineer shall select samples at random from the packed lot for carrying out acceptance tests.

5.7.3 The Contractor shall keep the Owner informed in advance of the time of starting and of the progress of manufacture of material in its various stages so that arrangements could be made for inspection.

5.7.4 The acceptance of any quantity of material shall in no way relieve the Contractor of his responsibility for meeting all the requirements of the Specification, and shall not prevent subsequent rejection, if such material are later found to be defective

5.8 **Packing and Marking**

5.8.1 All material shall be packed in strong and weather resistant wooden cases/crates. The gross weight of the packing shall not normally exceed 200 Kg to avoid handling problems.

5.8.2 The packing shall be of sufficient strength to withstand rough handling during transit, storage at site and subsequent handling in the field.

5.8.3 Suitable cushioning, protective padding, dunnage or spacers shall be provided to prevent damage or deformation during transit and handling.

58.4 Bolts, nuts, washers, cotter pins, security clips and split pins etc. shall be packed duly installed and assembled with the respective parts and suitable measures shall be used to prevent their loss.

5.8.5 Each component part shall be legibly and indelibly marked with trade mark of the manufacturer.

5.8.6 All the packing cases shall be marked legibly and correctly so as to ensure safe arrival at their destination and to avoid the possibility of goods being lost or wrongly despatched on account of faulty packing and faulty or illegible markings. Each wooden case/crate shall have all the markings stenciled on it in indelible ink.

5.9 **Standards**

5.9.1 The Hardware fittings; conductor and earth wire accessories shall conform to the following Indian/International Standards which shall mean latest revisions, with amendments/ changes adopted and published, unless specifically stated otherwise in the Specification.

5.9.2 In the event of the supply of hardware fittings; conductor and earth wire accessories conforming to standards other than specified, the Bidder shall confirm in his bid that these standards are equivalent to those specified. In case of award, salient features of comparison between the Standards proposed by the Contractor and those specified in this document will be provided by the Contractor to establish their equivalence.

Sl.	**Indian Standard**	**Title**	**International Standard**
1.	IS: 209-1992	Specification for zinc	BS:3436-1986
2.	IS:398-1992 Part-V	Aluminum Conductor Galvanized Steel- Reinforced For Extra High Voltage (400 KV) and above	IEC:1089-1991 BS:215-1970
3.	IS 1573	Electroplated Coating of Zinc on iron and Steel	
4.	IS : 2121 (Part-II)	Specification for Conductor and Earthwire Accessories for Overhead Power lines: Mid-span Joints and Repair Sleeves for Conductors	
5.	IS:2486 (Part-I)	Specification for Insulator Fittings for Overhead power Lines with Nominal Voltage greater than 1000 V: General Requirements and Tests	
6.	IS:2629	Recommended Practice for Hot Dip Galvanising of Iron and Steel	
7.	IS:2633	Method of Testing Uniformity of Coating on Zinc Coated Articles	
8.		Ozone test on Elastomer	ASTM- D1 171
9.		Tests on insulators of Ceramic material or glass for overhead lines with a nominal voltage greater than 1000V	IEC:383-1993
10.	IS:4826	Galvanized Coating on Round Steel Wires	ASTM A472-729 BS:443-1969
11.	IS:6745	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles	BS:433 ISO : 1460 (E)
12.	IS:8263	Method of Radio Interference Tests on High Voltage Insulators	IEC:437 NEMA:107 CISPR
13.	IS:6639	Hexagonal Bolts for Steel Structures	ISO/R-272
14.	IS:9708	Specification for Stock Bridge Vibration Dampers for Overhead Power Lines	
15.	IS:10162	Specification for Spacers Dampers for Twin Horizontal Bundle Conductors	

6. ANNEXURE - A

1.0 **Tests on Complete Strings with Hardware Fittings**

1.1 **Voltage Distribution Test (For Insulator String with Disc Insulators)**

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed following percentage value for different voltage level lines:-

SL. NO.	VOLTAGE LEVEL OF LINE	SUSPENSION STRING	TENSION STRING
1.	400 kV	9.0 %	10.0 %
2.	220 kV		

1.2 Corona Extinction Voltage Test (Dry)

The sample assembly when subjected to power frequency voltage shall have a corona Extinction voltage, line to ground under dry condition shall not be less than following value for different voltage level lines. . There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results; shall be accordingly corrected with suitable correction factor as stipulated in IEC:60383.

SL. NO.	VOLTAGE LEVEL OF LINE	MINIMUM CORONA EXTINCTION VOLTAGE
1.	400 kV	320 KV line to ground
2.	220 kV	

1.4 **RIV Test (Dry)**

Under the conditions as specified under (1.2) above, the insulator string along with complete hardware fittings shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305 kV line to ground under dry condition for 400 kV line. The test procedure shall be in accordance with IS:8263/IEC:437.

1.5 **Mechanical Strength Test**

1.6 **Mechanical Strength Test (for line up to 400 kV voltage level only)**

The complete insulator string along with its hardware fitting excluding arcing horn, corona control ring, grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

1.7 **Vibration Test**

The suspension string shall be tested in suspension mode, and tension string in tension mode itself in laboratory span of minimum 30 meters. In the case of suspension string a load equal to 600 kg shall be applied along the axis of the suspension string by means of turn buckle. The insulator string along with hardware fittings and two/ four sub conductors each tensioned at 43 KN in case of ACSR Moose shall be secured with clamp

SL. NO.	VOLTAGE LEVEL OF LINE	NAME OF CONDUCTOR	NO. OF SUBCOND-UCTOR	TENSION OF EACH SUB-CONDUCTOR
1.	400 kV	ACSR MOOSE	2	43 KN
2.	220 kV	ACSR Zebra	1	

The system shall be suitable to maintain constant tension on each sub-conductors throughout the duration of the test. Vibration dampers shall not be used on the test span. Both the sub-conductors shall be vertically vibrated simultaneously at one of the resonance frequencies of the insulators string (more than 10 Hz) by means of vibration inducing equipment. The peak to peak displacement in mm of vibration at the antinode point nearest to the string shall be measured and the same shall not be less than $1000/f^{18}$ where f is the frequency of vibration in cycles/sec. The insulator string shall be vibrated for not less than 10 million cycles without any failure. After the test the disc insulators shall be examined for looseness of pins and cap or any crack in the cement. The hardware shall be examined for looseness, fatigue failure and

mechanical strength test. There shall be no deterioration of properties of hardware components and disc insulators after the vibration test. The disc insulators shall be subjected to the following, tests as per relevant standards :

Sl.	**Test**	**Percentage of Disc insulator units to be tested**
a)	Temperature cycle test followed by mechanical performance test	60
b)	Puncture test/steep wave front test (Only for glass insulators)	40

1.7 **Power Arc test (for 400 kV line only)**

This test shall be performed on the complete string in accordance with IEC Technical Report IEC : 61467-1997 with the following test series :

Test circuit	**Short circuit current**	**Number and duration of test**
B	$I_n = I_{sys} = 40$ KA	Two of $t_n = 0.2$s and one of $t_n = 0.5$s

The acceptance criteria after the completion of test series shall be following.

a) Insulator separation not permitted.

b) Burning/melting of metal components, breaking of insulator sheds, glaze removal are permitted.

c) The complete insulator string along with its hardware fittings including arcing horn, corona control ring/grading ring shall withstand 80% of UTS.

1.8 **Assembly Test**

This test shall be carried out to ensure that the cotter pins, bolts, clamps etc., fit freely and properly.

2.0 **Tests on Hardware Fittings**

2.1 **Magnetic Power Loss Test for Suspension Assembly**

2.1.2 Two hollow aluminum tubes of 32 mm diameter shall be placed 457 mm apart. An alternating current over the range of 400 to 800 Amps for shall be passed through each tube. The reading of the wattmeter with and without two suspension assemblies along with line side yoke plate, clevis eye shall be recorded. Not less than three suspension assemblies shall be tested. The average power loss for suspension assembly. shall be plotted for each value of current. The value of the loss corresponding to 600 amperes shall be read off from the graph.

2.2 **Galvanising/Electroplating Test**

The test shall be carried out as per Clause no. 5.9 of IS:2486-(Part-1) - 1972 except that both uniformity of zinc coating and standard preecee test shall be carried out and the results obtained shall satisfy the requirements of this specification.

2.3 **Mechanical Strength Test of Each Component**

Each component shall be subjected to a load equal to the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. The component shall then again be loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified UTS and held for one minute. No fracture should occur. The applied load shall then be increased until the failing load is reached and the value recorded.

2.4 **Mechanical Strength Test of Welded Joint**

The welded portion of the component shall be subjected to a Load of 2000 kgs for one minute. Thereafter, it shall be subjected to die-penetration/ultrasonic test. There shall not be any crack at the welded portion.

2.5 **Clamp Slip Strength Vs Torque Test for Suspension Clamp**

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of ACSR conductor shall be fixed in the clamp. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the conductor. The Clamp slip strength vs. torque curve shall be drawn. The above procedure is applicable only for free center type

suspension clamp. For AG suspension clamp only clamp slip strength after assembly shall be found out.

2.6 **Shore Hardness Test for Elastomer Cushion for AG Suspension Assembly**

The shore hardness at various points on the surface of the elastomer cushion shall be measured by a shore hardness meter and the shore hardness number shall be between 65 to 80.

2.7 **Proof Load Test**

Each component shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength which shall be increased at a steady rate to 67% of the UTS specified. The load shall be held for one minute and then removed. After removal of the load the component shall not show any visual deformation.

2.8 **Tests for Forging Casting and Fabricated Hardware**

The chemical analysis, hardness test, grain size, inclusion rating and magnetic particle inspection for forging, castings and chemical analysis and proof load test for fabricated hardware shall be as per the internationally recognised procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding test will be as in the Quality Assurance programme.

2.9 **Mechanical Strength Test for Suspension/Tension Hardware Fittings**

The complete string without insulators excluding arcing horn, corona control rings/grading ring and suspension assembly/dead end assembly shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. This load shall be held for five minutes and then removed. After removal of the load, the string component shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for the one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

2.10 **Ozone Test for Elastomer**

This test shall be performed in accordance with ASTM D-1171 by the Ozone chamber exposure method (method B). The test duration shall be 500 hours and the ozone concentration 50 PPHM. At the test completion, there shall be no visible crack under a 2 x magnification.

3.0 Tests on Conductor and Earth wire Accessories

3.1 **Mid Span Compression Joint for Conductor and Earth wire**

(a)Slip Strength Test

The fitting compressed on conductor/earth wire shall not be less than one meter in length. The test shall be carried out as per IS:2121 (Part-II) clause 6.4 except that the load shall be steadily increased to 95% of minimum ultimate tensile strength of conductor/earth wire and retained for one minute at this load. There shall be no movement of the conductor/ earth wire relative to the fittings and no failure of the fit tings during this one minute period.

3.2 **T-Connector for Conductor**

(a) Axial Tensile Load Test for Welded Portion

The sleeve portion of the T-Connector shall be compressed on conductor. The compressed portion shall be held rigidly on some fixtures and axial load shall be applied along with the jumper terminal The load shall be increased gradually till breaking of welded joint occurs. The breaking load should be above 30 kN.

3.3 **Flexible Copper Bond for earthwire**

Slip Strength Test

On applying a load of 3 kN between the two ends, stranded flexible copper cable shall not come out of the connecting lugs and none of its strands shall be damaged. After the test, the lugs shall be cut open to ascertain that the gripping of cable has not been affected.

3.4 **Vibration Damper for conductor and earth wire**

(a)Dynamic Characteristics, Test

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for aeolian vibration frequency band range as per table 3.4 for vibration damper for different type of conductor/earthwire. The damper assembly shall be vibrated vertically with a $\pm$ 1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at $\pm$ 0.5mm to determine following characteristics with the help of suitable recording instruments:

(i) Force Vs frequency

(ii) Phase angle Vs frequency
(iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the aeolian vibration frequency-band between the lower and upper dangerous frequency, limits determined by the vibration analysis of conductor/earth wire without dampers.

Acceptance criteria for vibration damper.

(i) The above dynamic characteristics test on five damper shall be conducted.
(ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.
(iii) The above mean reactance response curve should lie within limits as per table 3.4.
(iv) The above mean phase angle response curve shall be between 25^{O} to 130^{O} within the frequency range of interest.
(v) If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.
(vi) Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

Table 3.4

Conductor name	**Range of vibration frequency for dynamic characteristic test**	**Range of mean reactance**	**Tension of each sub-span for vibration analysis test**
ACSR MOOSE	5 Hz to 40 Hz	0.191 f to 0.762 f	43 KN
ACSR Zebra			
7/3.66 mm GS EARTHWIRE	5 Hz to 40 Hz	0.060 f to 0.357 f	14 KN

(a) Vibration Analysis

The vibration analysis of the conductor/earthwire shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis :

(b) The analysis shall be borne for single conductor/earthwire without armour rods as per the parameters given under clause 2.5.13 and 3.3.8 of this part of the Specification. The tension shall be taken as per table 3.4 for a span ranging from 100 m to 1100 m.
(ii) The self damping factor and flexural stiffness (El) for conductor/earthwire shall be calculated on the basis of experimental results. The details of experimental analysis with these data should be furnished.
(c) The power dissipation curve obtained from Dynamic Characteristics Test shall be used for analysis with damper.
(iv) Examine the ecogni vibration level of the conductor/earthwire with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.
(d) From vibration analysis of conductor/earthwire without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the ecogni vibration levels exceed the specified limits shall be determined.
(vi) From vibration analysis of conductor/earthwire with damper/dampers installed at the recommended location, the dynamic strain level, at the clamped span extremities, damper attachment point and the antinodes on the conductor/earthwire shall be determined. In addition to above damper clamp vibration amplitude and antinode vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment points, clamped span extremities and antinodes shall not exceed the specified limits. The damper vibration amplitude shall not be more than that of the specified fatigue limits.

c) Clamp Slip and Fatigue Tests

(i) Test Set Up

The clamp slip and fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30 m. The 7/3.66 mm earth wire at 14 and shall not be equipped with protective armour rods at any point. Constant tension shall be maintained within the span by means of lever arm arrangement. After the earthwire has been tensioned, clamps shall be installed to support the earthwire at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The

clamps shall not be used for holding the tension on the earthwire. There shall be no loose parts, such as suspension clamps, U bolts on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for stepless speed control as well as stepless amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

(ii)Clamp Slip test

The vibration damper shall be installed on the test span. The damper clamp, after lightning with the manufacturer's specified tightening torque, when subjected to a longitudinal pull of 2.5 kN parallel to the axis of earthwire for a minimum duration of one minute shall not slip i.e. the permanent displacement between earthwire and clamp measured after removal of the load shall not exceed 1.0 mm. The load shall be further increased till the clamp starts slipping. The load at which the clamp slips shall not be more than 5 kN.

(e) Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than ± 25/f mm, where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the, test if resonance shift is observed the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned hereinabove shall be repeated after fatigue test without retorquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from conductor/earthwire and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristic of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The conductor/earthwire under clamp shall also be free from any damage.

For the purpose of acceptance, the following criteria shall be applied.

(1) There shall not be any frequency shift by more than $\pm$2 Hz for frequencies lower than 15 Hz and ± 3 Hz for frequencies higher than 15 Hz.

(2) The force response curve shall generally lie within guar anteed % variation in reactance after fatigue test in comparison with that before fatigue test by the Contractor.

(3) The power dissipation of the damper shall not be less than guaranteed % variation in power dissipation before fatigue test by the Contractor. However, it shall not be less than minimum power dissipation which shall be governed by lower limits of reactance and phase angle indicated in the envelope.

3.5 Spacer (for twin bundle)

(a) Vibration Tests

The test set up shall be as per Clause No.3.4€ (i) of Annexure-A. The spacer assembly shall be clamped to conductor. During the vibration tests the axis of the clamp of sample shall be maintained parallel to its initial static position by applying a tension of as per table 3.4 on the conductor. The spacer assembly shall be free to vibrate and shall not be re-torqued or adjusted between the tests.

All the vibration tests mentioned hereunder shall be conducted on the same sample on the same test span. The samples shall withstand the vibration tests without slipping on the conductor. Loosening, damage or failure of component parts. After each vibration test, clamp slip test shall be carried out as per the procedure given in Clause No3.5 (b) below

(f) Longitudinal Vibration Test

The stationary conductor and the vibrating conductor/equivalent diameter of aluminium alloy tube shall be restrained by fixed clamps. The displacement of the vibrating conductor shall be 25mm minimum on either side. The longitudinal movement shall be parallel to the conductor at frequency not less than 2 Hz for minimum one million cycles.

(g) Vertical Vibration Test

The spacer/spacer damper shall be installed in the middle of the test span and the frequency chosen so as to get an odd number of loops. The shaker shall be positioned at least two loops away from the test specimen to allow free movement of the conductor close to the test specimen. One conductor shall be connected to the shaker and vibrated to an amplitude such that.

$F^{1.8}$ Ymax > 1000 mm/sec.

Where Ymax being the antinode displacement (mm) and f is the test frequency (Hz). The test frequency shall be greater than 24 Hz and the total number of cycles shall be more than 10 millions.

(h) Sub-span Oscillation Test

The test shall be conducted for oscillation in horizontal plane at frequency higher than 3 Hz for minimum one million cycles. The amplitude for oscillation shall be kept equivalent to an amplitude of 150 mm for a full sub-span of 80m. Both the conductor shall be vibrated 180 deg. Out of phase with the above minimum amplitude.

(i) Clamp Slip Test

The spacer assembly shall be installed on test span of required bundle conductor configuration at sub-conductor tension as per Table 3.4. In case of spacer for jumper, the. Clamp of sample shall be tightened with a specified tightening torque. One of the clamp of the sample when subjected to a longitudinal pull of 2.5 kN parallel to the axis of conductor for a minimum duration of one minute shall not slip on the conductor i.e. the permanent displacement between the conductor and the clamp of sample measured after removal of the load, shall not exceed 1.0 mm. Similar test shall be performed on the other clamp of the same sample. Such clamp slip tests shall also be conducted after each of the vibration test mentioned in clause3. 5(a). Each clamp shall withstand a minimum longitudinal load of 2 kN for a minimum duration of one minute after the vibration test without any adjustment of sample.

3.6 Magnetic Power Loss Test for Damper/Spacer

The sample involving ferrous parts shall be tested in a manner to simulate service conditions for 50 Hz pure sine-wave. The test should be carried out at various currents ranging from 300 amperes to 900 amperes and the magnetic power loss at various currents should be specified in tabulated graphical form. The difference between the power losses without and with sample at room temperature shall be limited to 600 amperes current (rms) for ACSR MOOSE Conductor. The losses shall be determined by averaging the observations obtained from at least four samples.

3.7 Earthwire Suspension/Tension Clamp

(a) **Mechanical Strength Test**

The suspension assembly/tension assembly (excluding tension clamp) shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. This load shall be held for five minutes and then removed. After removal of the load, the components shall not show any visual deformation and it shall be possible to disassemble them by hand. Hand tools may be used to loosen the nuts initially. The assembly shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

(j) Clamp Slip Strength Vs Torque Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length of Earthwire shall be fixed in the clamps. The clamp slip strength at various tightening torques shall be obtained by gradually applying the load at one end of the earthwire. The clamp slip strength Vs torque curve shall be drawn. The clamp slip strength at the recommended tightening torque shall be more than 12 kN but less than 17 kN for 7/3.66 mm earthwire and more than 9 kN but less than 14 kN for 7/3.15 mm earthwire.

(k) €Slip Strength Test of Tension Clamp

Tension clamps shall be compressed on a 5 m length of earthwire on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load of 50% of the specified breaking load of the earthwire shall be applied & the sample shall be marked in such a way that movement relative to the fitting can easily be detected. Without any subsequent adjustment of the fitting, the load shall be steadily increased to 95% of the specified breaking load and maintained for one minute. There shall be no movement of the earthwire relative to the fitting during this one minute period and no failure of the fitting also.

(l) Electrical Resistance Test of Tension Clamp

The tension clamp and the jumper shall be compressed on two suitable lengths of earthwire. The electrical resistance shall be measured between points on earthwire near the clamp and near the jumper mouth keeping 25 mm clearance of the fitting and should not exceed 75% of the measured resistance of equivalent length of earthwire. The test shall be conducted with direct current. The current connections shall be at a distance not less than 50 times the diameter of earthwire from the fitting and shall be made so that effective contact is ensured with all those strands of the earth wire which would be taken into account in calculating its equivalent resistance. The test shall be repeated with the polarity reversed and the average of the two results considered as the measured value.

3.8 Corona Extinction Voltage Test (Dry)

The sample when subjected to power frequency voltage shall have a corona extinction voltage of not less than 320 kV (rms) line to ground under dry condition for 400 kV line. There shall be no evidence of corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IS:731.

3.9 Radio Interference Voltage Test (Dry)

Under the conditions as specified under (3.8) above, the sample shall have a radio interference voltage level below 1000 micro volts at one MHz when subjected to 50 Hz AC voltage of 305 kV rms line to ground under dry condition for 400 kV line. The test procedure shall be in accordance with IS 8263.

3.10 Chemical Analysis Test

Chemical analysis of the material used for manufacture of items shall be conducted to check the conformity of the same with Technical Specification and approved drawing.

4.0 Tests on All components (As applicable)

4.1 Chemical Analysis of Zinc used for Galvanizing

Samples taken from the zinc ingot shall be chemically analyzed as per IS-209-1979. The purity of zinc shall not be less than 99.95%.

4.2 Tests for Forgings

The chemical analysis hardness tests and magnetic particle inspection for forgings, will be as per the internationally ecognized procedures for these tests. The, sampling will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Purchaser in Quality Assurance Programme.

4.3 Tests on Castings

The chemical analysis, mechanical and metallographic tests and magnetic particle inspection for castings will be as per the internationally ecognized procedures for these tests. The samplings will be based on heat number and heat treatment batch. The details regarding test will be as discussed and mutually agreed to by the Contractor and Purchaser in Quality Assurance Programme.

7. ANNEXURE-B

Acceptance Tests

1 **Mid Span Compression Joint for Conductor and Earthwire**

(a) Hardness Test

The Brinnel hardness at various points on the steel sleeve of conductor core and of the earthwire compression joint and tension clamp shall be measured.

2. **T-Connector for Conductor**

(a)Axial Tensile Load Test for Welded Portion:-Same as clause 3.2 of Annexure-A .

3. **Flexible Copper Bond**

(a) Slip Strength Test:- Same as clause 3.3 of Annexure – A.

4. **Vibration Damper for Conductor/ Earthwire**

(a) Verification of Resonance Frequencies

The damper shall be mounted on a shaker table and vibrate at damper clamp displacement of +/-0.5 mm to determine the resonance frequencies. The resonance shall be visually identified as the frequency at which damper mass vibrates with maximum displacement on itself. The resonance frequency thus identified shall be compared with the guaranteed value. A tolerance of ± 1 Hz at a frequency lower than 15 Hz and ± 2 Hz at a frequency higher than 15 Hz only shall be allowed.

(m) Clamp Slip Test

Same as Clause 3.4 € (ii) of Annexure – A.

(n) Clamp Bolt Torque Test

The clamp shall be attached to a section of the conductor/earthwire. A torque of 150 percent of the manufacturer's specified torque shall be applied to the bolt. There shall be no failure of component parts. The test set up is as described in Clause 3.4 € (i), Annexure-A.

(o) Strength of the Messenger Cable

The messenger cable shall be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. Alternatively, each strand of message caste may be fixed in a suitable tensile testing machine and the tensile load shall be gradually applied until yield point is reached. In such a case, the 95% of yield strength of each wire shall be added to get the total strength of the caste. The load shall be not less than the value guaranteed by the Contractor

(p) Mass Pull off Test

Each mass shall be pulled off in turn by fixing the mass in one jaw and the clamp in the other of a suitable tensile testing machine. The longitudinal pull shall be applied gradually until the mass begins to pull out of the messenger cable. The pull off loads shall not be less than the value guaranteed by the Contractor.

(q) Dynamic Characteristics Test

The test will be performed as acceptance test with the procedure mentioned for type test with sampling mentioned below:-

Vibration Damper:

- 1 Sample for 1000 Nos. & below Conductor
- 3 Samples for lot above 1 000 & up to 5000 nos.
- Additional 1 sample for every additional 1500 pieces above 5000.

The acceptance criteria will be as follows

(r) The above dynamic characteristics curve for reactance & phase angle will be done for frequency range for vibration damper as per Table 3.4 of Annexure-A for different type of conductor/earthwire.

(ii) If all the individual curve for dampers are within the envelope as already mentioned for type test for reactance & phase angle, the lot passes the test.

(iii) If individual results do not fall within the envelope, averaging of characteristics shall be done.

(a) Force of each damper corresponding to particular frequency shall be taken & average force of three dampers at the frequency calculated.

(b) Similar averaging shall be done for phase angle.

€ Average force Vs frequency and average phase Vs frequency curves shall be plotted on graph paper. Curves of best fit shall be drawn for the entire frequency range.

(d) The above curves shall be within the envelope specified.

5. Spacer

(a) Dynamic Characteristic Test

The test shall be carried out as per clause 3.5 of Annexure-A.

(b) Movement Test

The spacer assembly shall be capable of the following movements without damaging the conductor, assuming one conductor is fixed and the other moving :

(i)	Longitudinal movement parallel to the conductor	± 50 mm
(ii)	Vertical movement in a vertical direction at right angle to the conductor	± 25 mm
(iii)	Torsional movement/angular Movement in a vertical plane parallel to the conductor	± 5 deg.

(c) Compressive and Tensile Test

The spacer assembly shall withstand ultimate compressive load of 14 kN and tensile load of 7.0 kN applied between sub conductor bundle and held for one minute without failure. Line distance between clamps shall be recorded during each of the compression and tension test. Measurement shall be recorded at (i) no load (ii) with load (iii) after release of load. The center line distance under load shall be within ± 100 mm of the nominal design spacing. After release of load it shall be possible to retain the clamps at their original position using only slight hand pressure. There shall be no deformation or damage to the spacer assembly which would impair its function of maintaining the normal spacing.

(d) Clamp Slip Test:- Same as clause 3.5(b) of Annexure-A.

€ Clamp Bolt Torque Test

The spacer assembly shall be attached to conductor. A torque of 150 per cent of the manufacturer's specified tightening torque shall be applied to the clamp bolts or cap screws. There shall be no failure of the component parts.

(d) Assembly Torque Test

The spacer assembly shall be installed on conductor. The same shall not rotate on either clamp on applying a torque of 0.04 kN in clockwise or anti-clockwise direction.

(e) Hardness test for Elastomer

The shore hardness at different points on the elastomer surface of cushion grip clamp shall be measured by shore hardness meter. They shall lie between 65 to 80.

(h) UTS of Retaining Rods:-

The ultimate tensile strength of the retaining rods shall be measured. The value shall not be less than 35 kg/sq mm.

SECTION IV-B

// VENDOR LIST //

As per approved vendor list appended in CSPTCL website:-

i) The name of the vendors shall be as per the list displayed in CSPTCL's website www.cspc.co.in on date of issue of NIT

ii) Other equipments/materials which are required but not covered in the above vendor list reputed make with prior approval of CSPTCL.

iii) Other vendors who possess requisite manufacturing capability (wherever required), type test certificate and performance certificate as per criteria of CSPTCL may also be considered with specific approval of CSPTCL.

iv) However, CSPTCL reserves right to add, delete, revise and specify any vendor subsequently and CSPTCL;s decision shall be final.

Note:- *Vendor selection for OPGW & its associated accessories shall be applicable as per tender clause No.4.26.3 (10 "VENDOR LIST OF OPGW AND OPGW ASSOCIATED HARDWARE & FITTINGS" PAGE NO.495 OF VOL.-II OF TENDER SPECIFICATION.*

Date :

Signature :
Name :
Designation

SECTION -II-C

TECHNICAL CONDITIONS FOR ERECTION, TESTING AND COMMISIONING (SURVEY AND SOIL INVESTIGATION, STUB SETTING, ERECTION OF TOWER, STRINGIING ETC.)

This section cover technical condition and standards for installation, construction of 400 KV and 220 KV transmission line including Check survey, detailed survey, tower spotting, foundation, erection, stringing, testing and commissioning of line.

General requirement:-As per IS 5613 (Part 3/ Sec. 2): 1989 and as per tender specification.

SURVEY

1.0 SCOPE OF WORK:-

General Information & scope of work :-

A. The technical specifications covers detailed survey, check survey, including route alignment, profiling, tower spotting, optimization of locations, check survey, contouring, and soil investigation for the transmission lines / part of the transmission lines covered under this specification.

B **Preparation of Survey reports including estimation of Bill of Quantities, identification and explanation of route constraints (like Forest, Animal/Bird sanctuary, reserve coal belt areas, oil pipe line/underground inflammable pipe lines etc.), infrastructure details available en-route etc.**

B The Provisional quantities for the scope of work are indicated in relevant Price Schedules. The actual quantities to be executed shall be decided by CSPTCL during execution stage and the final quantities shall be as approved by CSPTCL.

C The Contractor must note that the CSPTCL shall not be responsible for loss or damage to properties, trees etc. due to contractor's work during survey. The Contractor shall indemnify the Owner for any loss or damage to properties, trees etc. during the survey work.

D The Contractor shall also engage services of a reputed consultant or experts from independent educational/research institutions for examining stability aspects of the selected transmission line route/locations in hilly terrain wherever required.

1.A General

1.A.1. The technical specifications covers detailed survey, check survey, including route alignment, profiling, tower spotting, optimization of locations, check survey, contouring, and soil investigation for the transmission lines / part of the transmission lines covered under this specification.

1.1 Requirement of Transmission Line

1.1.1. The alignment of the transmission line shall be most economical from the point of view of construction and maintenance. The contractor shall identify & examine alternative route alignments and suggest to the Owner the optimal route alignment.

1.1.2. Routing/Re-routing of transmission line through protected/reserved forest area should be avoided. In case it is not possible to avoid the forests or areas having large trees completely, then keeping in view of the overall economy, the route should be aligned in such a way that cutting of trees is minimum.

1.1.3. The route should have minimum crossings of Major River, Railway lines, National/State highways, overhead EHV power line and communication lines.

1.1.4. The number of angle points shall be kept to minimum.

1.1.5. Marshy and low lying areas, river beds and earth slip zones shall be avoided to minimize risk to the foundations.

1.1.6. It would be preferable to utilize level ground for the alignment.

1.1.7. Crossing of power lines shall be minimum. Crossing of communication line shall be minimized and it shall be preferably at right angle. Proximity and parallelism with telecom lines shall be eliminated to avoid danger of induction to them.

1.1.8. Areas subjected to flooding such as nalah shall be avoided.

1.1.9. Restricted areas such as civil and military airfield shall be avoided. Care shall also be taken to avoid aircraft landing approaches.

1.1.10. All alignment should be easily accessible both in dry and rainy seasons to enable maintenance throughout the year.

1.1.11. Certain areas such as quarry sites, and rich plantations, gardens & nurseries should be avoided.

1.1.12. The line routing should avoid large habitations, densely populated areas, Forest, Animal/Bird sanctuary, reserve coal belt areas, oil pipe line/underground inflammable pipe lines etc. to the extent possible.

1.1.13. The areas requiring special foundations and those prone to flooding should be avoided.

1.2 The contractor shall submit his preliminary observations & suggestions along with various information/data /details collected and marked with the alternative routes etc. The final evaluation of the alternative routes shall be conducted by the contractor in consultation with Owner's representatives and optimal route alignment shall be proposed by the contractor. if required. Site visit and field verification shall be conducted by the contractor jointly with the Owner's representative for the proposed route alignment.

1.3 SURVEY & ROUTE OF THE TRANSMISSION LINE:-

(i) Walk over Survey:- Before starting the detailed survey a walk-over survey of the line shall be made . The various feasible routes shall be ascertained and marked on the topo sheet.

(ii) Three alternate tentative route alignment of the proposed **400KV and 220 KV LINES** shall be submitted by bidder. The preliminary survey of the line should be made and plotted on the latest 1: 50000 topo sheet of survey of India map, using the shortest route technically feasible. In respect of forest involvement two or more alternate routes should be submitted for approval. These alternate routes are to be fixed in consultation with the Forest Authorities and the concerned Engineer-in-charge of CSPTCL. The route is subjected to modification / alterations depending on exigencies during the currency of the contract. The contractor will carry out the survey work, prepare the profile, mark the towers and will submit the profile to the O.I.C. of the works for approval from the CE (Transmission).

(iii) At the starting point of the commencement of route survey an angle iron spike of 65x65x6mm section and 1000mm long shall be driven firmly into the ground to project only 150mm above the ground level. A punch mark on the top section of the angle iron shall be made to indicate location of the survey instrument. Teak wood peg 50x50x650mm six shall be driven at prominent position at intervals of not more than 750 metre along the transmission line to be surveyed up to the next angle point. Nails of 100mm wire length should be fixed on the top of these pegs to show the location of instrument. The pegs shall be driven firmly into the ground to project 100mm only above ground level. At angle position stone/concrete pillar with CSPTCL marked on them shall be put firmly on the ground for easy identification.

(iv) Soil resistivity along the route alignment, shall be measured in dry weather by four electrode method keeping inter-electrode spacing of 50 meters. For calculating soil resistivity fallowing formula shall be use:-

$$P = 2 \prod a R$$

where a=50 meters

R= Earth resistivitymeasure in Ohms

P=Soil resistivity in Ohm-mtr

Measurement shall be made at every 2.5 Kms. along the route of transmission lines. In case soil characteristic, changes within 2.5 kms., the value shall also to be measured at intermediate locations. The megger reading and soil characteristics shall also be indicated in the soil resistivity results.

The soil resistivity values shall be submitted duly marked on the route map and also in the form of statement. The quoted rates for detailed survey/ check survey work shall be inclusive of cost of measuring soil resistivity values along the proposed route and the contractor will not be paid separately for this work.

(v) All topographical details, permanent features, such as trees, building etc. **23 mtr for 400KV** on either side of the alignment shall be detailed on the profile plan.

All topographical details, permanent features, such as trees, building etc. **xx mtr for 220KV** on either side of the alignment shall be detailed on the profile plan.

The contractor shall be responsible for correct setting of stubs. Discrepancies, if any, shall be brought to the notice of Board and final approval shall be taken before execution of work. The requirement of tower site levelling and revetment work if required, will be marked by the contractor in the profiles while carrying out the survey work.

(vii) If due to site conditions any change in the tower location/ provision of extension is considered necessary compared to approved profiles, the contractor shall bring the same to the knowledge of the Board well in time and get revised approval of the profile before setting the stubs of the work.

1.3.1 DETAIL SURVEY

Detailed survey shall be conducted on the approved alignment. In hilly region level of ground at a suitable distance below the outer conductor on either side from the central line is also be noted and marked in the profile , so as to ensure required ground clearance underneath condition and side clearances in swung condition of conductor. Application of detail survey shall be done as per IS 5613 (Part 3/ sec. 2):1989 and tender specification.

Final route alignment drawing with latest topographical and other details/features including all rivers, railway lines, canals, roads etc. of selected route alignment shall be submitted by the contractor for Owner's approval along with report containing other information/details as mentioned above.

1.3.2 The contractor shall be responsible for correct setting of stubs. Discrepancies, if any, shall be brought to the notice of Board and final approval shall be taken before execution of work. The requirement of tower site levelling and revetment work if required will be marked by the contractor in the profiles while carrying out the survey work.

If due to site conditions any change in the tower location/ provision of extension is considered necessary compared to approved profiles, the contractor shall bring the same to the knowledge of the CSPTCL well in time and get revised approval of the profile before setting the stubs of the work.

PROFILE PLOTTING AND TOWER SPOTTING:-

The Survey is to be conducted by the bidder and the profiles will be handed over to C.S.P.T.C.L. progressively marking of towers on the profiles. The profile will be prepared on cm. Graph paper on scale 1: 2000 horizontal and 1:200 vertical on 1.0, 10mm squared paper as per approved procedure. Reference levels at every 20 metres along the profile are also to be indicated on the profile besides, R/Ls at undulations. Areas along the profile sheet, in the view of the contractor, are not suitable for tower spotting, shall also be clearly marked on the profile plots. If the difference in levels be too high, the chart may be broken up accordingly to requirement. A 10mm overlap shall be shown on each following sheet. The chart shall progress from left to right. Sheet shall be 594mm wide in accordance with the IS standard. For 'as built' profile these shall be in A1 size. The profile should be submitted to OIC of the work along with the tower schedule indicating the minimum and maximum weight spans.

Application of tower spotting shall be done as per IS 5613 (Part 3/ sec. 2):1989 Annexture –B.

The contractor will be responsible for the correct setting of tower as shown in approved profiles. If tower after erection are found to be out of the approved alignment / position in the profile, the contractor will dismantle and re erect them correctly fully at his own cost and without extension of time.

Tolerance in over head line construction as per IS 5613 (Part 3/ sec. 2):1989 Annexture –C.

The fallowing tolerance shall be applicable in case of position of foundation erected with reference to the tower position spotting on survey chart:-

Type of Tower	**Out of alignment**	**From centre line of Route**	**From transverse centre line**
Suspension or intermediate	0.5 degree	25 mm	$\pm$ 250mm
Section or Tension (set at bi-section of diversion angle)	0.5 degree	25 mm	$\pm$ 25mm

TOWER LOCATION:-

SAG TEMPLATE AND TOWER SPOTTING DATA :-

Sag template curve drawing and Tower Spotting Data shall be supplied by the Contractor Sag template prepared based on the sag template curve drawing shall only be used for tower spotting on the profiles. Two numbers of the approved template, prepared on rigid transparent plastic sheet, shall be provided by the Contractor to the Owner for the purpose of checking the tower spotting.

The templates shall be on the same scale as that of the profile. Sag template shall be made as per IS 5613 (Part 3/ sec. 2):1989 Annexture-B.

TOWER SPOTTING :-

As per sag template and tower spotting data, tower locations shall be marked on the profiles. While spotting the towers on the profile sheet, the following shall be borne in mind:-

(a) SPAN:- The number of consecutive spans between the section points shall not exceed 15 spans or 5 Kms. In plain terrain and 10 spans or 3 kms in hilly terrain.

(b) EXTENSION:- An individual span shall be as near to the normal design span as possible. In case an individual span becomes too short with normal supports on account of undulations in ground profile, one or both the supports of the span may be extended by inserting standard body extension designed for the purpose according to technical specification. In case of locations where the ground clearance is available, truncated towers may be spotted. The provisions kept in the design of towers w.r.t. body/leg extns , truncations shall be intimated by the contractor to the Owner during execution.

(c) LOADING:- The towers shall be spotted such that wind & weight spans are within permissible limits (as per tower spotting data), to avoid any loading on towers beyond design provisions. **In case at certain locations where actual spotting spans exceed the design spans and cross-arms and certain members of towers are required to be modified / reinforced , in that case drawings for the modified/reinforced towers will be supplied by the Contractor .**

(d) CLEARANCES :- The minimum ground clearance of 8.84 metres shall be available corresponding to the maximum working temperature and normal span of 400 metres or as per IS:5613. The clearance from building, trees, power line crossings should be made in accordance with the Indian Electricity Rules, 1956 as amended up-to-date and as per IS:5613.

d) Road Crossing

At all important road crossings, the tower shall be fitted with tension insulator strings but the ground clearance at the roads under maximum temperature and in still air shall be such that even with conductor broken in adjacent span, ground clearance of the conductor from the road surfaces will not be less than specified. At all national highways crossing span will not be more than 250 meters.

e) Railway Crossings

All the railway crossings coming-enroute the transmission line shall be identified by the Contractor. At the time of detailed survey, the railway crossings shall be finalized as per the regulation laid down by the Railway Authorities. The following are the important features of the prevailing regulations (revised in 1987)

i) The crossings shall be supported on large angle & dead end type tower on either side depending on the merits of each case.

The crossing shall normally be at right angle to the railway track.

The minimum distance of the crossing tower shall be at least equal to the height of the tower plus 6 meters away measured from the centre of the nearest railway track.

No crossing shall be located over a booster transformer, traction switching station, traction sub-station or a track cabin location in an electrified area.

Minimum ground clearance above rail level of the lowest portion of any conductor under condition of maximum sag shall be maintained at 17.90 m 400 KV transmission lines.

The crossing span will be limited to 300 meters.

f) River Crossings

In case of major river crossing, towers shall be of suspension type along with anchor towers of large angle & dead end type tower on either side of the main river crossing. Alternately on the basis of economics and / or site/ execution constraints crossing of rivers using extended angle towers also shall be considered. For

navigable rivers, clearance required by navigation authority shall be provided. For non navigable river, clearance shall be reckoned with respect to highest flood level (HFL).

g) Power line Crossings

Where the line is to cross over another line of the same voltage or lower voltage, tower with suitable extensions shall be used. Provisions to prevent the possibility of its coming into contact with other overhead lines shall be made in accordance with the Indian Electricity Rules, 1956 as amended up-to-date. In order to reduce the height of the crossing towers, it may be advantageous to remove the ground-wire of the line to be crossed (if this is possible, and permitted by the Owner of the line to be crossed).

Minimum clearance in metres between lines when crossing each other:

Nominal System Voltage	**132 KV**	**220 KV**	**400 KV**	**765 KV**
400 KV	5.49	5.49	5.49	7.94
220 KV	4.58	5.49	5.49	7.94

h) Telecommunication Line Crossings

The angle of crossing shall be as near to 90 degree possible. However, deviation to the extent of 30 degree may be permitted under exceptionally difficult situations.

When the angle of crossing has to be below 60 degree, the matter will be referred to the authority in charge of the telecommunication System. On a request from the Contractor, the permission of the telecommunication authority may be obtained by the Owner.

Also, in the crossing span, power line support will be as near the telecommunication line as possible, to obtain increased vertical clearance between the wires.

1.5 Clearance from Ground, Building, Trees etc.

Clearance from ground, buildings, trees and telephone lines shall be provided in conformity with the Indian Electricity Rules, 1956 as amended upto date.

The Contractor shall count, mark and put proper numbers with suitable quality of paint at his own cost on all the trees that are to be cut by the Owner at the time of actual execution of the work as detailed below. Contractor may please note that Owner shall not pay any compensation for any loss or damage to the properties due to Contractor's work.

1.5.A To evaluate and tabulate the trees and bushes coming within 23 m for 400 KV lines on either side of the central line alignment the trees will be numbered and marked with quality paint serially . The trees list should contain the following:

a) Girth (circumstances) measured at a height of 1 meter from ground level.
b) Approximate height of the tree with an accuracy of +2 meters.
c) Name of the type of the species/tree.
d) Name of village, owner of tree, khasara no and other details as required by revenue authority.

1.5.B The Contractor shall also identify the forest/Revenue- forest areas involved duly authenticated by concerned authorities.

a) A statement of forest areas with survey/compartment Nos.(all type of forest RF/PF/Acquired forest/Revenue forest/Private forest/Forest as per dictionary meaning of forest etc.)
b) A statement of Revenue -forest areas with survey/compartment nos.
c) Tree cutting details(Girth wise & specie wise)
d) Marking of forest areas with category on topo sheets 1:2,50,000 showing complete line route, boundaries of various forest divisions and their areas involved.
e) Village forest maps of affected line and affected forest area and marking of the same.
f) Forest division map showing line and affected forest area.

1.5.C The Contractor shall finalize the forest clearance proposal on the prescribed format duly completed in all respects for submission by the Owner to the Forest Department.

1.6 Preliminary Schedule

The profile sheets showing the locations of the towers together with preliminary schedules of quantities indicating tower types, wind & weight spans, angle of deviation, crossing & other details etc shall be submitted by the contractor for review & approval by Owner's site-in-charge.

1.7 CHECK SURVEY:-

(a) After approval of profile from ED (Transmission), the check survey shall be conducted to locate and peg mark the tower positions on ground conforming to the approved profile and tower schedule. In the process, it is necessary to have the pit centres marked according to the excavation marking charts. The levels, up or down of each pit centre with respect to the centre of the tower location shall be noted and recorded for determining the amount of earthwork required to meet the approved design parameters.

(b) Changes in the preliminary tower schedule after detailed survey, if required, shall be carried out by the Contractor and he shall thereafter submit a final tower schedule for the approval of Owner. The tower schedule shall show position of all towers, type of towers, span length, type of foundation for each towers and the deviation at all angles as set out with other details.

(c) If due to site conditions any change in the tower location/ provision of extension is considered necessary compared to approved profiles, the contractor shall bring the same to the knowledge of the CSPTCL well in time and get revised approval of the profile before setting the stubs of the work.

(d) The contractor will be responsible for the correct setting of tower as shown in approved profiles. If tower after erection are found to be out of the approved alignment / position in the profile, the contractor will dismantle and re erect them correctly fully at his own cost and without extension of time.

(e) Shall be made as per IS 5613 (Part 3/ sec. 2):1989.

2.0 SOIL INVESTIGATION /GEOTECHNICAL INVESTIGATIONS:-

2.1 General

CSPTCL requires that a detailed Geotechnical investigation be carried out at tower locations as per requirement of CSPTCL to provide the designer with sufficiently accurate information, both general and specific, about the substrata profile and relevant soil and rock parameters at site on the basis of which the foundation of transmission line towers can be classified and designed rationally.

These specifications provide general guidelines for geotechnical investigation of normal soils. Cases of marshy locations and locations affected by salt water or saltpeter shall be treated as special locations and the corresponding description in these specifications shall apply. Any other information required for such locations shall be obtained by Contractor and furnished to CSPTCL.

2.2 Scope

The scope of work includes detail soil investigations and furnishing bore log data at various tower locations as per requirement of CSPTCL. The provisional quantities have been indicated in Bill of Quantities. However, during actual execution of work, the location shall be decided by the site engineer in charge, depending upon the soil strata and terrain. Based on the bore log data / soil parameter /soil investigation results, the Contractor/soil investigation agency shall submit the test result for the locations and the approval for soil classification shall be taken from CSPTCL. The decision of CSPTCL is full and final.

2.2.2 These specifications cover the technical requirements for a detailed soil investigation work shall include mobilization of all necessary tools and equipment, provision of necessary engineering supervision and technical personnel, skilled and unskilled labour, etc. as required to carry out the entire field investigation as well as laboratory tests, analysis and interpretation of data and results, preparation of detailed soil report including specific recommendations for the type of foundations.. **The aforementioned work shall be done or supervised by any independent educational/research institutions or any govt. department laboratory or any govt./board approved agency having work experience of least 5 years in geotechnical investigation work as per technical specification. The approval for the same shall be obtained from CSPTCL.**

2.2.3 Contractor shall make his own arrangements to establish the co-ordinate system required to position boreholes, tests pits and other field test locations .Contractor shall arrange to collect the data regarding change of course of rivers, major natural streams and nalas, etc., encountered along the transmission line route from the best available sources and shall furnish complete hydrological details including maximum velocity discharge, highest flood level (H.F.L), scour depth etc. of the concerned rivers, major streams and nalas (canals).

2.2.4 The filed and laboratory data shall be recorded on the Performa recommended in relevant Indian Standards. Contractor shall submit to CSPTCL after the completion of each boreholes/test.

2.2.5 After reviewing Contractor's geotechnical investigation report, Owner will call for discussions, at Owner's site Office, in order to comment on the report in the presence of Contractor's Geotechnical Engineer. Any expenditure associated with the redrafting and finalizing the report, traveling etc. shall be deemed included in the rates quoted for the geotechnical investigations.

2.2.6 Contractor shall carry out all work expressed and implied in these specifications in accordance with requirements of the specification.

2.2.7 The contractor shall prepare and submit soil profile along the transmission line route indicating salient soil characteristics / features, water table etc based on detailed soil investigations and other details / information collected during detailed survey.

2.2.8 It is essential that equipment and instruments be properly calibrated at the commencement of the work. If the CSPTCL so desires. Contractor shall arrange for having the instruments tested at an approved laboratory at its cost and shall submit the test reports to the Owner. If the Owner desires to witness such tests, Contractor shall arrange for the same.

2.3 Field Investigation for Soils

Tentative numbers of detailed soil investigation to be done is given in PBS

2.3.A Boring

Boreholes are required for detailed soil investigations.

2.3.A.1 General Requirements

a) Boreholes shall be made to obtain information about the subsoil profile, its nature and strength and to collect soil samples for strata identification and for conducting laboratory tests. The minimum diameter of the borehole shall be 150mm and boring shall be carried out in accordance with the provisions of IS:1892 and the present specification:

b) All boreholes shall be 7mtr deep for normal soil conditions. The depth of boreholes at river crossings and special locations shall be 40m. If a strata is encountered where the Standard Penetration Test Records N values greater than 100, with characteristics of rock, the borehole shall be advanced by coring atleast 3 mtr further in normal locations and at least 7 mtr further for the case of river crossing locations with prior approval of the Owner. When the boreholes are to be termination in soil strata an additional Standard Penetration Test shall be carried out at the termination depth. No extra payment shall be made for carrying out Standard Penetration Tests.

c) Casing pipe shall be used when collapse of a borehole wall is probable. The bottom of the casing pipe shall at all times be above the test of sampling level but not more than 15cm above the borehole bottom. In case of cohesion less soils, the advancement of the casing pipe shall be such that it does not disturb the soil to be tested or sampled. The casing shall preferably be advanced by slowly rotating the casing pipe and not by driving.

d) In-situ tests shall be conducted and undisturbed samples shall be obtained in the boreholes at intervals specified hereafter. Representative disturbed samples shall be preserved for conducting various identification tests in the laboratory. Water table in the bore hole shall be carefully recorded and reported following IS:6935. No water or drilling mud shall be used while boring above ground water table. For cohesion less soil below water table, the water level in the borehole shall at all times be maintained slightly above the water table.

e) The borehole shall be cleaned using suitable tools to the depth of testing or sampling, ensuring least or minimum disturbance of the soil at the bottom of the borehole. The process of jetting through an open tube sampler shall not be permitted. In cohesive soils, the borehole may be cleaned by using a bailer with a flap valve. Gentle circulation of drilling fluid shall be done when rotary mud circulation boring is adopted.

f) On completion of the drilling, Contractor shall backfill all boreholes as directed by the Owner.

2.3.A.2 Auger Boring

Auger boring may be employed in soft to stiff cohesive soils above the water table. Augers shall be of helical or post hole type and the cuttings brought up by the auger shall be carefully examined in the field and the description of all strata shall be duly recorded in the field bore log as per IS:1498. No water shall be introduced from the top while conducting auger boring.

2.3.A.3 Shell and Auger Boring

Shell and auger boring may be used in all types of soil which are free from boulders. For cohesion less soil below ground water table, the water level in the borehole shall always be maintained at or above ground water level. The use of chisel bits shall be permitted in hard strata having SPT-N value greater than 100 Chisel bits may also be used to extend the bore hole through local obstructions such as old construction. Boulders rocky formations etc. The requirements in Clause 4.5.1.2 shall apply for this type of boring also.

Rotary method may be used in all types of soil below water table. In this method the boring is carried out by rotating the bit fixed at the lower end of the drill rod. Proper care shall be taken to maintain firm contact between the bit and the bottom of the borehole. Bentonite or drilling mud shall be used as drilling fluid to stabilize and protect the inside surface of the borehole. Use of percussion tools shall be permitted in hard clays and in dense sandy deposits.

2.3.B Standard Penetration Test (SPT)

2.3.B.1 This test shall be conducted in all types of soil deposits encountered within a borehole, to find the variation in the soil stratification by correlating with the number of blows required for unit penetration of a standard penetrometer. Structure sensitive engineering properties of cohesive soils and sifts such as strength and compressibility shall not be inferred based on SPT values.

2.3.B.2 The test shall be conducted at depths as follows:

Location	**Depths (m)**
Normal Soils	2.0, 3.0, 5.0, 7.0
River crossings and special Locations.	2.0, 3.0, 5.0, 7.0, 10.0 and thereafter at the rate of 3m intervals upto 40 m or refusal whichever occur earlier.

2.3.B.3 The spacing between the levels of standard penetration test and next undisturbed sampling shall not be less than 1.0m. Equipments, accessories and procedures for conducting the test and for the collection of the disturbed soil samples shall conform to IS:2131 and IS:9640respectively. The test shall be conducted immediately after reaching to the test depth and cleaning of bore hole.

2.3.B.4 The test shall be carried out by driving a standard split spoon sampler in the bore hole by means of a 650N hammer having a free fall of 0.75 m. The sample shall be driven using the hammer for 450mm recording the bumper of blows for every 150mm. The number of blow for the last 300mm drive shall be reported as N value.

2.3.B.5 This test shall be discontinued when the blow count is equal to 100 or the penetration is less than 25 mm for 50 blows. At the level where the test is discontinued, the number of blows and the corresponding penetration shall be reported. Sufficient quantity of disturbed soil samples shall be collected from the split spoon sampler for identification and laboratory testing. The sample shall be visually classified and recorded at the site as well as properly preserved without loss of moisture content and labeled.

2.3.C Sampling

2.3.C.1 General

a) Sufficient number of soil samples shall be collected. Disturbed soil samples shall be collected for soil identification and for conducting tests such as sieve analysis, index properties, specific gravity, chemical analysis etc. Undisturbed samples shall be collected to estimate the physical bearing capacity and settlement properties of the soil.

b) All samples shall be identified with date, borehole or test pit number, depth of sampling, etc. The top surface of the sample in-situ shall also be marked. Care shall be taken to keep the core and box samples vertical, with the mark directing upwards. The tube samples shall be properly trimmed at one end and suitably capped and sealed with molten paraffin wax. The Contractor shall be responsible for packing, storing in a cool place and transporting all the samples from site to the laboratory within seven days after sampling with probe, protection against loss and damage.

2.3.C.2 Disturbed Samples

a) Disturbed soil samples shall be collected in boreholes at regular intervals. Jar samples weighing approximately 1 kg shall be collected at 0.5m intervals starting from a depth of 0.5m below ground level and at every identifiable change of strata to supplement the boring records. Samples shall be stored immediately in air tight jars which shall be filled to capacity as much as possible.

b) In designated borrow areas, bulk samples, from a depth of about 0.5m below ground level shall be collected to establish the required properties for use as a fill material. Disturbed samples weighing about 25kg (250N) shall be collected at shallow depths and immediately stored in polythene bags as per IS:1892. The bags shall be sealed properly to preserve the natural moisture content of the sample and placed in wooden boxes for transportation.

2.3.C.3 Undisturbed Samples

In each borehole undisturbed samples shall be collected at every change of strata and at depths as follows:

Location	Depths (m)
Normal Soils	1.0, 4.0, 6.0
Special Locations	1.0, 4.0, 6.0, 8.0,10.0 and thereafter at the rate of 3 m intervals up to 33m or refusal whichever occur earlier.

2.3.C.3.1 The spacing between the top levels of undisturbed sampling and standard penetration testing shall not be less than 1.0m. Undisturbed samples shall be of 100mm diameter and 450mm in length. Samples shall be collected in a manner to preserve the structure and moisture content of the soil Accessories and sampling procedures shall conform to IS:1892 and IS:2132

a) Undisturbed sampling in cohesive soil :

Undisturbed samples in soft to stiff cohesive soils shall be obtained using a thin walled sampler. In order to reduce the wall friction, suitable precautions, such as oiling the surfaces shall be taken. The sampling tube shall have a smooth finish on both surfaces and a minimum effective length of 450mm. The area ratio of sampling tubes shall be less than 12.5%. However, in case of very stiff soils area ratio up to 20% shall be permitted.

b) Undisturbed sampling in very loose, saturated, sandy and silty soils and very soft clays :

Samples shall be obtained using a piston sampler consisting of a cylinder and piston system. In soft clays and silty clays, with water standing in the casing pipe, piston sampler shall be used to collect undisturbed samples in the presence of expert supervision.

Accurate measurements of the sampling depth, dimensions of sampler, stroke and length of sample recovery shall be recorded. After the sampler is pushed to the required depth, the cylinder and piston system shall be drawn up together, preventing disturbance and changes in moisture content of the sample;

c) Undisturbed sampling in cohesion less soils

Undisturbed samples in cohesion less soils shall be obtained in accordance with IS:8763. Sampler operated by compressed air shall be used to sample cohesion less soils below ground water table.

2.3.D Ground Water

2.3.D.1 One of the following methods shall be adopted for determining the elevation of ground water table in boreholes as per IS:6935 and the instructions of the Owner:

a) In permeable soils, the water level in the borehole shall be allowed to stabilize after depressing it adequately by bailing before recording its level. Stability of sides and bottom of the boreholes shall be ensured at all times.

b) For both permeable and impermeable soils, the following method shall be suitable. The borehole shall be filled with water and then bailed out to various depths. Observations on the rise or fall of water level shall be made at each depth. The level at which neither fall nor rise is observed shall be considered the water table elevation and confirmed by three successive readings of water level taken at two hours interval.

2.3.D.2 If any variation of the ground water level is observed in any specific boreholes, the water level in these boreholes shall be recorded during the course of the filed investigation. Levels in nearby wells, streams, etc., if any, shall also be noted in parallel.

2.3.D.3 Subsoil water samples

a) Subsoil water samples shall be collected for performing chemical analysis. Representative ground water samples shall be collected when first encountered in boreholes and before the addition of water to aid boring or drilling.

b) Chemical analysis of water samples shall include determination of pH value, turbidity, sulphate, carbonate, nitrate and chloride contents, presence of organic matter and suspended solids. Chemical preservatives may be added to the sample for cases as specified in the test methods or in applicable Indian Standards. This shall only be done if analysis cannot be conducted within an hour of collection and shall have the prior written permission and approval of the Owner.

2.4 Laboratory Testing

2.4.A Essential Requirements

a) Depending on the types of substrata encountered, appropriate laboratory tests shall be conducted on soil and rock samples collected in the field. Laboratory tests shall be scheduled and performed by qualified and experienced personnel who are thoroughly conversant with the work. Tests indicated in the schedule of items shall be performed on soil, water and rock samples as per relevant IS codes. One copy of all laboratory test data records shall be submitted to Owner progressively every week. Laboratory tests shall be carried out concurrently with the field investigations as initial laboratory test results could be useful in planning the later stages of field work. A schedule of laboratory tests shall be established by Contractor to the satisfaction of the Owner within one week of completion of the first borehole;

b) Laboratory tests shall be conducted using approved apparatus complying with the requirements and specification of Indian Standards or other approved standards for this type of work. It shall be checked that the apparatus are in good working condition before starting the laboratory tests. Calibration of all the instruments and their accessories shall be done carefully and precisely at an approved laboratory.

2.4.A1 Tests

Tests as indicated in these specifications and as may be requested by the Owner, shall be conducted. These tests shall include but may not be limited to the following:

a) Tests of undisturbed and disturbed samples

Visual and engineering classification, Sieve analysis and hydrometric analysis, Liquid, plastic and shrinkage limits, Specific gravity, Chemical analysis, Swell pressure and free swell index determination, Proctor compaction test.

b) Tests of undisturbed samples:

Bulk density and moisture content, Relative density(for sand), Unconfined compression test; Box shear test (for sand), Triaxial shear tests (depending on the type of soil and field conditions on undisturbed or remolded samples Unconsolidated undrained, Consolidated drained test),

c) Chemical analysis of sub soil water.

2.4.B Salient Test Requirement

a) Triaxial shear tests shall be conducted on undisturbed soil samples, saturated by the application of back pressure. Only if the water table is at sufficient depth so that chances of its rising to the base of the footing are small or nil, the triaxial tests shall be performed on specimens at natural moisture content. Each test shall be carried out on a set of three test specimens from one sample at cell pressures equal to 100, 200 and 300 KPa respectively or as required depending on the soil conditions:

b) Direct shear test shall be conducted on undisturbed soil samples. The three normal vertical stresses for each test shall be 100, 200 and 300 KPa or as required for the soil conditions;

c) Consolidation test shall have loading stages of 10, 25, 50, 75, 100, 200, 400 and 800 KPa. Rebound curve shaft be recorded for all samples by unloading the specimen at its in-situ stress. Additional rebound curves shall also be recorded wherever desired by the Owner;

d) Chemical analyses of subsoil shaft include determination of PH value, carbonate, sulphate (both SO_3 and SO_4). chloride and nitrate contents, organic matter, salinity and any other chemicals which may be harmful to the foundation material. Their contents in the soil shall be indicated as percentage (%);

e) Chemical analysis of subsoil water samples shall include the determination of properties such as colour, odour, turbidity, PH value and specific conductivity, the last two chlorides, nitrates, organic matter and any other chemical harmful to the foundation material. The chemical contents shall be indicated as parts per million (PPM) based on weight.

SUMMARY OF RESULTS OF LABORATORY TESTS ON SOIL AND WATER SAMPLES

1. Bore hole test pit. no
2. Depth (m)
3. Type of sample
4. Density(kg/m3)
   a) Bulk (b)Dry. **d**
5. Water content (%)
6. Particle Size (%)
   a) Gravel (b) Sand (c) Silt (d) Clay
7. Consistency properties
   a) LL (b) PL (c) PI (d) LI
8. Soil
   a) Classification –IS, (b) Description, (c) Specific gravity
9. Strength Test
   a) Type (b) C (Cohesion) (c) Ø (angle of internal friction)
   d) Angle of repose
   e) Consolidation Test
   – $e_{0,}$ Pc, Cc, DP, Mv, Cv
   f) Shrinkage limit(%)
   g) Swell Test
   – S.Pr, FS
   h) Relative Density (%)
   i) Remarks

Notations:

I. For type of Sample:

DB - Disturbed bulk soil sample., DP - Disturbed SPT soil sample
DS - Disturbed samples from cutting edge of undisturbed soil sample.
RM - Remoulded soil sample, UB - Undisturbed block soil sample
US - Undisturbed soil sample by sampler, W - Water sample

II. For Strength Test :

SCPT - Static Cone Penetration Test, UCC - Unconfined Compression Test
VST - Vane Shear Test, Tuu - Unconsolidated Undrained Triaxial Test
Note: Replace T by D for Direct Shear Test
Tod - Consolidation Drained Triaxial Test

III. For Others :

LL - Liquid Limit (%), PL - Plastic Limit, PI - Plasticity Index
LI - Liquidity Index, C - Cohesion (kPa), Ø - Angle of Internal Friction (degrees)
S-Pr. - Swelling Pressure (kPa), e0 - Initial Void Ratio
Pc - Reconsolidation Pressure (kPa), Cc - Compression Index
DP -Change in Pressure (kPa),
m_v - Coefficient of Volume Compressibility (m2/ KN)
Cv - Coefficient of Consolidation (m2/hr)

IV. For Chemical Test

As per Specifications - Clause 2.4.D

2.4.C Recommendations

a) Recommendations shall be provided for tower location duly considering soil type and tower spotting data. The recommendations shall provide all design parameters and

considerations required for proper selection, dimensioning and future performance of tower foundations considers such investigations necessary.

2.4.D Hydro geological Conditions

2.4.D.1 The maximum elevation of ground water table, amplitudes of its fluctuations and data on water aggressivity with regard to foundation structure materials shall be reported. While preparing ground water characteristics the following parameters should be specified for each acquifier:

a) bicarbonate alkalinity mg-eq/(deg),
b) pH value
c) content of aggressive carbon dioxide, mg/l;
d) content of magnesia salts. mg/l, recalculated in terms of ions Mg+2;
e) content of ammonia salts, mg/l, recalculated in terms of ions NH4+
f) content of caustic alkalis, mg/l, recalculated in terms of ions Na+ and K+
g) contents of chlorides,mg/l recalculated in terms of ions Cl-
h) contents of sulphates, mg/l, recalculated in terms of ions SO4-2
i) aggregate content of chlorides, sulphates, nitrates, carbonates and other salts. mg/l.

2.5 Rates and Measurements

2.5.A Rates

The contractor's quoted rates shall be inclusive of making observations, establishing the ground level and co-ordinates at the location of each borehole, test pit etc. No extra payments shall be made for conducting Standard Penetration Test, collecting, packing, transporting of all samples and cores, recording and submittal of results on approved formats.

The contractor at mutually agreed rates shall carry out the testing of soil in the River beds if required.

2.6 Codes and Standards for Geotechnical Investigations

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions. In case of conflict between the present specifications and those referred to herein, the former shall prevail. Internationally accepted standards which ensure equal or higher performance than those specified shall also be accepted.

All work shall be carried out in accordance with the following Indian Standards and Codes:

Indian Standards (IS)	**Title**	**International Standard/Code**
IS:1080-1990	Codes of Practice for Design and Construction of Simple Spread Foundations.	
IS:1498-1992	Classification and Identification of Soils for General Engineering purposes.	ASTM D 2487 ASTM D2488
IS:1892-1992	Code of Practice for Subsurface Investigation for Foundation	
IS:1892-1992	Code of Practice for Subsurface Investigation for Foundation	
IS:1904-1986	Code of Practice for Design and Construction of foundation in Soils: General Requirements.	
IS:2131-1992	Method of Standard Penetration Test for Soils	ASTM D 1586
IS:2132-1992	Code of Practice for Thin Walled Tube Sampling of Soils	ASTM D 1587
IS:2720-1992	Method of Test for Soils(Relevant Parts)	ASTM D 420
IS:3025	Methods of Sampling and Testing(Physical and Chemical) for water used in Industry	
IS:4091-1987	Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles.	
IS:4434-1992	Code of Practice for In-situ Vane Shear Test for Soils	ASTM D 2573 ASTM D 4648
IS:4453-1992	Code of Practice for Exploration by Pits, Trenches, Drifts and Shafts.	
IS:4464-1990	Code of Practice for Presentation of Drilling information and core description in Foundation investigation	
IS:4968(Part-	Method for Subsurface sounding for soils, dynamic	

Indian Standards (IS)	**Title**	**International Standard/Code**
II)1992	method using cone and Bentonite slurry.	
IS:5313-1989	Guide for Core Drilling observations.	
IS:6403-1990	Code of Practice for Determination of Allowable Bearing Pressure on Shallow Foundation.	ASTM D 194
IS:6935-1989	Method of Determination of Water level in a Bore Hole.	
IS:7422-1990	Symbols and Abbreviations for use in Geological Maps Sections and subsurface Exploratory Logs (Relevant parts).	
IS:9259-1992	Specification for Liquid Limit Apparatus.	ASTM D 4318

FOUNDATION

The construction of tower foundation shall be accordance with IS 4091: 1979

3.0 **EXCAVATION**

Excavation work in the section must not be started until the tower schedule and profile of that section has been approved by the Owner.

Pit marking shall be carried out accordance to tower schedule chart

Except as specifically otherwise provided, all excavation for footing shall be made to the lines and grades of the foundation. For estimation purposes, the excavation walls shall be vertical and the pit dimensions shall be such as to allow a clearance of 150 mm on all sides from the foundation pit, where form boxes are used. In undercut / stepped (slab type) foundations where form box is not required to be used at the base, the pit dimensions should be as per the standard drawing. All excavations shall be protected so as to maintain a clean sub-grade, until the footing is placed, using timbering, shoring or casing, if necessary. Any sand, mud, silt or other undesirable materials which may have accumulated in the excavation shall be removed by the contractor before placing concrete.

3.1 The soil to be excavated for tower foundations shall be classified as under for the purpose of payment for excavation for tower site leveling and building stone revetment:

(a) Dry soil : Soil removable by means of ordinary pick axes and shovels (Normal soil, intermediate soil and black cotton soil, Partial black cotton soil sandy soil fall under this category).

(b) Wet soil : Soil as per (a) above, where the subsoil water table is encountered within the range of foundation depth, the soil below the water table and that at locations where pumping or bailing out of water is required due to presence of surface water, will be treated as wet soil.(partially submerged & fully submerged soil fall under this category)

(c) Soft Rocks: This will mean fissured rock i.e. decomposed rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature which can be easily excavated with pick axe or spade. (Soft rock/Fissured Rock, Submerged fissured rock fall under this category)

(d) Hard Rocks: Hard rock will be that which requires chiseling or drilling and blasting.

3.1.1 **No extra charges shall be admissible for the removal the fallen earth in the pits when once excavated. Shoring and strutting shall be done keeping in view the requirement given in IS-3764: 1966. In pit excavated in sandy soil or water bearing strata and where there is every like hood of pit collapsing.**

3.1.2 **If water is encountered in the foundation pit, de-watering will have to be done. The cost of dewatering shall be deemed to be included in the unit rates of foundations indicated by the Bidder in his offer. The guideline for dewatering during construction specified in IS-9759:1981 shall be kept in view.**

3.1.3 **For foundation in rock, where blasting is unavoidable, care should be taken to minimize the amount of concrete necessary for filling up the blasted area. The blasted area shall be reduced to the minimum possible so that the specified form for the foundation could be obtained. No extra payment for excavation in hard rock shall be allowed if the excavated area exceeds the designed excavation volumes. Similarly, no extra payment shall be made if concreting; reinforcement volume exceeds the designed volume due to excessive blasting. During execution of work in rock the provision given in IS-4081:1986 shall be fallow. For excavation in hard rock blasting can be resorted to. Reference shall be made to statutory rules for blasting & use of explosives for this purpose.**

3.1.5 **The contractor shall arrange requisite blasting material, excavation and drilling equipment at his own cost and the quoted rates shall be deemed to be inclusive of such costs.**

3.1.6 Indian Standard IS: 3764 shall be followed regarding safety of excavation work

3.2 BENCHING:-

When the line passed through hilly/undulated terrain, levelling the ground may be required for casting of tower footings. All such activities shall be termed benching and shall include cutting of excess earth and removing the same to a suitable point of disposal as required by Owner. Benching shall be resorted to only after approval from Owner. Volume of the earth to be cut shall be measured before cutting and approved by Owner for payment purpose. Further, to minimise benching, unequal leg extensions shall be considered and provided if found economical. The proposal shall be submitted by the Contractor with detailed justification to the Owner.

3.3 **SETTING OF STUBS:-**

The stubs shall be set correctly in accordance with approved method at the exact locations and alignment and in precisely correct levels. The stub setting templates shall be used for proper setting of stubs. Stubs shall be set in the presence of Board's representative available at site whenever required and for which adequate advance intimation shall be given to the site Engineer by the contractor.

The foundations are to be made as per designs and drawings approved by the Board. The extent of work as defined by such drawings shall not be exceeded except in very special cases where the prior approval of the Board has been obtained.

Each tower shall be provided with suitable foundation based on the approved designs after classification of soil. The soil classification shall be done after digging a small section of a pit upto full depth (excluding hard rock locations). The soil should be classified strictly as per details encountered in the foundation pit , as per clause 4.42 of Sec.IV-A & as per IS-5613 (part 3/sec 2):1989 clause 9. For example, dry soil foundations should be adopted at the locations where dry soil is encountered in the full depth of foundation. Similarly the wet type foundation should be adopted at the locations where water level is met at level of 1.5 metre or more below the ground level or in paddy fields or other places, which remain in surface water for long periods with water penetration not exceeding one meter below the ground level. Deviation, if any , from the approved / specified conditions shall be brought to the notice of C.E. (Transmission) through site Engineer before taking up the work and his decision shall be final and communicated through site Engineer. If at a later date, it is found that the contractor has carried out some work, not according to the specification and without taking specific approval, than in that case, entire payments made to the contractor for carrying out such works shall be recovered and the contractor will have to rectify the same at the rates indicated in the order for carrying out such work and without extension of time.

The setting of stubs in hard rock foundation may require cutting of stubs depending on depth at which hard rock is encountered. The cutting of stubs and drilling of new holes for fixing cleats etc. shall be considered inclusive in the rate of foundation of towers in hard rock.

Setting of stub at each location shall be approved by the Board's site Engineer. This approval shall not however, absolve the contractor of his responsibility of correct setting of stubs and casting of foundations, who will be required to rectify the faulty work at his own expense.

The allowable tolerance on template setting shall be IS-5613(part 3/sec 2) : 1989 Ann.C

3.4 **PLACEMENT OF REINFORCEMENT**:

i. Tower foundation may be designed with steel reinforcement so as to achieve better foundation strength with lesser space. The contractor will indicate in relevant schedules, the details of reinforcement to be provided along with the weight and size of steel rods. The cost of placing of reinforcement steel, binding etc. in the foundation pit shall be deemed to be included in the quoted rates of foundation of towers.

ii. All reinforcement shall be properly placed according to design drawing with a min. concrete cover of 50 mm

iii. The reinforcement steel shall be arranged by the contractor at his own cost. The reinforcement bars will have to be properly cut, bent in required shape and placed in the foundation in approved manner after due cleaning of soil grease or organic matter. The reinforcement shall be properly tied by binding wire of not less than 0.9 mm. the work shall confirmed to IS 2502 :1963/ IS-5613(part 3/sec 2) : 1989 wherever applicable

3.5 **CONCRETE:**

i. The cement concrete used for the main foundation shall be of M 20 1:1.5:3. and For lean concrete sub-base or pad M 10 1:3:6 mix cement concrete be used . The property of concrete and mix proportions shall be as per IS 456.

ii. The coarse aggregates (stone metal) to be used shall be single size aggregate 40 mm nominal size for pyramid / slab portions concrete and 20 mm nominal size for chimney portion concrete confirming to IS 383 :1970 . For RCC, the aggregates shall preferably be of 20 mm nominal size.

iii. The cement required for the purpose of foundations, building revetment walls etc. shall be arranged by the contractor at his own cost.

iv. The sand used for the concrete shall be composed of hard silicate materials. It shall be clean and of a sharp angular grit type and free from earthy or organic matter and deleterious salts. The fine aggregate (sand) shall be of zone-I grade to IS 383:1970 which is the course variety. Zone –II grade of fine aggregates may also be used.

v. The aggregate shall be of clean broken hard granite or other stone specified or approved by the Board. It shall be of hard, coarse-grained quality. It shall also be as far as possible cube like, preferably angular, but not flaky, perfectly clean and free from earth, organic or other deleterious matter. 40 mm aggregate shall be of size as will pass through a mesh of 40 mm measured in the clear and 20 mm aggregate through 20 mm square mesh measured in clean.

vi. The water used for mixing concrete shall be fresh clean and free from oil, acid and alkali, organic materials or other deleterious substances, Salty / Saline or brackish water should not be used. Potable water is generally satisfactory.

vii. The concrete shall be mixed in a mechanical mixer. However in case of locations not accessible for concrete mixers, hand mixing may be permitted at the discretion of our site Engineer. mixing placing and compacting of concrete shall be done as per IS-5613 (part3/sec2) : 1989 clause 11.10 and Ann. D

viii. Mixing shall be continued until there is uniform distribution of materials and the mixing is uniform in colour and consistency but in no case the mixing be done for less than two minutes, Normally mixing shall be done close to the foundation but in case it is not possible, the concrete may be mixed at nearest convenient place. The concrete shall be transported from the place of mixing to the place of final deposit as rapidly as practicable by methods which shall prevent segregation or loss of any ingredient. The concrete shall be placed and compacted before setting commences.

ix. The concrete shall be mixed as stiff as the requirements of placing the concrete in the form boxes, with ease and the degree to which the concrete resists segregation. Hence the quantity of water used should not be too much.

x. Proper form boxes, adequately braced to retain proper shape while concreting should be used for chimney or pyramid and slab portions. The form boxes should be made water tight so that the cement cream should not come out leaving only sand and jelly consequently forming of honey combing in the concrete. The form boxes shall be cleaned and oiled before these are used for concreting.

xi. The concrete shall be laid in 150 m.m. layers and consolidated well so that the cement cream works up to the top and no honey combing is left in the concrete. The concreting is to be done continuously so that the subsequent layers are laid before the initial setting of the bottom layer begins. The consolidation of concrete shall normally be done by using vibrators.

xii. After concreting the chimney portion to the required height, the top surface should be finished smooth, with slight slope towards the outer edge to drain off the rain water falling on the coping.

xiii. In wet locations, the site must be kept completely de-watered both during placing of the concrete and for 24 hours after completion. There should be no spilling to concrete during this period.

xiv. The form boxes shall not be removed at least 24 hours after the completion of concreting after removal of the forms, the concrete surface, wherever required shall be repaired with a mixture of rich cement and sand mortar in the shortest possible time.

3.6 **BACKFILLING AND REMOVAL OF STUB TEMPLATES**:

i. Following opening of the form work and removal of shoring and shuttering, if required, backfilling shall be started after 24 hours of casting repairs, if any, to the foundation concrete. Backfilling shall normally be done with the excavated soil, unless, it is a clay type or it consists of large boulders/stones which shall be broken to a maximum size of 80 mm At locations where borrowed earth is required for backfilling, Contractor shall bear the cost irrespective of lead and lift.

ii. The backfill materials should be clean and free from organic or other foreign materials. A clay type soil with a grain size distribution of 50% or more passing the 200 sieve as well as a black cotton soil are unacceptable for backfilling. The earth shall be deposited in maximum 200mm layers, levelled, wetted if necessary and compacted properly before another layer is deposited.

iii. The back filling and grading shall be carried out to an elevation of about 75 mm. above the finished ground level to drain out water. After backfilling, 50 mm. high earthen embankments (bund) will be made along the sides of excavation pits and sufficient water will be poured in the back filled earth for at least 24 hours. After the pits have been backfilled to full depth the stub template can be removed.

iv. The stub setting templates shall be opened only after the completion of back filling.

v. After completing the stringing work, if level of back filling of some of the location gets settled and it is required to back fill the locations again, the same would be done by the contractor at no extra cost.

vi. No extra charge is admissible for carrying out the back filling of foundation pit (including backfilling from borrowed earth if required) and the cost of backfilling is included in the cost of foundations of towers.

3.7 **CURING**:- The concrete after it is 24 hours old shall be cured by keeping the concrete wet continuously for a period of 14 days after laying. The pit may be back filled with selected earth sprinkled with necessary amount of water and well consolidated in layers not exceeding 200 mm of consolidated thickness after a minimum period of 24 hours and thereafter both the back filled earth and exposed chimney top shall be kept wet for remaining period of the prescribed time of 14 days. The uncovered concrete chimney above the back filled earth shall be kept wet by providing empty cement bags dipped in water fully wrapped around the concrete chimney for curing ensuring that the bags are kept wet by frequent pouring of water on them. The contractor may use anti-curing paint.

3.7.1 **SHORING OF PITS:-**

Shoring of the pits with shuttering on the internal wall surrounding the vertical facing of approved dimensions of the pit shall be done when the soil condition is to so bad that there is likelihood of accidents due to falling of surrounding earth in foundation pit. The cost of carrying out shoring and shuttering shall be deemed to be included in the unit rate of foundation of tower and no extra payment shall be made on this account.

3.8 **TOWER EARTHING:-**

The Galvanized pipe Earthing are to be provided on two legs diagonally of the tower. Each tower shall be earthed before the foundation is casted as per tender clause 4.33 Section IV-A The tower footing resistance of all towers shall be measured in dry weather after the erection and before stringing of earth wire the counter poise earthing shall be resorted to, in accordance with the instructions of the site Engineer, in case the resistance exceeds the specified value. It shall be ensured that the tower footing resistance is less than 10 Ohms. Each tower footing resistance shall be intimated (along with tower location number) while submitting the progress report of the foundation.

3.8.1 COUNTER POISE EARTHING:-

In case of high resistivity, counter poise earthing shall be provided which consists of four lengths of galvanized steel stranded wire, each fitted with a leg / clamp for connection to the tower leg at one end. The counter poise will be laid radially away from the tower and will normally be 30 metres in length, buried to the depth of 01 meter below ground level. The length of counter poise wire may be increased if the resistance requirements are not met.

Connecting clamps shall be buried in the chimney portion of the foundation. The scope of work of connecting counter poise to the tower leg shall be deemed to be included in the cost of laying of counter poise. The counter poise connecting wire and clamps will be arranged by the contractor. The counter poise shall preferably be laid through soft areas if available. The planning of laying counter poise shall be done as per approval of site Engineer. The cost of laying of counter poise shall be inclusive of excavation and back filling work.

The contractor shall have to provide Galvanized pipe earthing at the end of each counter poise wire and this may lead to getting required soil resistivity values. This work of additional Galvanized Earthing pipe shall be done extra which shall include the cost of providing such Galvanized Earthing pipe and clamp etc The earthing of towers to be done as per I.S.S. 5613 Part II & latest revision of I.S.S.

*3.*9 BUILDING STONE REVETMENT:

Stone revetment in 1:5 cement mortars shall be constructed by the Contractor at specified locations. The detailed proposal in consultation with the site Engineer, for carrying out revetment work shall be submitted to the O/o. Chief Engineer (Trans), through concerned Superintending Engineer, EHT Construction and approval shall be obtained before carrying out revetment work. The top seal cover of revetment work shall be done with 1:2:4 normal mixes. All materials including cement shall be provided by the contractor and cost of building revetment shall be deemed to include cost of such materials also i.e. Cement, sand , metal and stone. Curing of revetment shall be done as specified for tower foundation. The back filling of the inside of the revetment wall with Soil/borrowed earth will be paid for extra on per m^3 basis and shall include its compacting and watering. The excavation for revetment foundation shall be paid at the rates as indicated by the bidder in Price Schedule. The revetment work, wherever necessary, shall have to be completed before taking up final tensioning work in the Section.

3.10 TOWER ERECTION, STRINGING AND INSTALLATION OF LINE MATERIALS

3.10.1 General

The scope of erection work shall include the cost of all labour, tools and plant such as tension stringing equipment and all other incidental expenses in connection with erection and stringing work. The stringing equipment shall be of sufficient capacity to string the bundle conductors of specified size

The Contractor shall be responsible for transportation to site of all the materials to be supplied by the Contractor as well as proper storage and preservation of the same at his own cost, till such time the erected line is taken over by the CSPTCL.

3.11 TOWER ERECTION / ASSEMBLY:-

Tower shall be erected after the concrete is at least 14 days old, but a gap of 24 days shall be preferred. The method followed for the erection of towers, shall ensure the points mentioned below:-

Straining of the members shall not be permitted for bringing them into position. It may, however, be necessary to match hole positions at joints and to facilitate this, Tommy bars not more than 450 mm. long may be used.

Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided in accordance with approved drawings.

All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up.

The bolt positions in assembled towers shall be as per I.S:5613(Part-II/ section 2).

All blank holes, if any left, after complete erection of tower, are to be filled up by nuts and bolts of correct size.

Tower shall be fitted with number, phase and danger plate which shall be arranged by the contractor.

Anti climbing Devices: Barbed wire will be used at a height of approx. 3 meters as an anti climbing measure, which shall be arranged by the contractor. At every location three layers of barbed wires will be provided each inside and outside the tower in horizontal plane. Spacing between the layers with fixing arrangements shall be provided as per the provisions of IS-5613 (Part-II/Sec.1) 1976 with latest modifications. The angle pieces with notches for accommodating barbed wire shall be supplied with the tower members. After the barbed wire is placed in position in the notches, the notch opening shall be welded to avoid the theft of barbed wire and anti-corrosive treatment with cold galvanizing paint shall be given, as also in the case of bolts to be welded. Suitable locking arrangement (pad-lock) shall also be provided.

3.12 **Treatment of Minor Galvanisation Damage**:-

Minor defects in hot-dip galvanized members shall be repaired by applying at least two coats of zinc rich primer (having approx.90% zinc content) and two coats of enamel paint to the satisfaction of the CSPTCL before erection.

3.13 **TIGHTENING PUNCHING AND WELDING OF BOLTS AND NUTS**

i. All nuts shall be tightened properly using correct sizes of spanners and torque wrench. Before tightening, it will be verified that filler (packing & spring), washers and plates are placed in relevant gaps between members; bolts of proper diameter size and length are provided and one spring washer used under each nut and in case of step bolts, spring washers shall be placed under the outer nut.

ii. The tightening shall progressively be carried out from the top downwards, care being taken that all the bolts at every level are tightened simultaneously. The threads of bolts projecting outside. The nuts shall be punched at three positions at the periphery to ensure that the nuts are not loosened in course of time. If during tightening, a nut is found to be slipping or running over the bolt threads, the bolt together with the nut shall be replaced.

iii. The threads of all the bolts projected outside the nuts shall be welded on entire circular length of the bolt. The welding shall be provided on complete bolts of tower from ground level to top level (canopy). However, for towers with +18 meter, +25 meter extension and special/ river crossing towers, the welding shall be provided from ground level to bottom cross arm level.

iv. After welding zinc-rich primer having approximately 90% zinc content shall be applied to the welded portion. At least two coats of the paint shall be applied. The surface coated with zinc rich primer shall be further applied with two finish coats of high built enamel of the grade recommended by the manufacturer of the zinc rich primer. The coat of welding and paint including application of paint shall be deemed to be included in the erection price.

STRINGING

3.14 **INSULATOR HOISTING:-**

Suspension insulator strings shall be used for suspension towers and Double tension insulator strings on tension towers. Damaged insulators and fittings, if any, shall not be employed in the assemblies. Before hoisting all insulators shall be cleaned in a manner that will not spoil, injure or scratch the surface of the insulator, but in no case shall any oil be used for the purpose. For checking and soundness of insulator, IR measurement using 5 KV (DC) Megger shall be carried out on 100% insulators. Corona control rings/arcing horn shall be fitted in an approved manner. Torque wrench shall be used for fixing various line materials and components, such as suspension clamp for conductor and earthwire, etc., whenever recommended by the manufacturer of the same.

3.15 HANDLING OF CONDUCTOR AND EARTH WIRE:-

a. Running Out of the Conductors as per IS-5613 (part 3/sec.2):1989 :

a. The conductors shall be run out of the drums form the top in order to avoid damage. Conductors do not touch & rub against the ground or object which could cause scratches or damage the conductor strand. The Contractor shall be entirely responsible for any damage to tower or

conductors during stringing.

b. A suitable braking device shall be provided to avoid damaging, loose running out and kinking of conductor. Care shall be taken that the conductors do not touch or rub against the ground or objects which could scratch or damage the strands.

c. The sequence of running out shall be from the top down in order to avoid damage due to chafing i.e. the earthwire shall be run out first followed in succession by the conductors. Unbalanced loads on towers shall be avoided as far as possible. Inner phase of line conductors shall be strung before the stringing of the outer phases is taken up.

d. The contractor shall take adequate steps to prevent clashing of sub conductors until instillation of the spacers/spacer dampers. Care shall be taken that sub conductors of a bundle are from the same Contra ctor and preferably from the same batch so that creep behaviour of sub conductors remains identical. During sagging, care shall be taken to eliminate differential sag in sub-conductors as far as possible. However, in no case shall sag mismatch be more than 25mm.

e. Towers no designed for one sided stringing shall be well guyed and steps taken by the Contractor to avoid damage. Guying proposal along with necessary calculations shall be submitted by the Contractor to Owner for approval. All expenditure related to this work is deemed to be included in the bid price and no extra payment shall be made for the same.

f. When the transmission lines runs parallel to existing energized power lines, the Contractor shall take adequate safety precautions to protect personnel; from the potentially dangerous voltage built up due to electromagnetic and electrostatic coupling in the pulling wire, conductors and earth wires during stringing operations.

g. The Contractor shall also take adequate safety precautions to protect personnel from potentially dangerous voltage build up due to distant electrical storms.

3.15.1 Running Blocks:

i. The groove of the running blocks shall be of such a design that the seat is semicircular and larger than the diameter of the conductor/earthwire and it does not slip over or rub against the slides. The grooves shall be lined and with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

ii. The running blocks shall be suspended in a manner to suit the design of the cross-arm. All running blocks, especially at the tensioning end will be fitted on the cross-arms with jute cloth wrapped over the steel work and under the slings to avoid damage to the slings as well as to the protective surface finish of the steel work.

3.16 Repairs to Conductors:

i. The conductor shall be continuously observed for loose or broken strands or any other damage during the running out operations.

ii. Repairs to conductor if necessary, shall be carried out with repair sleeve.

iii. Repairing of the conductor surface shall be carried out only in case of minor damage scuff marks, etc. The final conductor surface shall be clean, smooth and free from projections, sharp points, cuts, abrasions, etc.

iv. The Contractor shall be entirely responsible for any damage to the towers during stringing**.**

3.17 **CROSSINGS :** Derricks or other equivalent methods ensuring that normal services need not be interrupted nor damage caused to property shall be used during stringing operations where roads, channels, telecommunication liens, power lines and railway lines have to be crossed. However, shut down shall be obtained when working at crossings of overhead power lines. The Contractor shall be entirely responsible for the proper handling of the conductor, earthwire and accessories in the field.

3.18 STRINGING OF CONDUCTOR AND EARTH WIRE:-

The stringing of the conductor for 400 KV shall be done by the control tension method. The equipment shall be capable for maintaining a continuous tension per bundle such that the sag for each conductor is about twenty percent greater than the sag specified in then stringing sag table.

i. The Contractor shall give to site Engineer in Charge complete details of the stringing methods he proposes to follow. Prior to stringing the Contractor shall submit the stringing charts for the conductor and earth wire showing the initial and final sags and tension for various temperatures and spans along with equivalent spans in the lines for the approval of the Owner at least one

month in advance. The stringing shall be carried out as per the stringing chart approved by the purchaser in accordance with the relevant standard. All the tolerances for the line shall be conforming to IS 5613.

ii. A controlled stringing method suitable for simultaneous stringing of the stub conductors shall be used. The two conductors making up one phase bundle shall be pulled in a paid out simultaneously. These conductors shall be of matched length. Conductors or earth wires shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

iii. Conductor creep are to be compensated by over tensioning the conductor at a temperature of 26^0C lower than the ambient temperature or by using the initial sag and tensions indicated in the tables.

iv. Suitable guying arrangement shall be made by the Contractor to ensure safety during stringing & final sagging operation.

v. IS-5613 (part 3/sec.2):1989 shall be fallow for Stringing of conductor and earth wire.

3.19 JOINTING:

i. When approaching the end of a drum length at least three coils shall be left in place when the stringing operations are stopped. These coils are to be removed carefully, and if another length is required to be run out, a joint shall be made as per the recommendations of the accessories manufacturer.

ii. Conductor splices shall not crack or otherwise be susceptible to damage in the stringing operation. The Contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.

iii. All the joints on the conductor and earthwire shall be of the compression type, in accordance with the recommendations of the manufacturer, for which all necessary tools and equipment like compressors, dies etc., shall be obtained by the Contractor. Each part of the joint shall be cleaned by wire brush till it is free of dust or dirt etc., and be properly greased with anti-corrosive compound. If required and as recommended by the manufacturer, before the final compression is carried out with the compressors.

iv. All the joints of splices shall be made of at least 30 metres away from the structures. No joints shall be made in span crossing over main roads, railways and small rivers tension spans. Not more than one joint per sub conductor per span shall be allowed. The compression type fittings shall be of the self centering type or care shall be taken to mark the conductors to indicate when the fitting is centered properly. During compression or splicing operation; the conductor shall be handled in such a manner as to prevent lateral or vertical bearing against the dies. After compressing the joint the aluminium sleeve shall have all corners rounded, burrs and sharp edges removed and smoothened.

v. During stringing of conductor to avoid any damage to the joint, the Contractor shall use a suitable protector for mid span compression joints in case they are to be passed over pulley blocks/aerial rollers. The pulley groove size shall be such that the joint along with protection can be passed over it smoothly.

3.20 **TENSIONING & SAGGING OPERATIONS:**

i. The tensioning the sagging shall be done in accordance with the approved stringing charts or sag tables. The “initial” stringing chart shall be used for the conductor and final stringing chart for the earthwire. The conductors shall be pulled up to the desired sag and left in running blocks for at least one hour after which the sage shall be rechecked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamp. The conductor shall be clamped within 56 hours of sagging in.

ii. The sag will be checked in the first and the last section span for sections up to eight spans, and in one additional intermediate span for sections with more than eight spans. The sag shall also be checked when the conductors have been drawn up and transferred from running blocks to the insulator clamps.

iii. The running blocks, when suspended from the transmission structure for sagging, shall be so adjusted that the conductors on running blocks will be at the same height as the suspension clamp to which hit is to be secured.

iv. At sharp vertical angles, conductor and earthwire sags and tensions shall be checked for equality on both sides of the angle and running block. The suspension insulator assemblies will normally assume vertically when the conductor is clamped.

v. Tensioning and sagging operations shall be carried out in calm whether when rapid changes in temperature are not likely to occur.

3.21 **CLIPPING IN:-**

i. Clipping of the conductors in position shall be done in accordance with manufacturer's recommendation and approved by our Engineer. At suspension location free centre type suspension clamp with armour rod set or A.G.S. type suspension clamps shall be used.

ii. The jumpers at the section and angle towers shall be formed to parabolic shape to ensure maximum clearance requirements. Pilot suspension insulator string shall be used, if found necessary, to restrict the jumper swing to the design values.

iii. Fasteners in all fittings and accessories shall be secured in position. The necessary clip shall be properly opened and sprung into position.

3.22 **FIXING OF CONDUCTORS AND EARTH WIRE ACCESSORIES:-**

Conductor and earth wire accessories including spacers, bundle spacer (for bundle conductor) and vibration dampers shall be installed by the Contractor as per the design requirements and manufacturer's instruction within 24 hours of the conductor/earth wire clampingand as per instruction of the Engineer. While installing the conductor and earth wire accessories, proper care shall be taken to ensure that the surfaces are clean and smooth and no damage shall occur to any part of the accessories or of the conductors. Torque wrench shall be used for fixing the Dampers, suspension clamps etc. and torque recommended by the manufacturer of the same shall be applied.

3.23 **REPLACEMENT:-** If any replacement are to be effected after stringing and tensioning or during maintenance, leg members and bracings shall not be removed without reducing the tension on the tower with proper guying or releasing the conductor. If the replacement of cross arm becomes necessary after stringing, the conductor shall be suitably tied to the tower at tension points or transferred to suitable roller pulleys at suspension points.

3.24 **ELECTRICAL INSPECTOR'S INSPECTION FEES:-**

Electrical inspector's inspection fees to be deposited by the contractor and he has to obtain the clearance from Electrical Inspector before charging the line.

3.25 **FINAL CHECKING, TESTING & COMMISSIONING:-**

After completion of the works, final checking of the line shall be done by the contractor to ensure that all the foundation works; tower erection and stringing have been done strictly in accordance with the specifications and as approved by the Board. All works shall be thoroughly inspected keeping in view of the following main points:-

i) Sufficient back filled earth is lying over each foundation pit and it is adequately compacted.

ii) Concrete chimneys and their copings are in good finely shaped conditions.

iii) All the tower members are correctly used, strictly according to the approved drawing and are free from defects or damages, what-so-ever.

iv) All bolts are properly tightened, punched, and tack-welded and painted with zinc rich paint.

v) The stringing of conductors and earth wire has been done as per the approved sag and tension charts and desired clearances are clearly available.

vi) All conductor and earth wire accessories are properly installed.

vii) All other requirements to complete the work like fixing the danger plate, phase plate, number plate, anti-climbing devices, aviation signal (wherever required) etc. are properly installed. The double coded painting has been done where required as per

aviation rules.

viii) Wherever required, it should be ensured that revetment is provided.

ix) The line insulation is tested by the contractor by providing his own equipment, labour etc. to the satisfaction of the Board to ascertain the insulation conditions of the line.

x) The original tracings of profile and route alignment as well as tower design, structural drawings, bill of material and shop drawings of all towers with all extensions are submitted to the Owner for reference and record.

xi) All towers are properly grounded.

xii) Conductor continuity test is carried out to verify that each conductor of the over head line is properly connected electrically.

xiii) The line may be charged at a low value of power, frequency, voltage for the purpose of testing.

Xiv) The contractor should also fulfill the requirements of pre-commissioning procedure as given this tender Specification.

3.26 COMPLETION DESIGN:-

The contractors have to supply free of cost complete drawing and information to the Engineer in Charge:-"Complete as executed drawing of the line showing each and every structure as actually erected, double insulator points, roads and railway crossings, together with measured spans. All major or small river crossings shall also be indicated. At all deviation points the angles shall be marked in degrees. All kutcha and metalled roads, trees, structures, ponds and other obstructions etc. within 46 meters on either side of the route shall be clearly indicated. The drawings shall be drawn on good quality tracing cloth. These drawings shall also show any communication or Power lines within 50 meters on either side of the line."

3.27 FIELD QUALITY PLAN

The contractor shall perform the construction/Erection work of line as per standard Field Quality Plan provided by CSPTCL.

SECTION – III

PRICE VARIATION FORMULAE FOR EHV SUBSTATION EQUIPMENTS AND LINE MATERIALS

ANNEXURE –PV-1

PRICE VARIATION FORMULA FOR POWER TRANSFORMERS

CIN No. U99999MH1970GAPO14629

ieema
your link to electricity

Indian Electrical & Electronics Manufacturer's Association
501, Kakad Chambers
132, Dr. A. B. Road, Worli,
Mumba i 400 018
India
P +91 22 2493 0532
F +91 22 2493 2705
E mumbai@ieema.org
W www.ieema.org

IEEMA/PVC/PWR TRF_upto 400 KV/2015

Effective from: 1st April 2015

PRICE VARIATION CLAUSE FOR POWER TRANSFORMERS AND REACTORS COMPLETE WITH ALL ACCESSORIES AND COMPONENTS of ratings above 10 MVA or voltage above 33 kV up to 400 kV Of supplied against domestic contracts

This price variation clause is applicable for 'Power Transformers', ratings above 10 MVA or voltage above 33 kV up to 400 kV. The clause is to be used for domestic contracts. A separate price variation IEEMA/PVC/PWR TRF_upto 400 KV/DE/2015has been evolved for above types of Transformers supplied against export/deemed export contracts under special imprest licensing scheme.

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(10 + 29\frac{C}{C_0} + 27\frac{ES}{ES_0} + 7\frac{IS}{IS_0} + 5\frac{IM}{IM_0} + 7\frac{TO}{TO_0} + 15\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

C_0 = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, **ONE** month prior to the date of tendering.

ES_0 = Price of CRGO Electrical Steel Lamination (refer note)
This price is as applicable on the 1st working day of the month, **ONE** months prior to the date of tendering.

IS_0 = Average price of steel Plates 10 mm thick (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of tendering.

IM_0 = Price of Insulating Materials (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** months prior to the date of tendering.

TO_0 = Price of Transformer Oil (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)
This index number is as applicable on the first working day of the month, **THREE** months prior to the date of tendering.

HEAD OFFICE - DELHI
Rishyamook Building, First Floor, 85 A, Panchkuian Road, New Delhi 110001
P +91 11 2336 3013 / 14 • F +91 11 2336 3015 • E delhi@ieema.org • W www.ieema.org

CIN No. U99999MH1970GAPO14629

ieema
your link to electricity

Indian Electrical & Electronics Manufacturer's Association
501, Kakad Chambers
132, Dr. A. B. Road, Worli,
Mumba i 400 018
India
P +91 22 2493 0532
F +91 22 2493 2705
E mumbai@ieema.org
W www.ieema.org

For example, if date of tendering falls in June 2015, applicable prices of Copper Wire Bars (C_0), Transformer Oil (TO_0), Steel Plates 10 mm thick (IS_0), CRGO Electrical Steel Laminations (ES_0) and Insulating material (IM_0) should be as on 1st May 2015 and all India average consumer price index no. (W_0) should be for the month of 1st March 2015.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/PWR_TRF/_/_ **ONE** month prior to the date of tendering.

C = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, **TWO** months prior to the date of delivery.

ES = Price of CRGO Electrical Steel Lamination (refer note)
This price is as applicable on the 1st working day for the month, **TWO** months prior to the date of delivery.

IS = Average price of Steel Plates 10 mm thick (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of prior to the date of delivery.

IM = Price of Insulating Materials (refer notes)
This price is as applicable on the 1st working day of the month, **TWO** months prior to the date of delivery.

TO = Price of Transformer Oil (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)
This index number is as applicable on the first working day of the month, **THREE** months prior to the date of delivery.

For example, if date of delivery in terms of clause given below falls in December 2015, applicable prices of Copper Wire Bars (C), Insulating material (IM), CRGO Electrical Steel Lamination (ES) should be as on 1st October 2015 and Transformer Oil (TO), Plates 10 mm thick (IS) should be 1st November 2015 and all India average consumer price index no. (W) should be for the month of September 2015.

The date of delivery is the date on which the transformer is notified as being ready for inspection/despatch (in the absence of such notification, the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

HEAD OFFICE - DELHI
Rishyamook Building, First Floor, 85 A, Panchkuian Road, New Delhi 110001
P +91 11 2336 3013 / 14 • F +91 11 2336 3015 • E delhi@ieema.org • W www.ieema.org

CIN No. U99999MH1970GAPO14629

ieema
your link to electricity

Indian Electrical & Electronics Manufacturer's Association
501, Kakad Chambers
132, Dr. A. B. Road, Worli,
Mumba i 400 018
India
P +91 22 2493 0532
F +91 22 2493 2705
E mumbai@ieema.org
W www.ieema.org

IEEMA/PVC/PWR TRF_upto 400 KV/2015

Effective from: 1st April 2015

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes, octroi etc. transformers manufacturers import major raw materials like Copper, CRGO Steel Sheets and Plates etc. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:

1. The LME price of Copper Wire Bars (in Rs./MT) is the LME average settlement price of Copper Wire Bars converted into Indian Rupees with applicable average exchange rate of SBI of the month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
2. The price of CRGO is the price of CRGO Electrical Steel Lamination in Rs./MT suitable for Transformers of rating above 10 MVA or voltage above 33 kV up to 400 kV
3. Price of steel is the average retail price of steel plates 10 mm thick as published by Joint Plant Committee (JPC) in Rs./MT as on 1st working day of the month.
4. The price of Insulting materials (in Rs./Kg) of pre-compressed pressboards of size 10 mm thick, 3200 mm x 4100 mm is the average C&F price in free currency per MT converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month as quoted by primary suppliers. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.
5. The price of Transformer Oil (in Rs./K.Ltr) is the average price on ex-refinery basis as quoted by primary producers for supply in drums.

(d) Some purchasers are purchasing oil immersed Transformers from manufacturers without first filling of oil. Oil for first filling is procured and filled by the purchasers. For such supplies PVC formula, excluding Oil will apply as under:

$$P = \frac{P_0}{93}\left(10 + 29\frac{C}{C_0} + 27\frac{ES}{ES_0} + 7\frac{IS}{IS_0} + 5\frac{IM}{IM_0} + 15\frac{W}{W_o}\right)$$

Where description of P, P_0, C, ES, IS, IM, W etc. remains same as mentioned earlier.

Deputy Director General

IEEMA/PVC/PWR TRF_upto 400 KV2015/3/3

ANNEXURE –PV-2
PRICE VARIATION FORMULA FOR INSTRUMENT TRANSFORMERS (BELOW 72.5 KV)

IEEMA
Your Link to Electricity

IEEMA/PVC/INST.TR (BELOW 72.5 KV)/2005 Effective from: 1st June 2005

PRICE VARIATION CLAUSE FOR INSTRUMENT TRANSFORMERS BELOW 72.5 KV
(Current and Potential Transformers designed for operation on system voltage below 72.5 KV)

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(18 + 18\frac{C}{C_0} + 20\frac{ES}{ES_0} + 10\frac{IS}{IS_0} + 12\frac{ER}{ER_0} + 09\frac{TB}{TB_0} + 13\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

C_0 = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, two months prior to the date of tendering.

ES_0 = C&F price of CRGO Electrical Steel Sheets (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

IS_0 = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100)' (refer notes)
This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of tendering.

ER_0 = Price of Epoxy Resin (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tending.

TB_0 = Price of Transformer Oil Base Stock (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100)
This index number is as applicable on the first working day of the month, three months prior to the date of tendering.

For example, if date of tendering falls in October 2005, the applicable prices of Copper Wire Bars (C_0) and Transformer Oil Base Stock (TB_0) should be for the month August 2005, where as the applicable price of CRGO Electrical Steel Sheets (ES_0) and Epoxy Resin (ER_0) should be as on 1st September 2005 and Wholesale price index number for 'Iron & Steel' (IS_0) should be for the week ending first Saturday of July 2005 and all India average consumer price index number (W_0) should be for the month of July 2005.

Reply to: IEEMA/PVC/INST.TR (BELOW 72.5 KV)/2005/01/03

501, Kakad Chambers, 132, Dr. Annie Besant Road, Worli, Mumbai 400 018, India
Tel: +91 (0) 22 2493 0532 Fax: +91 (0) 22 2493 2705 E-mail: mumbai@ieema.org

204, Swiss Complex, 33, Race Course Road, Bangalore 560 001, India
Tel: +91 (0) 80 2220 1316 Fax: +91 (0) 80 2220 1317 E-mail: bangalore@ieema.org

804, Surya Kiran, 19, Kasturba Gandhi Marg, New Delhi 110 001, India
Tel: +91 (0) 11 2373 3013 Fax: +91 (0) 11 2373 3015 E-mail: delhi@ieema.org

5G, Hastings Chambers, 7C, Kiron Sankar Roy Road, Kolkata 700 001, India
Tel: +91 (0) 33 2213 1326 Fax: +91 (0) 33 2213 1326 E-mail: kolkata@ieema.org

www.ieema.org / www.elecrama.com

Indian Electrical & Electronics Manufacturers' Association
An ISO 9001 Organisation

IEEMA/PVC/INST.TR (BELOW 72.5 KV)/2005 Effective from: 1st June 2005

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/CTPT/_/_ prevailing as on first working day of the month ..... i.e., one month prior to the date of tendering.

C = Average LME settlement price of copper wire bars (refer notes)

This price is as applicable for the month, two months prior to the date of delivery.

ES = C&F price of CRGO Electrical Steel Sheets (refer note)

This price is as applicable on the 1st working day for the month, one month prior to the date of delivery.

IS = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100)' (refer notes)

This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of delivery.

ER = Price of Epoxy Resin (refer notes)

This price is as applicable on the 1st working day of the month, one month prior to the date of delivery.

TB = Price of Transformer Oil Base Stock (refer notes)

This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100)

This index number is as applicable on the first working day of the month, three months prior to the date of delivery.

For example, if date of delivery in terms of clause given below falls in December 2005, the applicable prices of Copper Wire Bars (C) and Transformer Oil Base Stock (TB) should be for the month October 2005; where as applicable prices of CRGO Electrical Steel Sheets (ES) and Epoxy Resin (ER) should be as on 1st November 2005 and Wholesale price index number for 'Iron & Steel' (IS) should be for the week ending first Saturday of September 2005 and all India average consumer price index number (W) should be for the month of September 2005.

The date of delivery is the date on which the instrument transformer is notified as being ready for inspection/despatch (in the absence of such notification, the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes; octroi etc. Instrument transformers manufacturers import major raw materials like Copper, CRGO Electrical Steel Sheets and TOBS etc. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.

(b) All prices are as on first working day of the month.

IEEMA/PVC/INST.TR (BELOW 72.5 KV)/2005/02/03

IEEMA/PVC/INST.TR (BELOW 72.5 KV)/2005 Effective from: 1st June 2005

(c) The details of prices are as under:

1) The LME price of Copper Wire Bars (in Rs./MT) is the LME average settlement price of Copper Wire Bars for one month prior to the month of the circular converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the subsequent month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

2) The price of CRGO Electrical Steel Sheets (in Rs./MT) is the average CIF price in US $ per MT converted into Indian Rupees with applicable exchange rate prevailing as on 1st working day of the month, as quoted by primary producers. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

3) The wholesale price index number for 'Iron & Steel' is as published by the Office of Economic Advisor, Ministry of Industry, Govt. of India, New Delhi with base 1993-94=100. This wholesale price index number is being published weekly on provisional basis. However, the same gets finalized after eight weeks and is normally available after two months. Therefore, we are considering in our calculations this final index for the first Saturday of the months two months prior to the date of which the prices of other raw materials such as Al, IM are published for the corresponding month.

4) The price of Epoxy resin is price quoted by resin manufacturer for their grade CT 5900 or its nearest equivalent.

5) The price of TOBS is C&F price (in Rs./K.Ltr) for Group II grade 70 Base Oil as published in ICIS-LOR bulletin for the 1st week of the previous month. This price is normally published in US$ per US Gallon, which is converted in Rs./K.Ltr with applicable exchange rate prevailing on 1st working day of the subsequent month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

Authorized Signatory

IEEMA/PVC/INST.TR (BELOW 72.5 KV)/2005/03/03

(72.5 KV & ABOVE)

IEEMA
Your Link to Electricity

IEEMA/PVC/INST.TR (72.5 KV AND ABOVE)/2005 Effective from: 1st June 2005

PRICE VARIATION CLAUSE FOR INSTRUMENT TRANSFORMERS 72.5 KV AND ABOVE
(Current and Potential Transformers designed for operation on system voltage 72.5 KV and above)

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(18 + 13\,\frac{C}{C_0} + 12\,\frac{ES}{ES_0} + 12\,\frac{IS}{IS_0} + 23\,\frac{IM}{IM_0} + 6\,\frac{TB}{TB_0} + 16\,\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

C_0 = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, two months prior to the date of tendering.

ES_o = C&F price of CRGO Electrical Steel Sheets (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

IS_o = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100)' (refer notes)
This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of tendering.

IM_0 = IEEMA Index for Insulator (Base: January 2003=100) (refer notes)
This index is as applicable on the 1st working day of the month, one month prior to the date of tending.

TB_0 = Price of Transformer Oil Base Stock (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100)
This index number is as applicable on the first working day of the month, three months prior to the date of tendering.

For example, if date of tendering falls in October 2005, the applicable prices of Copper Wire Bars (C_0) and Transformer Oil Base Stock (TB_0) should be for the month August 2005, where as the applicable price of CRGO Steel Sheets (ES_0) and IEEMA Index for Insulator (IM_0) should be as on 1st September 2005 and Wholesale price index number for 'Iron & Steel' (IS_0) should be for the week ending first Saturday of July 2005 and all India average consumer price index number (W_0) should be for the month of July 2005.

IEEMA/PVC/INST.TR (72.5 KV AND ABOVE)/2005/01/03

Reply to:

501, Kakad Chambers,
132, Dr. Annie Besant Road,
Worli, Mumbai 400 018, India
Tel: +91 (0) 22 2493 0532
Fax: +91 (0) 22 2493 2705
E-mail: mumbai@ieema.org

204, Swiss Complex,
33, Race Course Road,
Bangalore 560 001, India
Tel: +91 (0) 80 2220 1316
Fax: +91 (0) 80 2220 1317
E-mail: bangalore@ieema.org

804, Surya Kiran,
19, Kasturba Gandhi Marg,
New Delhi 110 001, India
Tel: +91 (0) 11 2373 3013
Fax: +91 (0) 11 2373 3015
E-mail: delhi@ieema.org

5G, Hastings Chambers,
7C, Kiron Sankar Roy Road,
Kolkata 700 001, India
Tel: +91 (0) 33 2213 1326
Fax: +91 (0) 33 2213 1326
E-mail: kolkata@ieema.org

www.ieema.org / www.elecrama.com

Indian Electrical & Electronics Manufacturers' Association
An ISO 9001 Organisation

IEEMA/PVC/INST.TR (72.5 KV AND ABOVE)/2005 Effective from: 1st June 2005

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/CTPT/_/_ prevailing as on first working day of the month ..... i.e., one month prior to the date of tendering.

C = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, two months prior to the date of delivery.

ES = C&F price of CRGO Electrical Steel Sheets (refer note)
This price is as applicable on the 1st working day for the month, one month prior to the date of delivery.

IS = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100)' (refer notes)
This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of delivery.

IM = IEEMA Index for Insulator (Base: January 2003=100) (refer notes)
This index is as applicable on the 1st working day of the month, one month prior to the date of delivery.

TB = Price of Transformer Oil Base Stock (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100)
This index number is as applicable on the first working day of the month, three months prior to the date of delivery.

For example, if date of delivery in terms of clause given below falls in December 2005, the applicable prices of Copper Wire Bars (C) and Transformer Oil Base Stock (TB) should be for the month October 2005; where as applicable prices of CRGO Electrical Steel Sheets (ES) and IEEMA Index for Insulator (IM) should be as on 1st November 2005 and Wholesale price index number for 'Iron & Steel' (IS) should be for the week ending first Saturday of September 2005 and all India average consumer price index number (W) should be for the month of September 2005.

The date of delivery is the date on which the instrument transformer is notified as being ready for inspection/despatch (in the absence of such notification, the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes; octroi etc. Instrument transformers manufacturers import major raw materials like Copper, CRGO Electrical Steel Sheets and TOBS etc. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.

(d) All prices are as on first working day of the month.

IEEMA/PVC/INST.TR (72.5 KV AND ABOVE)/2005/02/03

IEEMA/PVC/INST.TR (72.5 KV AND ABOVE)/2005 Effective from: 1st June 2005

(e) The details of prices are as under:

1) The LME price of Copper Wire Bars (in Rs./MT) is the LME average settlement price of Copper Wire Bars for one month prior to the month of the circular converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the subsequent month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

2) The price of CRGO Electrical Steel Sheets (in Rs./MT) is the average C&F price in US $ per MT converted into Indian Rupees with applicable exchange rate prevailing as on 1st working day of the month, as quoted by primary producers. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

3) The wholesale price index number for 'Iron & Steel' is as published by the Office of Economic Advisor, Ministry of Industry, Govt. of India, New Delhi with base 1993-94=100. This wholesale price index number is being published weekly on provisional basis. However, the same gets finalized after eight weeks and is normally available after two months. Therefore, we are considering in our calculations this final index for the first Saturday of the months two months prior to the date of which the prices of other raw materials such as Al, IM are published for the corresponding month.

4) IEEMA Index for Insulator (Base January 2003=100) is published in basic price circular for Insulator vide reference IEEMA (PVC)/INSLR/--/-- applicable for IEEMA price variation clause for Insulator viz. IEEMA (PVC)/INSLR effective from 01st April 2003.

5) The price of TOBS is C&F price (in Rs./K.Ltr) for Group II grade 70 Base Oil as published in ICIS-LOR bulletin for the 1st week of the previous month. This price is normally published in US$ per US Gallon, which is converted in Rs./K.Ltr with applicable exchange rate prevailing on 1st working day of the subsequent month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

Authorized Signatory

IEEMA/PVC/INST.TR (72.5 KV AND ABOVE)/2005/03/03

ANNEXURE – PV-3

PRICE VARIATION FORMULA FOR COUPLING CAPACITOR

ieema
your link to electricity
501 kakad chambers
132 dr. a. b. road, worli,
mumbai 400 018
india
p +91 22 2493 0532
f +91 22 2493 2705
e mumbai@ieema.org
w www.ieema.org

IEEMA/PVC/CAP_PWR/2009

Effective from: 1st July 2009

PRICE VARIATION CLAUSE FOR POWER CAPACITORS

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(18 + 16\frac{CO}{CO_0} + 17\frac{AF}{AF_0} + 26\frac{BO}{BO_0} + 23\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

CO_0 = Price of Non-PCB Condenser Oil (refer notes)
This price is as applicable for the month, one month prior to the date of tendering.

AF_0 = Average LME settlement price of Aluminium (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

BO_0 = Price of BOPP Film (refer notes)
This price is as applicable for the month, one month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)
This index number is as applicable on the first working day of the month, three months prior to the date of tendering.

For example, if date of tendering falls in October 2010, the applicable prices of Non-PCB Condenser Oil (CO_0), LME average settlement price of Aluminium (AF_0) and BOPP Film (BO_0) should be for the month September 2010, and all India average consumer price index number (W_0) should be for the month of July 2010.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/CAP_PWR/_/_ prevailing as on first working day of the month ..... i.e., one month prior to the date of tendering.

CO = Price of Non-PCB Condenser Oil (refer notes)
This price is as applicable for the month, one month prior to the date of delivery.

AF = Average LME settlement price of Aluminium (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of delivery.

IEEMA/PVC/CAP_PWR/2009/01/02

delhi
804, surya kiran,
19, kasturba gandhi marg,
new delhi 110 001, india
p +91 11 2373 3013 / 14
f +91 11 2373 3015
e delhi@ieema.org

bangalore
204, swiss complex,
33, race course road,
bangalore 560 001, india.
p +91 80 2220 1316 / 1318
f +91 80 2220 1317
e bangalore@ieema.org

kolkata
503a, oswal chambers,
2, church lane,
kolkata - 700 001, india
p +91 33 6510 7855
f +91 33 2213 1326
e kolkata@ieema.org

indian electrical & electronics manufacturers' association

ieema
your link to electricity

IEEMA/PVC/CAP_PWR/2009 Effective from: 1st July 2009

BO = Price of BOPP Film (refer notes)

This price is as applicable for the month, one month prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)

This index number is as applicable on the first working day of the month, three months prior to the date of delivery.

For example, if date of delivery in terms of clause given below falls in December 2010, the applicable prices of Non-PCB Condenser Oil (CO), LME average settlement price of Aluminium (AF) and BOPP Film (BO) should be for the month November 2010, and all India average consumer price index number (W) should be for the month of September 2010.

The date of delivery is the date on which the Power Capacitor is notified as being ready for inspection/dispatch. In the absence of such notification, the date of manufacturer's dispatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes; octroi etc. Power Capacitor manufacturers import major raw materials like Non-PCB Condenser Oil, Aluminium Foil and BOPP Film. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:

1) The Non-PCB Condenser Oil price (in Rs./MT) is Jarylec Base Oil Grade- C101D as received from an imported supplier in foreign currency. The price is converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

2) The LME price of Aluminium (in Rs./MT) is the LME average settlement price of Aluminium converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

3) The BOPP Film price of 10 micron thickness (in Rs./Kg) is as received from an imported supplier in foreign currency. The price is converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

Authorized Signatory

IEEMA/PVC/CAP_PWR/2009/02/02

ANNEXURE –PV- 4
PRICE VARIATION FORMULA FOR ISOLATORS AND SWITCHGEARS ABOVE36KV

ieema
your link to electricity

501 kakad chambers
132 dr. a. b. road, worli,
mumbai 400 018
india

p +91 22 2493 0532
f +91 22 2493 2705
e mumbai@ieema.org
w www.ieema.org

IEEMA/PVC/HT-SWGR (ABOVE 36KV)/2007 Effective from: 1st June 2007

PRICE VARIATION CLAUSE FOR HT SWITCHGEAR AND CONTROLGEAR (ABOVE 36KV)

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula.

The price variation clause is split up into two parts. Part-I is for indigenous content of the switchgear and Part-II is for the import content of the switchgear.

Part-I: Part variation clause for indigenous content of the switchgear (above 36KV)

$$P = \frac{P_0}{100}\left(19 + 17\frac{IS}{IS_0} + 17\frac{C}{C_0} + 13\frac{AL}{AL_0} + 19\frac{IN}{IN_0} + 15\frac{W}{W_0}\right) - P_0$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

IS_0 = Wholesale price index number for 'Iron & Steel (Base: 1993-94=100)' (refer notes)
This index number is as applicable for the week ending 1st Saturday of the month, three months prior to the date of tendering.

C_0 = Average LME settlement price of copper wire bars (refer notes)
This price is as applicable for the month, two months prior to the date of tendering.

AL_0 = Price of Busbar grade Aluminium (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

IN_0 = IEEMA Index for Insulator (Base: January 2003=100) (refer notes)
This index number is as applicable on the 1st working day of the month, one month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 2001 = 100)
This index number is as applicable on the first working day of the month, four months prior to the date of tendering.

For example, if date of tendering falls in May 2006, the applicable prices of average LME Copper Wire Bars (C_0) should be for the month March 2006, where as the applicable price of Busbar grade Aluminium (AL_0) and IEEMA index of Insulator (IN_0) should be as on 1st April 2006 and Wholesale price index number for 'Iron & Steel' (IS_0) should be for the week ending first Saturday of February 2006 and all India average consumer price index no. (W_0) should be for the month of January 2006.

delhi
804, surya kiran,
19, kasturba gandhi marg,
new delhi 110 001, india.
p +91 11 23733013/14,
f +91 11 23733015
e delhi@ieema.org

bangalore
204, swiss complex,
33, race course road,
bangalore 560 001, india.
p +91 80 2220 1316/1318
f +91 80 2220 1317
e bangalore@ieema.org

kolkata
503a, oswal chambers,
2, church lane,
kolkata - 700 001, india
p +91 33 22131326
f +91 33 22131326
e kolkata@ieema.org

Indian Electrical & Electronics Manufacturers' Association

IEEMA/PVC/HT-SWGR (ABOVE 36KV)/2007 Effective from: 1st June 2007

E = IEEMA's Banker's selling rate of exchange between foreign currency and Indian Rupees expressed in concerned foreign currency equivalent to Rupees 100 prevailing on the first Bankers working day four months prior to the date of delivery (refer notes)

D = Effective import duty rate in percentage (Excluding duties set off against MODVAT) as per item no. 85.38 of customs tariff act in so far as it applies to the parts of customs tariff item 85.35 prevailing on 1st working dat of the calendar month, two months prior to the date of delivery.

D_0 = Effective import duty rate in percentage (Excluding duties set off against MODVAT) as per item no. 85.38 of customs tariff act in so far as it applies to the parts of customs tariff item 85.35 prevailing on 1st working dat of the calendar month, one month prior to the date of tendering.

EC = Rate of exchange between foreign currency and Indian Rupees expressed in foreign currency equivalent to Rs. 100/- adopted by Customs prevailing on first working day of the calendar month, two months prior to the date of delivery (refer notes)

EC_0 = Rate of exchange between foreign currency and Indian Rupees expressed in foreign currency equivalent to Rs. 100/- adopted by Customs prevailing on first working day of the calendar month, one month prior to the date of tendering (refer notes)

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes, octroi etc. transformers manufacturers import major raw materials like Copper, CRGO Steel Sheets, TOBS and Insulating pressboards etc. The landed cost of these imported raw materials includes applicable custom duty but exclusive of modvatable CVD.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:

1) The wholesale price index number for 'Iron & Steel' is as published by the Office of Economic Advisor, Ministry of Industry, Govt. of India, New Delhi with base 1993-94=100. This wholesale price index number is being published weekly on provisional basis. However, the same gets finalized after eight weeks and is normally available after two months. Therefore, we are considering in our calculations this final index for the first Saturday of the months two months prior to the date of which the prices of other raw materials such as Al, IN are published for the corresponding month.

2) The LME price of Copper Wire Bars (in Rs./MT) is the LME average settlement price of Copper Wire Bars for one month prior to the month of the circular converted into Indian Rupees with applicable exchange rates prevailing as on 1st working day of the subsequent month. This price is the landed cost, inclusive of applicable customs duty only but exclusive of countervailing duty.

3) The price of Busbar grade Aluminium (in Rs./MT) is the average Ex-works price as quoted by primery producer of the Busbar size 152.4 x 6.35 mm flat approx. of grade equivalent to E91E as per IS 5082-1981 or latest.

4) The exchange rates that would be published by IEEMA would be for the following currencies only.
1) US Dollars 2) Pound Sterling 3) Japanese Yen 4) Euro

Authorized Signatory

PRICE VARIATION FORMULA FOR ISOLATORS AND SWITCHGEARS (BELOW 36 KV)

Indian Electrical & Electronics Manufacturers' Association
501, Kakad Chambers, 132, Dr. Annie Besant Road, Worli, Mumbai 400 018.
Tel: +91 (0) 22 493 6528, 493 6529 • Fax: +91 (0) 22 493 2705.
E-Mail: mumbai@ieema.org • website: http://www.ieema.org

IEEMA/PVC/SWGR/2001 (R-1) *Effective from : 1st January, 2002*

PRICE VARIATION CLAUSE FOR SWITCHGEAR AND CONTROLGEAR

The price quoted/confirmed is based on the cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials / components and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and Index number, the price payable shall be subject to adjustment up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(25 + 17\,\frac{IS}{IS_0} + 18\,\frac{C}{C_0} + 10\,\frac{Al}{Al_0} + 13\,\frac{In}{In_0} + 17\,\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with above formula.

P_0 = Price quoted/confirmed.

IS_0 = Wholesale price index of 'Iron and Steel' (base: 1993-94 = 100) (refer notes).
This index is as applicable on the first week ending Saturday of the month, three months prior to the date of tendering.

C_0 = Price of electrolytic copper wire bars (refer notes).
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

Al_0 = Price of busbar grade aluminium (refer notes).
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

In_0 = Price of phenolic moulding powder for switchgear and controlgear of medium/lower voltage (upto 650 volts) or price of epoxy resin for HT switchgear (above 650 volts) (refer notes).
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100).
This index number is as applicable for the month, four months prior to the date of tendering.

For example, if the date of tendering falls in May 2001, the applicable prices of electrolytic copper wire bars (C_0), busbar grade aluminium (Al_0) and insulating material (In_0) should be for the month of April 2001 and wholesale price index of 'Iron and Steel' (IS_0) should be for the first week ending Saturday of February 2001 and all India average consumer price index number (W_0) should be for the month of January 2001.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)SWGR/_/_ prevailing as on first working day of the month ..... i.e., one month prior to the date of tendering.

IS = Wholesale price index of 'Iron and Steel' (base: 1993-94 = 100) (refer notes).
This index is as applicable on the first week ending Saturday of the month, four months prior to the date of delivery.

C = Price of electrolytic copper wire bars (refer notes).
This price is as applicable on the first working day of the month, two months prior to the date of delivery.

IEEMA/PVC/SWGR/1/2

Al = Price of busbar grade aluminium (refer notes).
This price is as applicable on the first working day of the month, two months prior to the date of delivery.

In = Price of phenolic moulding powder for switchgear and controlgear of medium/lower voltage (upto 650 volts) or price of epoxy resin for HT switchgear (above 650 volts) (refer notes).
This price is as applicable on the first working day of the month, two months prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100).
This index number is as applicable for the month, five months prior to the date of delivery.

For example, if the date of delivery in terms of clause given below falls in December 2001 the applicable price of raw materials viz: C, Al and In should be for the month of October 2001 and wholesale price index of 'Iron and Steel' (IS) should be for the first week ending Saturday of August 2001 all India average consumer price index number (W) should be for the month of July 2001.

The "date of delivery" is the date on which the switchgear equipment is notified as being ready for inspection/despatch. (In the absence of such notification the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes, octroi etc.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:

1) The wholesale price index number for 'Iron and Steel' is as published by the office of Economic Advisor, Ministry of Industry, Govt. of India, New Delhi, with base 1993-94 = 100. This wholesale price index is being published weekly on provisional basis. However, the same gets finalised after eight weeks and is normaly available after two months. Therefore, we are considering in our calculations this final index published by Economic Advisor for the first Saturday of the months two months prior to the date of which the prices of other raw materials such as C, Al and In are published for the corresponding month.

2) The price for electrolytic copper wire bars (in Rs/MT) is ex-godown price as quoted by the primary producer of copper.

3) The price of busbar grade aluminium (in Rs/MT) is the average of ex-works price as quoted by the two primary producers for the busbar size 152.4 x 6.35 mm flat approxi mately, of grade equivalent to E91E as per IS 5082-1981 (or the latest).

4) The price of insulating material (in Rs/Kg)

is the average price of phenolic moulding powder quoted by three manufacturers. (for switchgear and controlgear of medium/lower voltage upto 650 volts). **or**

is the price of epoxy resin quoted by a resin manufacturer for their grade CT 5900 or its nearest equivalent. (for HT switchgear above 650 volts).

For Indian Electrical & Electronics Manufacturers' Association

Authorised Signatory

ANNEXURE –PV - 5

PRICE VARIATION FORMULA FOR LIGHTING ARRESTORS

IEEMA
Indian Electrical & Electronics Manufacturers' Association
501, Kakad Chambers, 132, Dr. A. Besant Road, Worli, Mumbai 400 018, India.
Tel: +91 (0) 22 493 6528, 493 6529. Fax: +91 (0) 22 493 2705. E-Mail: mumbai@ieema.org
website: http://www.ieema.org
ISO 9002

IEEMA/PVC/ARSTR/2001 Effective from : 1st September 2001

PRICE VARIATION CLAUSE FOR ZINK OXIDE GAPLESS LIGHTNING ARRESTER

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below in case of any variation in these raw material prices/indices, the price payable shall be subject to adjustment up or down, in accordance with the following formula:

$$P = \frac{P_0}{100}\left[20 + 15\frac{ZN}{ZN_0} + 15\frac{CO}{CO_0} + 10\frac{BI}{BI_0} + 10\frac{BC}{BC_0} + 10\frac{FP}{FP_0} + 15\frac{W}{W_0} + 5\frac{AL}{AL_0}\right]$$

Wherein,

P = Price payable as adjustable in accordance with the above formula.

P_0 = price quoted/confirmed

ZN_o = Price of electrolytic high grade zinc (refer note).
This price is as applicable on the first working day or the month, one month prior to the date of tendering.

CO_o = Price of Cobalt (refer notes)
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

BI_o = Price of Bismuth (refer notes)
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

BC_o = Price of Ball Clay (refer notes)
This price is as applicable on the first working day of the month, one month prior to the date of tendering.

AL_o = Price of Aluminium Ingots (refer notes)
This price is as applicable as the 1st working day of the month, one month prior to he date of tendering.

FP_o = Wholesale price index number for fuel, power, Light & Lubricants (refer notes).
This index number is as applicable for the 1st Saturday of the month, three months prior to the date of tendering.

W_o = All India average consumer price index number for industrial workers, as published by the Labour Bureau, ministry of Labour, Govt. of India (Base 1982 = 100)
This index number is as applicable for the month, three months prior to the date of tendering.

For example, if the date of tendering falls in May 2001, the applicable basic price of raw materials i.e. ZN_o, CO_o, BI_o, AL_o and BC_o should be as circulated by IEEMA as on 1st April 2001 and the applicable wholesale price index number for fuel, power, light and lubricants (FP_o) should be for the week ending 1st Saturday of the month of February 2001 and all India average consumer price index number (W_o) should be for the month of February 2001.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)ARSTR/_/_ prevailing as on first working day of the month ..... i.e., one month prior to the date of tendering.

ZN = Price of electrolytic high grade zinc (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of delivery.

CO = Price of Cobalt (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of the delivery.

BI = Price of Bismuth (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of delivery.

BC = Price of Ball Clay (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of delivery.

AL = Price of EC Grade Aluminium Ingots (refer notes)
This price is as applicable for the first working day of the month, two months prior to the date of delivery.

FP = Wholesale price index number for Fuel, Power, Light & Lubricants (refer notes)
This index number is as applicable for the 1st Saturday of the month, four months prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, ministry of Labour, Govt. of India (Base 1982 = 100).
This index number is as applicable for the month, four months prior to the date of delivery.

If the date of delivery in terms of clause given below falls in December 2001, the applicable price viz: ZN, CO, BI, BC and AL should be those as published by IEEMA prevailing as on 1st October 2001 and the applicable wholesale price index number (FP) and all India average consumer price index number (W) both should be for the month of August 2001.

The date of delivery is the date on which the lightening arresters are notified as being ready for inspection/despatch (in the absence of such notification, the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto whichever is earlier.

ANNEXURE–PV-6
PRICE VARIATION FORMULA FOR PLCC EQUIPMENTS

ieema
your link to electricity

501, Kakad Chambers
132, Dr. Annie Besant Road, Worli
Mumbai 400018
India

P: +91 22 2493 0532
F: +91 22 2493 2705
E: mumbai@ieema.org
www.ieema.org

IEEMA/PVC/PLCC/2010

Effective from: 1st July 2010

PRICE VARIATION CLAUSE FOR POWERLINE CARRIER COMMUNICATION EQUIPMENT, TEEMETERING EQUIPMENT, TRANSDUCERS AND ITS ACCESSORIES

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(10 + 32\frac{EP}{EP_0} + 29\frac{ER}{ER_0} + 12\frac{FE}{FE_0} + 4\frac{AL}{AL_0} + 13\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

EP_0 = Wholesale Price Index Number (WPI) of Electronic PCB/ Micro Circuits (refer notes)
This price is as applicable for the month, **THREE** months prior to the date of tendering.

ER_0 = IEEMA's Banker's selling rate of exchange between foreign currency prevailing on the Banker's first working day, **ONE** month prior to the date of tendering (refer notes)

FE_0 = Wholesale price index number for 'Ferrous Metals' (Base: 2004-05=100) (refer notes)
This index number is as applicable for the month, **THREE** months prior to the date of tendering.

AL_0 = Price of EC Grade Aluminium Ingots (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)
This index number is as applicable for the month, **THREE** months prior to the date of tendering.

For example, if date of tendering falls in October 2010, the applicable Wholesale Price Index Number (WPI) of Electronic PCB/ Micro circuits (EP_0) should be for July 2010, IEEMA's Banker's selling rate of exchange between foreign currency prevailing on the Banker's first working day (ER_0) of September 2010, Price of EC Grade Aluminium Ingots (AL_0) should be for September 2010 and Wholesale price index number for 'Ferrous Metals' (FE_0) should be for July 2010 and all India average consumer price index number (W_0) should be for the month of July 2010.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/PLCC-2010/_/_ prevailing as on first working day of the month ..... i.e., **ONE** month prior to the date of tendering.

IEEMA/PVC/PLCC/2010/01/02

New Delhi
Rishyamook Building, First Floor
85 A, Panchkuian Road
New Delhi 110001, India
P: +91 11 2336 3013/14
F: +91 11 2336 3015
E: delhi@ieema.org

Bangalore
204, Swiss Complex
33, Race Course Road
Bangalore 560001, India
P: +91 80 2220 1316/18
F: +91 80 2220 1317
E: bangalore@ieema.org

Kolkata
503 A, Oswal Chambers
2, Church Lane
Kolkata 700001, India
P: +91 33 6510 7855
F: +91 33 2213 1326
E: kolkata@ieema.org

ieema
your link to electricity

IEEMA/PVC/PLCC/2010 Effective from: 1st July 2010

EP = Wholesale Price Index Number (WPI) of Electronic PCB/ Micro Circuits (refer notes)
This price is as applicable for the month, **THREE** months prior to the date of delivery.

ER = IEEMA's Banker's selling rate of exchange between foreign currency prevailing on the Banker's first working day **ONE** month prior to the date of delivery. (refer notes)

FE = Wholesale price index number for 'Ferrous Metals' (Base: 2004-05=100) (refer notes)
This index number is as applicable for the month, **THREE** months prior to the date of delivery.

AL = Price of EC Grade Aluminium Ingots (refer notes)
This price is as applicable on the 1st working day of the month, **ONE** month prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100)
This index number is as applicable for the month, **THREE** months prior to the date of delivery.

For example, if date of delivery in terms of clause falls in December 2010, the applicable Wholesale Price Index Number (WPI) of Electronic PCB/ Micro circuits (EP) should be for September 2010, IEEMA's Banker's selling rate of exchange between foreign currency prevailing on the Banker's first working day (ER) of November 2010, Price of EC Grade Aluminium Ingots (AL) should be for November 2010 and Wholesale price index number for 'Ferrous Metals' (FE) should be for September 2010 and all India average consumer price index number (W) should be for the month of September 2010.

The date of delivery is the date on which the PLCC product is notified as being ready for inspection/dispatch. In the absence of such notification, the date of manufacturer's dispatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes: (a) All prices of raw materials are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes; octroi etc.

(b) All prices are as on first working day of the month.

(c) The details of prices are as under:

1) The price of Aluminium in Rs./MT is the average of EC Grade Aluminium ingots as quoted by three primary producers of Aluminium as per IS:4026-1987

2) The wholesale price index number for 'Ferrous & Metals' and Electronic PCB/ Micro Circuits is as published by the Office of Economic Advisor, Ministry of Industry, Govt. of India, New Delhi with base 2004-05-100.

3) The exchange rate that would be published by IEEMA would be for US Dollars

Authorised Signatory

IEEMA/PVC/PLCC/2010/02/02

ANNEXURE- PV-7

PRICE VARIATION FORMULA FOR WAVE TRAPS

Indian Electrical & Electronics Manufacturers' Association
501, Kakad Chambers, 132, Dr. Annie Besant Road, Worli, Mumbai 400 018.
Tel: +91 (0) 22 493 6528, 493 6529 • Fax: +91 (0) 22 493 2705.
E-Mail: mumbai@ieema.org • website: http://www.ieema.org

IEEMA/PVC/WT/2001 *Effective from : 1st January, 2001*

PRICE VARIATION CLAUSE FOR WAVE TRAPS

The price quoted/confirmed is based on the cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials, index number for wave traps and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and Index number, the price payable shall be subject to adjustment up or down in accordance with the following formula:

$$P = \frac{P_0}{100}\left(30 + 30\,\frac{IN - WT}{IN_0 - WT} + 40\,\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

IN_0-WT = Index number for wave traps, based on relative prices and weightages (as given in the brackets) of aluminium busbar (20), and epoxy resin, CT-5900 (10) calculated considering their prices as on 1st June 2000 as base equal to 100 (refer notes).

This index number is as applicable on the first working day of the month, one month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base 1982 = 100).

This index number is as applicable for the month, three months prior to the date of tendering.

For example, if the date of tendering falls in May 2001, the applicable index number for wave traps (IN_0-WT) should be as on 1st April 2001 and all India average consumer price index number (W_0) should be for the month of February 2001.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA(PVC)/ WT/_/_ prevailing as on first working day of the month ..... i.e., one month prior to the date of tendering.

IN-WT = Index number for wave traps, based on relative prices and weightages (as given in the brackets) of aluminium busbar (20), and epoxy resin, CT-5900 (10) calculated considering their prices as on 1st June 2000 as base equal to 100 (refer note).

This index number is as applicable on the first working day of the month, two months prior to the date of delivery.

W = All India average consumer price index number for industrial workers, general index as published by the Labour Bureau, Govt. of India (Base 1982 = 100).

This index number is as applicable for the month, four months prior to the date of delivery.

IEEMA/PVC/WT/1/2

IEEMA/PVC/WT/2001 *Effective from : 1st January, 2001*

For example, if the date of delivery in terms of clause given below falls in December 2001 the applicable index for wave traps (IN-WT) should be that as published by IEEMA as prevailing on 1st October 2001 and the applicable all India average consumer price index number (W) should be for the month of August 2001.

The "date of delivery" is the date on which the wave trap is notified as being ready for inspection/despatch. (In the absence of such notification the date of manufacturer's despatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes: (a) All prices of raw materials considered for arriving at the index number for wave trap are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes, octroi etc.

(b) All prices are as on first working day of the month.

(c) The details of prices considered for index number for wave trap are as under:

1) The price of aluminium busbar (in Rs/MT) is the average of the ex-works prices as quoted by two manufacturers, for standard section of busbar of grade, equivalent to E 91 E as per IS 5082 - 1981.

2) The price of epoxy resin (in Rs/Kg) is as quoted by the manufacturer for epoxy resin CT-5900 or its nearest equivalent.

For Indian Electrical & Electronics Manufacturers' Association

Authorised Signatory

ANNEXURE-PV-8

PRICE VARIATION FORMULA FOR FABRICATED AND GALVANIZED TRANSMISSION LINE TOWER/ GI STRUCTURES FOR SUB-STATION

ieema
your link to electricity

501, Kakad Chambers
132, Dr. A. B. Road, Worli,
Mumbai 400 018
India

P +91 22 2493 0532
F +91 22 2493 2705
E mumbai@ieema.org
W www.ieema.org

IEEMA/PVC/TLT/2010 (R-1) **Effective from: 1st April 2014**

PRICE VARIATION CLAUSE FOR TRANSMISSION LINE TOWERS

The price quoted/confirmed is based on the input cost of raw materials/components and labour cost as on the date of quotation and the same is deemed to be related to prices of raw materials and all India average consumer price index number for industrial workers as specified in the price variation clause given below. In case of any variation in these prices and index numbers, the price payable shall be subject to adjustment, up or down in accordance with the following formula:

(A) Transmission Line Tower with both Heavy and Light angles

$$P = \frac{P_0}{100}\left(11 + 32\,\frac{SBLR}{SBLR_0} + 25\,\frac{SBIR}{SBIR_0} + 09\,\frac{Zn}{Zn_0} + 23\,\frac{W}{W_0}\right)$$

(B) Transmission Line Tower with only Heavy angles

$$P = \frac{P_0}{100}\left(11 + 57\,\frac{SBLR}{SBLR_0} + 09\,\frac{Zn}{Zn_0} + 23\,\frac{W}{W_0}\right)$$

(C) Transmission Line Tower with only Light angles

$$P = \frac{P_0}{100}\left(11 + 57\,\frac{SBIR}{SBIR_0} + 09\,\frac{Zn}{Zn_0} + 23\,\frac{W}{W_0}\right)$$

Wherein,

P = Price payable as adjusted in accordance with the above formula.

P_0 = Price quoted/confirmed.

$SBLR_0$ = Price of Steel Blooms- Retail (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

$SBIR_0$ = Price of Steel Billets- Retail (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

Delhi
Rishyamook Building, First Floor,
85 A, Panchkuian Road
New Delhi 110001
P +91 11 2336 3013 / 14
F +91 11 2336 3015
E delhi@ieema.org
W www.ieema.org

Bangalore
204, Swiss Complex
33, Race Course Road
Bangalore 560001, India
P +91 80 2220 1316/18
F +91 80 2220 1317
E bangalore@ieema.org
W www.ieema.org

Kolkata
503 A, Oswal Chambers
2, Church Lane
Kolkata 700001, India
P +91 33 6510 7855
F +91 33 2213 1326
E kolkata@ieema.org
W www.ieema.org

Indian Electrical & Electronics Manufacturer's Association

IEEMA/PVC/TLT/2010 (R-1) **Effective from: 1st April 2014**

Zn_0 = Price of Electrolytic high grade zinc (refer notes)
This price is as applicable on the 1st working day of the month, one month prior to the date of tendering.

W_0 = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100) (Refer notes)
This index number is as applicable on the first working day of the month, three months prior to the date of tendering.

For example, if date of tendering falls in May 2014, the applicable prices of Steel Bloom-Retail ($SBLR_0$), Steel Billets-Retail ($SBIR_0$) and Zinc (Zn_0) should be for the month April 2014 and all India average consumer price index number (W_0) should be for the month of February 2014.

The above prices and indices are as published by IEEMA vide circular reference number IEEMA (PVC)/TLT-2014/_/_ one month prior to the date of tendering.

SBLR = Price of Steel Bloom-Retail (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

SBIR = Price of Steel Billets-Retail (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

Zn = Price of Electrolytic high grade zinc (refer notes)
This price is as applicable on the 1st working day of the month, two months prior to the date of delivery.

W = All India average consumer price index number for industrial workers, as published by the Labour Bureau, Ministry of Labour, Govt. of India (Base: 2001 = 100) (refer notes)
This index number is as applicable on the first working day of the month, four months prior to the date of delivery.

For example, if date of delivery falls in December 2014, the applicable prices of Steel Bloom-Retail (SBLR), Steel Billets-Retail (SBIR) and Zinc (Zn) should be for the month October 2014 and all India average consumer price index number (W) should be for the month of August 2014.

ANNEXURE-PV-9

PRICE VARIATION FORMULAE FOR AAC/AAAC/ACSR CONDUCTORS

The price quoted/confirmed for Aluminium Conductor is based on the input cost of raw materials as on the date of quotation. It is deemed to be related to the prices of raw materials, as specified in the price variation clauses given below. In case of any variation in these prices, the prices payable shall be subject to adjustment up or down in accordance with the following formulae.

1. AAC/ AAAC Conductors

P = Po+WA(AL-ALo)

1. ACSR Conductors

P = Po+WA(AL-ALo) + WF (FE-FEo)

Wherein,

P = Ex-works price payable in Rs. per km as adjusted in accordance with the price variation clause.
Po = Ex-works price quoted/confirmed in Rs. per km.
WA = Weight of Aluminium in AAC/AAAC/ACSR Conductor in MT per km. as per the type of conductor (Refer the enclosed table – A giving this factor for various types of conductors)
ALo = Price of Daily LME Cash SELLER Settlement price of Aluminium
This price is applicable prevailing as on 30 days prior to the date of tender opening.
WF = Weight of Steel Content in ACSR Conductor in MT per km as per the type of conductor (Refer the enclosed table-A giving this factor for various types of conductors).
FEo = Price of High Tensile Galvanized Steel Wire in Rs./MT of appropriate size.
This price is applicable prevailing as on the 30 days prior to the date of tender opening.
For example, if tender is opened on 31st October 2014, the applicable raw material prices (ALo and FEo) would be those, prevailing as on the 1st day of October 2014.
AL = Price of Daily LME Cash SELLER Settlement price of Aluminium
This price is applicable prevailing as on 30 days prior to the date of delivery.

FE = Price of High Tensile Galvanized Steel Wire in Rs./MT of appropriate size.
This price is applicable prevailing as on the 30 days prior to the date of delivery.
For example, if the date of delivery is 31st December 2014, the applicable raw material prices (AL and FE) would be those prevailing as on the 1st day of December 2014.

The above prices and indices are as published by IEEMA vide circular reference IEEMA(PVC)/AL Conductor-LME/-

The date of delivery is the date on which the Conductor is notified as being ready for inspection/dispatch (in the absence of such notification, the date of manufacturer's dispatch note is to be considered as the date of delivery) or the contracted delivery date (including any agreed extension thereto), whichever is earlier.

Notes:

1. All domestic prices of raw materials applicable to excise duty units are exclusive of modvatable excise/CV duty amount and exclusive of any other central, state or local taxes, octroi etc.

2. Price of Daily LME Cash SELLER Settlement price of Primary Aluminium in US$ per MT is as published by London Metal Bulletin (LME). Premium for Aluminium Ingot in US$ per MT is added in this Daily LME price and converted in Indian Rs./MT using exchange rate and adding appropriate customs duty.
   Monthly price circular will contain daily prices of Aluminium during the month as announced by LME.

3. The price of High tensile Galvanized Steel Wire (in Rs./MT) for different sizes in mm is the price as quoted by a primary producer; which is normally valid for the entire month. Further revisions in prices; if any; as quoted by the primary producer will also be published.

TABLE-A

WEIGHT FACTOS FOR VARIOUS TPES OF CONDUCTORS AS PER IS:398

Sr. No.	Conductor types	A/AA Strands	Steel strands	Aluminium EC Grade/Alloy kg/km	HTGS Steel kg/km	Total kg/km
1	ACSR Panther	30/3	7/3	586	388	974
2	ACSR Zebra	54/3.18	7/3.18	1185	436	1621
3	ACSR Moose	54/3.53	7/3.53	1465	539	2004
4	AAAC Panther	19/3.94	0	636.67	0	636.67
5	AAAC Zebra	37/4	0	1280.5	0	1280.5
6	AAAC Moose	61/3.45	0	1573.71	0	1573.71