CHHATTISGARH STATE POWER TRANSMISSION CO. LTD.

(A Govt. of Chhattisgarh undertaking) (A successor company of CSEB)

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(VOLUME – II OF III)

PROJECT A :- (1) 132/33 KV S/S BALODA (DISTT.-JANJGIR – CHAMPA
(2) 132 KV DCDS LINE from 220/132 KV S/S BANARI to proposed 132 KV S/S BALODA (DIST.-JANJGIR – CHAMPA (RL-21 KM Approx.)

PROJECT B :- (1) 132 KV S/S MASTURI (Distt.-BILASPUR)
(2) LILO OF 132 KV BANARI-SEORINARAYAN LINE from Loc. No. 12 to proposed 13/332 KV S/S MASTURI (Distt.-BILASPUR) (RL-33 KM Approx.)

ON TURNKEY BASIS (Through E-Bidding)

RFx No. 8100020653

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TECHNICAL SPECIFICATION FOR SUB-STATION

S E C T I O N – I

SECTION - I – A

TECHNICAL SPECIFICATION FOR CIVIL WORKS FOR 132/33 KV SUBSTATION MASTURI AND BALODA

1. **SCOPE:-**

This specification covers civil works like construction of Control Room Building. Peripheral chain link mesh 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.

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

2.1 Construction of Control Room Building and all civil works at 132/33 KV switch yard viz; x-mer/equipment foundations cable trenches, yard fencing, yard levelling, metalling, earth pits, gate, burnt oil tank, approach roads rain water harvesting tank, 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.

The data related to soil investigation in the tender document is intended to give the bidder an idea about soil characteristics of site. However, the bidders are advised to visit the site before submitting their offer, to assess the actual working condition prevailing. In case, expansive / compressible / highly compressible soil strata is encountered while actual execution of work, specifications / drawings suitable to the expansive / compressible / highly compressible soil will have to be adopted, even though the bearing capacity mentioned in the tender specification indicates otherwise, for which no extra payment will be made.

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.

2.2 DRAWINGS

The Contractor shall execute the work at site as per drawings provided by CSPTCL. Photocopies shall not be used at site. Civil drawings of the equipment foundations, control

room, rain water harvesting tank & pit, burnt oil tank, road, retaining wall, chain link mesh fencing etc. shall be provided by CSPTCL. **However drawings for some equipments which are make dependant viz. Circuit breaker, lighting mast, capacitor bank, Bay marshalling room (Kiosk), 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.**

2.3 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 GI class 'C' pipes of minimum 300 dia. for which no extra payment shall be made. Burnt oil tank / pit shall be provided with 3.0 HP Submersible pump of KSB/Kirloskar make.

3.0 SITE PREPARATION :-

3.1 Clearing, levelling

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

3.2 **Excavation and backfill:**

1. Excavation and backfill for foundations shall be in accordance with the relevant code.
2. If excavated soil in foundations is non-expansive, then same shall be used for backfilling. If, excavated soil is expansive, then the foundation shall be backfilled by non-expansive soil. In either case no separate payment shall be made.
3. No separate payment shall be made for any type of soil / rock encountered during excavation of foundation as per approved LUP/Drawings.
4. 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 for which no extra payment shall be made by CSPTCL.
5. 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.

6. 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 at OMC 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.
7. 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 at OMC 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.
8. The soil from excavation of foundation, cable trenches etc. if used for yard levelling (with proper compaction at OMC using vibratory plate compactor) as per direction of Engineer-in-Charge, no extra payment shall be admissible. The soil so used shall be adjusted in the quantity for levelling. If the excavated material is not usable, then same shall be disposed off as per direction of Engineer-in-charge for which no extra payment shall be made.

3.3 **Compaction:**

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. At all times unfinished construction shall have adequate drainage. Upon completion of the road's surface course, adjacent shoulders shall be given a final shaping, true alignment and grade.
3. Each layer of earth embankment when compacted shall be as close to optimum moisture content as practicable. Embankment material which does not contain sufficient moisture to obtain proper compaction shall be wetted. If the material contains any excess moisture, then it shall be allowed to dry before rolling. The rolling shall begin at the edges overlapping half the width of the roller each time and progress to the centre of the road or towards the building as applicable. Rolling will also be required on rock fills. No compaction shall be carried out during rain.
4. Drainage arrangement like Katcha drain should be made around periphery of substation yard so that storm water does not enter/foul construction area /substation yard.

3.4 **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.

4.0 ANTI WEED TREATMENT & METAL SPREADING:

4.1 **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 over coarse sand/stone dust layer shall be done in the areas of the switchyard under present scope of work. However the metal spreading over 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.**

4.2 **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.

4.2.1 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
63mm	100
40mm	85-100
20mm	0-20
10mm	0-5

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

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

(b) Hardness

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

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

(c) Flakiness Index

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

4.2.2 After all the structures/equipments are erected, anti weed treatment shall be applied in the switchyard where ever metal spreading over 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 every day 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.

4.2.3 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.

4.2.4 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.

4.2.5 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.

4.2.6 Over the prepared sub grade, first 100 mm thick layer of coarse sand 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.

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

4.2.8 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
1.	Metal	8 %
2.	Moorum/Sand	16 %
3.	Stone dust	25%

5.0 STORM WATER DRAINAGE & RAINWATER HARVESTING:

5.1 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.

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

5.3 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.

6.0 ROADS AND CULVERTS:

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

6.2 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.

6.3 Road construction shall be as per IRC standards.

6.4 Adequate provisions shall be made for road drainage.

6.5 Adequate turning radius, tracking off / extra widening / swept path shall be provided for trailer at all turnings of roads. No extra payment shall be made on this account.

7.0 FOUNDATION / RCC CONSTRUCTION:-

7.1 General:-

(a) 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 equipment & 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.

(b) 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.

(c) 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.

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

(e) **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.

(f) **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.

(g) **External cable trenches**.-

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

7.2 Admixture & additives:

7.2.1 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.

7.2.2 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.

7.2.3 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.

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

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

8.0 CHAIN LINK FENCING AND GATE:

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

8.1 Product materials:

The minimum requirements are as follows:

a) 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

b) 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 diameter.

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.

(v) **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.**

c) 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**.

8.2 Installation:

(i) Mesh:-

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

b) Post of hole/pit shall be excavated by approved method.

c) 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 fondation shall be extended upto FYL. In case of fencing in filling zone the depth of foundation shall be increased so that min. 0.60m foundation depth falls **in side natural ground level** and top of foundation shall be extended upto FYL The fencing angle shall be grouted upto 100 mm from bottom of foundation in eachcase.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.**

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

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

f) 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.

g) 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**.

(ii) 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 approved General arrangement drawing.
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.

9.0 WATER SUPPLY FOR BUILDINGS & EARTH PITS

Two number 150 mm dia tube wells 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.

The rain water from control room building shall be collected at one or more outlet points through rain water pipe of suitable size or as per drawing. At each outlet points rainwater harvesting filter such as 'Rainy Filter FL-200' suitable for roof area of control room building to be provided at outlet point and these outlet shall be connected to rainwater harvesting pit. Rain water harvesting pit are to be constructed as per drawing provided by CSPTCL around bore well for direct recharge of bore wells. No extra payment shall be made on this account.

9.1 Sewerage System

- Sewerage system shall be provided for control room building by contractor.
- 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 shall be applied Birla/J.K 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 Painting on all external walls two or more coats of **Ultima or Weather Coat or Weather Shield brand** paint over two under coats of **Plasto proof** make primer over new cement plaster surfaces of the C/R building inclusive of required tools, scaffolding, materials and other painting accessories etc. as per recommendations of manufacturer.

10.6 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.

10.7 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.

10.8 Filter 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. Cement plaster skirting (up to 15 cm height) with cement mortar 1:3 (1 cement: 3 coarse sand) mixed with metallic concrete hardener in same ratio as for floor finished with a floating coat of neat cement 21 mm thick in Filter room.

10.9 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.

10.10 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.

10.11 All Brick Works shall be with cement mortar 1:6 (1cement: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.**

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

(a) 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.

(b) PVC glazed shutters made up of rigid PVC hollow sections used for shutters frame with panelling 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 panelling 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:

a. 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.

b. 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.

c. 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.

d. 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 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 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:

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

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

iii) **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.

iv) **6 mm thick bevelled 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.**

i) 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.

ii) 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.

iii) 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.

iv) **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.

a) 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).

b) 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 wire for L&F circuits. **T-5 tube lights, CFLs**, 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 132 KV control room front side with GI structure supports with internal T-5 tube light arrangements for illumination with name of S/S .

10.46 132 KV 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 **SINGLE LINE DIAGRAM**: **1800 x 1200 mm board** showing the single line diagram of the substation shall be provided by the contractor in the control room.

10.48 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.

10.49 Backfilling shall be done as per direction of engineer in charge of CSPTCL using approved backfill material 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.

10.50 **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.

10.51 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**.

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

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

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

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

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

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

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

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

10.60 The T-5 tube lights shall be of **Phillips/Havells'/Bajaj** make and CFL bulbs shall be of **Bajaj/Wipro/Havells'** make.

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

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

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

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

10.65 The filling below plinth and ramp shall be well compacted **hard moorum /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 upto 95% proctor density.

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

10.67 **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.

10.68 In case of **B.C. soil,** the portion above NGL shall be filled with hard moorum well compacted 90% of MDD. If there is unavailability of moorum then hard soil may be used for filling. In case of control room building the filling shall be done with hard moorum only.

10.69 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.

11.0 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/sq. m.** 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 **<u>VARIATION IN QUANTITIES</u>: -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.**

<u>Bidders are advised to visit the yard site prior to submission of offer.</u>

12.0 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

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SECTION - I - B

TECHNICAL SPECIFICATION FOR SWITCH YARD & CONTROL ROOM EQUIPMENTS, OTHER MATERIAL, ERECTION AND COMMISSIONING

1.1 PRINCIPAL PARAMETERS OF SUB-STATION:-

Sl. No	PARTICULARS	132 KV	33 KV
1	System Operating Voltage	132 KV	33 KV
2	Maximum System Highest Voltage for which equipments are to be rated for continuous operation	145 KV	36 KV
3	Rated Frequency	←50 Hz. →	
4	No. of Phase	3	3
5	RATED INSULATION LEVELS		
I	Full wave impulse withstand voltage (1.2 / 50 micro-sec)	650 KVp	170/250 KVp (Y/D)
Ii	One minute power frequency – dry & wet withstand voltage (rms)	275 KV	80 KV
6	Corona Extinction voltage	105 KV	-
7	Minimum creepage distance	25 mm /KV (3625 mm)	25 mm /KV (900 mm)
8	CLEARANCES		
i	Phase to Phase	1300 mm	320 mm
ii	Phase to Earth	1300 mm	320 mm
iii	Sectional Clearance	4000 mm	3000 mm
iv	Ground Clearance	4600 mm	3700 mm
9	System Neutral Earthing	← Solidly Earthed→	
10	Rated Short Circuit Current for 1 Second	31.5 KA	25.0 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 YARD AND CONTROL ROOM EQUIPMENT:-

Supply of sub-station equipments and other materials include following. The quantities of these equipments have been indicated in the schedule III-C.

(i) 40 MVA 132/33 KV transformer with oil & fittings complete.
(ii) 132 & 33 KV Potential Transformers (PT)
(iii) 132 & 33 KV Current Transformers (CT)
(iv) 132 & 33 KV Lightning Arrestors (LA)
(v) 132 & 33 KV Circuit Breakers (CB)

(vi) 132 & 33 KV Isolators with & without Earth Switches.

(vii) 132 & 33 KV Solid core Post insulators.

(viii) 200 KVA, 33/0.4 KV Station transformer.

(ix) GPS base time synchronising equipment with accessories which is suitable for synchronization of internal clocks of meters, relays and computer.

(x) 10 MVAR, 33 KV Shunt capacitor bank with series reactors and associated all equipments.

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

(xii) 300AH 110V & 48V Battery set with electrolyte & teak wood stands & Battery charger & its commissioning.

(xiii) AC/DC Boards, Junction /marshalling box with standard connectors & channel etc.

(xiv) Supply, preparation of cable schedules & laying etc.

(xv) Supply of 2.5 mm sq un-armoured copper control cables with numbered core including power cables laying & termination of control cables after construction of cable trenches as required.

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

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

(xviii) Luminaries of Switchyard & Control Room illumination.

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

1.3 ERECTION OF STRUCTURE & EQUIPMENTS:-

1.3.1 The structures are to be fabricated according to the CSPTCL design & drawing.

1.3.2 After the columns / supporting structures are erected respective equipment (132/33 KV) are to be erected carefully with suitable crane. But breaker and isolators are to be erected as 3 phase-unit basis, and other item like 132/33 KV CT, PT, CC, LA & PI etc. are to be erected on I-phase unit basis and rigidly mounted on the supporting structures to be supplied by the developer. Simplex/Duplex control relay panels are to be mounted inside the control room in the same order as in the switchyard.

1.3.3 After the earth mat design is finalised, the earth mats with 65 x 8 mm GI Flat are to be put with each equipment. Then flats are to be inter connected with each other as per latest amended ISS.

1.3.4. 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 Unarmoured control cable and Armoured 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 shall submit drawing showing cable schedule and connections of both ends of control cables, for approval.

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

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

1.3.7 All the equipments / structures required for erection will be arranged by the contractor.

1.3.8 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.

1.3.9 As safe custody of 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, for which the contractor shall submit indemnity bond (Annexure A-18) towards safe custody of various material/equipments equivalent to cost of material provided in price schedule of supply order, indemnifying CSPTCL towards loss and damages if any. This bond shall be valid till contractual completion period or actual completion period whichever is later.

1.3.10 Following important points regarding the erection work of switch yards should be taken care of.

(i) As far as possible 132KV CTs should be placed below the gantry.

(ii) Proper arrangement should be made to connect transformer neutral to earth pits at two different points having 4 Nos. of 100mm size GI pipe electrodes of length 3 Mtr. through 2 No. separate conductors routed through the supporting pin insulator through a small cable trench with cover.

(iii) Earth screen should be provided on 33KV side also.

(iv) For 33KV feeders, over current and earth fault relay should be numerical with high set and IEC 61850 complied.

(v) PT secondary connection from switch yard to control room should be through 4 core 4 sq mm copper cable for metering core & 4 Core 2.5 Sq.mm for rest of the cores.

(vi) All breaker secondary connections should be stud type. No screw type connectors shall be used.

(vii) All high bus and main/ auxiliary bus T- clamps should be strengthened by a by pass conductor with double PG clamps at both ends.

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 :-

1. Contractor shall furnish a cable schedule for the work involved for approval of CSPTCL. 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. Likewise 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" as per schedule III-D only.

1.7 WORK SCHEDULE:-

The work schedule for construction & commissioning of entire sub-station shall be as per Clause 6 of the GCC, section-II of the tender document 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

* * * * *

2. TECHNICAL SPECIFICATION OF 132/33 KV, 40 MVA POWER TRANSFORMER

1. SCOPE:

1.1 This specification covers design, engineering, manufacture, assembly, stage inspection and testing before supply and delivery of the 132/33 KV, 40MVA, 3 phase, two winding power transformer 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 transformer. However, the transformer shall conform in all respects to standards of engineering, design and workman ship listed in clause No.2.0 and shall be capable of performing in continuous commercial operation up to the contractor's guarantee in a manner acceptable to CSPTCL, who will interpret the meanings of drawing and specification and shall have the power to reject any work or material which, in CSPTCL's judgment, is not in accordance therewith. The transformer 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 manufacuturer'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 CSPTCL shall have the power to reject any work or material which, in his judgment, is not in full accordance therewith.

2.0 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,	Marking & arrangement for switch gear, bus bar,	

IS-11353	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	

2.2 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 transformer offered by the contractor 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.

3.0 SERVICE CONDITIONS

3.1 Climatic Conditions : The transformers and its accessories to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical 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	0.3 g.

3.2 AUXILIARY POWER SUPPLY

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

a.	Power devices like drive motors	415V, 3 phase 4 wire 50 Hz, neutral grounded AC supply
b.	Lighting, space heaters and fractional KW motors	240V, 1 phase, 50 Hz, neutral grounded AC supply

c.	Alarm, control and protective devices	110V DC, 2 wire

Each of the foregoing supplies shall be made available by the manufacturer at the terminal point for operation as accessories and auxiliary equipment. Contractor's scope includes supply of interconnecting cables, terminal boxes etc. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over entire range of voltages.

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

4. PRINCIPAL PARAMETERS

40MVA Power transformer shall conform to the following specific parameters: -

Sl.No.	**PARTICULARS**	**Specification of 40 MVA X'mer**
1.	Rated Voltage Ratio: kV	132/33
2.	Highest system voltage	145/36 KV
3.	No.of windings	Two winding transformer.
4.	Type of cooling	ONAN/ONAF
5.	MVA rating corresponding to cooling system: a) ONAN Cooling b) ONAF Cooling	 80% (32 MVA) 100% (40 MVA)
6.	Method of connection	HV & LV Star
7.	Connection Symbol (Vector group)	YN yn 0
8.	System earthing	Solidly/ Effectively earthed
9.	Percentage Impedance's, Voltage on normal tap and MVA base Corresponding to HV rating and applicable tolerances: a) HV-LV	Tolerance % Impedance ±10% 10
	Insulation resistance at an ambient temp of 30 Deg C with 5 KV Megger for 60 sec duration	HV/LV- Min. 4000 M.Ohms, HV/E, LV/E- Min 3000 M. Ohms
	Polarisation index i.e. ratio of 600 sec to 60 sec	≥ 2
	DAR (Die-electric absorption ratio) i.e. ratio of IR value of 60 sec to 15 sec	≥ 1.3
10.	**Anticipated continuous loading of windings**: a) HV and LV	110% of its rated capacity in any tap.
11.	**Tap changing gear** :- 1. Type	On load Provided on HV neutral end.
	2. Tap range & steps	-15% to + 5%, steps 1.25%
	3. Voltage & current rating	132KV (neutral end) & 500 amp Min.
12.	Over voltage operating capability and duration	110% rated voltage Continuous 125% rated voltage for 60 secs. 140% rated voltage for 5 secs.
13.	Minimum Air core reactance of HV windings.	20%
14.	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.
15.	Minimum knee point voltage	110% rated voltage
16.	(a) Max. Flux density in any part of core and yoke at rated MVA, frequency and normal voltage (Tesla)	1.6
	(b) No load current of the transformer at 105 % of rated voltage	0.5% of rated current(Maximum)
	(c) Current density in winding	≤ 3 Amp/ sq. mm

17.	Insulation levels : For windings a) 1.2/50 microsecond wave shape impulse withstand (kVp)	HV 650	LV 170	
	b) Power frequency voltage withstands (kV rms.)	230	95	
	c) Tan delta values of winding	The measured Tan delta values of winding shall not exceed 0.45% at 20^0C temperature. In case Tan delta of transformers during testing at works of manufacturer is measured above maximum ceiling of 0.45% at 20^0C temperature, then CSPTCL reserves right not to accept such of the transformer. This requirement is to be confirmed specifically by the manufacturer in their offer.		
18.	**Type of winding insulation** :- I) HV winding II) LV winding	 GRADED FULL		
19.	System short circuit level and duration for which the transformer shall be capable to withstand thermal & 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.		
20.	Maximum partial discharge level at 1.5/sq.root 3 of rms. Phase to ground voltage.	500 pico coulombs		
21.	Noise level at rated voltage and frequency	81 dB		
22.	**Permissible temperature rise: Over ambient temp**. (i) of top oil measured by thermometer (ii) of winding measured byresistance (iii)temperature gradient between oil & winding	 40^0 c 45^0 c Not more than 16^0 c		
23.	**Minimum clearances in air (mm):**	Phase to phase	Phase to ground	
	(a) HV	1430	1270	
	(c) LV	700	660	
24.	**Terminals:-** a) HV Winding Line end (OIP condenser bushing)	170 KV		
	b) HV/LV Winding Neutral	72.5 kV OIP condenser bushing		
	c) LV Winding	72.5 kV OIP condenser bushing with center spacing of 1000 mm.		
25.	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		
26.	Minimum Visual Corona extinction voltage	320 KV rms		
27.	Cooling equipment's: Number of Banks with adequate number of Fans.	Two Banks each 50%		
28.	**Bushings :**	**HV**	**LV**	**HVN & LVN**
	i) Voltage Rating (kV rms)	170	72.5	72.5
	ii) Current Rating	1250	1250	1250
	iii) Insulation level :			
	a) Lightning impulse with stand (kVp)	750	325	325
	b) 1 Minute power frequency withstand voltage (kV rms)	275	140	140
	c) Creepage distance (mm)	3625	1813	1813
29.	(i) Permissible range of respective losses at rated voltage & frequency & at 75°C	Minimum		Maximum
	a) No Load Loss (Iron Loss) in KW	18		20

	b) Load loss in KW	93	103
	c) Aux. Loss in KW	1.8	2
	(ii) No load losses at 110% of rated voltage & rated frequency	Not more than 130% of the losses at rated voltage & frequency	
30.	Type of design of the transformer	Only Bell type tank construction is acceptable	
31.	Tank sheet thickness		
	(i) Top & bottom	Minimum 20 mm	
	(ii) Sides	Minimum 10 mm	
32.	Conservator tank sheet thickness	Minimum 8 mm	
33.	There shall be two CT cores per HV, LV and HVN/LVN Bushing CT for REF (1-phase ring type turret mounted).	a) Ratio for HV & HVN bushings - 400/1-1A KPV- min. 800V Accuracy: PS (both cores) b) Ratio for LV & LVN bushings - 1200/1-1A KPV- min. 1200V Accuracy: PS (both cores)	
34.	There shall be one CT core in middle phase of HV and LV Bushings for WTI	Ratio to be specified by the manufacturer	
35.	**Transformer oil**		
	(a) Appearance	The oil shall be clear & transparent and free from suspended matter or sediment	
	(b) Density at 27° C max.	0.89g/cm^3	
	(c) Kinematic viscosity max. (i) At 27 ° 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°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) a) 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 90° C max	0.002	
	(k) Specific resistance (resistivity) i) At 90 ° C min. ii) At 27 ° 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	
36.	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. i. Break down strength	 Minimum 70 KV withstand	

	ii. Moisture content	Maximum of 10 ppm
	iii. Resistivity at 90°c minimum	$35x10^{12}$ ohm.cm (min)
	iv. Interfacial Tension at 27°c	0.04 N/M (min)
	v. Dielectric dissipation factor at 90 °C	0.002 (max.)

5. GENERAL TECHNICAL REQUIRMENTS

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.

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 132KV system & also 31.5 KA for 33 KV System.

5.1.3 The transformer shall be capable of bearing loads in accordance with IS: 6600. There shall 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 "Principal Parameters". 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 details in the offer.

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

5.1.5 Radio interference and Noise level:

(i) 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.

(ii) 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 i.e. as ONAN rating. The forced cooling equipment shall come into operation by preset 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 at-least ten(10) minutes without the calculated winding hot spot temperature not exceeding 140°C. Also stopping of one or 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°C at continuous maximum rating.

5.1.7 Transformer shall be capable of withstanding thermal and mechanical stress caused by symmetrical / 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 & frequency refers to rated voltage and frequency

ii) Over fluxing withstand characteristics upto 170% shall be admitted.

5.1.9 **PARALLEL OPERATION:** The offered transformer shall be suitable for parallel operation of similar transformer of 63/40/20 MVA rating of any make.

5.2 GUARANTEED LOSSES AND GUARANTEE PERIOD:

5.2.1 **Permissible losses:-**

The losses of 40 MVA, 132/33 KV transformer should be within the range prescribed below for respective losses (without any positive tolerance) :

S. No.	Particulars	Minimum	Maximum
1	No load loss in KW	18.0	20.0
2	Load loss at rated voltage, rated frequency and rated current at 75ºC in KW	93.0	103.0
3	Auxiliary Loss in KW	1.8	2.0

The bidder shall have to offer no load loss, load loss or 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 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 losses prescribed above shall only be considered.

5.2.2 **CAPITALISATION OF LOSSES:** The capitalisation of no load loss, load loss and auxiliary loss for the bidder who has quoted the losses within the respective range of losses specified above in clause 5.2.1, shall be done on following rates (differential of quoted loss and minimum value of the range of respective loss) :-

i) For differential no load loss above 18 KW : Rs. 4,01,840.00 per KW
ii) For differential load loss above 93 KW : Rs. 2,13,780.00 per KW
iii) For differential auxiliary loss above 1.8 KW : 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 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.

The differential losses so worked out separately for each of the no load loss, load loss and auxiliary loss shall be multiplied with number of transformer in the package and the capitalisation factors as mentioned above.

However, it should be clearly noted that during final testing of each of transformer, the measured losses individually (i.e. No load, load & auxiliary losses as applicable) should

not exceed the values quoted by the bidders in the bid (in Annexure A-3). In case, any of the losses exceed the quoted losses, respective transformer shall not be accepted.

5.2.3 **GUARANTEE PERIOD:**

1. 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

i) Forfeiture of 10% BG submitted against Performance of transformer.
ii) Forfeiture of additional 10% performance BG of transformer furnished subsequent to second time failure.
iii) The contractor shall be debarred from future business with CSPTCL and other Chhatishgarh state power companies for a period as decided by management.
iv) 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 Chhatishgarh 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 (1^{st} or 2^{nd} 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)-

(i) 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.

(ii) 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) 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

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

b) All seams & those joints which are 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

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

d) The tanks shall be designed to withstand
   (i) Mechanical shocks during transportation
   (ii) Vacuum filling of oil at 10 millitorr in transformer with fitting
   (iii) Continuous internal pressure of 35 kN/m² over normal hydrostatic pressure of oil.
   (iv) Short circuit forces.

e) 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.

f) 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.

g) The base of 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.

h) 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.

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

j) 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.
   (iv) 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.

k) 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 rain water 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. There should not be any leakage for three years and this should be guaranteed by the manufacturer.

(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 Axles and Wheels

(a) The transformer is 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°C 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 (i.e. longitudinal and transverse directions).

(d) The transformer tank shall be supported on a structure steel base equipped with forged steel or cast steel single flanged wheels available for moving the transformer completely filled with oil.

(e) 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.

(f) 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.

5.4.3 Anti Earthquake Clamping Device:

To prevent transformer movement during earthquake, clamping device shall be provided for fixing transformer to the foundation. The contractor 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 transformer to the foundation 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.

5.4.4 Conservator Tank

(a) The conservator tank shall be of minimum of 8 mm thickness & 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 100°C. Conservator shall be with volumetric capacity at least 7½ 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.

5.4.5 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.
e) Minimum quantity of silicagel to be 1 Kg for every 3500 lts of oil in the tank.

5.4.6 Pressure Relief Device

A minimum of 3 Nos. pressure relief devices are to be provided with transformer. These PRDs shall be preferably mounted on the tank cover above each phase winding.

Manufacturer 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.

The PRDs 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 less than the hydraulic pressure of transformer tank. It shall be directly mounted on transformer tank. One set of electrically insulated contacts shall be provided for alarm and tripping with the recommended settings.

5.4.7 Air Cell:

The transformer should be supplied with air cell type oil preservation system. It is obligatory on the part of the manufacturer 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 contractor 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 transformer.

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):

Transformer 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. The mounting of OTI should be anti vibrating type.

b) Winding Temperature Indicator (WTI):

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

(i) Temperature sensing element.
(ii) Image coil
(iii) Auxiliary CTs, if required to match the image coil.

(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) The mounting should be anti vibrating type.

(vii) In addition to the above, following indication equipment shall be provided for each winding.

(a) **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 1^{o}C. One RWTI shall be provided for each winding in the middle phase (HV & LV).

(b) Auxiliary supply if required, at CSPTCL's panel, for RWTI, shall be 110V DC only.

(c) Accuracy class of WTI shall be + 1.5% or better.

(d) Any special cables required for shielding purpose for connection between cooler control cabinet and remote winding Temperature Indicator control circuit shall be in contractor's scope or work.

5.4.10 EARTHING TERMINALS:

1) Two (2) earthing 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 opposite bottom corners of tank. Earthing strip shall be connected to grounding mat by the Contractor.

2) 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 ageing, low loss, cold rolled super grain oriented silicon steel laminations (Hi B). The core material should be of PRIME grade only. Contractor will offer the core for inspection & approval by CSPTCL during manufacturing stage. Contractor's call notice should be accompanied with the following documents as applicable as a proof towards use of PRIME core material.

i) Invoice of the manufacturer
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 arrangment:-** 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 thorough 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 WINDINGS:

a) The manufacturer shall ensure that windings of all EHV class transformers are made in dust proof, conditioned atmosphere.

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) The insulation paper shall be of high quality and the value of degree of polymerization shall not be less than 1200 Pv and the necessary test certificate shall be submitted alongwith the stage inspection report.

e) 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.

f) 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.

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 non-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 "Principal Parameters" clause –4, Sl. No. 35.

(f) The manufacturer 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 silicagel 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 tilted crystals can be easily observed from a distance.
(v) 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.
(ii) Communications protocols supported should include MODBUS, MODBUS/ TCP, DNP3.0, IEC61850.
(iii) Modules available for connection via RS232, RS485, Ethernet, PSTN modern and GSM or CDMA wireless modems.

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 leads 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.

a) Wet power frequency voltage withstand test.

b) Dry lighting impulse voltage withstand test.

c) Dry or wet switching impulse voltage withstand test.

d) Thermal stability test.

e) Temperature rise test.

f) Thermal short time current withstand test.

g) Dynamic current withstand test.

h) Cantilever load withstand test.

i) 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 conductors shall be bolted type.
ii) Connectors shall be electrolytic grade copper forged and silver plated/ tinned for 10 Microns.

iii) No part of a clamp shall be less than 15mm 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

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. 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) 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.
iv) The nut, bolts & washers used in current carrying path shall be hot dip galvanized.
v) 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.
vi) 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:

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

(b) One core each shall be provided on middle phase of HV, LV and neutral Bushing for WTI.

(c) 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.

(d) 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.

(e) Bushing CT parameters indicated in the specification are tentative and liable to within reasonable limits. The contractor shall obtain CSPTCL'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 flat strip of size 80x6 mm 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 3.2 of the technical specification, at any one place for OLTC Control and Cooler Control. The DC operated contactors coils & push buttons should be suitable for control voltages of 110 volt.

5.9.2 All loads shall be fed by one of the two feeders through an electrically interlocked automatic transfer switch housed in 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 indication 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 shall be supplied by the contractor.

5.9.4 <u>Tap changing equipment</u>: TAPS IN OLTC:

In 40MVA transformer, the OLTC is to be provided on HV winding (i.e. 132 KV) with tap range of –15 % to + 5 % in steps of 1.25 %.

(i) <u>Tap changer Switch (General Requirement):</u>

(a) The on load Tap changer shall be provided in the HV neutral end for HV variation as specified at clause-4.0" Principal Parameters".

(b) 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.

(c) 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.

(ii) <u>On Load Tap Changing Gear (OLTC):</u>

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. 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.

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

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

c) The contractor 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.

d) 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.

e) 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.

f) 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.

g) Transformer unit shall be provided with a local control cabinet and a remote OLTC control panel.

h) Local-remote selector switch mounted in the local control cubicle shall have 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 below. Remote control of RAISE-LOWER functions shall be prevented.

   (i) 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.

   (ii) 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.

   (iii) 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.

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

   (v) 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.

(vi) Emergency stop push button will be provided in local control cubicle as well as on remote tap changer control cubicle panel

i) 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-de-clutching mechanism is incorporated.

j) 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.

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

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

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

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

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

p) 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.

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

5.9.5 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 indicators 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.

(i) 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 panel.

(iv) 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 In no case, the radiators should be projected above the main tank height.

Cooling Equipment: Cooler shall be designed using 2x50 % radiators.

a) 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.

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

c) Cooling fans shall not be directly mounted on radiator bank and transformer tank which may cause undue vibration.

d) The exhaust air flow from cooling fan shall not be directed towards the main tank in any case.

e) 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.

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

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

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

i) Each radiator shall be provided with:

1. One shut off valve at the top (80 mm size).
2. One shut-off valve at the bottom (80 mm size).
3. Air release device at the top.
4. Main & sampling device at the bottom.
5. Lifting lugs.
6. 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 manufacturer 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 difference 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 of the control cubicle to be supplied by the manufacturer shall be 750 mm depth and 2312 mm height and colour opaline green shade No. 275 of B.S.271-C: 1948. The width of the cubicle shall be as per manufacturer's 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.
10. 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) Transformer shall be provided with a cooler control cabinet.

(ii) The cooler control cabinet shall have all necessary devices meant for cooler control and local temperature 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 (turrets) CT's shall also be wired up to 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 bushing (turrets) CT secondary. Alternatively the two sections may be provided as two separate panels depending on the standard practices of the manufacturer.

(iv) 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.

5.10.5 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.

5.11 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 barriers moulded integrally. Such block shall have washer and binding screws for external circuit wire connections, a white marking strip for circuit identification and moulded plastic cover. 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 blocks, preferably vertically mounted on the side of each panel. The terminal blocks shall be 1100 V grade and have 10 amps continuous rating, moulded 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 mm^2 copper.

(b) For all CT circuits minimum of two nos. 4 mm^2 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.631 of 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 galvanised. 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:-

415 volt Power	1100 Volt grade PVC insulated armoured aluminium cable
Control	1100 Volt grade PVC insulated 7/0.737 mm stranded armoured copper 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 7/0.737 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 manufacturer 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.

(1) 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.

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

(3) Oil preservation equipment.

(4) Pressure relief devices alarm contact.

(5) (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.

(6) Air release plugs

(7) Inspection openings and covers.

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

(9) 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).

(10) Oil temperature indicators.

(11) Cover lifting eyes, transformer lifting lugs, jacking pads, towing holes and core and winding lifting lugs.

(12) Protected type mercury or alcohol glass thermometer.

(13) Bottom and top filter valves with threaded male adapters, bottom & top sampling valve and drain valve.

(14) Rating and diagram plates on transformers and auxiliary apparatus.

(15) Earthing terminals.

(16) Flanged bi-directional wheels.

(17) Cooler control cabinet.

(18) On load tap changing equipment and OLTC control cabinet.

(19) Drain valves/plugs shall be provided in order that each section of pipe work can be drained independently.

(20) Bushing CTs for WTI &REF protection.

(21) Cooling fans.

(22) Terminal marking plate.

(23) Jacking pads.

(24) Lifting bollards

(25) Haulage lugs.

(26) Cover Lifting lugs.

(27) Valve schedule plate.

(28) RTCC panel

(29) Bushing terminal clamp & connector

(30) On line DGA monitor

(31) Insulating Oil

(32) 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 50°C
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

Note :

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 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.

5.18 SPECIFICATION FOR CONTROL CABINATES:

1. Control cabinets shall be of the free standing floor mounting type.
2. Control cabinet of the operating mechanism shall be made out of 3mm thick sheet or 10mm thick ones zed 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.

3. 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 braced to withstand forces corresponding to short circuit current of 25 KA.
4. 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.
5. Isolating switches shall be group operated units (3 pole for use on 3- MCBS 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.
6. 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.
7. For motors upto 5 KW, contactor 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 contactor 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 contractors. If possible, mechanical interlocks 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 contactors of the contactors shall be silver plated and the insulation class for the coils shall be class sE or better. The dropout voltage of the contactors shall not exceed 70% of the rated voltage.
8. 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.
9. Single phasing preventer relay shall be provided for 3 phase motors to provide positive protections against single phasing.
10. Mini starters shall be provided with no volt coils whenever required.
11. Power cables of 1100/650 volts grade stranded aluminium 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 Contractor's scope of supply. Suitable brass cable glands shall be provided for cable entry.
12. 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 sq mm. At least 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.
13. 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.
14. 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.

15. Space heaters shall be provided inside each cabinet complete with thermostat (preferably differential type) to prevent moisture condensation. Heaters shall be controlled by suitably treated double-pole miniature Circuit Breakers.
16. 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.
17. Electric measuring instruments shall be of moving iron type. Ammeters for measuring current up to 30 Amps shall be directly connected through suitable CTs. Ammeters shall be provided with selector switches.
18. Items inside the cabinet of organic material shall be coated with a fungus resistant varnish.

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:

i) The type test reports of the transformer (as per latest version of IS:2026) of the offered rating conducted at Govt./ Govt. approved laboratory or witnessed by Govt. / Govt. approved laboratory representative should be submitted alongwith the offer. The type tests should not be older than five years as on last date of submission of bid and the type test of all other assessories are as per guidelines issued for validity of type test conducted on major electrical equipment in power transmission system by Govt. of India, Ministry of Power in the May 2020.

ii) Copies of all routine test reports as per latest version of IS:2026 on transformer of similar rating conducted within five years should also be submitted alongwith the offer.

iii) All routine and additional routine tests shall be carried out on each transformer. The type tests and special tests mentioned at 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 without any extra cost.

iv) The pre-shipment checks to be carried out are given under clause 7 "Inspection & Testing".

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 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
	(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 N_2 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 have valid 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 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 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

(ii) 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 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 & 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.

(a) No load loss exceeds the values mentioned in GTP
(b) Load loss/Auxiliary exceeds the specified values mentioned in GTP
(c) 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:

(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.

© 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.

7.4.5 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.
(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 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-

i) 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.

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

iii) 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. **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.

16.1 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. C**alculations/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 S**hort 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.
(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. & 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, I^2R 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-

(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.

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 Capacity of 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 Limits of 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 ones zed shall be done & finite element software (FEM) may be used.

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GUARANTEED TECHNICAL PARTICULARS OF POWER TRANSFORMER

This schedule of Guaranteed Technical particular for Power Transformer is to be submitted by the contractor.

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 75^{o}C 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 75^{o}C average winding temp. at rated output (KW) (no positive tolerance is permissible)		
©	**Auxiliary losses:**		
	Auxiliary losses at rated output (no positive tolerance is permissible)		
10.	Guaranteed total losses at 75^{o}C temp. (i.e. 9 (a)(i) + 9 (b)+9(c)		
11.	Efficiencies at normal ratio, rated voltage, rated frequency and average winding temp. for 75^{o}C 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			
	© 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			
	© Positive sequence, LV			
19.	Regulation at full load and 75 degree centigrade a. 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 ones zed 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	
	©. 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.	
©	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	
©	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	
	© 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	

©	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.	
©	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	
©	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	
©	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	
	© 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, lxbxh (mm)	
	(b) Total weight with oil (Kg)	
	© 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	
	© 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	
	© Number of contacts	
	(d) Current rating of each contact	
	(e) Whether remote indicators provided. If so whether equipment required at CSPTCL'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 that the transformer will be transported oil filled.-	Yes/No
46.	**Lifting jacks**	
	(i) Governing standard	
	(ii) No. of jacks on one set	
	(iii) Type and make	
	(iv) Capacity (ones)	
	(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	
	© 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	
©	Interfacial Tension at 27°C in N/M	
(d)	Flash point in °C	
(e)	Pour point in °C	
(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 °C	
(j)	Saponification value in mg of KOH/gm	
(k)	Water content in ppm	
(l)	Specific resistance	
	(i) at 90 °C ohm/cm	
	(ii) at 27 °C 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 °C	
(p)	Saponification value in mg of KOH/gm	
(q)	Dielectric loss after 90 °C	
©	Aging characteristics as per NEMA 164 H/110 °C	
(s)	Neutralization value in mg of KOH/gm	
(t)	Sludge content weight %	
(u)	Pemitivity at 60 °C	
(v)	Specific heat at 60 °C	
(w)	Thermal conductivity at 60 °C	
(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	

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

I. Each transformer shall be provided with the following accessories.

(1) 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.

(2) 3 no. Winding temperature indicator for HV & 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.

(3) 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.

(4) 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.

(5) 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.

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

(7) 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.

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

(9) 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.

(10) 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.

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

(12) a/ Two oil conservator, with required accessories, one for main tank and other for OLTC.

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

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

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

(15) One rating and diagram plate.

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

(17) 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.

(18) Suitable jacking lugs and haulage holes.

(19) Inspection window & main holes with bolted cover

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

(21) One foldable ladder on main tank.

(22) 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.

(23) 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.

(24) 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.

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

(26) 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.

(27) In no case, the radiators should be projected above the main tank height.

(28) Transformer 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 "Taparia" make.

II. 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 CSPTCL. All valves shall be provided either with blind companion flanges or with pipe plugs for protection.

III. Indication, alarm and relay equipment shall have contacts suitable for operation with 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.

IV. (a) OLTC and its controls shall be as per relevant clause of specification.

(b) All cabinets & panels shall be conforming to stipulations under relavent clause of specifications.

© All 132/33KV and neutral bushings shall be of OIP condenser type and as per relevant clause of specifications.

V. On line DGA Monitoring device as per relevant clause.

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 contract without any extra cost to CSPTCL.

LIST OF TRANSFORMER ACCESSORIES AND TEST CERTIFICATES REQUIRED

S.No	Accessory	Test-certificates required
1.	Condenser Bushing	1. Appearance, construction and dimensional check. 2. Test for leakage of internal filling at a pressure of 1.0 Kg/cm for 12 hours. 3. Insulation resistance measurement with 2000V megger. 4. Dry/wet power frequency voltage withstand test. 5. Dry/wet power frequency voltage withstand test for test tap insulation 6. Partial discharge measurement upto 1.5 UN 3Kv. 7. Measurement of tangent delta and capacitance.
2.	Pressure Gauges/ Differential Pressure Gauges	1. Appearance, construction and dimensional check. 2. Calibration test. 3. Alarm contact setting test.
3.	OLTC.	1. Oil tightness test for the diverter switch oil chamber at an oil pressure of 0.5 Kg/cm^2 at 100 degree centigrade for 1 hour. 2. Mechanical operation test. 3. Operation sequence measurement 4. Insulation resistance measurement using 2000V megger. 5. Power frequency voltage withstand test on diverter switch to earth and between even and odd contacts. 6. Power frequency voltage withstand test on tap selector- between stationary contacts, between max. And min. Taps, between phases and supporting frames, between phases. 7. Operation test of complete tap changer. 8. Operation and dielectric test of driving mechanism.
4.	Winding & Oil Temperature Indicator	1. Calibration test. 2. Dielectric test at 2 KV for one minute. 3. Accuracy test for indication and switch setting scales. 4. Test for adjustability of switch setting. 5. Test for switch rating. 6. Measurement of temperature rise with respect to the heater coil current.
5.	PRV	1. Functional test with Compressed air to check bursting pressure, indicating flag operation and switch operation. 2. Dielectric test at 2 Kv for one minute. 3. Switch contact test at 5A, 240 Volt AC.
6.	Cooling fans	1. Insulation resistance measurement. 2. Dielectric test at 2 KV between winding and body for one minute. 3. Operation check. 4. Appearance, construction and dimensional check.

7.	Buchholz relay	1. Leak test with transformer oil at a pressure of 3 Kg/cm^2 for 30 minutes at ambient temperature for relay casing. 2. Insulation resistance measurement with 500V megger. 3. Dielectric test at 2KV for 1 minute. 4. Elements test at 1.75 Kg/cm^2 for 15 minutes using transformer oil at ambient temperature. 5. Loss of oil and surge test. 6. Gas volume test. 7. Mechanical strength test. 8. Velocity calibration test. 9. Appearance construction and dimensional check.
8.	Oil level indictor	1. Test for oil levels. 2. Switch operation for low level alarm. 3. Switch contact test at 5A 240V AC. 4. Dielectric test at 2 KV for 1 minute. 5. Appearance, construction and dimensional check.
9.	Pressed steel radiators	1. Air pressure test at 2 kg/cm^2 under water for 15 minutes. 2. Appearance, construction and dimensional check.
10.	OLTC control cubicle/ cooler control cabinet	1. Appearance, construction and dimensional check. 2. Electric operation. 3. Insulation resistance measurement using 500V megger at ambient temperature. 4. Dielectric test at 2 KV for 1 minute.
11.	Bushing current transformer	1. Appearance, construction and dimensional check. 2. Polarity check. 3. Measurement of insulation resistance. 4. High voltage power frequency test. 5. Determination of ratio error and phase angle of measuring and protection BCTs. 6. Determination of Turns ratio error for PS class BCT. 7. Determination of composite error for protective class BCT. 8. Interturn insulation withstand test. 9. Exciting current characteristic test. 10. Secondary winding resistance measurement. 11. 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

S. No.	Name of Item	Supplier/manufacturer
		M/s. Rubber Products M/s Sukrut Udyog M/s Nu-cork Product (P)Ltd. Bhiwadi Rajasthan
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 Product (P)Ltd. Bhiwadi Rajasthan
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

S. No.	Name of Item	Supplier/manufacturer
		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.	NIFPS	M/s CTR M/s Easun MR Tap Changer (P) Ltd., Puducherry

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.

(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 & LV Neutral Bushings

(aj) Drawing for Lead termination to bottom of HV & 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.

1.1 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.

1.2 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.

(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.

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.

1. **Tank and conservator:**

a) Certification of chemical analysis and material tests of plates.

b) Welder's qualification and weld procedure.

c) Testing of electrodes for quality of base materials and coatings.

d) Inspection of major weld preparation and joint.

e) Crack detection of major strength weld seams by 'dye penetration test'.

f) Measurement of film thickness of:

i) Oil insoluble varnish.
ii) Zinc chromate paint.
iii) Finished coat.

g) Check correct dimensions between wheels, demonstrate turning of wheels through 90 degrees and further dimensional check.

h) 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.

i) Tank vacuum & Tank pressure tests as per CBIP manual on transformer & as per this specification.

j) Leakage test of the conservator and tank.

k) Measurement of thickness of tank plates i.e. top, Bottom & Sides.

l) All double welds shall be tested for leaks with dry nitrogen, at the pressure not less than 7 kg/sq.cms. (atm)

m) 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.

n) Certification of all test results.

2. Core:

a) Sample testing of core material for checking thickness of lamination, special loss, bend properties, magnetization characteristics (B-H Curve) and Epstein curve.

b) Check on the quality of varnish, if used on the stampings.

i) Measurement of thickness and hardness of varnish on stampings.

ii) Solvent resistance test to check that varnish does not react in hot oil.

iii) 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.

c) Check on the amount of burrs.

d) Bow check on stampings.

e) Check for the over lapping of stampings, Corners of the sheets are to be apart.

f) Visual and dimensional check during assembly stage.

g) 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.

h) 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.

i) High voltage test of 2KV for one minute between core and clamps.

j) Certification of all test results.

3. Insulating material:

a) Sample check for physical properties of materials.

b) Check for dielectric strength, .

c) Visual and dimensional checks.

d) Check for the reaction of hot oil on insulating materials.

e) Dimensional stability test at high temperature for insulating material.

f) Tracking resistance test on insulating material.

g) Certification of all test results.

4. Winding:

a) Sample check on winding conductor for mechanical properties and electrical conductivity.

b) Check insulating distance between high voltage/low voltage connection, cable and earth and other live parts.

c) Check for proper cleanliness and absence of dust.

d) Visual dimensional checks on conductor for scratches, dent marks etc.

e) Sample check on insulating paper for PH values bursting strength and electric strength.

f) Check for bonding of insulating paper on conductor and absence of short circuit between parallel strands.

g) Check for brazed joints wherever applicable.

h) Measurement of voltage, when yoke/core is completely restocked and all connection are ready.

i) Measurement of no. of turns in each winding and cross sectional area of windings. Weightment of windings.

j) Certification of all test results.

5. Checks before drying process:

Weight of complete core, winding and insulation.

a) 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.

b) Insulation of core shall be tested at 2KV /min between core to bolts and core to clamp plates.

c) Check for proper cleanliness and absence of dust etc.

d) Certification of all test results.

6. Checks after drying process:

a) Record measurement of temperature, vacuum and drying time during vacuum treatment.

b) Check for completeness of drying by measuring IR values and Tan Delta.

c) DP test shall be carried out after jacking test.

7. Pre shipment check at manufacturer's works:

a) Check for inter changeability of components of similar transformers for mounting dimensions.

b) 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.

c) Check for proper provision of bracing to arrest the movement of core and winding assembly inside the tank.

d) Gas tightness test to conform tightness.

e) 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

A. 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 (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
B	Hydraulic jack of minimum 100 T capacity each with 150 mm lift. Two jacks shall be motorised.	04 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 60^{th} / 15^{th}& 600^{th} / 60^{th} 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	**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**

(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.
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

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3.0 TECHNICAL SPECIFICATION FOR 145 KV CIRCUIT BREAKERS

3.1 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.

3.2 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.

3.3 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.

3.4 **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%.

3.5 **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.

3.6 **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

S.No	Items	Requirement of 145 KV SF_6 Circuit Breaker
9.	Type of operation	Normal Duty
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.

S.No	Items	Requirement of 145 KV SF_6 Circuit Breaker
26.	Rated characteristics for short line faults	As per IEC 56-2, 1971 Clause no. 8.
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)

3.7 SPECIAL DUTY REQUIREMENT

3.7.1 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.

3.7.2 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.

3.7.3 **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.

3.8 **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.

3.8.1 **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"

3.8.2 **TRIP FREE OPERATION:**

The circuit breakers mechanism shall be suitable for trip-free operation.

3.8.3 **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.

3.8.4 **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

3.8.5 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.

3.8.6 **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.

3.9 **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.

3.10 **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.

3.11 **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.

3.12 **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.

3.13 **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.

3.14 **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.

3.15 **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.

3.16 **GENERAL TECHNICAL REQUIREMENTS:**

3.16.1 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.

3.16.2 Exposed live parts shall be placed high enough above ground to meet the requirement of local safety codes.

3.16.3 Any part of' the breaker, especially the removable ones, shall be freely inter-changeable without the necessity of any modification at site.

3.16.4 Circuit-breaker shall comprise of three identical single pole units which should be linked together.

3.16.5 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.

3.16.6 Circuit breaker shall be suitable for hot line washing.

3.16.7 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.

3.16.7 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.

3.17 **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.

3.18 **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.

3.19 **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.

3.20 **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.

3.21 **TOTAL BREAK TIME:**

3.21.1 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).

3.21.2 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.

3.21.3 The values guaranteed shall be supported with the type test reports.

3.22 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.

3.23 **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**.**

3.24 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%

3.25 **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.

3.26 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.

3.27 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.

3.28 RATING AND NAME PLATE

3.28.1 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.

3.28.2 Breaker wiring diagram should be engraved on the back side of the front door of the panel.

3.29 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.

3.30 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.

3.31 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.

3.32 **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.

3.33 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.

3.34 **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.

3.35 **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. The type tests should not be older than ten years as on last date of submission of bid. 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.

3.36 **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.

3.37 **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.

3.38 **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.

4) 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	110 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 110 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 110 V DC:	2 Nos.
3.	Closing coil suitable for 110 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**:-

5. 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 10 years from the last date of submission of bid.

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.

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5) TECHNICAL SPECIFICATION FOR INSTRUMENT TRANSFORMERS

(*Note:- 132 KV CT & 132 KV PT shall be provided by CSPTCL.*)

5.1 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 .

5.2 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.

Sl. No.	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		Indian electricity rules 1956.

5.3 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.

5.3.1 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.

5.3.2 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.

5.3.3 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.

5.3.4 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.

5.3.5 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 manufacturer 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 should be provided with leak proof Teflon sealing arrangement and wide area visible indication and a float to indicate the oil level. The oil level shall be visible from ground level. Projected type oil level indicator welded into main metal tank shall be preferred to avoid oil leakage.

5.3.5 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.

5.3.7 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.

5.3.8 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.

5.3.9 During inspection, each CTs will be subjected to pressure test at 0.7 kg /cm^2 for 8hrs.

5.3.10 The CTs should be provided with pressure relief diaphragm.

5.3.11 The secondary terminals shall be brought out in a weather proof terminal box. Firstly the connections will be terminated on 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.

5.3.12 Polarity shall be invariably marked on each primary & secondary terminals. All marking shall be engraved or through anodised plate to be fixed firmly.

5.3.13 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.

5.3.14 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.

5.3.15 The castings of base, collar etc. shall be die-cast and tested before assembly to detect cracks and voids if any.

5.3.16 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.

5.3.17 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.

5.3.18 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.

5.4 **PRIMARY WINDINGS**:-

5.4.1 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.

5.4.2 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>

5.4.3 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.

5.5. **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.

5.6 **PRIMARY TERMINALS**:-

Current Transformer's primary terminal shall be made of HDEC.The primary terminal on either side of the tank shall be of not less than 100 mm clear length (i.e. after bolts/washers/check-nuts) to accommodate terminal connector. For CTs the dia /size of the primary terminal shall be 30mm diameter copper.

The primary terminals shall be of heavily tinned electrolytic copper. The minimum thickness of tinning shall be 15 microns.

5.7 **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.

5.8 **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. As far as PS class core is concerned all precautions shall be taken in design to achieve KPV & magnetization curve for the same shall be furnished with the drawings. It may please be noted that additional devices / components such as condenser/ resisters/ inductor should not be used internally or externally to achieve the accuracy class/ ISF of CTs.

5.9 INSULATION OIL :-

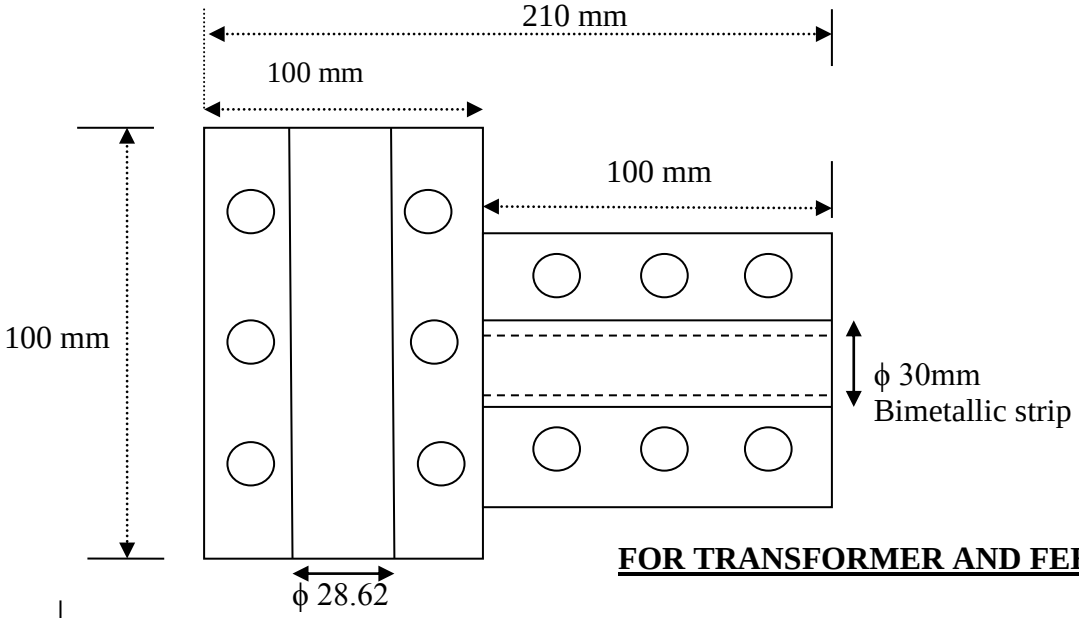
The quantity of oil for first filling of oil in each transformer shall be in the scope of supplier. Only best quality new EHV Gr-I transformer oil should be filled in the equipments with BDV of 70 KV. The BDV of oil filled in the equipment will have to be recorded in the test certificate.

5.10 SURFACE FINISH:-

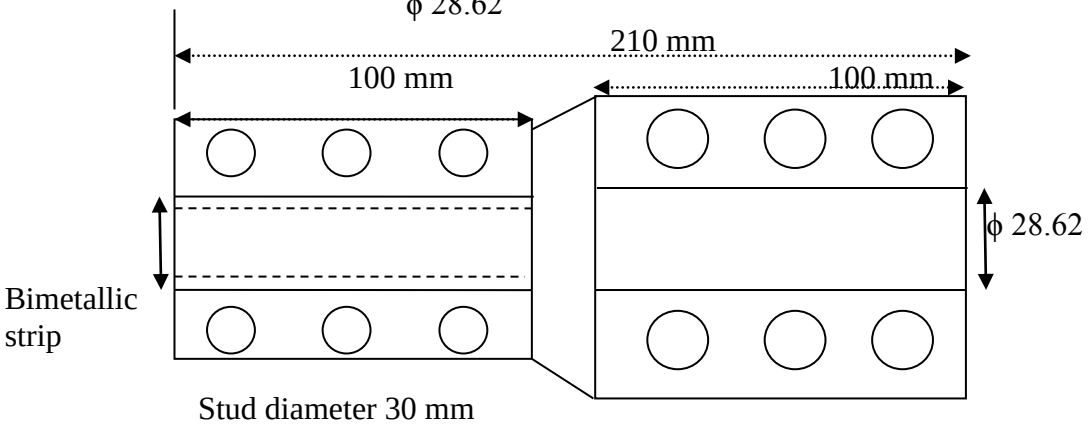
The metal tanks & all the ferrous parts/hardware, exposed to atmosphere, shall be hot dip galvanised conforming to IS; 2633. All other fixing nuts, bolts, washers shall be made out of galvanized steel.

5.11 TERMINAL CONNECTORS;-

The terminal connector for primary terminal shall be designed with min. thickness of 12 mm having 100 mm coverage of conductor and CT stud with six bolts of M10 size,having bimetallic strip of 2 mm (1mm Cu+1 mm Al) as per the drawing furnished below.



FOR TRANSFORMER AND FEEDER



FOR TRANSFER BUS BAY

5.12 The Instrument Transformer shall be suitable for mounting on steel structure of CSPTCL design.

5.13 The Capacitance and Tan Delta Measuring Terminal is to be provided on each CT.

5.14 The height of centre of primary terminal to base shall be 2300±100mm. This is necessary to ensure ease of replacement of CTS.

5.15 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 .

5.16 TESTS :-

All acceptance and routine tests as stipulated in the relevant standards shall be carried out in the presence of CSPTCL's representative:-

(i) Verification of terminal marking.
(ii) Measurment of Tan Delta value at 27deg centigrade.
(iii) Power frequency withstand test on primary and secondary winding
(iv) Partial discharge measurement (as per clause 8.2.2 of IEC 44-1)
(v) Power frequency withstand tests between section (as per clause 8.3of IEC 44-1)
(vi) Inter turn voltage tests per clause 8.4 of IEC 44-1)
(vii) 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. The type tests should not be older than seven years from the last date of submission of bid.

5.17 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

5.18 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, 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	400/1-1-1 A	800/1-1-1-1 A
6	Ratio Taps	On secondary side	-	-
7	No. of Cores	4	3 (Feeder)	4 (X'mer & Transfer Bus)
8	Class of accuracy (winding I/II/III/IV)	PS/PS/0.2s/0.2s	PS/0.5s/0.2s	PS/PS/0.5s/0.2s
9	Burden in VA	---/---/15/15 VA	--/30/15 VA	---/---/30/15 VA
10	Knee point voltage	P.S.1100 V Min 30x (RCT+36)V	P.S > 600 V	
11	Method of earthing the system	Solidly earthed	Solidly earthed	
12	Rated continuous thermal current (A)	120 %	125%	

S.N	ITEM	Specifications for 132 KV CT	Specification for 33 KV CT
13	Acceptable partial discharge level at 1.1 times the rated voltage	Less than 5 p Coulombs	
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 KV	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/sec	25 KA/sec
20	Rated dynamic withstand current (KAp)	78.75 KAp	62.5 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	Total weight of CT with oil		>120 Kg
24	Total quantity of oil		>20 Ltr.
25	Bushing creepage factor	< 4	
26	Primary to earth insulation resistence at 30° C	> 50 G ohm	> 50 G ohm
27	Flux density at knee point voltage for CT.	1.4 Tesla	1.4 Tesla
28	Cross section of primary winding	For 400-200/1-1-1-1A CT- 367 sqmm approx	For 400 A CT-275 sqmm For 800 A CT-550 sqmm
29	Current density of primary winding of CTs at ratedcurrent	shall not exceed 1.5 Amp per Sq mm	
30	Dielectric dissipation factor (Tan delta) at 1/√3 rated voltage & ambient temperature (10 deg C. to 40 deg C.)	Max 0.005 (Tolerance + 10 %) for all ratio.	--
31	Material of primary winding	99.9% electrolytic copper	
32	Material of secondary winding	99.9% electrolytic copper	
33	Earthing terminal arrangements.	2 terminal for bolted connection to 50x6mm MS flat**.**	
34	Grade of oil	EHV Gr.-I as per IS:335	
35	Instrument security factor for metering core	Max 5	
36	Material of Gasket used	Nitrite butyl rubber/ Neoprine	
37	Core material used	Grade M4 toroidal core of high grade non ageing electrical silicon or better grade	
38	Material of enamel used	Polyvinyl acetate or amide type	
39	CT top / bottom Gasket mounting surface	Gasket mounting surface shall be smooth laser cutting finish	
40	Secondary lead out connection	2.5 Sqmm flexible copper wire	

5.19 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	--
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.	≥ 120 Ltr	> 30 Ltr
21	Over all dimensions	2450x600x600 mm	Please furnish with drawing
22	Material of gaskets used	Nitrite butyl rubber/ Neoprine	--

S.N.	ITEM	SPECIFICATIONS	
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.	--

5.20. 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 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

xi) All connections with ACSR conductors shall be bolted type.

Two numbers grounding terminals for connection with sub-station earth mat shall be provided on each CT & PT. Size of the earthing pad shall be suitable for 50 x 8 or 60 x 8 mm Earth flat.

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6.0 TECHNICAL SPECIFICATION FOR 10 MVAR, 33 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 10 MVAR 33 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. The type tests should not be older than ten years from the last date of submission of bid. 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.

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7.0 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 :

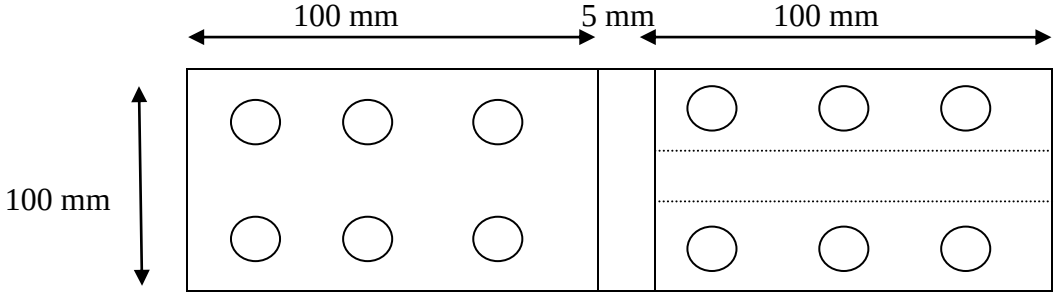
a. Electro-dynamic withstand capability of contacts should be sufficient to ensure that during short circuit there is no risk of repulsion of contacts.
b. The current density in the Copper parts shall not be more than 1.5A/sq.mm but may be less.
c. Thermal withstand capability during short circuit should 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	

Sr.	Technical Parameter	Requirement
	a) 150% of rated current	5 minutes
	b) 120% of rated current	30 minutes
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 ten years from the last date of submission of bid. 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.

8.0 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 type tests should not be older than ten years from the last date of submission of bid. 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.

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9. TECHNICAL SPECIFICATIONS FOR INDOOR CONTROL AND RELAY PANELS.

9.1 SCOPE:-

This section contains the technical specifications for the indoor control, indication, relay and metering panels associated with the outdoor switch gear for the sub-station. The various control and relay panels shall be complete in themselves with all main and auxiliary relays, fuses, link switches wherever necessary, wiring, labels, terminal boards, earthing terminals, foundation bolts etc. All the main numerical relays such as Distance Protection Relay, Differential Relay, REF Relay, O/C and E/F Relay, LBB Relay shall comply to IEC 61850 protocol. The DC Control voltage should be 110V DC. The supplier of C&R panel should ensure to supply all the relays from the approved vendor list.

9.2 STANDARD SPECIFICATION:-

9.2.1 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.

9.2.2 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.

9.3 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 Duplex type for 132 KV and simplex type for 33 KV. Simplex type panels consist of equipments mounted on the front side of the panel and having wiring access from the rear. Double leaf door with lift off hinges shall be provided at the back of the simplex panels. The control panels have a floor mounting type.

9.3.1 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 Panels shall have the following dimensions:**

Type	132 KV Duplex Panel
Height	2300 mm
Depth	400 + 700 + 400 mm.
Width	800 mm.

iii) The control panels shall be floor mounting dead front sheets steel assemblies of unitized design.

iv) 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.

v) 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.

vi) The control panels shall be placed over the cable trench supported by channel of not less than 100x100mm size.

9.3.2 **PANEL LIGHTING**:-

a. In each control and relay panel for interior illumination one tube light 20 W operating at 230 V 50 cycle with door operated switch shall be provided in the corridor. The tube light shall be located at the ceiling and guarded with a protective cage. In addition to corridor tube light, two incandescent lamp one each on front and rear panel with switch shall also be provided.

b. One 15 A, 3 pin socket with plug and switch shall be provided for each of the control board of duplex type C&R panels. The third pin of the socket shall be effectively earthed through the metallic structure. The socket shall be industrial grade control panel type complete with protective metallic cover.

c. A test lamp 230V AC 18 W CFL with 3 M lead and holder with a controllable 5 A switch is to be mounted at the top inside each panel.

9.3.3 AUXILIARY SUPPLY:- For each group of control boards, the CSPTCL will arrange to provide at one point only the following:

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 110 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.	10A
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

9.3.4 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.

9.3.5 TERMINAL BLOCKS:

i) Multi-way stud type 10 A current carrying capacity terminal blocks complete with necessary binding nut and bolt , washers for wire connection and making strip for circuit identification shall be furnished for terminating the panel wiring and outgoing cables. The terminal block shall be suitable for receiving at least 2x7/0.737 mm standard copper or aluminium conductor wire per terminal. It may also be noted that the current rating shall be double the current rating of 2x7/0.737 non-stranded copper wire and the terminal shall be suitable to receive 2 x 2.5 sq. mm/ 2x4 sq. mm copper conductor of copper control cables.

ii) Terminal blocks shall have shorting and disconnection facilities. The Board side and outgoing wires can be disconnected just by opening the disconnecting links which slides up or down without lodging the wires from their position. 'ASEA' type sliding links shall be provided. However, disconnecting type terminal connectors may be limited to CT & PT circuits only. All other terminals should be of bolted type.

iii) Highly reliable terminal blocks with facilities of shorting and easy removal of connection shall be provided for CT & PT circuits. Instrument transformer wires shall be terminated through suitably mounted test terminal blocks for site testing facility.

iv) The terminal blocks shall be grouped according to the circuit functions and each terminal block group shall have at least 20% spare terminals.

v) Not more than two wires shall be connected to any terminal or either side of the terminal block. If necessary, a number of terminals shall be jumpered together to provide the wiring points.

vi) Each terminal point shall be marked with designation obtained from the CSPTCL's schematic drawings.

vii) Adjacent rows of terminal blocks shall be spaced not less than 100 mm apart. They shall be mounted vertically at the sides of the cubicle and set obliquely towards the rear doors to give easy access to terminating end to enable ferrule number to be read without difficulty.

viii) The bottom of terminal blocks shall be spaced at least 200 mm above the cable trench incoming multicore cables.

ix) Separate test terminal block should be provided for the KWH meters to facilitate the testing and calibration of energy meters without disturbing the other circuits such as ammeter/MW meters. The TTBs should be 3 phase, 4 wire with screw type CT shorting arrangement.

x) Stud type terminal connectors rated for not less than 10 Amps shall be used in the CRP panel.

9.3.6 CABLE ENTRY:-

i) The control board shall have provision of cable entry from the bottom. Necessary cable glands should also be provided. The CSPTCL will arrange for necessary floor opening below the panels to suit the cable trench design of CSPTCL's requirement.

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.

vi) The following quantities of cable glands with blanking plate shall be supplied fitted along with each panel:-

i)	For 8 core x 2.5 sq. mm 1.1 kV control cable	4 Nos.
ii)	For 4 core x 2.5 Sq. mm 1.1 KV Control cable	8 Nos.
iii)	For 12 core x 2.5 sq. mm 1.1 KV Control cable	2 Nos.
iv)	For 10core x 2.5 sq. mm 1.1 KV Control cable	2 Nos.

9.3.7 GROUNDING:-

i) 25 mm x 6 mm copper ground bus shall be providing for each control boards extending along with entire length of the board and effectively grounding all metal structures.

ii) Each continuous length of ground bus shall have provision of two terminals at two separate points for connection to main ground grid of the substation.

iii) Whenever a circuit is shown grounded on the drawings a single wire for the circuit shall be run independently to the ground bus and connected to it.

9.3.8 Invariably for all the panels end doors with suitable lock and handle on both the sides should be included in the offered prices. As per our standardisation end doors should be of full size without requiring any end sheets on the sides.

9.3.9 CONTROL AND RELAY PANELS:

i. The control and relay boards required for 132 KV side shall be duplex type panels of the back to back corridor type with central roofed access. The control, recording and indication apparatus shall be mounted in the front panel. These shall be of the flush pattern. The relays shall be mounted on the rear panels and these may be of the projecting pattern. However, if relays of "draw out" type are offered, these may be arranged to be flush.

ii The central access way shall be provided with interchangeable lockable doors. Suitable tube light shall be provided inside the panels for adequate illumination & the same being controlled by a switch provided on one end, including two incandescent lamps with switch one each on the front & rear panel.

iii The labelling for the circuits shall be provided at the front control panels, at the rear relay panels as well as on the inside of the panels.

iv 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.

v 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.

vi. 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.

9.3.10 CONTROL & INDICATION CIRCUITS:

9.3.11 The control and indication circuit for each circuit breaker controlling feeder or transformer shall generally comprise the following:

a) Mimic diagram (main and transfer bus scheme)
b) Ammeters and voltmeters where specified.
c) PF, Mega Watt, MVAR meter where specified.
d) Circuit Breaker Control switch.
e) "Trip Circuit Healthy" I & II lamps.
f) Alarm Cancellation arrangement.
g) Breaker ON/OFF indication lamps.
h) Breaker Spring Charge indication lamp.

9.3.12 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.

The mimic diagram offered shall be of Azure blue shade 104 of IS-5.

9.3.13 LED type semaphore indicator 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.

9.3.14 ANNUNCIATION SYTEM:

9.3.15 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.

9.3.16 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. The facia plates shall be engraved in black lettering with respective inscriptions which will be furnished to the contractor by CSPTCL. 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.

9.3.17 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.

9.3.18 **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

9.3.19 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. CSPTCL reserves the right to ask for a sample of annunciation system for approval, if so considered necessary from the successful contractor.

9.3.20 **Multi-Functional Transducer (MFT):**

1 No. MFT shall be provided for each panel. The MFT should be accommodated in respective feeder/ transformer panel and output signal of MFT shall be taken to RTU panel through 1.5 Sq mm multi strand copper wire (screened cable). The analog parameters of all feeders, transformers, bus voltages and frequency shall be measured through MFT and Breaker ON/ OFF indications shall be double point indication and isolator indication shall be single point indication and will be coupled to RTU through OPTO isolator print. The wiring of digital indication shall be done by 1.5 sq mm multi strand copper wire, Bus PT voltage and frequency signal shall be terminated to RTU panel. The MFT should have accuracy class of 0.2, 3 ph-4wire type with 2 no digital & 4 no.20mA analog outputs, should have USB & RS485 ports for communication and operating voltage 40-276V AC/DC. Necessary software interface shall also be provided.

9.3.21 **Digital Multi function Energy Meter**: -

1 No. Digital Multi Function Energy Meter of 0.2s accuracy class shall be provided on each panel to measure currents & voltage of all the 3 phases and MW, MVAR, PF. etc. The multi function energy meter shall have suitable CT and PT ratio with dial factor of unity for 132 KV & 33 KV C&R panels. The specification of multifunction energy meter is:-P-N Voltage, Average P-N voltage, P-P voltage, (L1, L2, L3 and Average), Active/Reactive Current, Frequency, Power factor, Average Power factor, Active Power, Total Active Power, Reactive Power, Total Reactive Power, Apparent Power, Total Apparent Power, Active Total Import/ Export Energy. Active/Apparent Forwarded, Reactive Lag/Lead Forwarded, Phase Angle, Power On/Off Hours, Load On/Off Hours, Feeder Interruption Count(When Aux is also off), RPM with Freq and VUnb and IUnb, Modbus on RS485.

Ethernet pluggable port by separate detachable Module, Calibration LED for accuracy test on site. Load Survey: 40 days for 6 parameters @ 30 min IP, Options for 15or 60 minute integration period.Type tested by NABL accredited Lab.

9.4.0 PROTECTION SCHEME

The protection schemes to be supplied under this contract shall cover the following type of panels for 132 KV System:

(a).Transformer panel (b). Transmission line panels (c). Transfer breaker panel

9.4.1 **TECHNICAL REQUIREMENT OF 132/33 KV, 40 MVA TRANSFORMER CONTROL & RELAY PANELS :-**

01. **DC SUPPLY:-**The panel wiring shall be made considering a single source of 110V DC battery but two independent protection DC circuits to be wired by providing separate DC fuses in such a way that even with the availability of one set of protection fuses C.B. tripping should take place.

02. **DC FAIL INDICATION**:- One No. DC fail relay energizing an AC bell shall be provided for monitoring the DC supply to the protection circuit. The DC fail relay should have a reverse flag.

03. **P.T.SUPPLY**:- The panel shall be wired for a double set of 132 KV PTs having metering and protection cores. Thus, the provision of P.T. Selection switch is required. The selection shall be through a manual stay put switch having VT-1, inter, VT-2 positions. There shall be a lamp indication for the selected PT supply so that when VT-1 is selected, the lamp for VT-1 shall be lighted and similarly for VT-2. PT selection switch shall be break before make type to avoid paralleling of PT ckt.

1. PROTECTIONS AND CONTROL PROVIDED IN THE PANEL:-

a) Numerical Differential Relay:

i) **A two winding numerical differential relay** shall be provided. The operating time of the relay should be less than 30 ms. The relay shall be suitable for display of load current and fault data through a HMI. Relay shall have IRIG-B port for time synchronising. It shall conform to clause 9.6.4 and 9.6.5 also.

ii) It shall have an adjustable bias setting range and dual bias slope.

iii) It shall be stable under severe through fault condition.

iv) It shall be suitable for rated current of 1 Amp.

v) It shall be IEC61850 compliant.

vi) The exact model of the offered relay shall be finalised by the CSPTCL at the time of the engineering based on the requirement of protection scheme and it shall be binding on the contractor.

vii) It shall have internal feature in the relay to take care of the angle & ratio correction.

viii) It shall have second, fifth and higher harmonic and other inrush proof features and should be stable under normal over fluxing conditions. Magnetising inrush proof feature shall not be achieved through any intentional time delay e.g use of timers to block relay operation

ix) It shall have an operating current setting of 15% or less. Shall have settable operating current setting.

x) It shall have Bus PT voltage inputs also. PT input shall be rated for 110 V.

xi) There shall be at least two protection setting groups.

xii) The connecting leads from the relay to the computer as well as the software interface for setting and data extraction from relay shall also be supplied

xiii) Shall have a minimum of 12 output out of which a min of four should be trip heavy duty type and 12 Opto input contacts.

xiv) All the instantaneous values of wdg currents, operating and bias currents shall be displayed on the HMI on demand.

xv) It shall have an unrestrained instantaneous high set Id>> feature.

xvi) The relay shall have following inbuilt protection features. However, these are not to wired in the protection scheme as separate relays are to be provided for below given protection functions.
a) Over excitation (V/f) protection
b) Overvoltage protection
c) REF protection
d) Definite time and IDMT Over current protection with settable time

xvii) The relay shall have a disturbance recording feature to record graphic form of instantaneous values of current in both the windings in analogue channels, operate current, restraining current and voltages in separate 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 minimum external digital channel signals apart from the digital signals pertaining to differential relay.
1. REF protection operated (HV and LV)
2. HV breaker status
3. LV breaker status
4. Bucholtz /OLTC Bucholz alarm and Trip ; PRD trip
5. WTI/OTI alarm/trip of transformer

The Relay shall be suitable for :

i. CT secondaries : 1A
ii. PT Secondary: - 110V
iii. DC auxiliary supply: - suitable for 110V DC nominal
iv. System earthing: - solidly grounded
v. Max. Ambient temperature: - 55 degrees centigrade

Necessary hardware and software for down loading the data captured by disturbance recorder to the workstation computer in the substation shall be included in the scope.

b) Numerical Back-up Over Current and Earth fault (Directional) protection scheme with high set feature;

It shall be IEC 61850 compliant. It shall have continuous self-monitoring and diagnostic features. It shall have a trip value recorder feature to record instantaneous fault values of current & voltage. It shall have oscillographic disturbance recording feature facility. It;

(i) Shall have three over current and one earth fault element(s)

(ii) The scheme shall include necessary VT fuse failure relays for alarm purpose

(iii) Shall have freely configurable 4 nos each of input and output contacts. Shall have a minimum of four nos LEDs for indications.

(iv) Over current relay shall

- have multiple characteristic including a directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current
- have low transient, over reach high set instantaneous unit of continuously variable setting range 200-2000 % of rated current
- have a variable selectable characteristic angle

(v) Earth fault relay shall

- have multiple characteristics (including a directional and non-directional IDMT definite minimum time of 3.0 seconds at 10 times setting) and have a variable setting range of 0.20-3.0 times of rated

current.

- have low transient, high set instantaneous unit of continuously variable setting range 200-1500 % of rated current with settable time delay
- have a variable selectable characteristic angle
- have internal feature in the relay for open delta voltage

(vi) It shall have power and energy measurement facility. Shall also have measurement facility of instantaneous voltage and currents on HMI.

(vii) It shall have at least two setting groups

(viii) Shall have negative sequence over current feature also.

(ix) The O/C and E/F relay shall have disturbance recording capability and event logger. It should display at least previous five fault data on HMI on demand.

(x) The relay model shall be Micom P141/Siemens 7SJ6611/Schneider P141 or higher version or equivalent model of approved make of relay. The exact model of the offered relay shall be finalised by the CSPTCL at the time of the engineering based on the requirement of protection scheme of CSPTCL and it shall be binding on the contractor.

c) Transformer body protections:- A total of 08 Nos. self reset type heavy duty tripping relays with operating time less than 12 ms having indicating flags shall be provided for the following:-

a) Transformer Buchholz trip.
b) Transformer OLTC Buchholz trip
c) Transformer winding temperature trip
d) Transformer oil temperature trip.
e) Transformer PRV trip.
f) Transformer OLTC PRV trip.
g) Spare 2 Nos.

d) In addition to the above, a total of 11 nos of VAA Self Resetting elements as above for alarm circuits shall also be provided, as follows:-

a) Low Oil Level alarm.
b) Main Buchholz alarm.
c) W.T.I. Alarm.
d) O.T.I. Alarm.
e) Low SF_6 Alarm.
f) Low Air pressure alarm.
g) Low SF_6 CB Lock out
h) Low Air Pressure CB Lock out
i) Over flux alarm.
j) Spare – 1 No.

e) **Over fluxing protection**:- A numerical over flux relay with instantaneous alarm & time delayed tripping shall be provided (timer 01 to 30 sec in steps of 1 sec.).

f) **Trip circuit supervision relays**:- Two Nos. trip circuit supervisory relays for monitoring healthiness of trip circuit shall be provided with indicating flags.

g) **Trip transfer scheme**:- A 32A lockable best quality NORMAL, INTER and TRANSFER switch shall be provided for transfer of trip to the transfer breaker. A lamp indication shall be provided for transfer position.

h) **L.B.B**.:- In case the breaker fails to trip within 200 m.s. of the trip relay operation; the phase segregated LBB relay shall be allowed to trip all the breakers connected to the BUS. An independent LBB relay shall have the provision for independent setting of current and time delay. The relay contacts shall be terminated up to terminal block. LBB trip circuits ferrule numbers shall be 'P' series.

The LBB relay shall be of Numerical type and separate from Dist/Diff/Back up relays. It shall be IEC61850 complaint. It shall

i) be phase segregated type.
ii) have an operating time of less than 15 milli seconds
iii) 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 x'mer for each over current element.
(f) have a setting range of 20-150% 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) have event logger and oscillographic Disturbance Recorder,
(k) The relay model shall be Micom P141/ Siemens7SJ6611/ Schneider P141 or higher version or equivalent model of approved make of relay. The exact model of the offered relay shall be finalised by the CSPTCL at the time of the final engineering based on the requirement of protection scheme of CSPTCL and it shall be binding on the contractor.

i) **Tripping relays**:- Two separate hand reset type trip relays shall be provided. The relay should have enough contacts for TC-1 & TC-2 trip of main CB as well as provision for tripping of transfer CB & inter tripping of 33 KV breakers. Further the trip relays shall have NC type contacts for CB close interlock. The operating time of trip relays shall not exceed 12 ms. Contactors shall not be accepted as trip relays.

9.4.2 **DIFFERENTIAL RELAY, NUMERICAL OVER CURRENT & E/F RELAY, REF Relay etc: -**

a) All protective relays shall be of numerical type and communication protocol IEC 61850 compliant. All main relays shall have Ethernet/RJ45 ports. 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. The input and output contacts shall be freely configurable. These relays shall conform to clause 9.6.4 & 9.6.5 also.

b) All the Numerical relays shall have self monitoring feature. The Numerical relays shall have event logger, trip value recorder and oscillographic Disturbance Recorder and on initiation of event, the DR shall automatically be downloaded at the workstation.

c) All the Numerical Relays shall have 20 % spare input and output contacts over what has been utilised in the scheme.

9.4.3 **FREQUENCY METER**:- Digital frequency meter suitable for 45 – 55 Hz with up to two decimal digits shall be provided. The make shall be Motwane, AE , Rishub of display LED size 1 inch.

9.4.4 **METERING AND CONTROL**:-

i All the ampere meters shall be digital meters of class-0.2S accuracy. One number digital voltmeter shall be provided with voltmeter selector switch. The 3 Phase 4 wire MW and MVAR meter shall also be digital having CT ratio 200/1A and PT ratio 132 KV / 110V.

ii **Secure Meters Ltd make** One number 3 phase 4 wire static Trivector Exp/Imp meter of 0.2S class of accuracy having facility of load survey for a minimum period of 35 days of 15 minutes block & instantaneous load parameters like ampere, KW, KVA and KVAR. The dial factor shall be unity for a CT ratio of 200/1A and PT ratio of 132 KV/110V. Meter shall be provided with suitable TTB. The meter shall have RS 485 port for data communication and shall support Modbus protocol. The relay shall have optical front port for MRI communication.

iii A 24-window facia enunciator with following inscription shall be provided on the front with audible DC alarm bell. The make shall be Alan Electronics systems (P) Ltd, Bombay / Bharni.

S. No.	Name of Annunciation	Initiation From
1.	Differential Protection Trip	Differential Relay
2.	Back Up Trip	Over Current / Earth Fault
3.	Over Load Trip	Over Load Trip Timer
4.	Main Buchholz Trip	Main Buchholz Trip Auxiliary Relay
5.	OLTC Buchholz Trip	OLTC Trip Relay
6.	W.T.I. Trip	W.T.I. Trip Relay
7.	O.T.I. Trip	O.T.I. Trip Relay
8.	P.R.V. Trip	P.R.V. Trip Relay
9.	Over flux Trip	Over flux Trip Relay
10.	L.B.B. Operated	L.B.B. Operated
11.	Main Buchholz Alarm	Auxiliary Relay Of Main Buchholz
12.	W.T.I. Alarm	Auxiliary Relay Of W.T.I. Alarm
13.	O.T.I. Alarm	Auxiliary Relay Of O.T.I. Alarm
14.	Over fluxing Alarm	Output From Instantaneous Element of Over fluxing Relay
15.	Over Load Alarm	Alarm Contact Of Over Load Relay
16.	Low Oil Level Alarm	Auxiliary Relay For Low Oil Level Indicator
17.	Low SF6 Gas Alarm	Auxiliary Relay For Low SF6 Gas Alarm
18.	Low Air Pressure Alarm	Auxiliary Relay For Low Air Pressure Alarm
19.	SF6 / Air Pressure Low Trip Block	Auxiliary Relay For SF6 / Air Pressure Low Trip Block
20.	Trip Circuit-1 Fail	TCH Relay Coil 1
21.	Trip Circuit-2 Fail	TCH Relay Coil 2.
22.	Differential Relay Faulty	From Differential Relay Supervision Contact
23.	IDMT Relay faulty	From Numerical IDMT Relay Supervision Contact
24.	Spare	---

iv Breaker indication:- Separate breaker ON – OFF lamp indication shall be provided in addition to CB semaphore indications.

v 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.

9.4.5 The CT & PT circuit wires should be colour coded i.e. red, yellow, blue and black for three phases and neutral respectively. The DC and control wires should be grey. The cable size shall be 2.5 mm^2 for CT & PT and 1.5 mm^2 for control circuit. However, **for tripcircuit, white wires** should be used & it shall be 2.5 Sq. mm

9.4.6 **GENERAL**:-

Te**r**minal connectors for control and other circuits shall be of stud type. For CT & PT circuits the terminal connectors shall be of best quality disconnecting type. The terminal connector size shall be 16A current rating.

The DC circuit wires shall be grey of size of 1.5 Sq. mm. However, for trip wires shall be of 2.5 Sq. mm size.

9.5 TECHNICAL SPECIFICATIONS OF 132 KV FEEDER CONTROL AND RELAY PANELS.

9.5.1 THE DETAILS OF RELAY TO BE PROVIDED IN EACH PANEL ARE MENTIONED BELOW :

132 KV Feeder & Transfer breaker protection panel: - The 132 KV C&R panel shall be provided for protection of 132 KV (3-ϕ) line with trip transfer facility. The protection for 132 KV (3-ϕ) lines is one Main distance protection (numerical relays with min. 4-zones) with separate Numerical directional backup protection (IDMT) shall be provided. These relays should have disturbance recording facility, event recording & time synchronising facility. The relay shall comply to IEC61850.The LBB protections should be provided for all the 132 KV breakers. All the inbuilt features of numerical DPR such as over current protection, SOTF. LBB, reverse power flow protection, power swing blocking and out of step blocking, pole discrepancy, trip circuit supervision, DC supply supervision & PT fuse failure etc. shall also be provided. Separate relays shall be provided for LBB protection, trip circuit supervision and DC supply supervision.
The exact model of the offered relay shall be finalised by CSPTCL at the time of the engineering based on the requirement of protection scheme of CSPTCL and it shall be binding on the contractor.

9.5.2 DC. Supply:-The panel wiring should be made considering one single source of 110V DC supply, but two independent protection DC circuits, to be wired by providing separate DC fuses in such a way that even with the availability of one set of protection fuses CB tripping should take place.

9.5.3 DC Fail Indications:-Two Nos. DC fail relay energising an AC bell shall be provided for monitoring of DC supply to the protection circuit. The DC fail relay shall have a reverse flag. It shall monitor both Main & back up protection ckt. DC.

9.5.4 PT Supply:-The panel shall be wired for a double set of 132 KV PT, having metering and protection cores. Thus the provision of PT selection switch is required. Further DPR relays should not mal-operate during the changeover period of PT supply. Lamp indications shall be provided to indicate the selected PT supply. Suitable HRC fuse protections shall be provided on the incoming side of the PT supply. Neutral wire of the PT supply shall be provided with a fuse link. Disconnecting type good quality terminal connecters shall be used for PT circuits. 'E' series ferrules shall be used for PT circuits.

Further 1100V grade flexible copper wires of R Y B and Black coloured 1.5 sq mm shall be used for easy phase identification. PT selection switch shall have intermediate position where in DPR may be blocked during change over.

Digital Ampere meters shall be used on all the 3 phases having ratio 800-400/1A without ammeter selection switch. The panel shall be provided with 3phase 4 wire MW & MVAR meters of digital type suitable to 400/1A CT ratio & 132KV/110V PT ratio. All the ampere meters shall be of class 0.2S accuracy, of reputed manufacture like AE or equivalent make only.

9.5.5 Protection Transfer Switch:-Provision shall be made to provide a trip transfer switch to transfer the protection trip command to Bus-Transfer Bay CB. Special care may be taken not to mix the DC circuits of main and bus transfer protection circuits. The lockable switch shall have normal-inter-transfer positions and the key shall be removable only in normal positions. A lamp indication shall be provided to indicate the transfer positions. The switch shall be of make **Alstom / Switron**.

9.5.6 Panel shall be provided with semaphore indications for CB on-off. Semaphore shall be needed to provide to indicate the positions of isolators/earth switch with separate lamp indications. Separate lamp indications shall be provided to indicate CB on-off positions.

9.5.7 SEMS make 0.2S class, electronic 4 quadrant, import-export, 3phase 4wire, tri-vector energy meters shall be provided with suitable 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 35 days. The energy meter shall be suitable to CT ratio 400/1A and PT ratio 132KV/110V, and without any external M.F. The meter should have RS485 port for data communication on Modbus protocol. Meter shall have front optical port for the purpose of extraction of data through MRI.

9.5.8 All the CT terminal connectors shall be of best quality, sliding type connectors of suitable size. 2.5 square mm flexible 1100V grade copper wires shall be used. The colour of wires shall be R Y B and black for easy identification. The 'A' series ferrules shall be used for DPR CT circuits, 'C' series ferrules shall be used for back up O/C&E/F, CT circuits, and 'D' series ferrules shall be used for metering CT circuits.

9.5.9 All the control, tripping and indications circuit wiring shall be of grey wires of 1100v grade flexible best quality copper wires. All the wires shall be ferruled systematically without repetition. Control protection wires shall be provided with 'K' series ferrules and alarm /indications circuits shall be provided with 'L' series ferrules. AC 230 V supply wires shall have H ferrules. All the terminal connecters shall be of stud type of suitable size, except of CT-PT circuits. All the wires shall be provided with insulated copper lugs properly crimped. The ferrules used shall be of best quality printed sleeve type ferrule having legible letters/numbers.

9.5.10 For back-up protection, numerical directional relay having 3 no. directional over current and one earth fault shall be provided. It shall be IEC61850 compliant. It shall have RJ45 port/Ethernet port. It shall have continuous self monitoring and diagnostic feature .It shall have a trip value recorder feature to record instantaneous fault values of current & voltage. It shall have event logger and oscillographic disturbance recording feature facility.

(a) It shall have three over current and one earth fault element(s)

(b) The scheme shall include necessary VT fuse failure relays for alarm purposes

(c) Over current relay shall

- have multiple characteristic with a directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and

have a variable setting range of 50-200% of rated current

- have low transient, over reach high set instantaneous unit of continuously variable setting range 200-2000 % of rated current
- have a variable selectable characteristic angle
- include hand reset flag indicators or LEDs.

(d) Earth fault relay shall

- have multiple characteristics (with a directional IDMT definite minimum time of 3.0 seconds at 10 times setting) and have a variable setting range of 0.20-3.0 times of rated current.
- have low transient, over reach high set instantaneous unit of continuously variable setting range 200-1500 % of rated current
- have a variable selectable characteristic angle
- include hand reset flag indicators or LEDs
- have internal feature in the relay for open delta voltage to the relay

(e) The relay model shall be Micom P141/Siemens 7SJ6611/Schneider P141 or higher version or equivalent model of approved make of relay. The exact model of the offered relay shall be finalised by the CSPTCL at the time of the engineering based on the requirement of protection scheme and it shall be binding on the contractor.

9.5.11 Two separate high speed hand reset type tripping relays shall be provided with adequate no. of contacts for tripping through trip coil 1 and trip coil 2, and also the additional contacts required for Bus transfer CB trip. The tripping relays shall have NC contacts for CB close inter locks. The operating time of trip relays shall not exceed 12 ms. Contactors shall not be acceptable as trip relays.

9.5.12 Two nos. of TCH monitoring relays shall be provided with flag/LED indicators. The relay shall be connected to an audible facia annunciation scheme. The TCH relay shall be capable of monitoring complete trip circuit.

9.5.13 Flag Relays:- Two nos. flag relays of type VAA 33 of Areva make or equivalent type for CB trouble shall be provided in the panel to route annunciation from yard to electronic facia for CB SF6 low gas pressure Alarm & CB Low SF6 gas lock out etc.

9.5.14 **LBB Relay** :- The LBB relay shall be of Numerical type and separate from Dist/Diff/Back up relays. It shall be IEC61850 complaint. It shall

i) be phase segregated type.
ii) have an operating time of less than 15 milli seconds
iii) have a resetting time of less than 15 milli seconds
iv) have three over current elements.
v) be arranged to get individual initiation from the corresponding phase of main protections of line/x'mer for each over current element.
vi) have a variable setting range of 20-150% of rated current
vii) have a continuous thermal withstand two times rated current irrespective of the setting.
viii) have a timer with continuously adjustable setting range of 0.1-1 seconds
ix) have necessary auxiliary relays to make a comprehensive scheme.
x) 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.
xi) have event logger,trip value recorder and oscillographic Disturbance Recorder.
xii) The relay model shall be Micom P141/Siemens 7SJ6611/Schneider P141

or higher version or equivalent model of approved make of relay. The exact model of the offered relay shall be finalised by the CSPTCL at the time of the engineering based on the requirement of protection scheme and it shall be binding on the contractor.

9.5.15 **Minimum 18 way facia annunciator** with following indications shall be provided.

S. No.	Name of Annunciation	Initiation From
1.	Distance Protection Trip	Distance Relay
2.	Zone 1	Distance Relay
3.	Zone 2	Distance Relay
4.	Zone 3	Distance Relay
5.	Back Up Trip	Over Current / Earth Fault Relay
6.	SOTF Optd	Distance Relay
7.	Fuse Failure Optd	Distance Relay
8.	Distance Relay Faulty	Distance Relay
9.	Back up Relay faulty	Over Current / Earth Fault Relay
10.	L.B.B. Relay Operated	L.B.B. Relay
11.	Low SF6 Gas (CB)Alarm	Auxiliary Relay For Low SF6 Gas Alarm
12.	SF6 / Air Pressure Low Trip Block	Auxiliary Relay For SF6 / Air Pressure Low Trip Block
13.	Trip Circuit-1 Fail	TCH Relay Coil 1
14.	Trip Circuit-2 Fail	TCH Relay Coil 2.
15.	Spare	
16.	Spare	
17.	Spare	
18.	Spare	---

9.5.16 The C&R panel shall be provided with necessary wiring suitable to single phase 230V AC supply for internal lighting and cubical heaters. Two nos 2 feet size tube lights shall be provided with suitable switches. Further a 15A size 3pin plug with switch shall be provided. Necessary HRC fuse protection shall be provided on phase side and solid fuse link on the neutral side. A separate TB shall be used for 230 V circuits. 'H' series ferrules shall be used for the AC supply circuits

9.5.17 The panel shall be provided an earthing bar of copper of adequate size to connect the earth wires of various relays, CT secondary earthing etc. Necessary holes shall be provided to interconnect the earthing bar to the adjacent panels. Green coloured flexible copper wire of size 2.5 sq mm shall be used for earthing of relays/ equipments/ CT star point etc.

9.5.18 **Wiring in the panel** : The CT & PT circuit wires should be colour coded i.e. red, yellow, blue and black for three phases and neutral. The DC 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 trip circuit, white wires** should be used & it shall be 2.5 mm².

9.5.19 **A min. 4 zone numerical distancerelay** shall be provided as the main protection to clear all type of line faults. The DPR relays shall be provided with suitable test blocks to test the relays with out disturbing any of the panel wiring. Necessary arrangements shall be made to block the trip commands to CB while testing on line. The relay shall conform to clause 9.6.5 also. The DPR relay shall be of numerical type and IEC61850 compliant.

The relay shall be suitable to the following:-

i. CT ratio: - 400A/1A
ii. PT ratio: - 132KV/110V
iii. DC auxiliary supply: - suitable for 110V DC nominal
iv. System earthing: - solidly grounded
v. Max. Ambient temperature: - 55 degrees centigrade

The relay shall have the following features:-

a. **Maximum operating trip output time in zone 1**:- 25 ms.
b. **Operating characteristic**:- Mho/ quadrilateral;
c. **Fuse failure monitoring**:- Should be available internally. The relay shall be blocked during fuse fail condition. A contact shall be available for fuse fail alarm. An inbuilt feature of O/C and E/F trip shall be available as back up protection during fuse fail block condition.
d. **Operating Zones**:- Min 4 Zone protections excluding the power swing boundaries. Zone1 is instantaneous and the other zones with a settable time delay from 0 to 2000 ms in steps of 1ms.
e. **SOTF**: - Shall be provided as inbuilt feature.
f. **Power swing detection**:- Inbuilt feature shall be available to detect power swing condition. Provision shall be available to set the relay to block in any desired zone. Setting shall also be available to set the nature/ severity of power swing.
g. **Distance to fault location**:- Shall be available as an integral part.
h. **Disturbance Analog Record of fault current, voltage and other parameters**:- Record of previous fault current, voltage and other parameters for at least 4 events for a duration of 1.5 Sec. each in the oscilloscopic form.
i. **Protection signalling**:- Internal arrangement shall be available to 'send' and 'receive' carrier signal for carrier aided protections schemes.
j. **Inbuilt feature** shall be available for **parallel feeder compensation**.
k. **Inbuilt LBB feature**.
l. **Inbuilt directional over current** and **earth fault protection** shall be available.
m. **Necessary software** for viewing the fault currents fault voltages and other measurements in a PC.
n. **Minimum 08 nos. of output contacts** of trip duty.
o. Minimum 12 no of input contacts/ input **Opto connectivity**.
p. Relay shall have **independent port for IRIG-B.**
q. Carrier / fibre optic signal aided remote end tripping.
r. The relays shall have terminal blocks suitable for wiring ring (eye) type lugs for CT and PT wires.
s. Shall be IEC61850 compliant and shall have RJ45/ethernet ports**.** It shall have continuous self monitoring and diagnostic feature .It shall have a trip value recorder feature to record instantaneous fault values of current & voltage. It shall have oscillographic disturbance recording feature facility.
t. It shall have broken conductor detection feature.
u. The relay shall preferably have Trip Circuit monitoring feature.
v. The exact model of the relay shall be the latest proven model and shall be finalised by the CSPTCL at the time of the engineering and it shall be binding on the contractor.
w. 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)

NOTE :- The contractor shall arrange/provide the software required for setting and data extraction of the numerical relays along with panels.

9.6.0 TECHNICAL SPECIFICATIONS OF 132 KV BUS TRANSFER CONTROL AND RELAY PANEL.

9.6.1 **THE BUS TRANSFERCONTROL AND RELAY PANEL** is intended to be used as a line or transformer breaker using the by-pass isolator for taking out normal circuit breaker for maintenance purpose or to transfer the feeder or transformer circuit from Main bus to Transfer bus or vice-versa. Therefore this panel is required to be provided with one no. numerical distance protection relay with requirements similar to that of a feeder panel. Further 3 nos. directional over current and one earth fault with facility to switch over to Non Directional type shall be provided. All other requirements shall be similar to feeder panels.

9.6.2 MISCLLANEOUS

9.6.2.1 INSTRUMENTS:

i) All indicating instruments shall be conforming to IS-722 and shall be of type and sizes specified under relevant sections. The Ampere meters and all the other meters should be of Digital type. They shall be capable of carrying their full load currents continuously without undue heating. All indicating instruments shall be provided with non reflecting type glass fronts. Instruments connected to double ratio current transformers shall be provided with reversible scale, instrument transformer ratios names etc. shall not appear on the dials but shall be marked in approved positions.

ii) The instruments shall not be damaged by the passage of fault current through the primary of their corresponding instrument transformers. All potential circuits to instruments shall be protected by a fuse on each pole of the circuit placed as close as possible to the instruments transformer terminals or where instruments are direct-connected as close as possible to the main connection. All instruments and apparatus shall be back connected and all instrument cases shall be earthed. All indicating instruments shall be of accuracy class 0.2S.

iii) **SEMS** make 0.2S class, electronic 4 quadrant, import-export, 3phase 4wire, tri-vector energy meters shall be provided with suitable 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 35 days. The meter shall be suitable to CT ratio 400/1A and PT ratio 132KV/110V, and without any external M.F. The meter should have RS485 port for data communication on Modbus protocol. Meter shall have front optical port for the purpose of extraction of data through MRI.

9.6.2.2 SWITCHES:

(i) Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out. Handles of different shapes and suitable inscriptions on switches shall be provided as an aid to switch identification.

(ii) The selection of operating handles for the different type of switches shall be as follows:

a)	Breaker control switches	Pistol grip, black
b)	Selector switches	Oval or knob black.
c)	Instrument switches	Round, Knurled, black.
d)	Protection transfer switch	Pistol grip lockable and black.
e)	PT Selection switch	Pistol grip lockable and black

(iii) The control switch of breaker shall be of spring return to neutral type. The control springs shall be strong and robust enough to prevent inadvertent operation due to light touch. The spring return type switch shall have spring return from close and trip positions to neutral position after close and after trip position respectively. Protection transfer switch shall be provided on each control panel i.e. on feeder as well as transformer control panel except Bus transfer bay panel.

(iv) Instrument selection switches shall be of maintained contact (stay put) type. Ammeter selection switches shall have make-before-break type contacts (heavy duty) so as to prevent open circuiting of CT secondary when charging the position of the switch. Voltmeter transfer switches for AC shall be suitable for reading all line to line and line to neutral voltages.

(v) Lockable type of switches which can be locked in particular positions shall be provided when specified. The key locks shall be fitted on the operating handles.

(vi) The contacts of all switches shall preferably open and close with snap action to minimise arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Spring shall not be used as current carrying parts. The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.

9.6.2.4 INDICATING LAMPS:

(i) Indicating lamps shall be panel mounting multiple bright LED type with rear terminal connections. Lamps shall be provided with series connected resistors preferably built in the lamp assembly. Lamps shall have translucent lamp covers to diffuse lights coloured red, green, amber, clear white or blue as specified.

(ii) Multiple LED indicating lamps shall be provided wherever specified.

(iii) The indicating LED lamps with resistors shall withstand 120% of rated voltage on a continuous basis and should also give sufficient illumination with – 20% auxiliary voltage condition.

9.6.2.5 POSITION INDICATORS:

(i) Position indicators of "semaphore" type shall be provided when specified as part of the mimic diagrams on panels for indicating the position of circuit breakers. The indicator shall be suitable for semi-flush mounting with only the front disc projecting out and with terminal connection from the rear. Their strips shall be of the same colour and size as the associated mimic.

(ii) Position indicators shall be suitable for operation as specified. When the supervised object is in the closed position, the pointer of the indicator shall take up a position in line with the mimic bus bars, and at right angles to them, when the object is in the open position. When the supply failure to the indicator occurs, the pointer shall take up an intermediate position to indicate the supply failure. The rating of the indicator shall not exceed 2.5 W.

(iv) The position indicators shall withstand 120% of rated voltage on a continuous basis

9.6.3 **TIME SYNCHRONISATION EQUIPMENT**

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

ii) Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.

iii) It shall be compatible for synchronisation of Numerical Relays, Disturbance recorders at substation through individual port or through Ethernet realised through optic fibre bus.

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

v) The synchronisation equipment shall have accuracy better than 500ns. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, & temperature variations, propagation & processing delays etc).

vi) Equipment shall meet the requirement of IEC 60255 for storage & operation.

vii) The system shall be able to track the satellites to ensure no interruption of synchronisation signal.

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

ix) 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

x) The equipment shall have a periodic time correction facility of one second periodicity or better.

xi) Time synchronisation equipment shall be suitable to operate from 110V DC

xii) Equipment shall have real time digital display in hour, minute, second (24 hour mode).

xiii) It shall have a separate Visual Time Display Unit to be mounted on the top of control panels having display size of approx. 100 mm height.

9.6.4 **RELAYS**: **All protective relays shall be of numerical type and communication protocol IEC 61850 compliant. All main relays shall have Ethernet/RJ45 ports. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable to these. The exact model of all the relays shall be finalised by CSPTCL at the time of engineering and that shall be binding on the contractor. All the Numerical Relays shall have 20 % spare input and output contacts over what has been utilised in the scheme. The Numerical Relays shall have freely configurable input and output contacts. All the Numerical relays shall have self monitoring feature. The Numerical relays shall have event logger, trip value recorder and oscillographic Disturbance Recorder and on initiation of event, it shall automatically be downloaded at the workstation of S/S.**

9.6.5 OTHER REQUIREMENTS FOR RELAYS:

9.6.5.1 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.

9.6.5.2 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.

9.6.5.3 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.

9.6.6.4 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.

9.6.5.5 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.

9.6.5.6 All AC relays shall be suitable for operation at 50 Hz AC voltage operated relays shall be suitable for 110 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 110 V DC and shall operate satisfactorily on ±20% of rated voltage. Voltage operated relays shall have adequate thermal capacity of continuous operation.

9.6.5.7 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.

9.6.5.8 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 CSPTCL'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.

9.6.5.9 Timers shall be of numerical or solid state type.

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

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

9.6.5.12 All relays shall withstand a test voltage of 2.5 KV 50 Hz. rms voltage for one second except static relays.

9.6.5.13 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.

9.6.5.14 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.

9.6.5.15 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.

9.6.5.16 All protective relays and alarm relays shall be provided with minimum three extra isolated pair of contacts wired to terminals exclusively for future use.

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

9.6.5.18 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.

9.6.6 **CONTROL CONNECTIONS AND INSTRUMENT WIRING**:

9.6.6.1 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.

9.6.6.2 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.

9.6.6.3 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.

9.6.6.4 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.

9.6.6.5 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.

9.6.6.6 All secondary fuses shall be of an approved type. HRC fuses of some standard make shall only be used.

9.6.6.7 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.

9.6 33 KV CONTROL & RELAY PANELS

9.7.1 THE DETAILS OF RELAY TO BE PROVIDED IN EACH PANEL HAS BEEN MENTIONED BELOW :

i) **33 KV Transformer C&R panel: -** The C&R panel shall be provided with a numerical IDMT non-directional over current relay with 2 Nos. of trip relays, Amp meter, MW meter etc. The transformer panel shall have export/import MVAR meter also. The 33 KV transformer C&R panel shall have -

a) 1 No. 3 O/C + 1 E/F back up IDMT numerical relay with high set feature. The relay should be IEC61850 compliant.It shall have trip value recording and oscillographic recording facility. It shall have -

(i) Shall have three over current and one earth fault element(s)

(ii) Shall have freely configurable 5 nos each of opto inputs and output contacts. Shall have a minimum of four nos LEDs for indications.

(iii) Over current relay shall

- have multiple characteristic including an IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current
- have low transient, high set instantaneous unit of continuously variable setting range 200-2000 % of rated current

(iv) Earth fault relay shall

- have multiple characteristics (including an IDMT definite minimum time of 3.0 seconds at 10 times setting) and have a variable setting range of 0.20-3.0 times of rated current.
- have low transient, high set instantaneous unit of continuously variable setting range 200-1500 % of rated current

(v) It shall have Double stage Under Frequency feature ,each having independent timer and output contact

(vi) Shall also have measurement facility of instantaneous value of currents.

(vii) It shall have at least two setting groups

(viii) Shall have negative sequence Over current feature also.

(ix) The O/C and E/F relay shall have disturbance recording capability and event logger. It should display at least previous five fault data on HMI

on demand.

(x) The instantaneous voltage values shall be displayed on HMI.

(xi) The relay model shall be Micom P141/Siemens 7SJ6611/Schneider P141 or higher version or equivalent model of approved make of relay.
However the exact model of the offered relay shall be finalised by the CSPTCL at the time of the engineering based on the requirement of protection scheme and it shall be binding on the contractor.

b) Single phase numerical over voltage relay with time delay settable. The numerical relay shall have self monitoring features, disturbance recorder, event logger in addition to general features described for Numerical relays in this section. The instantaneous voltage values shall be displayed on HMI.

c) Numerical LBB Relay - shall have same features as described for 132 KV panels

d) 2 No. Master Trip relay & CB status indicating lamps, semaphores, annunciator & breaker TNC switches.

e) The C&R panels should be provided with digital ammeter, digital volt meter, digital MW and MVAR meter (Export-Import type) and SEMS make import – export trivector energy meter (3ϕ,4W).

f) The panel also should be provided with trip transfer switch and two nos TCH relays and one no DC monitoring relay.

g) **Over load protection** :- Numerical three phase relay IEC 61850 compliant relay having fixed time delay over load protection having current setting 0.5A to 1.5A in steps of 0.05A or continues. The relay should have two independent, variable time delayed output contacts one for alarm / load shedding and the other, for trip. The relay shall be provided in Y phase only. The trip out put contact shall be wired up to terminal connector however the alarm contact shall be connected to annunciator of transformer panel.

ii) 33 KV Feeder C&R panel :

The C&R panel shall be provided with the following;

a) 1 No. 3 O/C + 1 E/F back up IDMT numerical relay with high set feature. The relay should be IEC61850 compliant, shall have RJ45/ethernet ports .It shall have trip value recording and oscillographic recording facility. It shall have same features as described for 33 KV transformer panels.

b) The relay model shall be Micom P141/Siemens 7SJ6611/Schneider P141 or higher version or equivalent model of approved make of relay.
However the exact model of the offered relay shall be finalised by the CSPTCL at the time of the engineering based on the requirement of protection scheme and it shall be binding on the contractor.

c) Single phase over voltage relay with time delay settable.

d) Numerical LBB Relay as described for 132KV panels

e) 2 No. Master Trip relay & CB status indicating lamps, semaphores, annunciator & CB TNC switches.

f) The C&R panels should be provided with digital Ammeter, digital volt meter, digital MW and MVAR meter (Export-Import type) and SEMS make import – export tri vector energy meter (3ϕ,4W).

g) The panel also should be provided with trip transfer switch and two nos TCH relays and one no DC monitoring relay.

iii) 33 KV Transfer Breaker C&R panel

The C&R panel shall be provided with the following;

a) 1 No. 3 O/C + 1 E/F back up IDMT numerical relay with high set feature. The relay should be IEC61850 compliant.It shall have trip value recording and oscillographic recording facility.It shall have same features as described for 33 KV transformer panels.

b) The relay model shall be Micom P141/Siemens 7SJ6611/Schneider P141 or higher version or equivalent model of approved make of relay.
However the exact model of the offered relay shall be finalised by the CSPTCL at the time of the engineering based on the requirement of protection scheme and it shall be binding on the contractor.

c) Single phase over voltage relay with time delay settable.

d) Numerical LBB Relay - shall have same features as described in 132 KV panels

e) 2 No. Master Trip relay & indicating lamps, semaphores, annunciates & CB TNC switches.

f) The C&R panels should be provided with digital Ammeter, digital volt meter, digital MW and MVAR meter (Export-Import type) and SEMS make import – export tri vector energy meter (3ϕ,4W).

g) The panel also should be provided with two nos TCH relays and one no DC monitoring relay.

iv) 33 KV Capacitor Bank C&R panel

The C&R panel shall be provided with the following;

a) 1 No. 3 O/C + 1 E/F back up IDMT numerical relay with high set feature. The relay should be IEC61850 compliant.It shall have same features as described for 33 KV transformer panels.

b) The relay model shall be Micom P141/Siemens 7SJ6611/Schneider P141 or higher version or equivalent model of approved make of relay.
However the exact model of the offered relay shall be finalised by the CSPTCL at the time of the engineering based on the requirement of protection scheme and it shall be binding on the contractor.

c) Single phase over voltage and under voltage relay with time delay settable.

d) Numerical LBB Relay – shall have same features as in 132 KV panels

e) 2 No. Master Trip relay & CB status indicating lamps, semaphores, annunciator & CB TNC switches.

f) The C&R panels should be provided with digital Ammeter, digital Voltmeter, MVAR meter (Export-Import type) and SEMS make import – export tri vector energy meter (3ϕ,4W).

g) The panel also should be provided with two nos TCH relays and one no DC monitoring relay.

h) The panel shall be provided with Timer for closing circuit.

i) The panel shall have Numerical Unbalance Current relay with a Neutral CT arrangement. The Numerical Unbalance Current relay shall have disturbance recording, event logging and self-monitoring features. It shall have facility for display of instantaneous current values on its HMI.

9.7.2 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 33 KV Panels shall have the following dimensions:**

Type	33 KV Simplex Panel
Height	2250 mm
Depth	500 mm.
Width	Min 660 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 good appearance, outside and inside with no works of welds, reverts, screw or bolts head apparent from the exterior surfaced of the control boards.

v) 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.

vi) The mimic diagram offered shall be of Azure blue shade 104 of IS-5.

vii) 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.

viii) 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.

ix) Other requirements regarding indicating meters, control wiring, energy meters, switches, position indicators etc shall be same as for 132 KV Panels.

x) **SEMS** make 0.2S class, electronic 4 quadrant, import-export, 3phase 4wire, tri-vector energy meters shall be provided with suitable 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 35 days. The meter shall be suitable to CT ratio 400/1A and PT ratio 33KV/110V, and without any external M.F. The meter should have RS485 port for data communication on Modbus protocol. Meter shall have front optical port for the purpose of extraction of data through MRI.

9.8 **TESTS:** Relay and control panels shall be subjected to following tests:

a. Mechanical operation test.
b. Verification of Degree of protection as per IS: 2147
c. High voltage test as per IS or IEC as may be applicable
d. Electrical control, interlock and sequential operation tests
e. Verification of wiring as per approved schematic diagram.
f. Type tests and routine tests shall be carried out on all associated Equipment as per relevant Indian Standards or IEC. The type tests should not be older than seven years from the last date of submission of bid.
g. Certified copies of all type and Routine test certification shall be submitted for Company's approval before dispatch in the control relay panel.

9.9 **The details of relays and other facilities required in each panel is mentioned below :-**

S. No.	Protection Schemes	40 MVA		132 KV feeder bay	132 KV Bus Transfer bay	33 KV Feeders	33KV Capacitor Bank	33 KV Bus Transfer
		132 KV Side X'mer	33 KV Side X'mer					
1	Numerical Differential protection relay	1 No.	NIL	NIL	NIL	NIL	NIL	NIL
2	Numerical Distance protection relay	NIL	NIL	1 No.	1 No	NIL	NIL	NIL
3	Numerical Over fluxing relay	1 No.	NIL	NIL	NIL	NIL	NIL	NIL
4	Numerical Over voltage Protection	In built	In built	NIL	NIL	NIL	1 No.	NIL
5	Under voltage Protection	NIL	NIL	NIL	NIL	NIL	1 No.	NIL
6	Trip circuit supervision relay	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.
7	DC Auxiliary 110 V supply voltage monitoring relay	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.
8	Numerical Local Breaker back up relay	1 No.	1 No.	1 No.	1 No.	1 No	1 No	1 No
9	Numerical Neutral displacement current relay	NIL	NIL	NIL	NIL	NIL	1 No.	NIL
10	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.
11	Over load Protection	NIL	1 No.	NIL	NIL	NIL	NIL	NIL
12	Double stage U/F relay	NIL	NIL	NIL	NIL	In built	NIL	In built
13	Master trip relay	2 Nos.	2 No.	2 Nos.	2 Nos.	2 Nos.	2 Nos.	2 Nos.
14	LBB Trip relay	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.
15	Transformer body protection relays.	1 Set	NIL	NIL	NIL	NIL	NIL	NIL
16	MW Meter	1 No.	NIL	1 No.	1 No.	1 No.	NIL	1 No.
17	MVAR Meter	1 No.	1 No.	1 No.	NIL	NIL	1 No.	NIL
18	Digital Ampere meter (with selection switch where necessary)	3 Nos.	3 Nos.	3 Nos.	3 Nos.	3 Nos.	3 Nos.	3 Nos.
19	Digital Volt meter (with selection switch where necessary)	3 No.	1 No.	3 Nos	1 No.	NIL	1 No.	3 No.
20	Digital frequency meter (1 inch LED display)	NIL	NIL	NIL	1 No.	NIL	NIL	1 No.
21	Annunciator relay	1 Set	1 Set	1 Set	1 Set	1 Set	1 Set	1 Set
22	Trip transfer switch	1 No.	1 No.	1 No.	NIL	NIL	NIL	NIL
23	TNC switch	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.
24	Numerical REF Relay	2 No.	NIL	NIL	NIL	NIL	NIL	NIL
25	SEMS make Energy Meter 3 Phase 4 wire Export-import, with load survey facility, RS 485 port with TTB (heavy duty screw type TTB).	1 No.	1 No.	1 No.	1 No.	1 No.	NIL	1 No.
26	Multifunction Transducer	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.
27	Digital Multifunction Energy Meter	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.	1 No.
28	Indicating LEDs, semaphores	As per requirement						

10.0 TECHNICAL SPECIFICATION FOR (110 VOLT AND 48 VOLT) BATTERY SETS

10.1 **SCOPE:-**

This specification covers manufacture, testing at works and delivery FOR destination of 110 V/300 AH and 48 V/300 AH Battery sets at discharge voltage 1.85V/Cell.

10.2 **STANDARD.**

Batteries shall conform to the latest edition and amendments available of IS 1651.

10.3 **PRINCIPAL PARAMETERS**.

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 110 V DC system is unearth and 48 V DC system is + ve earth system.

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.

10.3.2 Lead acid battery, comprising of closed type cells shall be complete with tubular positive plate assemblies, glass boxes or hard rubber boxes, lids providing micro porous and plastic separators, poly-styrene dwells and buffers, inter cell connectors and plastic encapsulated bolt-on terminal and units. The battery shall be offered complete with:-

i. Inter row connectors, acid jars and packing case.
ii. Stands.
iii. Stand insulator, and,
iv. Cable sockets for end and tapping connections.

10.3.3 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.

10.3.4 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.

10.3.5. Separators

The design of separators shall ensure that there is no misalignment during normal operation and handling.

10.3.6. 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.

10.3.7 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. The inter cell connectors shall be of insulated type. 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.

10.3.8 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.

10.3.9 Battery Bank Stand

All batteries shall be mounted in a suitable single tier wooden stand 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.

10.3.10 Capacity Requirements

When the battery is discharged at 10 hour rate, it shall deliver 80% of C (rated capacity, corrected at 27º 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%.

10.3.11 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.

10.3.12 The cells shall be accommodated in double 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	Two Copies Of Printed Instruction Sheet
3	1 No. Cell Testing digital Voltmeter (3-0-3) Volts complete with Leads
4	1 No. Rubber Syringe
5	1 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

10.3.13 One set of batteries shall comprise of 55 cells with capacity not less than 300AH for 110 volts, 10 hour rate of discharge to 1.85 volts per cell.

One set of batteries shall comprise of 24 cells with capacity not less than for 48 volt batteries at 10 hour rate of discharge to 1.85 volts per cell.

10.3.14 Type Test of Battery

Contractor shall submit type test reports of following tests as per IEC 60896-21 & IEC 60896-22, 2004. The type test reports shall be submitted . The type tests should not be older than seven years from the last date of submission of bid.

Tests shall be conducted in accordance with IEC 60896-2 1 & IEC 60896-22, 2004

10.3.15 Installation and commissioning

10.3.15.1 Manufacturer of Battery shall supervise 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.

10.3.15.2. Contractor shall submit 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 1 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

10.4 TESTS:

The batteries shall be tested after manufacture as per the requirements of I.S. 1651:1991 (with latest amendments if any).

The Batteries used during inspection shall be discarded & not supplied to CSPTCL.

11.0 TECHNICAL SPECIFICATIONS FOR (110 VOLTS AND 48 VOLTS) BATTERY CHARGER.

11.1 SCOPE:-

This specification covers important details regarding design, manufacture and testing at manufacturer's works for 110 volts and 48 volts battery chargers.

11.2 STANDARDS.

Unless otherwise specified, the equipment shall conform to the latest applicable Indian, IEC, British or USA standards, and in particular to the following standards:-

1.	IS:1651	Specifications For Stationery Cells And Batteries, Lead Acid Type With Tubular Positive Plates
2.	IS:3895	Specification For Rectifier Equipments
3.	IS:9224	Specifications For HRC Fuses
4.	IS:1248	Indication Instruments
5.	IS:2147	Degree Of Protection For Cubicles
6.	IS:375	Specification For Wiring
7.	IS:4540	Mono Crystalline Semi Conductor Rectifier Assemblies And Equipment
8.	IS:6619	Safety Code For Semi Conductor Rectifiers
9.	IS:2026	Transformers
10.	IS:2959	AC Contractors For Voltage Not Exceeding 1000 V
11.	IS:4237	General Requirements For Switch Gear In Control Gear For Voltage < 1000 Volts
12.	IS:4064	Air Break Switches And Fuse Units
13.	IS:6005	Code Of Practice For Phosphating
14.	IS:5568	Colour For Ready Mix Paints
15.	IS:2489, 5921	Printed Circuit Boards
16.	IS:5578	Guide For Making Insulated Conductors

11.3 CONSTRUCTIONAL FEATURES:

One single sheet steel cabinet shall accommodate both boost & float chargers. The dimensions of battery charger shall be as under

a) Height- 1600 mm including base channel
b) Depth- 800 mm
c) Width- as per requirement.
d) Color – Opaline Green No 275 of BIS 271-C:1948

11.4 PARAMETERS

11.4.1 Basic requirement of 48 volt and 110 volt 300 AH battery charger is that under all conditions of failure of any component of trickle charger, boost charger, A.C. supply, faults during the short circuit etc. over voltage conditions, under voltage conditions etc. load and battery should always remain paralleled. The interruption of

D.C. supply to load under any circumstances cannot be afforded and therefore this requirement should be kept in view carefully.

The DC system for 110 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 up to 2.7 volts per cell at the desired rate.

11.4.2 The battery charger should consist of ***two independent*** float and one boost charger. Out of two floats one shall be in standby mode. Each charger should be built with power SCR/ diodes in full wave fully controlled bridge configuration. The FC/BC charger should meet the requirement of load. 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.

Float charger should be capable to supply trickle charging current to battery and the station load. 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. During boost charging, the battery tap shall be connected to the load through blocking diodes.

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.

11.4.3 The boost charger unit shall work independently and will be utilised for boost charging the battery.

11.4.4 The output voltage of boost charger should be designed on the basis of maximum cell voltage of 2.7 per cell.

11.4.5 The battery charger should fulfil the following salient features:

(a) Float & boost change over arrangement.
(b) Built in digitally controlled automatic regulation circuit.
(c) Built in auto phase sequence detector.
(d) Current limiting device.
(e) Smoothing filter circuit to limit AC ripple.
(f) Charger over load protection.
(g) LED indications for mains on, DC on, battery on charge, battery charged, rectifier trip, input over voltage and input under voltage.

11.5 VOLTAGE REGULATION

11.5.1 Battery charger shall be provided with a facility for both automatic and manual control out put voltage and current. A selector switch shall be provided for selecting the mode of out put voltage / current control, whether automatic or manual. When on automatic control mode during float charging, the charger out put voltage shall remain within

±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.

11.6 **FAULT LEVEL**

The fault level of the auxiliary AC supply at the terminals of the charge shall be 10 KA. All accessories shall be selected and equipment shall be designed accordingly.

11.7 **INPUT SUPPLY**

Input supply where the charger shall be 415 V with a variation from 360V to 450V.

11.8 **CONSTRUCTION**

11.8.1 Charger cabinets shall sheet metal enclosed and shall be dust, weather and vermin proof. Sheet steel used shall be at least 2.0 m.m. thick and properly braced to prevent wobbling wherever necessary. The cubicle shall be of iron angle frame, i.e. suitable sturdy frame shall be prepared with strong base channels, to bear the load of heavy accessories.

11.8.2 Charger cabinet shall be free standing, floor mounting type and shall be provided with a hinged door in the back with suitable pad locking arrangements.

11.8.3 All doors, removable covers and plates shall have gasket all around with neoprene gaskets. Louvers where provided shall have screens and filters. The screens shall have fine wire mesh made of G.I. wire.

11.9 **WIRING.**

11.9.1 For the wiring purpose standard 1100 volt stranded copper conductor of 2.5 mm^2 area with minimum seven strands should only be used.

11.9.2 The terminations shall be crimped tag solder-less type with covering sleeves only. Colour coded wire should be used to facilitate easy tracing of wires as under:-

a) AC circuit

1. Red, yellow and blue for RYB phases
2. Green for earthing
3. Black for neutral

b) **DC Circuit**.

1. Red for positive.
2. Black for negative.

c) **Control Wiring**

1. Grey for annunciation & other control circuits.

11.9.3 Electrical indicating instruments shall be mounted flush on the front panel.

11.9.4 Since a number of wires 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 blank plastic channels should be provided by the sides of the panels to accommodate the incoming channels from switch-yard.

11.9.5 The input and output terminals should be neatly brought out on the backside of the charger. The terminals to be provided are 4 Nos. for AC input i.e. RYB and two nos from load i.e. positive (+), and Negative (-), plus two numbers from battery connections i.e. positive, negative and all tap cell connections.

11.10 **PRE-TREATMENT & PAINTING PROCESS**

The sheet steel fabricated members shall be subjected to pre treatment process before painting. The process of pre treatment and final painting shall be in conformity with latest engineering practices.

11.11 CAPACITY & RATING FOR CHARGERS.

For battery chargers of different ratings the ultimate capacity shall be designed based on the following requirements.

Requirements	**48 V 300 AH**	**110 V 300 AH**
a. **FLOAT CHARGER UNIT**		
1. Load (Amperes)	30	25
2. Trickle current (mA)	300	300
b. **BOOST CHARGER UNIT**		
1. Load (Amperes)	30	25
2. Boost current (Amps)	30	30
3. Boost charger capacity	60	55

11.12 **COMMON FEATURES AND GENERAL REQUIREMENTS:-** The Battery Charger shall have two independent units one for Boost charging and the other for the float charger. At a time only one unit shall be in service through a selector switch.

11.12.1 **RATING OF MAIN X-MER FOR FLOAT & BOOST CHARGER:-**The main step down transformer rating shall be decided considering the rated DC out put, efficiency and a factor of safety of 1.2. The current density in the copper windings shall be 1.5A/mm2. The X'mer shall be double wound type. The magnetizing current shall be less than 3% of the rated current at 415V AC. Thus the Xmer shall function at low value of flux density. The temperature rise of the transformer when supplying full load DC out put shall not exceed 40 Deg. C above an ambient temperature of 45 Deg. C. These features shall be checked at the time of inspection.

11.12.2 **MEASUREMENT OF BATTERY CURRENT:- N**ormal Trickle current is in the range of 300-600 mA. The charge/discharge Ammeter should have a range of –45 A to + 60 Amp.

Further, it is desired that a suitable arrangement shall be made to display the battery trickle current in the mA range during normal float charger operation. This mA meter will remain shunted through a selector switch so that the above meter will be by-passed during boost charging condition. **A Red Colour light emitting diode (LED) shall glow immediately as soon as the battery goes in discharge mode.** This will be provided on the front panel.

11.12.3 **MEASUREMENT OF DC VOLTAGE**:- Separate DC volt meter shall be provided for boost voltage, float voltage & load voltage.

11.12.4 **PROTECTION & SPECIAL FEATURES:-**The charger shall incorporate the following features:-

i) **Over voltage alarm**:- If the voltage exceeds +10% across load terminal charger shall give an over voltage alarm.

ii) **Under voltage alarm:-**If the load voltage falls to 90% the charger shall give an under voltage alarm.

iii) **Earth leakage for 110V battery charger:-**There shall be an earth leakage ammeter in addition to an audible alarm for the earth leakage of DC circuit.

iv) Single phasing:-In case of single phasing of input AC supply to float / boost charger, the charger shall give an alarm. The single phasing detector shall work on current principle and not on voltage.

v) Other protections:-The charger shall be provided with over load alarm, rectifier fuse failure alarm for float and boost charger and also fuse failure alarm for filter capacitors.

The annunciation circuit shall be simple and robust design and shall provide a disconnecting fuse link at the front panel in series with the bell so that the ringing of the bell can be stopped by the operator.

11.12.5 **AC Circuit:-**The AC Circuit shall consist of input main switch, supply indication lamps in put ammeter and volt meter with selector switches, control MCBs, contactors for float and boost chargers, single phasing preventer etc.

11.12.6 **Soft start feature** :-**The Thyristor control unit to be provided for Trickle charger unit should incorporate soft start feature**. The voltage should not shoot up when the supply of the charger is switched ON and soft start feature shall be incorporated.

11.12.7 **Output Ammeter:-**The float charger shall be provided with an output DC ammeter of range depending on a float out put current.

11.12.8 **Limits of Ripple Content:-**The ripple content shall be 1% or less of the out put voltage for float charger and in case of boost charger the ripple shall be less than 2%.

11.12.9 **Control of load voltage:-**All the 24/55 Cells will remain across the load terminals while boost charging. Hence the control of load voltage at the time of boost charging shall be done by means of dropping diodes. The number of dropping diodes in the circuit shall be selectable by means of a rotary switch on a front panel. In one position of the switch all the diodes shall be by passed. Further all the dropping diodes shall also be by passed by means of an AC contactor in case of AC supply failure or boost charger off. Thus the dropping diodes shall come into circuit only in case of boost charger in service.

11.12.10 **Make & Rating of the components:-**It is necessary that the contractor adheres to the following makes & ratings for the components to be used in the battery charger:-

(i) **3 Phase Auto X'mer for boost charger :-** In case of use of 3 phase Auto X'mer for boost charger , this transformer shall be of full rating i.e. 0 to 415 Volts. The current rating of the Auto Transformer shall be selected considering the DC out put and a factor of safety of 1.5.

(ii) **Rectifiers for Float & Boost Chargers:-**These shall be of **Hirect, USHA, RIR** make only.

(iii) **Ammeter & Volt Meters:-**These shall be of **AE, MECO, Rishabh** make only.

(iv) **Selector Switches:-**These shall be **KAYCEE/ Switron** make only. No switches below the rating of 16 Amp shall be provided except for the Volt Meter Selector switch for the AC voltage selection.

(**v) Diodes:-**

a) All dropper diodes shall be of not less than 70 Amp rating.

b) All diodes / SCR for 110V battery charger shall be 1000V and current rating shall be selected with a factor of safety of 2.5.

c) All diodes/ SCR for 48 V battery charger shall be 600 V and current rating shall be selected with a factor of safety of 2.5.

(**iv) HRC Fuses:-**The HRC fuses shall be of **AREVA / Standard / S&S** make only.

11.12.11 **AC Contactors:-**The AC Contactors to be used in a charger shall be of **ABB / L&T/ Siemens** only. The AC current rating of the contactors shall be selected with a factor of safety of 1.5.

i) **MCBs:- Havells or Siemens.**

ii) **Filter Capacitors:-**The voltage rating of filter capacitors shall not be less than 450 V for 48V and also for 110V chargers. The make shall be **Alcon / RESCON/ SFPL**. The capacity shall be selected to achieve the ripple content. There shall be at least two capacitors for the construction of pie circuits.

iii) **Annunciator Relay**:- Minilec, Alan, JVS.

11.12.13 The charger should have a short circuit protection. Charger shall have load limiters having drooping characteristic, which shall cause gradual lowering of output voltage when the DC load current exceeds the load limiters setting of the charger in automatic voltage control mode. The load limiter characteristic shall be such that any sustained over load or short circuit in DC system shall not damage the charger or shall cause blowing of any other charger fuses.

11.13 TESTS

11.13.1. Battery chargers shall conform to all type tests as per relevant Indian Standard. The type tests should not be older than seven years from the last date of submission of bid.

Performance test on the Chargers as per Specification shall also be carried out on each Charger as per specification. Rectifier transformer shall conform to all type tests specified in IS : 4540 and short circuit test as per IS:2026. Following type tests shall be carried out for compliance of specification requirements:

i) Voltage regulation test
ii) Load limiter characteristics test
iii) Efficiency 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

11.13.2 The Contractor may be required to demonstrate to CSPTCL 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.

11.13.3 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 CSPTCL.

11.13.4. The Contractor shall present for inspection, the type and routine test certificates for the following components whenever required by CSPTCL.

(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 CSPTCL's approval.

12.0 COMMUNICATION SYSTEM :-

12.1 REMOTE TERMINAL UNIT

12.1.1. SCOPE :

It comprises the supply, installation & commissioning of Remote Terminal Unit for SCADA System of CSPTCL.

12.1.2 STANDARDS:

The RTUs under this tender specification shall have IEC-870-5-101 standard protocol supported by the Front-end-server. The RTU shall additionally support IEC 61850, IEC 870-5-103, MODBUS & DNP 3.0 protocol and all relevant IEC standards.

12.1.3 TECHNICAL SPECIFICATION:-

This specification covers detailed Design, Engineering, Testing, Supply and Commissioning of Remote Terminal Units, Interface Cabinets, Multi-Function Transducers and other associated equipments. Such as suitable test software & accessories for telemetry of real time electrical data from various EHV Sub-stations and Power Stations located in Chhattisgarh.

The Load Dispatching functions at SLDC Bhilai is supplemented with the real time SCADA system, installed & commissioned under ULDC project, using Remote Terminal Units, which use IEC 870-5-101 protocol.

The RTUs proposed to be procured under this tender specification shall have IEC-870-5-101 standard protocol supported by the Front-end-server along with support of IEC61850, IEC 870-5-103 & MODBUS protocol for data acquisition from the field.

12.1.4 FUNCTIONAL REQUIREMENT OF RTUs :

The overall functions to be performed by the RTUs are as below :-

Each function are presented in detail for initial and future requirements of the RTUs. The contractor shall provide all functional capabilities described herein even if a function is not initially implemented.

As a minimum, the RTUs shall be capable of performing the following functions:

i) Collecting, processing and transmitting status changes, accumulated values and analog values.
ii) Receiving and processing digital and analog commands from the master station.
iii) Accepting polling messages from the master station.
iv) Supporting data transmission rates from 300 to 19200 bits per second as per IEC 870-5-101 specifications.
v) Shall have four communication ports.
vi) The RTU shall additionally support IEC61850, IEC 870-5-103, MODBUS protocol also for acquiring data from field devices like digital relays & meters.
vii) All ports of the RTU shall be capable to communicate with different master, operating on above mentioned different protocol, at a time without affecting the performance of the RTU. The RTU shall also be capable of acquiring data from digital relays & energy meters using IEC61850, IEC 870-5-103 & MODBUS protocol respectively.
viii) At the time of communication failure, the performance of the RTU should not be affected due to buffer overflow or any other reason and the RTU should start

communicating to its master automatically as & when the communication restores, without re-setting the RTU unit.

ix) Analog and digital input points (including points reported by exception) shall be assignable to scan groups.

x) The RTU communication protocol shall report status changes by exception (spontaneous change of status indication). The communication protocol shall also support an update demand scan of all status data by master station regardless of the lack of any changed data. The update scan will report the status of all RTU data assigned to the scan group.

xi) Each RTU communication message shall include an error code, the use of which shall result in a very low probability of an erroneous message being accepted as valid. The error code shall be determined and appended to the message for all messages transmitted by the RTU and verified by the RTU for all message addressed and received by the RTU. Cyclic error detection codes such as CRC are required.

xii) Although the control functions are not being implemented at present, the RTU should be capable of supporting the same. By putting additional hardware modules only the control functions shall be possible, necessary software shall be an integral part of the RTU SCADA software.

12.1.5 COMMUNICATION INTERFACE:

Each RTU shall be equipped with a minimum of four (4) communication ports. The communication ports and their usage are as follows:

(a) Port 1 and 2 shall be for normal communication to the LD Control Centre.

(b) Port 3 shall be for output to a local printer. The outputs shall be:

  (i) Report of all S/S status indication and all telemetry values with a time stamp.

  (ii) Upon user request, print the RTU sequence of event with time stamps.

(c) Port 4 shall be a maintenance port.

RTU should have provision for two more ports for communication with the Field devices like Digital Relays & Energy Meter over IEC61850,IEC 870-5-103 and MODBUS protocol respectively, if required. The ports shall support the EIA RS232C or RS485 (CCITT V.24/V.28) asynchronous / synchronous interface capable of operating between 50 and 9600 bps. All communication ports shall use CCITT V.24 and V.28 signal specifications to interface to the modems, local logger and local support terminal. All ports shall be accessible to employer to attach the interface equipment and to provide access for the maintenance, test and monitoring equipment. The RTU shall be equipped with of 100 Mbps, 10/100 Base T Ethernet port.

12.1.6 MASTER STATION COMMUNICATION INTERFACE:

The RTU shall be connected to master station over either power line carrier communication (PLCC) channel or OFC or VSAT communication using RS232C or other suitable port. Therefore, RTU should be compatible to be connected to these communication mediums. However, the RTU shall also have provision to make compatible for other modes of communication media such as, UHF / Microwave etc.

12.1.7 MODEM:

The modem shall be supplied for communication with the front-end server / master station. A modem combining all of the characteristics defined below is required such that changing the communication data rate shall only require reconfiguration of the

RTU modem. The modems shall not require manual equalization and shall include self-test features such as manual mark/space keying, analog loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem.

The modems shall meet the following requirements as a minimum:

i) Use CCITT standards including V.24, V.28, V.52 & V.54
ii) Communicate at data rates from 50 to 1200 bits per second, factory set at 200 Bauds.
iii) Use CCITT V.21, V.23, R.35, R.37, R.38a and R.38b standard tones for the selected data rate.
iv) Use frequency shift keying (FSK) modulation.
v) Use both 2 wire and 4 wire communication lines.
vi) Receive level adjustable from 0 to -40 dBm @ 600 Ohms.
vii) Transmit level adjustable from 0 to -30 dBm @ 600 Ohms.
viii) Have a minimum sensitivity of -48dBm.
ix) LED's shall be provided on modem for indicating Tx/Rx activity (ON/OFF) and carrier fail alarm.
x) The modem shall be fed through the DC auxiliary supply available in the RTU itself.
xi) Supporting data transmission rate shall be minimum 300-1200 bits per second for PLCC modems. For RTUs, the data transmission rate shall be 300-19200 bits per second.

12.1.8 MASTER STATION COMMUNICATION PROTOCOL :

A communication protocol for communicating with the front-end server conforming to IEC-870-5-101 communication standard shall be provided. The communication protocol shall be non-proprietary. Complete implementation details of IEC-870-5-101 protocol shall be provided and contractor shall be responsible for tuning / configuring, in the front-end server/ master station, to establish communication with existing/ new SCADA computer system.

12.1.9 COMMUNICATION CHANNEL CONTROL:

The RTU shall perform as a slave on the communication channel to CSPTCL's SCADA system. All communication shall be initiated by the SCADA system front-end server/ master station. The RTU must notify the master station on an unusual condition in the RTU (such as a power fail/restoration or RTU malfunction) or must initiate the transfer of changed data. The notification shall be accomplished within the framework of the periodic data acquisition exchanges.

12.1.10 (a) ANALOG INPUT:

The RTU shall accommodate analog current inputs, which are isolated, uni-polar, or bipolar, 2 wire ungrounded differential signal with full resolutions as follows:-

i) +4 to 20 mA
ii) 0 to 10 mA
iii) -10 to 10 mA
iv) 0 to 20 mA

(b) ANALOG OUTPUT:

RTU shall support analog output of 4-20 mA

12.1.11 (a) DIGITAL STATUS INPUTS:

The digital status input interface shall be capable of accepting isolated, wet or dry contract status input. The contractor shall apply necessary sensing voltage, current limiting, and optical isolation and debounce filtering independently for each digital status input. The sensing voltage source shall be isolated from that of the RTUs logic power such that any noise or short circuit across the sensing supply's output terminals would not disrupt the RTU operation other than the shorted digital status input.

The following types of digital inputs shall be supported:

a) Status inputs
b) SOE Inputs
c) BCD inputs
d) Binary Word inputs
e) Pulse accumulator inputs

The following types of status inputs shall be supported:

a) Single Contact Digital Status input (SS)
b) Double Contract Digital Status input point (DS)
c) Three-state status

(b) DIGITAL STATUS OUTPUTS:

For command purpose

12.1.12 CLOCK:

The internal RTU time base shall have a stability of 1 ppm that is 3.6 milli seconds per hour or better. The RTU time will be set from time synchronization messages received from a master station. The RTU shall synchronize its internal clock with the master station system clock when the Time synchronization is available. It shall be possible to display the RTU time on a local digital clock.

12.1.13 INTERFACE CABINETS:

The contractor shall provide interface cabinets between the RTU and the field equipment. The interface cabinet shall house all transducers, interposing relays / opto-isolator, and interface terminal blocks. The interface cabinet shall be mounted adjacent to the RTU cabinet. All RTU signals shall be connected to the transducers, interposing relays, and field signals in the interface cabinets. However, as per field conditions transducers may be required to be installed in respective control panels and the out put of transducers shall be brought to RTU panel.

The Contractor shall submit a cabinet design to the Employer for approval upon award of contract. The cabinet shall be logically partitioned to have transducers in one section, interposing relays / opto isolators in another section and interface connections to the RTU in another section. The Contractor shall install all components and inter wire all components prior to shipment. The entire cabinet shall be lockable. If multiple locks are provided, the same key shall open any lock.

The interface cabinet shall house various pieces of equipment that are needed to interface to the RTU. It shall be of modular type. The equipment shall be rail / wall mounted type. The connections shall be on the front end for incoming and outgoing circuits and on the rear end for internal connections different sub-assemblies of the interface cabinet.

Pre-wired and standardized solutions for cabling shall be used. This shall enable a few standardized designs for the interface cabinet to be developed, all of which shall have identical provision for various types of plug –in Company / modules (e.g. position indication, MW and MVAR measuring signals).

The interface components for each typical bay shall comprise typical modules and sub-assemblies logically sorted by type of interface. For example, interface component associated to a double bus bar type feeder shall consists of a module for the circuit breaker position indication, a module for the associated bus bar isolators position indication, a module associated to power measurements and a module associated to position control. Each module or sub-assembly shall be provided with all testing (switching, disconnecting and inserting) facilities, allowing easy maintenance.

Wire ways not more than 50% full for maximum RTU configuration, shall be provided to route the necessary connectors from the CSPTCL's choice of top or bottom access to the I/O terminations. For wire way-sizing purposes, the RTU supplier shall assure that each point uses a independent cable.

The terminal connectors should be stud type only both in the inter phase cabinet as well as RTU. The RTU should have minimum 20% spare connectors.

The provided RTU must have 100% expandability. Each RTU shall be provided with 05 Nos of analog input card (each having capacity to accommodate 08 Nos of analog input) and 06 Nos of digital input cards to accommodate 16 Nos single point indications. The RTU shall be supplied with 02 Nos of CPU and 02 Nos. of modems along with rack & power supply. The system provided should be along with basic licence i.e it should communicate with 101, mod bus, 103 and other international protocol. It will be the responsibility of the contractor to integrate RTU with our SCADA. The MFT may be accommodated in respective feeder panel of RTU and output signal of MFT shall be taken to RTU panel through 1.5 Sq mm multi strand copper wire. The analog parameters of all 132 KV feeders & provision for 33 KV feeders for future use, transformers, 132 KV&33KV bus voltages and frequency shall be measured through MFT (Multi-Functional Transducer) and Breaker ON/OFF indications shall be double point indication and isolator indication shall be single point indication and will be coupled to RTU through OPTO isolator print (if digital input card is provided with opto isolator then separate opto isolator print is not required). The wiring of digital indication shall be done by 1.5 sq mm multi strand copper wire, Bus PT voltage and frequency signal shall be terminated to RTU panel.

The RTU provided should be compatible to work with transducers as well as be able to communicate with energy meters and numerical relays which are working on different protocols (other than 101) . The supplied RTU's should be with 2 Nos. modems along with power supply unit and other accessories (1 NO. for RTU & 1 NO. for SCADA end). Opto isolators Print shall be similar to C&R panels size. All digital indication wiring shall be terminated in this panel and before routing to RTU.

Although the control functions are not being implemented at present, the RTU should be capable of supporting the same. The supply of digital out put card is not in the scope. However, RTU should have functionality to support control functions so that as per requirement CSPTCL may obtain control functions by simply providing digital out put cards without any further modification in RTU.

12.1.14. GUARANTEED TECHNICAL PARTICULARS OF REMOTE TERMINAL UNIT (RTU)

Sl. No.	DESCRIPTION	TECHNICAL PARTICULARS
1	Communication Protocol to Communicate with SCADA– IEC 60870-5-101	To match our SCADA
2	Communication Protocol to communicate with Numerical Relays, Meters Etc. –IEC61850, IEC 60870-5-103 or MODBUS (Interoperability Sheet Required)	To match our SCADA
3	Number of Communication Ports (a) For Primary SCADA Master (b) For substation slave devices like numerical relays, meters etc. (c) For Maintenance (d) For Local Logger (e) For Secondary SCADA Master (f) Ethernet port.	 01 no. 02 nos 01 no. 01 no. 01 no. 01 no.
4	Type of Interface for Communication Ports	RS-232, RS-485 & Ethernet/LAN
5	100 Mbps 10/100 Base T Ethernet port support	Supports 100 Mbps in FO & 10/100 base T Ethernet
6	Mode of Communication with Master Station with Baud rate (a). PLCC (b). OFC (c). VSAT (d). Digital Radio (e). UHF / Microwave (f). GSM / CDMA	Configurable serial ports & Ethernet support at 10/100 Mbps
7	Number of compatible Modem required	02 nos. with each RTU
8	Analog Input	0-20 mA with configurable subsets in this range
9	Digital Input Support	▪ Status inputs ▪ SOE inputs ▪ BCD inputs ▪ Binary Word inputs ▪ Pulse accumulator inputs
10	RTU internal clock stability & Synchronization With Master SCADA	1 ppm.
11	Cable sizing details (i) For inter-panel wiring (ii) For field wiring (i.e. CT & PT) (iii) For Field Status Indication	Through multi-strand copper cable D.C. 1.5 sq.mm. C.T.- 4 sq.mm. P.T.- 2.5 sq.mm. Status – 0.5 sq.mm. Analog (4-20)mA. – 0.5 sq.mm.
12	Interface Cabinet type & Details	Full size floor standing cabinet.
13	Availability of Raw A.C. Supply	Yes

14	Availability of Aux. 48 Volts DC Supply Points	Yes
15	Illumination inside RTU & Interface Enclosure	Yes
16	Cool Air system within RTU panel	Not required
17	Redundancy of RTU & Modem DC Supply	Yes
18	Potential free interposing relays & Opto-isolator arrangement	
19	Analog Input Module Details	8 Channel input modules
20	Digital Input Module Details	16 signal indication with time stamp, 8 double indications with time stamp. 2 digital measured values with 8 bits, 1 digital measured value with 16 bit, 16 pulse counter Binary input, 16 channel potentially isolated LED. 16 input modules
21	Connector types, Tag / Terminal block types	Stud and bolt type for D.I. Disconnecting link type for analog.
22	RTU internal (Inter cabinet & inside panel) and external wiring identification methodology & Ferruling	Each component will be identified with tag. Each wire will be provided with ferrule no. at both ends. Each cable will be identified with no. at both ends.

12.1.15 **BILL OF MATERIAL OF R.T.U.**

Each RTU shall consist of the following components:

(1). 5 No. analog cards with 8 inputs each.
(2). 6 digital cards with 16 inputs each.
(3). CPU with basic license: 2 No. with each RTU.
(4). Power supply module 1 No. with each RTU.
(5). Compatible modems: 2 No. with each RTU along with rack & power supply.
(6). Inter face cabinet duly wired 1 with each RTU

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13.0 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(a)	Continuous current rating of 2.5 Sq mm when laid in air & for Max. conductor temp. 70 ºC .	Un-armoured number of core	2C	4C	10C	12C	19C
		Amp.	27	24	15	14	12
6(b)	Continuous current rating of 4 Sq mm when laid in air & for Max conductor temp. 70 ºC .	Un-armoured number of core	4C				
			24				
7	Rating factor for variation in ambient air temperature.(for cables laid direct in ground)						
	Air temp. in deg C	25	30	35	40	45	50
	Rating factor	1.25	1.16	1.09	1	0.9	0.8
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 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	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
	Note :- In addition to manufacturers identification of cable following marking shall also be embossed over outer sheath (i) ISI marked with registration (ii) Cable size and voltage grade (iii) Word "CSPTCL" and name of manufacturer at every meter length. The embossing shall be impressive automatic in line and marking shall be legible.	
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) 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	2C 4C 10C 12 C 19C
	a. The dimension of the cable drum	42x20x12 38x20x10 42x20x12 38x20x10 52x24x14
	b. The approximate weight of the drum	60 40 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 section al 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	38	2280	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	52	4035	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	22.5	862	1.91	2.45	73	70

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14. TECHNICAL SPECIFICATION FOR AUTOMATIC DATA LOGGING SYSTEM:-

14.1 Features & Specification of Automatic Data Logging System

This feature is intended for local monitoring of Sub-station parameters on computer screen installed in control room, automatic acquisition of energy meter data & preparation of customized reports and automatic download of disturbance records in workstation computer of control room. The objective shall be achieved with the help of customized software and hardware connection to IEDs like relays and meters.

14.2 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 such as IEDs (protective numerical relays) to station HMI, gateway to remote station etc.

The Automatic data logging System shall be designed, manufactured, tested, installed and commissioned at the substation as per IEC-61850 for protective relays & Modbus for Energy meters.

The Automatic data logging System shall contain the following main functional parts:

- Intelligence Electronic Devices (IEDs) for monitoring (Numerical protective relays and Energy meter IEDs of C&R panels).
- Station Human Machine Interface (HMI)
- Redundant managed switched Ethernet Local Area Network communication infrastructure for remote monitoring via industrial grade hardware.
- Gateway - Each IED shall communicate data to the Gateway through a serial or Ethernet network connection using a selected protocol. Additionally, the gateway should have the capability to communicate with SLDC on IEC 60870-5-101& 104 protocol.
- Peripheral equipment like printers, display units, key boards, Mouse etc.

Automatic data logging System shall be realised via a PC by means of human machine interface (HMI) and software package, which shall contain an extensive range of data acquisition functions. The contractor shall arrange for necessary software Licences.

The communication gateway shall have the provision to facilitate the information flow with remote control centres. The bay level intelligent electronic devices (numerical relay IED) for protection shall provide the direct connection to the switchgear without the need of interposing components and perform protection and monitoring functions.

14.3 System Architecture – The Automatic data logging system shall have following minimum components**:**

14.3.1 Gateway - Hardware capability: It shall have a flexible high performance expandable disc less & fan less platform. It should be powered by 2 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). The communication protocol for gateway must support IEC 60870-5-101,104, IEC 60870-5-103, IEC 61850 and all other protocol required for all levels of communication such as numerical relay IEDs and energy meter IEDs to station HMI etc.

The primary function of the Gateway shall be to concentrate substation data by polling and receiving information from connected IEDs. Each device shall communicate data to the Gateway through a serial or Ethernet network connection using a selected protocol. The Gateway shall retrieve point information from and shall send control requests to each communicating device. The Gateway can manipulate the data from devices to produce additional local/pseudo data points. The real data collected from devices and the calculated data shall be stored in a database in the Gateway and shall be available to pass on to remote master stations and/or HMI (Human-Machine Interface) applications.

The Gateway shall be able to accomplish these tasks through the use of embedded software applications. These software applications shall be configurable to set up the Gateway to operate as per the requirement of the system.

Salient Features of Gateway

1 . Data concentration
2 . Ease of use /configuration
3. Embedded substation HMI and alarm system
4 . Embedded security applications
5 . Expandable and upgradeable platform
6 . Redundancy
7 . Role based access control
8. Support for network time protocol (NTP)
9. Support for multiple Scada protocols for communication to multiple masters

14.3.2 Ethernet switch –

The switch shall be a Industrial grade managed Ethernet switch, designed for reliable high speed networking for all critical applications in substations. The switch shall provide flexibility in usage, security and shall offer ease of maintenance. The Ethernet switches shall be Industrially Hardened and IEC 61850 Compliant for networking equipment used in utility substations. It shall also be IEEE 1613 Compliant for Electric Power Substation communications equipment.

The switch shall have advanced network management and security features including SNMP, SNTP, web management ,interface, VLAN, IPV6, SSL web encryption and SSH securing switch access over unauthorized network.

The following functions shall be available in the switch;

1. RJ45 Ports – It shall have a minimum of 6 Nos spares over and above that utilised in the scheme (of 100 MBPS or above)
2. It should support all common media types
3. Power Supply - 110 VDC/240 VAC Power Supply
4. Link Loss Alert feature
5. Recovery of Ring Network Architectures feature
6. Modbus Protocol Support enabling integrating Switch Data and Network Alarms into monitoring systems.
7. Simple Switch Configuration and System Integration
8. The software shall allow for easy to use configuration, monitoring and integration of the Ethernet Switch.
9. The software shall cover following functionality also;
   - The Software shall allow for programming of all settings
   - Monitoring of all Ports and Alarming of network problems including: Port Failures, Power Supply Failures, Security Intruder Alarms

- The Integrator shall retrieve all of the information such as port status, network statistics and Network Alarms in the switch and send this data to monitoring systems

14.3.3 Automatic data logging system Work station

Computer System Configuration - Dual Core Processor,2.5 GHz or better, SDRAM-4GB, HDD-500 GB, Drive-52X, Ethernet Card, Serial Ports – min. 4 Nos, USB port-min 2 nos, Color **29**" LCD Monitor, Operating System – Windows 7 Professional or equivalent.

14.4 Objectives of Automatic data logging system

14.4.1 For Energy meter :

1. It shall have 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. One screen of SLD mimic shall be populated by data from energy meter.
3. **Meter Support** – The software shall acquire data from the Secure Meters Ltd make Premier meters over RS485 on MODBUS protocol.
4. **Viewing Online Data-** The software shall provide facility to monitor instantaneous electrical parameters on real time basis. Online data can be viewed in graphical / tabular formats/substation SLD mimic.
5. **Viewing Historical Data -**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 loss and consumption of a location.
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. **Reports -** The software shall provide various types of reports like min-max, energy consumption data, alarm data, interruption data, meter replacement, demand data, energy loss data etc. 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)
- 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 days etc. 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, load 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. Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer

v. Printout on adjustable time period as well as on demand system frequency and average frequency.

vi. Reports in specified formats which shall be handed over to contractor.

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. 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.

9. **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.

14.4.2 <u>For Relays :</u>

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. One screen of SLD mimic shall be populated by data from relays.
3. **Relay Support** – The software shall acquire data from the IEC61850 compliant IEDs.
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. **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 workstation computer of the system and be stored on the hard disc. The software shall provide historical data views of disturbance records and events for analysis purpose.

6. Disturbance analysis

The PC-based work station shall have necessary software to evaluate all the required information for proper fault analysis.

14.5 <u>List of Inputs:</u>

The list of input for typical bays is as below:-

14.5.1 . Analogue inputs:

i) **For line**

Current: R phase, Y phase, B phase
Voltage R-Y phase, Y-B phase B-R phase
MW, MVAR, MVA, PF

ii) **For transformer**:

Current: R phase, Y phase, B phase,
MW, MVAR, MVA, PF

iii) **For TBC**

Current: R phase, Y phase, B phase
MW, MVAR, MVA, PF

iv) **Common**

a) Voltage for Bus

Voltage R-Y phase,Y-B phase, B-R phase

b) Frequency

v) **Current from station LT transformer** (CSPTCL)

vi) **Current from CSPDCL supply**

14.5.2 Digital Inputs:

The list of inputs for various bays/Systems is as follows:

1**. Line bays**

i) Status of CB,
ii) Trip coil faulty
iii) LBB optd
iv) PT FUSE FAIL
v) DISTANCE PROTN TRIP
vi) DPR SOTF TRIP
vii) DPR R-PH TRIP
viii) DPR Y-PH TRIP
ix) DPR B-PH TRIP
x) DPR ZONE-2 TRIP
xi) DPR ZONE-3 TRIP
xii) Back-up O/C optd
xiii) Back-up E/F optd
xiv) Any other input as listed in relevant section

2. **Transformer bays**

i) Status of CB
ii) Trip coil faulty
iii) LBB optd
iv) REF OPTD
v) DIFF OPTD
vi) OVERFLUX ALARM
vii) OVERFLUX TRIP
viii) OTI ALARM/TRIP
ix) PRD OPTD
x) OVERLOAD ALARM
xi) BUCHOLZ TRIP
xii) BUCHOLZ ALARM
xiii) OLTC BUCHOLZ ALARM
xiv) OLTC BUCHOLZ TRIP
xv) WTI ALARM/TRIP
xvi) Back-up O/C HV optd
xvii) Back-up E/F HV optd
xviii) GR-A PROTN Optd
xix) GR-B PROTN Optd
xx) Back-up O/C (LV) optd
xxi) Back-up E/F (LV) optd
xxii) Any other as listed in relevant section

The exact number and description of digital inputs shall be as per detailed engineering requirement. Apart from the above mentioned digital inputs, minimum of 100 inputs shall be kept for future use of CSPTCL.

14.6 User-authority levels

It shall be possible to restrict activation of the process within a certain user authorisation group. Each user shall then be given access rights to each group of process, e.g.:

> Display only
> 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.

14.7 LIST OF EQUIPMENTS

Quantity of equipments shall include but not limited to the following;

a. Substation Automatic Data LoggingWork Station: 1 No.
Computer System Configuration - Dual Core Processor, 2.5 GHz or better SDRAM- 4GB, HDD-500 GB, Drive-52X, Ethernet Card, Serial Ports – min. 4 Nos, USB port- min 2 nos, Color **29**" LCD Monitor, Operating System – Windows 7 professional or equivalent.

b. Gateway : Minimum 1 No.

c. Ethernet switches : Minimum 1 No. (with 6 Nos redundant ports)

d. Laser Printer – 1 No. (For Reports & Disturbance records).

e. Dot matrix printer – 2 Nos.

f. Communication infrastructure between Bay level units, Station HMI, Printers, redundant LAN etc. as required.

g. 1 KVA or higher size inverters as per requirement: 1 No.

h. ADLS Panel for housing Ethernet switch, Gateway, UPS & various connectors.

i. Furniture for arranging Automatic Data Logging System : One Godrej make Computer table of adequate size and chair.

j. Other equipment as detailed in the technical specifications and any other necessary for Automatic Data Logging System and not listed.

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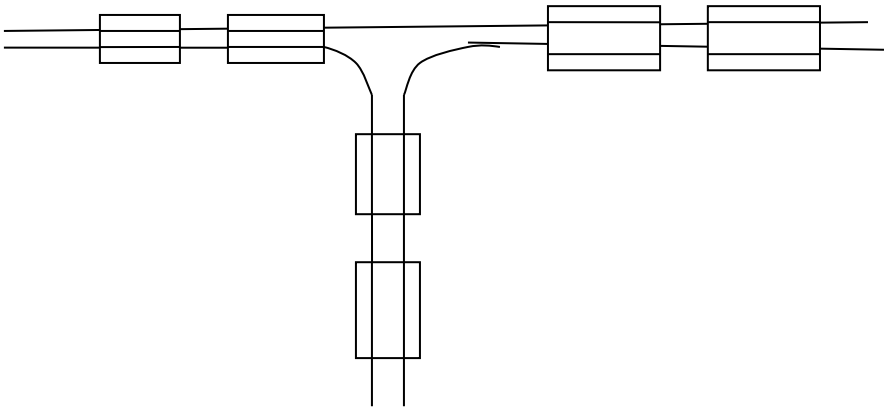
15.0 TECHNICAL SPECIFICATIONS OF CLAMPS, CONNECTORS AND HARDWARES:

15.1 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 mm 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 locations i.e., main 3 phase droppers on HV and LV side of transformer as also for 132 KV line take off, either 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.

15.1.1 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 4 mm thick cast copper liner (2 mm Cu and 2 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.

15.1.2 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 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

xi) All connections with ACSR conductors shall be bolted type.

15.1.3 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.

15.2 SUBSTATION TYPE HARDWARE:-

15.2.1 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.

15.2.2 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) Double Tension Hardware for for Zebra/Twin Zebra ACSR Zebra for substation:-

Double 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) 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.

iv) 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.

15.2.3 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.

15.2.4 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.

15.2.5 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.

15.2.6 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.

15.2.7 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 seven years as on last date of submission of bid.

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.

15.2.8 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.

15.2.9 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.

15.2.10 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.

15.2.11 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

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16.0 TECHNICAL SPECIFICATIONS OF STATION TRANSFORMER AND DO FUSE SET:-

16.1 **STATION SUPPLY**:- The LT station supply of the S/S shall be through a 200 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 400A having MCCB 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.The 400A MCCB and back up Porcelain Kit kat fuse protection shall be housed in a out door LT distribution box with front opening. The LT distribution box shall be tested for IP55 for out door use. The cable entry shall be from the bottom side of the above distribution box of adequate size. The incoming LT supply in the control room shall be through changeover switch so that in case of any trouble in the station transformer alternative supply may be availed from CSPDCL supply. LT CT Energy Metering arrangement shall be provided on all the incoming supplies by providing Secure Meters Ltd, LTCT energy meter, Model-Premier 300, rated for 3x240 V, 400/5 A having RS 485 port on Modbus protocol. A 3 Ph 4 W SEMS make 0.5s class electronic CT operated energy meter shall be provided for recording the substation energy consumption. Necessary metering class LT CTs rated for 400/5 A shall be provided in the ACDB.

16.2 **TECHNICAL PARAMETERSOF STATION TRANSFORMER:-**

The Station Transformer offered should conform to the following Technical specifications. The Technical specifications of the transformer should be filled in proforma prescribed below. The offers not complying this requirement may be rejected.

S.N	Particulars	As specified
1.	Reference Standards	IS:2026/IEC 176
2.	Name of Manufacturer	
3.	Rating	200 KVA
4.	Type of Winding	Copper Wound
5.	Service	Outdoor
6.	Rating Voltage: a) HV Winding KV b) LV Wind KV	 33 0.415
7.	Rating Frequency Hz	50
8.	Number of phase	3
9.	Rated current: HV LV	3.5 A 278 A
10.	Connections: a) HV Winding b) LV Winding	 Delta Star
11.	Connection symbol	Dyn 11
12.	Type of cooling	ONAN
13.	Tap changing equipment a) LV -variation +5% to - 5% b) Type c) No. of steps	 Off circuit, Bridging 4 steps, 5 position
14.	Guaranteed positive sequence impedance at 75 Deg. C. with 100 % rating at Principal tap:	4.5 % tolerance +10% -5%

15.	Temperature rise over ambient of 50 °C. a) Top Oil (if applicable) Deg. C. b) Winding (by resistance measurement method) Deg. C.	 40 Deg.C. 45 Deg.C.
16.	Guaranteed losses at rated voltage (excluding cooler loose) on principal tap and at rated frequency. a) No load loss or iron loss. b) Copper loss at full load at 75 Deg. C. c) Total losses	 500 W 2000 W 2500 W
17.	Core Material	CRGO Cores shall be constructed from high grade, cold rolled, non ageing, grain oriented silicon steel laminations, HI-B grade or better grade modern core material with lower core losses.
18.	Withstand time for three phase short circuit at terminals (secs.) NOTE:- The Xmer is protected by means of DO fuses on 33 KV side. The Xmer must be designed with proper supports for LV & HV winding with pre-compressed board / permali wood / filling with resin so as to make the wdg immovable.	3 Sec.
19.	No load current at rated voltage and rated frequency.	1 % of full load current
20.	Insulation level a) Separate source power frequency voltage withstand. i) HV Winding (KV rms) ii) LV Winding (KV rms) b) Induced over voltage withstand i) HV Winding (KV rms) ii) LV Winding (KV rms) c) Full wave lightning impulse withstand. i) HV Winding (KVp) ii) LV Winding (KVp)	 95 KV 2 KV 66 KV 0.83 KV 170 KV --
21.	Regulation at full load at 75oC a)At unit power factor (percent) b)At 0.8 power factor (Percent)	Please furnish
22.	Over excitation withstand time (sec.) a) 120 % b) 150 %	 1 Minute 3 Sec.
23.	Total Quantity of oil	Min. 600 Ltr
24.	Approximate dimensions a) Tank enclosure (mm) b) Overall L x B x H (mm) **NOTE**:-The size of tank shall be so decided that a minimum clearance of 75 mm is available at every point between live parts and tank. Minimum phase to phase clearance at outer dia of R & Y Y & B HT coils shall be 40 mm. This shall be specifically checked at the time of inspection.	Please furnish Supplier must confirm this point.
25.	Untanking height	Please furnish

26.	Approximate weight a)Core and winding (Kg.) b)Tank fittings (Kg.) c) Oil (Kg.)	Please furnish	
27.	Efficiency at 75°C a)At full load (%) b)At ¾ full load (%) c)At ½ full load (%)	Please furnish	
28.	Pressure release device: The Xmer 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	
29.	Tank plate gauge: Top & Bottom Side plates (with stiffeners)	minimum 6 mm minimum 4 mm	
30.	Top of tank	Slanted to avoid collection of rain water	
31.	Oil Parameters	EHV Grade-I as per ISS 335, BDV shall not be less than 50KV.	
32.	Bushing characteristics. HV- 36 KV bushing a. 1 minute Power frequency withstand voltage in KVp b. Lighting Impulse Withstand voltage (KVp) c. Creepage distance .	 95 KV 250 KV 25 mm/KV	
33.	Material used in Bushing rod	Brass	
34.	Size of Bushing Rod.	HV - 12 mm LV – 30 mm	
35.	Details of provision for shrinkage of winding.	Pre shrinking will be done before final essentially during process.	
36.	Type of transformer tank.	Rectangular	
37.	No. of radiators	Min. 2 nos on each HV & LV side	
38.	Arrangement of clamping of winding ends to bushing terminals.	Brazing through multi paper covered leads.	
39.	Explosion vent.	Please confirm	
40.	Electrical clearance	33KV	0.400KV
	i/ Phase to phase ii/ Phase to Earth	350mm 320mm	75mm 55mm
41.	Terminal connector		
	HV	Horizontal/vertical take off suitable to receive single ACSR Zebra conductor	
	LV	Suitable for power cable connection	

Electrical characteristic of bushing insulators shall be in accordance withIS:2099/ IS:3347 as amended from time to time. All type routine tests shall be carried out in accordance with IS: 2099/ IS:3347.

16.2.1 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° C max.	0.89g/cm^3
(c) Kinematic viscosity max. (i) At 27 ° 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°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° C max	0.002
(k) Specific resistance (resistivity) i) At 90 ° C min. ii) At 27 ° 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

16.2.2 **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.

16.2.3 **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.

16.2.4 **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.

16.3 **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).

16.4 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.

16.4.1 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.

16.4.2 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.

16.4.3 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.

16.4.4 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.

16.4.5 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.

16.4.6 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.

16.4.7 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.

16.4.8 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.

16.4.9 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

16.4.10 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.

16.4.11 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 as on the last date of submission of bid.

(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.

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17.0 TECHNICAL SPECIFICATIONS FOR LIGHTING LUMINARIES FOR SWITCH YARD & CONTROL ROOM LIGHTING AND HIGH MAST :

17.1 SCOPE:

This specification covers design, manufacture, testing at manufacturer's works, supply and delivery of LED lighting fixtures with all accessories for switch yard and control room lighting.

17.2 STANDARDS

17.2.1 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.

17.2.2 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.

17.3 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 LED 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 LED lighting 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.

g) **The specification of LED slim light panel for fixing in the ceiling grid size 600x600 mm in the False ceiling of Control Room of EHV Sub-Stations** –
Supply, fixing and testing edglite LED slim panel having white powder coated extracted aluminium body with high auality LGP and PMMA diffuser. Separate HPF driver suitable for Armstrong and Grid ceiling having grid of 600x600 mm make Polycab, Syska, Bajaj, Havells, Orient or equivalent.
Wattage- 40 W CCT-6000K.

17.4 TECHNICAL PARTICULARS OF LUMINARIES

17.4.1 FLOOD LIGHTING LED LUMINARIES (2 X 100 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
LED Lamps	100 Watt

17.4.2 STREET LIGHTING LUMINARIES (1 x 30 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
LED Lamp	30 Watt

17.4.3 **INDOOR DECORATIVE MIRROR OPTIC LUMINAIRE FOR 2 x 8 WATT LED 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.

17.4.4 **INDUSTRIAL LUMINAIRE SUITABLE FOR 2 x 8 WATT**

Rail	CRCA sheet, stove enamelled white colour.
Reflector	CRCA sheet, stove enamelled outside colour Grey & inside colour white.

17.4.5 **CORROSION PROOF INDUSTRIAL LUMINAIRE FOR 2x8 WATT**

Canopy	Fibre glass reinforced polyester
Gear tray	CRCA sheet, stove enamelled white.
Cover	Acrylic, transparent.

17.4.6 **INDOOR DECORATIVE LUMINAIRE SUITABLE FOR 1x8 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.

17.4.7 **M.S.COMMERICAL RAIL SUITABLE FOR USE WITH SINGLE 8 WATT FLUORESCENT LAMP**

Channel	CRCA sheet steel, stove enamelled, colour grey.
Cover	CRCA sheet steel, stove enamelled, colour white.

17.4.8 **TOP LANTERN TYPE LED LUMINARIES FOR 1 x 30 WATTS 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.

17.4.9 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
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	-

17.4.10 HIGH MAST:-

High mast shall be 20 sided polygonal type, hot dip galvanized and 20 mtr high. Each mast shall be provided with 6 Nos. carriage arrangement with LED flood light luminaries of 2x160W. It should be provided with integral motorized lifting and lowering arrangement for the easy maintenance purpose of flood lights provided at the top of the mast. Design standard should confirm to I.L.E. technical report No. 7:2000 and materials: shaft/gussets should confirm to S355 as per BS EN 10025:1993 and flange / door stiffener as per IS 2062. The mast should be suitable for withstanding a wind speed of 39 mtr./second. The door should be vandal proof and weather protected. The mast will have pad locking arrangement in the centre and

2 Nos. ALLEN BOLT at top and bottom. Wire rope shall be of reputed make. 2 pipe Earth pits already specified in this document are to be constructed with each high mast

GENERAL SPECIFICATION OF HIGH MAST SYSTEM
SUITABLE FOR 6 NOS LED LUMINAIRES SYMMETRICAL

Height of mast	:	20 Meter
No. of sections	:	Two
Material construction	:	S 355 grade as per BS-EN10025
Base dia and top diameter (A/F)	:	Top : 150 mm, Bottom : 410 mm
Plate thickness and section length	:	Top : 3 mm, length-9520 mm Bottom : 4 mm ,length-10980 mm
Cross section of Mast	:	20 side polygon.
Standard for galvanisation	:	As per BS EN ISO 1461
Size of opening and door at base	:	1200 x 250 mm
Diameter of base plate	:	570 mm
Thickness of base plate	:	25 mm
Lightning protection finial	:	G.I single spike
Max.wind speed	:	50 m/s - As per IS 875, Part III
Number of foundation bolts	:	8 Nos
PCD of foundation bolt	:	490 mm
Type / diameter / length of foundation bolts	:	TS 600 / 30 mm dia / 850 mm long
LUMINAIRES CARRIAGE		
Material of construction	:	50 NB ERW Class B - M. S. Pipe
Diameter of carriage ring (mm)	:	711 mm (ID)
Construction	:	6 Arm, Welded, 2 sections
Load carrying capacity		6 Luminaire
Luminaires	:	350 W Type BJFL350W LEDWH
TRAILING CABLE		
Conductor	:	Copper, 5 core, 2.5 sq mm
Insulation	:	PVC insulated PVC sheathed
No. of circuits per mast	:	One No. Cable per Mast
WINCH / POWER TOOL		
Type / SWL of winch	:	Double drum, SWL 750 Kg
Method of operation	:	Integral Motor
Motor capacity	:	1.0 HP
No of speeds	:	6 pole Single speed
Torque limitor	:	With mechanical tripping facility
STAINLESS STEEL WIRE ROPE		
Grade / construction	:	AISI 316, 7/19 construction
Number of ropes	:	Two continuous
Diameter (mm)	:	6 mm
Breaking load capacity	:	2350 kg x 2

18.0 SPECIFICATION FOR SUPPLY OF GALVANISED STEEL STRUCTURES AND EARTHING STEEL, AC DC DISTRIBUTION BOARD AND MARSHELLING BOX. ERECTION, TESTING AND COMMISSIONING OF 132 KV / 33 KV SUB STATION.

18.1 GALVANISED STEEL STRUCTURES

18.1.1 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 132 / 33 KV sub-station where ever required. These structures should match standards in all respects.

18.1.2 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.

18.2 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 31.5 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.

18.3 TECHNICAL SPECIFICATIONS FOR ACDB & DCDB PANELS AND MARSHALLING/ JUNCTION BOX

18.3.1 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 AC Board with Metal clad switches
2. 110V DC Board with Metal clad switches
3. 48V DC Board with Metal clad switches

18.3.2 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.

18.3.3 GENERAL REQUIREMENT

18.3.3.1 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) not exceeding 1600x 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 400 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. 400A capacity. The AC board shall be designed for fault current of 8KA on LT side for 3sec. The distribution of single/ 3 phase shall be arranged through metal clad switches of 3 no. 3 phase 200 amp, 6 no. 3 phase 100 amp, 6 no. 3 phase 32 amp 4 pole and 20 no. 32 amp DP SF with separate boxes in ACDB to various load points in the sub-station. The ACDBs & DCDBs should have arrangement of physical Isolation through knife switches in addition to the above mentioned features.

18.3.3.2 The 110 volt DC distribution board shall comprise of bus section of bus bars of adequate rating suitable for 110 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.

18.3.3.3 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.

18.3.3.4 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**.

18.3.3.5 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.

18.3.3.6 Detachable gland plates suitable for receiving the cable shall be provided at the bottom side of Distribution board with glands.

18.3.3.7 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 100/5A.

18.3.3.8 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.

18.3.3.9 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.

18.3.4 **MAIN BUS-BARS**

18.3.4.1 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.

18.3.4.2 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.

18.3.5 TESTS.

18.3.5.1 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.

18.3.5.2 Type tests and routine tests shall be carried out on all associated equipments as per relevant Indian Standards.

18.3.6 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.,

18.3.7 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.

18.4 TECHNICAL SPECIFICATION FOR MARSHALLING/JUNCTION BOXES.

18.4.1 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.

18.4.2 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

18.4.3 **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.

18.4.4 **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.

18.4.5 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):

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 distribution of 1 No. 63A for lighting and to 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

18.5 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.

18.5 EARTHING OF SUB STATION:-

18.5.1 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.

18.5.2 **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.

18.5.3 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 extended 2 Mtr. outside the switch yard fencing. 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.

18.5.4 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. earth pit of two electrode of GI pipe having size 100mm dia of 3mtr. length for each set of 132 KV PTs & 33 KV PTs.
ii) 1 No. of earth pit of two electrode of GI pipe having size 100mm dia of 3mtr. length for each set of 132 KV LAs .
iii) 1 No. of earth pit of two electrode of GI pipe having size 100mm dia of 3mtr. length for each high mast.
iv) 1 No. of earth pit of two electrode of GI pipe having size 100mm dia of 3mtr. length for each set of 2 Nos. 33 KV LAs .
v) 1 No. of earth pit of two electrode of GI pipe having size 100mm dia of 3mtr. length for 33/0.4 KV Station Transformer .
vi) 2 No. of earth pits of 04 electrode of GI pipe having size 100mm dia of 3mtr. length for 40 MVA Xmer HV & LV neutral. The earth pit shall be excavated up to the full depth of 3 m of size 1.25 m X 1.25 m. The earth pit shall be filled with black cotton soil mixed with wooden charcoal powder and bentonite clay.
vii) For 132 KV, 33 KV bus bar, gantry structures etc. the number of earth pits shall be in compliance with IS specifications.
viii) 2 No. Earth pit of 2 electrodes of GI Pipe having size 100mm dia of 3mtr. length for earthing of control room equipments.

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 7 meters in the 132 KV yard and not more than 5 meters in the 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***.

18.5.5 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.

In addition, individual spikes not less than 2.5mtrs shall be provided on each column of the switch yard.

18.5.6 **EARTH RESISTIVITY TEST:-**

This test shall be conducted by the contractor 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.

18.5.7 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
c) The contractor will under take preparation of earthing pits and installation of spikes.

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19.0 TECHNICAL SPECIFICATION FOR ACSR "ZEBRA" CONDUCTOR

19.1 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

19.2 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.

19.3 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.

19.4 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.

19.5 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.

19.6 TESTS AND STANDARDS

Type Tests, Routine and Acceptance tests on ACSR Conductor shall be conducted as per latest relevant standard & tender specification. The type tests should not be older than ten years from the last date of submission of bid.

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

19.7 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 Whole Alu./Steel Whole conductor	Sq. mm	 7.942/7.942 428.90/55.6 484.50	
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	1185	
	Steel	kg/km	436	
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	

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20.0 TECHNICAL SPECIFICATION FOR 7/3.66 mm GROUNDWIRE

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	
8.	Minimum Weight of Zinc coating on wire	260 gms./sq. Meter of uncoated wire surface.
9.	No. of one minute dip and half minute dip respectively	2 & 1 respectively
0.	Minimum purity of zinc	99.95%

21.0 TECHNICAL SPECIFICATION FOR 70 KN & 90 KN DISC INSULATORS AND SOLID CORE POST INSULATORS:-

21.1 70 KN & 90 KN DISC INSULATOR(Anti-fog type)

S.No	Particulars	70 KN	90 KN
1.	**Type of Insulator (Pin & Cap)**	**Ball & Socket**	**Ball & Socket**
2.	Size and designation of ball and socket with standard to which it will confirm	16 mmB	16mmB Conforming to IS: 2486 (part-II) 1974
3.	Dimension a) Porcelain disc diameter mm b) Unit spacing mm c) Creepage distance of single disc (min.) mm	 255 +/-10 145 +/-4 430	 255 +/-10 145 +/-4 430
4..	Colour of glaze of the finished porcelain insulator	Brown	Brown
5	Mechanical values. a) Combined mechanical & electrical strength in KN b) Materials used for ball pins. c) 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
6	Ultimate tensile stress Kg.Per mm2	63	63
7	Yield stress Kg. Per mm2	32.5	32.5
8	Hardness test value BHN	175	175
9	Percentage elongation	(min. 15%)	(min. 15%)
10	Whether machine forced	Yes	Yes
11	Normalising particulars(Temp in °C)	30-880	30-880
12	Withstand voltage of single disc a) Dry KV (RMS) b) Wet KV (RMS)	 70 40	 70 40
13	Impulse voltage 1.2 x 50 Micro sec. Positive KV (Peak) Negative KV (Peak)	 110 110	 110 110
14	Flash over voltage for the disc. Power frequency : a) Dry KV (RMS) b) Wet KV (RMS)	 78 45	 78 45
15	Flesh over Impulse voltage 1.2 x 50 Micro sec. a) Positive KV (Peak) b) Negative KV (Peak)	 120 120	 120 120
16	P.F. Puncher voltage KV (RMS)	120	125
17	Min. Corona extinction voltage KV	09	09
18	Max. RIV at 10 KV (RMS) Micro volts	50	50
19	Security clip/ locking device a) Type and dimension b) Material c) Standard to which security clip confirmed d) 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--
20	Standard specification to which insulator will confirm	IS- 731 & IS-13305	IS- 731 & IS- 13305
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

21.2 SOLID CORE POST INSULATORS

1. **Principal parameters:**

The principal parameters for 132 KV & 33 KVsolidcore insulators shall be as given below:

Voltage Class	**132KV**	**33KV**
a) Visible discharge test KV(RMS)	105	27
b) Dry one minute power frequency withstand test KV(RMS)	275	75
c) Wet one minute power frequency withstand test KV(RMS)	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
e) Impulse voltage withstand test KV(PEAK)	650	170
f) UltimateTorsional strength (KNM)	3	3
g) Ultimate bending strength (KN)	4	4
h) Ultimate contilever strength	140KN	80KN
i) Height of the insulator (mm)	1472	508
j) Creepage distance	3625 mm	900 mm
k) Top/ Bottom P.C.D.	127 /184	76/76

2 Puncture voltage: The insulator should be puncture proof.

3 Markings: Each post insulator shall be marked with following:-

a) Name & trade mark of the manufacurer, b) Month & Year of manufacture

4 Tests:

4.1 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.

4.2 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.

The type tests should not be older than ten years from the last date of submission of bid.

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

22. TECHNICAL SPECIFICATION FOR FIRE DETECTION SYSTEM

22.1 Suitable fire detection system using smoke detectors and/or heat detectors shall be provided for the control room building. 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.

22.2 Each zone shall be provided with two zone cards in the panel so that system will remain healthy even if one of the cards becomes defective.

22.3 Fire detectors shall be provided on false ceiling in control room building. **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.** Photoelectric smoke detectors shall be provided in all areas. 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.

SCHEDULE – C
DETAILS OF STEEL STRUCTURE
(Drawings shall be provided by CSPTCL)

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	
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
1	Gantry column	HG Lattice bolted	10650/ 8650	-	853	44 (Incl step

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)**
						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

--- End of Technical Specifications for EHV Sub-Stations-

SECTION – II

TECHNICAL SPECIFICATION FOR EHV LINES

TECHNICAL CONDITIONS

TECHNICAL CONDITIONS FOR FABRICATION AND SUPPLY OF LINE MATERIALS FOR CONSTRUCTION OF LINE.

1. SCOPE:-

The successful bidder will supply various types of G.I. towers as indicated in price schedule, their extensions and accessories as envisaged for **132 KV**DCDS Line.

2. TYPE OF TOWERS:

(i) The towers for 132 KV line are classified as below:-

Type of tower	**Deviation limit**	**Typical Use**
DN-2 /	0 deg. – 2 deg.	To be used as Tangent tower
DN-30 /	Up to 30 deg.	a) Angle tower with double/single tension insulator string. b) To be used for uplift forces resulting from an uplift span. c) To be used for anti cascading condition. d) To be used as section towers
DN-60 /	30 deg-60 deg.	a) Angle tower with double/single tension insulator string. b)To be used for uplift forces resulting from an uplift span. c) Dead end with 0 deg. Deviation both on line side and substation side (slack span)

Note:- The above towers can also be used for longer span with smaller angle of deviations.

(ii) **EXTENSIONS:-**

(a) The double circuit towers are designed so as to be suitable for adding 3M, 6M and 9M body extensions / leg extensions for maintaining adequate ground clearances without reducing the specified factor of safety in any manner.

(b) The provision for additional + 18M body extension for tower type of DN-60 is also kept by the CSPTCL. For power line crossing or any other obstacle the DN-60 tower can be used with 18M extension depending upon the merit of prevailing site conditions. The maximum reduced span for DN-60 type towers shall be mentioned in tower spotting data. However, this shall in no case be less than 200M.

(c) **Truncated Gantry -**Wherever necessary will also be required for crossing 132KV/220KV/400 KV transmission lines.

3. SPAN AND CLEARANCES :-

(a) **NORMAL SPAN**:-The Normal ruling span for 132 KV line is 335 M for DN-2, DN-30 & DN-60 type towers.

(b) **WIND SPAN**:- The wind span is sum of the two half spans adjacent to the support under consideration. For normal horizontal spans this equals to normal ruling span.

(c) **Weight Span**:- The weight span is the horizontal distance between the lowest point of the conductor on the two spans adjacent to the tower. For spotting of structures, the following span limits should be considered:-

Type of tower	Reliability condition		Security condition	
	Maximum	Minimum	Maximum	Minimum
DN-2	503	134	252	67
DN-30	503	0	252	(-) 200
DN-60	503	0	252	(-) 200

(d) 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.

(e) **Ground Clearance**:-

(i) The minimum ground clearance from the bottom conductor shall not be less than 6100 **mm for 132KV line** at the maximum sag condition and still air.

(ii) Conductor creep shall be compensated by over tensioning the conductor at a temperature of 26 deg C lower than the stringing temperature for ACSR Panther **for 132 V line.**

(f) Other than the items indicated above, some other Tower and Foundation Designs, Structural drawings, BOM, Shop drawings, if required for proper and effective execution of project may also be required to be developed by the Contractor without any extra cost to the owner.

4. 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 610 gms 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 300+/- 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, thickness 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 CSPTCL for approvals as part of Quality Assurance Plan.

5. MATERIAL :-

The tower members including cross-arms shall be of structural steel quality conforming to I.S. 2062 Gr.43-A of 2006 or latest revision thereof (section as per IEEMA circular). Only structural steel angles sections manufactured according to latest

revisions of I.S 808 -1976 (Part V & VI - The Dimensional and Section Properties) shall be taken into consideration in design of towers. Only tested steel sections having its yield strength not less than 2550kg/cm^2 shall be used.

6. FASTENERS : BOLTS AND NUTS AND WASHERS :

i. The design of the towers and extensions are based on use of HRH mild steel hot dip galvanized bolts (5.6 quality) and nuts (5.0 quality). The connections are designed on the basis of use of 16mm dia bolts. 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.

ii. All bolts and nuts shall conform to IS:12427. All bolts and nuts shall be galvanised 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.

iii. Bolts upto 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.

iv. 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 upto M16.

v. 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.

vi. 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.

vii. 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-galvanised.

viii. 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..

ix. The bolts of 16mm size shall be manufactured by cold/hot forging process and the threads shall be rolled.

x. The bolts and nuts shall be free from forging and threading defects such as cuts, splits, burrs, bulging, taper, eccentricity, loose fit etc.

xi. The bolts shall be threaded up to standard length only as per relevant Indian Standard and not to full length.

xii. 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.

xiii. 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".

xiv. 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.

xv. 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.

xvi. 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.

xvii. 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.

7. 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 m.m. long, spaced not more than 300 mm apart and extending from 2.5 metres 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 upto 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 vertical load not less than 1.5KN.

8. DANGER BOARD, NUMBER PLATE AND PHASE PLATES:-

Danger plates, Number plates, Circuit plates and phase plates shall be provided and installed by the Contractor:

i. Each tower shall be fitted with a danger plate, number plate, circuit plate and two sets of phase plates for double circuit tower.

ii. The letters, figures and the conventional skull and bones of danger plates shall conform to IS:2551 and shall be in a signal red on the front of the plate.

iii. The corners of the danger and number plate shall be rounded off to remove sharp edges.

iv. The letters of number plate shall be red enamelled with white enamelled background and should be centrally spaced.

The drawings for number plate, danger board, and phase plates are **enclosed in the tender**. Necessary provision for fixing of these items has been made.

9. ANTI-CLIMBING DEVICE WITH BARBED WIRE ON TOWER/GANTRY:-

The barbed wire type anti-climbing device shall be used at a height of approximately 3 meters as an anti-climbing deterrent measure, as per the details given in IS:5613(Part-2/Sec-I)1985. The towers to be supplied by the bidder shall have provision to fix the barbed wire as indicated above. The drawing of **Anti-climbing device is attached in tender.**

Thus the angle pieces with notches for accommodating barbed wire shall be supplied with the towers along with with provision for suitable bolt holes on leg members for fitting the angles. The scheme of the anti-climbing device shall be provided along with the tower drawing. It should have the facility of the locking arrangement. The Barbed wire shall confirm to IS:278/1978 with latest amendment and shall be type 'A-3'.

The Barbed wire shall be made of Hot dip Galvanised 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 galvanised by Hot dip process as per IS:2629/1966 (with latest amendment). The galvanised wire shall confirm to the requirement as per IS:4826/1971 with latest amendment in all respect. IS:2633/1972 and IS 6730/1972 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.

10 GALVANISED EARTHING ON TOWER/ GANTRY:-

10.1 The provision shall be made in the stub for fixing GalvanisedEarthing materials. The stub will be provided with a hole at a distance of 250 m.m. from bottom and at a distance of 500 mm below ground level for connection with GalvanisedEarthing materials. The hole will be of 17.5 m.m. diameter.

10.2 The contractor shall also supply and fix properly the following materials for GalvanisedEarthing towers (Two sets per tower) as per drawing provided by CSPTCL:-

(i) Hot dip galvanized earthing M.S. rod (2 metre long and 25 m.m. diameter).

(ii) Hot dip galvanised connecting clamps.

(iii) Hot dip galvanised stranded steel wire of size 7/ 3.66 m.m. to be used as connecting wire and counterpoise wire (wherever necessary) confirming to IS:2141-1968 and 2121 - 1979, with latest revisions thereof.

The details of GalvanisedEarthing rod and clamps and earthing arrangements for **towers are enclosed in the tender.**

10.3 The GalvanisedEarthing rod shall be of mild steel solid rod of 2 metres in length and 25 m.m. diameter with one end pointed. The rods shall be galvanised as per relevant I.S.S. The Zinc coating on the rod shall not be less than 610 gm./ sq. metre of surface area.

10.4 The tower end connecting clamp shall be of flat type and rod end shall be of "U" type. The clamps shall be of forged steel, cast iron / malleable iron. The clamps should be hot dip galvanised as per relevant I.S. 2621 - 1969, with latest revision thereof. The Zinc coating on the clamps shall not be less than 610 gm./ sq. metre of surface area.

10.5 The hot dip galvanised stranded steel wire of size 7 /3.66 m.m. shall be used as counterpoise wire. The steel wire shall conform to I.S. 2141 -1968 and IS:2141-1979 & latest revisions thereof, and shall consist of 7 strands, each strand having a diameter of 3.66 m.m. The galvanising shall be done as per Indian Standards Specifications 4826 - 1968 and 4826-1971 & latest revision thereof, for 'heavy' Zinc coating. The coating of Zinc shall not be less than 260 gm. / sq. metre.

11. 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 minimum ultimate tensile strength of 70 KN for single suspension string. The supply of hanger, D-Shackles, strain plate etc are also in the scope of Contractor. The drawing of tower accessories will be provided by CSPTCL.

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.

12. 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 500mm 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 12mm dia bolt and the other for 16mm dia bolt. The complete assembly shall also include one 16mm dia, 40mm long HRH MS Bolt hot dip galvanised with nut and lock washer.

13. OPGW CLAMPS ATTACHMENT :-

a) **Suspension Clamp :**OPGW suspension clamps will be supplied by the Contractor. The drawing shall be supplied by the Contractor for approval of CSPTCL. The Contractor shall also supply U bolts / D-shackles, wherever required.

b) **Tension Clamp:**OPGW 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 approval of CSPTCL for details of the attachments before the mass fabrication.

14 FABRICATION WORKMANSHIP:-

a. Except where here-in-after modified, details of fabrication shall conform to I.S. 802 (Part - II) – or relevant International Standards.

b. The fabrication of towers shall be done strictly in accordance with the drawing supplied by the CSPTCL.
c. The tower shall be of bolted construction.
d. 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.
e. 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.
f. The tower structures shall be accurately fabricated to bolt together easily at site without any undue strain on the bolts.
g. No angle member shall have two leg flanges brought together by closing the angle.
h. The diameter of the hole shall be equal to the diameter of the bolt plus 1.5 mm.
i. 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.

j. 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.
k. 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.

15 DRILLING AND PUNCHING:-

15.1 **B**efore 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.

15.2 The holes in the member shall either be drilled or punched with a jig, the former process will be preferred:-

(i) Punching may be adopted for sections up to 12 mm thickness. For thicker sections drilling shall be done.
(ii) 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 .
(iii) 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.
(iv) Holes must be square with the plates or angles and have their walls parallel.
(v) 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.
(vi) The minimum spacings of bolt and edge distance shall be as under :-

(a) 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).

(b) The gap between the edges of the connected members in butt joint shall not be more than 6mm and less than 4mm.

(vii) 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)."

16. TOLERANCES:-

(i) 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.

ii) The tolerance cumulative or between consecutive holes shall be within +/- 0.5 mm.

iii) The tolerance on the overall length of member shall be within +/- 1.6 mm.

iv) The tolerance on gauge distance shall be within +/- 0.5 mm.

17. MARKING:-

(i) 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 DN-2, DN-30 & DN-60 which indicate the transmission line and the type of tower shall precede erection mark.

(ii) Similarly all the designs, drawings and correspondence etc. shall invariably bear (i) **"Banari – Baloda & Banari-Sheorinarayan - Masturi"** stands for 132 KV line for easy identification and segregation of drawing/papers concerning this line.

18. 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 :-

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	Black cotton (Dry/ Wet)	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 up to 50% of the depth but the lower layer is a black cotton soil. For designing purpose the soil is to be considered as Submerged. To be used at locations where soil is clayey type, not necessarily black in colour, which shrinks when dry and swells when wet, resulting in differential movement extending to a maximum depth of about 3.5meter below ground level.
5	Fully submerged	When water table is within 0.75m below ground and soil is normal and cohesive.
6	Soft rock (Dry Fissured Rock)	To be used at locations where decomposed or fissured rock, hard gravel, kankar, limestone, laterite or any other soil of similar nature is met. Under cut type foundation is to be used at these locations.
7	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)
8	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.
9	Sandy soil	Sandy soil with clay content up to 5%

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 CSPTCL:-

(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 CSPTCL.

19 PROPERTIES OF CONCRETE:-

19.1 Wherever specified the cement concrete use for the foundations shall be as per approved drawing of foundations. However in general the concreting shall be as under :-

(a) Grade of concrete mix M-35 for pile foundation and cap work.

(b) The cement concrete used for tower and belt 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 40 mm 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: 306.

19.2 The cement concrete used for lean pad of Grade M-10 having 1:3:6 nominal mix ratio with 40 mm metal aggregate in bottom portion.

19.3 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.

19.4 Concrete aggregates shall confirm to IS:383.

19.5 The water used for mixing concrete shall be fresh, clean and free from oil, acids &alkalize, organic materials or other deleterious substances. Potable water is generally preferred.

20. REINFORCEMENT:-

20.1 Reinforcement shall confirm to Gr.I of IS:432 from MS bars and hard drawn steel wires and to IS:1139 and IS:1786 (Grade Fe 415) 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. For fixing the steel reinforcement bars in position arid binding with 0.9 mm annealed binding wire confirming to IS:280, 1978 should be used.

20.2 Grade of Steel Fe-500 as per IS 1786 or Thermo mechanically treated (TMT) bars of minimum yield strength 500 N/sq,mm slum 150 mm to 500 mm as per MORTH & IRC specification.

21 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.

22 STANDARDS: -

The manufacturing, fabrication, Galvanising, erection procedure and materials used for manufacture, 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.

23 GUARANTEED PARTICULARS:-

The guaranteed technical and other particulars shall be furnished**.** The bids which are incomplete in this respect or do not give clear information shall be ignored out rightly.

24 DEPARTURE FROM SPECIFICATIONS TECHNICAL CONDITIONS: In case of deviation from any of the requirements of the specifications, the same may be brought out clearly,otherwise it will be presumed that all the technical conditions of our specifications are acceptable to the bidder.

4.25 TECHNICAL CONDITION FOR ERECTION (SCOPE):-

The contractor is required to carry out complete construction with supply of all the materials. It involves all construction activities viz. Survey, soil investigation, excavation, stub-setting, erection of structures, stringing and final testing and charging of the transmission line.

26 GTP of LINE MATERIALS:-

26.1 TOWER & EXTENSIONS: As detailed in clause 02 of this specification.

26.2 CONDUCTOR: The conductor used in the line will be ISI marked (IS:398(P-II) 1996 with latest amendment) which will be supplied by the Contractor. The conductor size of ACSR Panther is furnished as below:-

S. No.	**CONDUCTOR DETAILS**	**PANTHER**
i.	Conductor	ACSR
ii.	Code name	Panther
iii.	Size	130 mm^2 Cu. Eq.
iv.	Nominal Aluminium area	207 mm^2.
v.	Sectional area of aluminium	212.10 mm^2
vi.	Weight per kilometre of 41Conductor	974 Kg.
vii.	Area of cross section of Conductor	261.5 mm2
viii.	Coefficient of linear expansion of Conductor	17.80 x 10^{-6} Kg/mm2
ix.	Modulus of elasticity is to be designed.	8155 kg/mm2
x.	Temp. Variation	
xi.	Calculated DC resistance at 20 deg. Centigrade	0.139 Ohm per km
viii	Material	Aluminium conductor steel reinforced
ix	Conductor Size	30(18+12) /3.00 mm Aluminium + 7 /3 mm Steel
x	Stranding	Yes
xi	Overall diameter	21.00 mm
xii	Ultimate Strength	89.67 KN
xiii	Current carrying capacity	430 Amp. at 45 deg. Cent. Ambient and 30 deg. rise
xiv	DC Resistance of Aluminium wire (Maximum at 20 Deg. Cent.)	4.07 Ohm per Km.
xv	Standard length	1500 Mtr. $\pm$5%
xvi	Net weight of conductor (Approximate)	1461 Kg.
xvii	Breaking load: Aluminium Wire(Min.) Steel Wire(Min.)	 1.11 KN 8.83 KN
xvii i	Galvanisation test of steel wire: Uniformity : Weight :	 237.5 gm per m^2

26.3 TECHNICAL SPECIFICATIONS FOR OPGW AND ASSOCIATED HARDWARES :-

(1) INTRODUCTION and GENERAL INFORMATION:.

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 associated Line on turnkey basis .:

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 **CSPTCL**, 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 24 fibre (DWSM) OPGW fibre optic cable. The cable length requirement is indicated in the appendices.

All optical fibre cabling including fibre itselfand 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 ± 2μm
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
Chromatic Dispersion; Maximum:	20 ps/(nm x km) 1550 nm 3.5 ps/(nm x km) 1288-1339nm 5.3 ps/(nm x km) 1271-1360nm
Zero Dispersion Wavelength: Zero Dispersion Slope:	1300 to 1324nm

Table 2-1(a)

DWSM Optical Fibre Characteristics

	-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. VENDER LIST FOR OPGW CABLE AND OPGW ASSOCIATED ARDWARE & 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 PGCIL , other power utilities 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

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
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.

Table B-2.1 **Type tests for OPGW Cable**				
S.NO.	**Test Name**	**Test Description**	**Test Procedure**	
		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 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

Table B-2.1 **Type tests for OPGW Cable**				
S.NO.	**Test Name**	**Test Description**	**Test Procedure**	
				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.

Table B-2.1 **Type tests for OPGW Cable**				
S.NO.	**Test Name**	**Test Description**	**Test Procedure**	
9	Impact Test	IEEE 1138 Section 4.1.1.7	IEEE 1138, Section 5.1.1.7 (IEC 794-1-E4/ EIA/TIA 455-25B)	The impact test shall be carried out 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	

Table B-2.1 **Type tests for OPGW Cable**			
S.NO.	**Test Name**	**Test Description**	**Test Procedure**
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	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. or 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 increasedat 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 16º. 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

Table B-5.1 **Factory Acceptance Tests for Fibres of all FO cables: Optical Tests**			
S.No.	**Test Name**	**Acceptance Criteria**	**Test procedure**
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 nr @ 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:	μm	

	@ 1550 nm:		
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^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 withtechnical 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:**
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:		
	Installation Clearances Front Access: Rear Access: Top * Bottom * Sides:	m	
22.	Excess length of fibre service loops		

26.4 GUARANTEED TECHNICAL PARTICULARS FOR GALVANISED SPRING WASHER FOR TRANSMISSION LINE

S.No	Particulars	
1.	ISS number to which spring washer will conform.	IS:3063
2.	ISS to which electro galvanised 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.	0 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 compressionof 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.	Thickness 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) Thickness 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 ± 0.2 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 thickness of 25 microns and average thickness of 38 microns.

26.5 GUARANTEED IS SPECIFICATION TO BE ADOPTED FOR G.I. NUT BOLTS :-

.No	Particulars	Relevant IS No.
1	IS Specification of BIS for all GI Nut Bolts	IS:12427-2001
2	Minimum sharing strength of bolts (kg per mm sq.)	IS:12427-2001
3	Minimum ultimate tensile strength of Bolts	IS:1367
4	Value of Hardness test: a. Rock well hardness test b. Brinell hardness test	IS:1367
5	Indian standard for bolts & nuts dimensions	IS:12427-2001, IS;6639-1972 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 galvanising	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

26.6 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 / as per relevant ISS

26.7 GUARANTEED TECHNICAL PARTICULARS OF ISI Mark 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 galvanising 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

26.8 DISC INSULATORS:-

S.N.	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) d) Wet KV (RMS)	 78 45	 78 45	 80 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	09	09	18

	(RMS)			
18	Max. RIV at 10 KV (RMS) Micro volts	50	50	50
19	Security clip/ locking device e) Type and dimension f) Material g) Standard to which security clip confirmed h) 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

26.9 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	7000/	7000/	16500/	9000/

	(kgf)	14000	14000	33000	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.

REQUIRED GUARANTEED STRENGTH OF HARDWARE:-.

i. The Hardwares fittings and accessories of 132 KV/220 KV single suspension and double suspension strings suitable for Panther ACSR and Zebra ACSR for transmission line and also all types of suspension and tension strings suitable for sub-station shall have the ultimate breaking strength of not less than 7,000 kgs.

ii. 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.

iii. The Hardware fittings and accessories of single and double tension strings suitable for Panther ACSR shall have ultimate breaking strength of not less than 9,100 Kgs.

iv. The Hardware fittings and accessories of single & double tension strings suitable for Panther ACSR for 132 kV transmission line shall have ultimate breaking strength of not less than 9100 kgs.

v. 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.

26.10 SINGLE SUSPENSION HARDWARE FOR PANTHER, ZEBRA ACSR CONDUCTOR WITH PREFORMED ARMOUR RODS

S.No.	ITEM	PANTHER
1.	Type of clamp	AGS type
2.	Ball & socket dimension	16mm
3.	Suitable for conductor size	ACSR Panther with amour rods
4.	Breaking strength	7000 kg.
5	Tension clamp & keeper	Alu.alloy GDC
6.	Anchor. Shackle. Ball Link & socket Eye	Forged steel HDG
7.	Bolts, nuts & washers	Galvanised MS
8.	Security clip	R type made of SS/PB
9,	Spring Washer	Electro galvanised spring steel
10.	Galvanising standard	IS:2633
11.	Standard reference	2486 part-I,II & III
12.	Arcing Horn	MS Flat 25x6
13.	Preformed Armour rods	As per standard in No. & size.

The 132 KV double suspension hardware set suitable for Panther 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.

26.11. SINGLE TENSION HARDWARE COMPRESSION TYPE SUITABLE FOR PANTHER,:-

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	PANTHER
1.	Type of clamp	Compression type
2.	Suitable for conductor size	ACSR Panther
3.	Breaking strength	9100 kg.
4.	Tension clamp jumper	Ex-Alu.alloy
5.	Steel sleeve, anchor shackle, ball link socket eve	Forged steel HDG
6.	Bolts, nuts and washers	Galvanised MS
7.	Security clip	'R' type made of SS/PB
8.	Spring washer	Electro galvanised spring wheel
9.	Galvanised Standard	IS:2633
10.	Standard reference	2486, part – I,II & III
11.	Arcing Horn	MS FLAT 25 X 6
12.	Standard Length of hardware set without pin and D shackle arrangement	457 m.m.
13.	Diameter of aluminiumtube before compression: a) Inner dimension b) Outer dimension	 23 mm 38 mm
14.	Diameter of aluminiumtube after compression:- a) Across Flat b) Across Corner	 32 mm 37 mm
15.	Diameter of steel tube before compression:- a) Inner dimension b) Outer dimension	 9.35 mm 18 mm
16.	Diameter of steel tube after compression. a) Across Flat b) Across Corner	 15.1 mm 17.4 mm
17.	Length of sleeve (Steel/Al.) a) Before compression b) After compression	 203/610 233/660
18.	Conductivity	Equal to ACSR Panther
19.	Weight of hardware	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.

26.12 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.

26.13. 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
1	Type of hardware	Compression
2	Breaking strength	100% of UTS of conductor
3	Conductivity	Equal to ACSR Panther
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
	Steel Joint :- a) Overall Dia before compression (i) Inner dimension (ii) Outer dimension b) Dimension after compression:- (i) Across Flat (ii) Across corner	 9.35 18 15.1 17.4
5	The material from which following is made of	
	Al. Sleeve	Extruded 99.5% pure Aluminium
	Steel Sleeve	HDG Steel

6	Standard weight	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
8	Reference	IS 2121

(D) STANDARD PARTICULARS OF REPAIR SLEEVES OF PANTHER ZEBRA AND EARTHWIRE

S. No	**Description**	**Panther ACSR**
1	Breaking strength of cable with sleeve compressed	100% of UTS
2	Conductivity of cable with sleeve compressed	Equal to conductor
3	Dimensions before and after compression (flat to flat).	38 / 32 mm
4	Length of sleeve before & after compression	241/270
5	The material from which sleeve is made	Extruded Aluminium
6	Weight of repair sleeve	0.42 kg

(E) VIBRATION DAMPER FOR PANTHER:-

Vibration dampers (4-R type) shall be used for Conductors &Groundwires.

S.No	**Item**	**Panther**
1	Type	4 – R type
2	Suitable for conductor size	21 mm
3	Material used for clamp	Alu. Alloy GDC as per IS 617
4	Messenger table	High tensile steel stranded galvanised wire
5	Damper weights	3.2 Kg
6	Slipping strength	500 Kg

7	Natural frequency of damper	7.14, 11.36, 25.64, 38.5 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
9	Minimum fatigue strength of damper in cycle	10 million cycle
10	Amplitude of fatigue test at the highest resonant frequency	+ 1 m.m.
11	Slip strength of clamp	300 kg
12	Clamping torque	5 kg-mtr
13	Maximum dynamic strain on the conductor with the damper at clamping points	Less than 150 micro strains
14	Standard to which material will be manufactured and tested	IS 98 / 1980
15	Magnetic power loss in watts	Below 1 watt per damper

26.14 **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.

26.15 VENDOR LIST:

All the materials required for construction of the line shall be supplied strictly as per the "list of vendors" on CSPTCL's official web-site.The vendor list as on date of issue of NIT shall be applicable for instant tender. No deviation in the vendor list shall be permitted during execution of the project at any stage. The materials which are not covered in this vendor list shall be of reputed make with prior approval of CSPTCL.

Note:- *Vendor selection for OPGW & its associated accessories shall be applicable as per tender clause No.26.3 (10).*

27 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 (as confirmed by the O.I.C. of the work) and on same prices as offered and on similar terms and conditions.**

However for offering tender prices the following quantum of work has been considered for **Construction 132 KV DCDS line from 220/132 KV S/S Banari to proposed 132/33 KV S/s Baloda Distt-Janjgir Champa (RL- Approx. 21 KM & No. of Tower Locs.-80 No and 12 sets Gantry)**:-

Type of Tower	Total No. of towers / Gantry	3M Extn. only	6 M Extn. only	9 M Extn. only	18 M Extn. only
DN-2	52	14	22	07	00
DN-30	3	01	02	00	00
DN-60	25	08	08	00	02
Gantry (3 Columns +2 Beams)	12 Set	00	00	00	00
Total:-	**80 + 12 Set Gantry (Col-36 & Beam-24)**	**23**	**32**	**07**	**02**

2. Type of Locations in Different soil:-

Particulars	%	DN-2	DN-30	DN-60	Gantry (Col)	Total No. of tower/Gantries
Normal & Dry Soil	10%	5	0	3	**0**	**8**
Wet Soil	15%	8	1	4	**0**	**13**
Partially submerged	05%	3	0	1	**0**	**4**
Fully submerged soil	05%	2	0	1	**0**	**3**
Black Cotton Soil	40%	20	1	10	**0**	**31**
Dry fissured Rock	05%	3	0	1	**0**	**4**
Submerged fissured rock	20%	11	1	5	**0 + 36 Col**	**17 + 36 Col**
Hard Rock	0%	0	0	0	**-**	**0**
Sandy soil	0%	0	0	0	**-**	**0**
Total:-		**52 No**	**3 No**	**25 No**	**36 Col**	**80 Nos + 36 Col (12 Sets Gantry)**

However for offering tender prices the following quantum of work has been considered for c**onstruction of proposed LILO of 132 KV Banari-Sheorinarayan**

line from location No.12 to proposed 132/33 KV S/s Masturi (Malhar) Distt-Bilaspur (RL- Approx. 33 KM & No. of Tower Locs.-107 No and 14 sets Gantry)

1. Type of Locations of towers:-

Type of Tower	Total No. of towers / Gantry	3M Extn. only	6 M Extn. only	9 M Extn. only	18 M Extn. only
DN-2	57	24	17	06	00
DN-30	13	04	06	00	00
DN-60	37	09	07	06	06
Gantry (3 Columns +2 Beams)	14 Set	00	00	00	00
Total:-	**107 + 14 Set Gantry (Col-42 & Beam-28)**	**37**	**30**	**12**	**06**

2. Type of Locations in Different soil:-

Particulars	%	DN-2	DN-30	DN-60	Gantry (Col)	Total No. of tower/Gantries
Normal & Dry Soil	10%	5	1	5	**0**	**11**
Wet Soil	15%	9	2	5	**0**	**16**
Partially submerged	05%	3	1	2	**0**	**6**
Fully submerged soil	05%	2	1	2	**0**	**5**
Black Cotton Soil	45%	27	5	16	**0**	**48**
Dry fissured Rock	05%	3	0	2	**0**	**5**
Submerged fissured rock	15%	8	3	5	**0 + 42 Col**	**16 + 42 Col**
Hard Rock	0%	0	0	0	**-**	**0**
Sandy soil	0%	0	0	0	**-**	**0**
Total:-		**57 No**	**13 No**	**37 No**	**42 Col**	**107 Nos + 42 Col (14 Sets Gantry)**

28. SURVEY & ROUTE OF THE TRANSMISSION LINE:-

(i) Three alternate tentative route alignment of this 132 KV transmission line wherever required, 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 C.S.P.T.C.L. The route is subjected to modification / alterations depending on exigencies during the currency of the contract.

(ii) **ROUTE MARKING**:- 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 upto 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.

(iii) While carrying out survey work, the Soil Resistivity values will have to be measured at convenient points along the route, not exceeding 2.50 Km between adjacent points. The Soil Resistivity will be measured using 4 electrode method with an inter electrode spacing of 50 M. The following formula shall be used:

$$P = 2\pi aR$$

Where a = Interelectrod spacing = 50M

R = Earth resistance measured in Ohms

P = Soil Resistivity in Ohm- m

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.

The contractor shall be responsible for correct setting of stubs. Discrepancies, if any, shall be brought to the notice of CSPTCL 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.

29 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 on the basis of sag template curve and tower spotting data provided by C.S.P.T.C.L. The profile will be prepared on cm. Graph paper on scale 1: 2000 horizontal and 1 : 200 vertical on 1.0, 10 mm 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 10 mm 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.

The number of consecutive spans between the section points shall not exceed 15 spans or 5 Km. in plain terrain and 10 spans or 3 km in hilly terrain.

The minimum ground clearance of **6.1metres for 132KV line** shall be available corresponding to the maximum working temperature and normal span of **355metres for 132kV line** 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.

All topographical details, permanent features, such as trees, building etc. **13.5 m for 132 KV line** on either side of the alignment shall be detailed on the profile plan.

30 CHECK SURVEY:-

(a) After approval of profile from CE/ED (Planning & Projects), 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 extn. 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 extn. of time.

(e) The following tolerances shall be applicable in case of position of foundations erected with reference to the tower positions spotted on Survey Charts :-

Type of tower	**Out of Alignment**	**From centre line of route**	**From Transverse centre line**
Suspension or Intermediate	0.5 degree	25mm	$\pm$250 mm
Section or Tension (Set at bi-section of deviation angel)	0.5 degree	25mm	$\pm$25 mm

31. **SOIL INVESTIGATION /GEOTECHNICAL INVESTIGATIONS:-**

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 saltpetre 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.

31.1 Scope

31.1.1 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.

31.1.2 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.**

31.1.3 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).

3.1.4 The field 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.

31.1.5 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.

31.1.6 Contractor shall carry out all work expressed and implied in these specifications in accordance with requirements of the specification.

31.1.7 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.

31.1.8 It is essential that equipment and instruments be properly calibrated at the commencement of the work. If the CSPTCLsodesires,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.

31.2 Field Investigation for Soils

Tentative numbers of detailed soil investigation to be done is given in PBS

31.2A Boring

Boreholes are required for detailed soil investigations.

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 4mtr 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.

31.2B 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.

31.2C 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 stabilise and protect the inside surface of the borehole. Use of percussion tools shall be permitted in hard clays and in dense sandy deposits.

31.2D Standard Penetration Test (SPT)

a. 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.

31.2E The test shall be conducted at depths as follows:

Location	**Depths (m)**
Normal Soils	1.0, 2.0, 3.0, 4.0
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.

a. 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.

b. 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.

c. 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.

31.2F Sampling

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.

31.2G 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.

31.2H 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	1.0,2.0, 4.0
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.

31.2I 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.

31.2J Ground Water

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.

31.2K 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.

31.2L 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.

31.3 Laboratory Testing

31.3A 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.

31.3B 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.

31.3C Salient Test Requirement

a) Tri-axial 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 tri-axial 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.
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
2. 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 UndrainedTriaxial 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

31.3D 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.

31.3D Hydro geological Conditions

2.2.A.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+ & 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.

31.3 E Rates and Measurements

31.3 F Rates

The contractor's quoted rates shall be inclusive of mobilization of necessary equipment, providing necessary engineering supervision and technical personnel, skilled and unskilled labour etc. as required to carry out field investigation and tests, laboratory tests, analysis and interpretation of data and results, preparation of detailed soil report including specific recommendations for the type of foundations making etc.

31.4 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 TransmissionLineTowers and Poles.	
IS:4434-1992	Code of Practice for In-situ Vane Shear Test for Soils	ASTM D 2573 ASTM D 4648

Indian Standards (IS)	Title	International Standard/Code
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-II)1992	Method for Subsurface sounding for soils, dynamic 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

32 EXCAVATION:-

32.1 Except as specifically otherwise provided, all excavation for footing shall be made to the lines and grades of the foundation. 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 drawings. All excavation 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.

32.2 The soil to be excavated for tower foundations shall be classified as under for the purpose of payment for excavation for tower site levelling and building stone revetment:

(a) Dry soil : Soil removable by means of ordinary pick axes and shovels (Normal soil, intermediate soil, sandy soil and black cotton 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.

(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. (DFR & SFR will fall under this category.)

(d) Hard Rocks: Hard rock will be that which requires chiselling or drilling and blasting.

32.3 No extra charges shall be admissible for the removal the fallen earth in the pits when once excavated.

32.4 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.

32.5 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 concrete volume exceeds the designed volume due to excessive blasting.

32.6 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.

33 BENCHING :-

When the line passed through hilly/undulated terrain, leveling 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 minimize 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.

34 SETTING OF STUBS:-

a. 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 CSPTCL's representative available at site whenever required and for which adequate advance intimation shall be given to the site Engineer by the contractor.

b. The foundations are to be made as per designs and drawings approved by the CSPTCL. The extent of work as defined by such drawings shall not be exceeded except in very special cases where the prior approval of the CSPTCL has been obtained.

c. 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 up to full depth (excluding hard rock locations). The soil should be classified strictly as per details encountered in the foundation pit. 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. (P&P) 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.

d. 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.

e. Setting of stub at each location shall be approved by the CSPTCL'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.

35 PLACEMENT OF REINFORCEMENT:

(i) Some of the 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) 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.

36 CONCRETE:

i. The cement concrete used for the foundation shall be of M 20 1:1.5:3 with 20 mm nominal size stone metal for chimney portion and 40 mm nominal stone metal for pyramid or slab portions. For RCC, the aggregates shall preferably be of 20 mm nominal size.

ii. The cement concrete used for lean pad shall be of M-10 1:3:6 ratio with 40mm nominal stone metal for bottom portion.

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.

v. The aggregate shall be of clean broken hard granite or other stone specified or approved by the CSPTCL. 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 clear.

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.

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 mm 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.

xv. The cost of carrying out concreting of foundations shall be deemed to be included in the unit rates of foundations of tower in different type of soils quoted by the tenderer.

37 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 200 mm 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 embankment (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.

38 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. However, no extra payment shall be made on this account.

39 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.

40 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 (P&P), 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.

41 TOWER EARTHING:-

(i) For the purpose of earthing, 2 No. GalvanisedEarthing rods (25 mm diameter and 2 metres long) connecting clamps and connecting wire will be provided by the contractor. The GalvanisedEarthing rods are to be hammered preferably in the foundation pits and connected to stub by 7/3.66mm Earthwireand with necessary connecting clamps before concreting the foundation. If it is not possible to tie the rods in the foundation pit i.e. rocky location, they shall be buried near the foundations pit and connected to the stubs. The GalvanisedEarthing rods are to be provided on two legs diagonally of the tower. Each tower shall be earthed before the foundation is casted.

(ii) The tower footing resistance of all towers shall be measured in dry weather after the erection and before stringing of OPGW 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

Ω (ohms). Each tower footing resistance shall be intimated (along with tower location number) while submitting the progress report of the foundation.

42 COUNTER POISE EARTHING:-

i) In case of high resistivity, counter poise earthing shall be provided which consists of four lengths of galvanised 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 15 metres in length, buried to the depth of 300 mm 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.

i. The contractor shall have to provide GalvanisedEarthing rods at the end of each counter poise wire and this may lead to getting required soil resistivity values. This work of additional GalvanisedEarthing rods shall be done extra which shall include the cost of providing such GalvanisedEarthing rods and clamp etc. cost of materials i.e. connecting arrangements GalvanisedEarthing rods (04 Nos.) and connecting arrangements.

ii. The earthing of towers to be done as per I.S.S. 5613 Part II & latest revision of I.S.S.

43. TOWER ERECTION / ASSEMBLY :-

i. The contractor shall be responsible for transportation to site of all the materials to be provided 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

ii. 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:-

i. 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.

ii. Before starting erection of an upper section, the lower section shall be completely braced and all bolts provided in accordance with approved drawings.

iii. All plan diagonals relevant to a section of tower shall be placed in position before assembly of upper section is taken up.

iv. The bolt positions in assembled towers shall be as per I.S:5613(Part-II/ section 2, 1976).

v. All blank holes, if any left, after complete erection of tower, are to be filled up by nuts and bolts of correct size.

vi. Tower shall be fitted with number, phase and danger plate which shall be arranged by the contractor.

vii. **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 below bottom cross arm level. Suitable locking arrangement (pad-lock) shall also be provided.

44. TREATMENT OF MINOR GALVANISATION DAMAGE:-

Minor defects in hot-dip galvanised members shall be repaired by applying atleast 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.

45. 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 of Bolts, projections as indicated above shall be provided from ground level to top cross arm level in all towers. However, for towers with +18 meter, +25 meter extn. and river crossing towers, the welding shall be provided from ground level to 35m height from stub 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.

46 INSULATOR HOISTING:-

Suspension insulator strings shall be used for suspension towers and tension insulator strings on Angle & Dead end towers. They shall be fixed on all the towers just prior to stringing. Damaged insulators and fittings, if any, shall not be used 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. Security clips shall be fitted in position for the insulator before hoisting. 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 OPGW, etc., whenever recommended by the manufacturer of the same.

47 HANDLING OF CONDUCTOR AND OPGW:-

47.1 The contractor shall be entirely responsible for any damage caused to the towers or conductors during stringing. While running out the conductors, proper care shall be taken ensuring that the conductors do not touch and rub against the ground or objects

which could cause scratches or damage to the strands. The conductors shall be run out of the drums from the top in order to avoid damage due to chafing. The drum stand shall be provided with a suitable braking device to avoid damage, loose running out and kinking of conductor. The conductor will be pulled by pull cable and consequently pass over the running out blocks. The groove of the running out blocks will be of such a design that the seat is semi-circular and larger than the diameter of the conductor and it does not slip over or rub against the sides. The grooves shall be lined with hard rubber or neoprene to avoid damage to conductor and shall be mounted on properly lubricated bearings.

47.2 The running blocks shall be suspended in a manner to suit the design of the cross arm. All running blocks especially those at the tensioning end, will be fitted on the cross arm 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. The conductor shall be continuously observed for loose or broken strands or any other kind of damage. When approaching towards end of a drum length, at least three coils shall be left when the stringing operations are to be stopped. These coils are to be removed carefully if another length is required to be run out, new length may be joined to the length already run out by the compression joint in approved manner.

47.3 The conductor joints and clamps shall be erected in such a manner that no bird caging, over tensioning of individual wires or layers or other deformities or damage to the conductor shall occur. Clamps or bracing devices shall under erection conditions allow no relative movement of strands or layers of the conductors. Repairs of conductors, in the event of damage being caused to isolated strands of a conductor during the course of erection, if necessary, shall be carried out during the running out operations, with repair sleeves. Repairing of conductor surface with repair sleeve shall be done only in case of minor damage, scuff marks etc., keeping in view both electrical and mechanical safety requirements. The final conductor surface shall be clean, smooth and shall be without any projections, sharp points, cuts, abrasions etc. Repair sleeves may be used when the damage is limited to the outermost layer of the conductor and is equivalent to the severance of not more than one third of the strands of the outermost layer. No repair sleeve shall be fitted within 30m of tension or suspension clamp or fittings not shall more than one repair sleeve per conductor be normally used in any single span.

47.4 Conductor splices shall be so made that they do not crack or get damaged in the stringing operation. The contractor shall use only such equipment/methods during conductor stringing which ensures complete compliance in this regard.

47.5 The sequence of running out shall be from top to downwards, i.e. the earth wire shall be run out first followed by the conductors in succession. Imbalances of loads on towers shall be avoided as far as possible.

47.6 The proposed transmission line may run parallel for certain distance with the existing 400/220/132KV lines which will remain energized during the stringing period. As a result there is a possibility of dangerous voltage build up due to electromagnetic and electrostatic coupling in the pulling cables, conductors and OPGW, which although comparatively small in magnitude during normal operations, can be severe during switching and ground fault conditions on the energised lines. It shall be the

contractor's responsibility to take adequate safety precautions to protect his employees and others from this potential danger.

47.7. 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.

48.8. When these **132 KV** transmission lines runs parallel to existing energised 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 OPGW during string operations.

48.9. After being pulled, the conductor / OPGW shall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

48 REPAIRS TO CONDUCTORS:

48.1 The conductor shall be continuously observed for loose or broken strands or any other damage during the running out operations.

4.48.2 Repairs to conductor if necessary, shall be carried out with repair sleeve.

4.48.3 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.

4.48.4 The Contractor shall be entirely responsible for any damage to the towers during stringing**.**

49 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, earth wire and accessories in the field.

50 STRINGING OF CONDUCTOR AND OPGW:-

50.1 The stringing of the conductor for **132 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.

50.2 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 OPGW 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 IS. All the tolerances for the line shall be confirm to IS 5613(Part-2/Sec-2) 1995.

50.3 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 and paid out simultaneously. These conductors shall be of matched length. Conductors or OPGWshall not be allowed to hang in the stringing blocks for more than 96 hours before being pulled to the specified sag.

50.4 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.

50.5 Suitable guying arrangement shall be made by the Contractor to ensure safety during stringing & final sagging operation.

51. JOINTING:

51.1. 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.

51.2. 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.

51.3 .All the joints on the conductor 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.

51.4. 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, Railway, small rivers and 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.

51.5. 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.

52 TENSIONING & SAGGING OPERATIONS:

52.1 The tensioning and sagging shall be done in accordance with the approved stringing charts before the conductors and OPGW are finally attached to the towers through the OPGW clamps for the OPGW and insulator strings for the conductor. Dynamometers shall be employed for measuring tension in the conductor and earth wire.

52.2 The conductors shall be pulled up to the desired sag and left in running block for at least one hour after which the sag shall be rechecked and adjusted, if necessary, before transferring the conductors from the running blocks to the suspension clamps. The conductors shall be clamped within 36 hours of sagging.

52.3 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.

52.4 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.

52.5 At sharp vertical angles, conductor and OPGW 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.

52.6 Tensioning and sagging operations shall be carried out in calm whether when rapid changes in temperature are not likely to occur.

53 CLIPPING:-

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.

54 FIXING OF CONDUCTORS AND OPGW ACCESSORIES :-

Vibration dampers (4R-type) and other conductor and OPGW accessories supplied by the contractor shall be installed by the contractor as per the design requirement and as per instruction of the Engineer. While installing the conductor and OPGW 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.

55 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.

56 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.

57 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 CSPTCL. 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, tack-welded and painted with zinc rich paint.

v. The stringing of conductors and OPGW has been done as per the approved sag and tension charts and desired clearances are clearly available.
vi. All conductor and OPGW 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 CSPTCL 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 extns 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.

58 COMPLETION DESIGN:-

The contractor has 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. The coordinates of all the locations of the line as finally erected shall also submit by the contractor along with final tower schedule. All kuchcha and metalled roads, trees, structures, ponds and other obstructions etc. within 50 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 35 meters on either side of the line."

SECTION – III

PRICE VARIATION FORMULAE FOR EHV SUBSTATION EQUIPMENTS AND LINE MATERIALS

ANNEXURE –PV-1

PRICE VARIATION FORMULA FOR POWER TRANSFORMERS

CIN No. U99999MH1970GAP014629

ieema
your link to electricity

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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.

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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.

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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)

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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

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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)

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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

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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 ISOLATORS AND SWITCHGEARS ABOVE36KV

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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.

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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)

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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 - 4

PRICE VARIATION FORMULA FOR LIGHTING ARRESTORS

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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-5

PRICE VARIATION FORMULA FOR FABRICATED AND GALVANIZED TRANSMISSION LINE TOWER/ GI STRUCTURES FOR SUB-STATION

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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.

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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-6

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