interlocking coils shall be wired up to terminal blocks in mechanism box through G.I. Conduits.

v) The earthing blades shall be required to carry peak current and rated short time current as the main blades of the isolator and shall withstand dynamic stresses.

vi) Each earth switch shall be provided with flexible copper braids for connection to the ground mat. These braids shall have same short time current carrying capacity as the earth blades.

- **Assembly**

i) The disconnecting switch along with its base frame and operating mechanism shall be completely assembled and checked for correct alignment and operation at manufacturer's works prior to despatch.

ii) All parts and accessories shall have appropriate benchmarks and part numbers for identifications at site.

- **Grounding**

i) Each equipment shall be provided with two ground pads for connection to station ground.

ii) The ground pad shall comprise buffed metal surface with two tapped holes, M10 G.I. bolts and spring washers for connection to G.S. flat of approved size.

iii) Each disconnecting/earth switch-operating rod shall be separately grounded at a point above the mechanism box. This is done by flexible copper braid of adequate section but in no case less than 70 mm^2.

- **Painting**

i) Base frame, operating rod and all hardwares shall be hot-dip galvanised.

ii) Mechanism box will be finished with two coats of aluminium paints after surface treatment, involving chemical cleaning, phosphating and application of under coats.

iii) Sufficient quantity of touch-up paints shall be furnished for application at site.

C. 33KV Current transformer

Type, rating, connections etc. Of the equipment shall be as detailed in the

annexure. The equipment shall be offered in strict compliance with the same.

The quantity of each type of Current transformers are as follows:-

i) Six (06) nos of 33KV CT at switchyard

- The equipment will be used in 33KV switchyard, having characteristics as listed in the Annexure-A. The equipment shall be furnished with fittings & accessories as listed in the Annexure-B.
- The equipment will be installed outdoor in a hot, humid and tropical atmosphere with heavy chemical pollution.
- All equipment, accessories and wiring shall have tropical protection, involving special treatment of metal and insulation against fungus, insects and corrosion.
- The maximum temperature in any part of the equipment at specified rating shall not exceed the permissible limits as stipulated in the relevant standards.
- The equipment shall be capable of withstanding the dynamic and thermal stresses of listed short circuit current without any damage or deterioration.
- There shall be no radio interference when the equipment is operated at maximum service voltage.
- The safety clearances of all live parts of the equipment shall be as per relevant standards.
- The Current Transformers shall be oil immersed self-cooled and hermetically sealed type.
- Current Transformers shall be furnished with number of independent cores with ratios and other ratings as specified above.

- **Constructional Features**

i) The current transformer shall be single pole unit, oil filled, self-cooled, designed for upright mounting on steel structure and furnished complete with fixing hardware.

ii) Insulator shall be of wet process porcelain, brown glazed and free from imperfections. All metal parts and hardwares shall be hot dip galvanised.

iii) The creepage distance shall correspond to heavily polluted atmosphere. Grading ring, if required, shall be furnished to maintain voltage gradient within permissible limit.

iv) The current transformer shall be filled up under vacuum with the insulating oil and be hermetically sealed. Current transformer shall be provided with oil level gauge, drain plug and pressure relief device. An inert gas cushion shall be provided on top of the oil.

v) Core lamination shall be of cold rolled grain-oriented silicon steel or mumetal as dictated by design consideration. The cores used for protection shall be of low reluctance type and shall produce undistorted secondary current at transient condition at all ratios. Instrument saturation factor for the metering core shall be low enough to prevent damage to the instruments connected to it under maximum short circuit current specified.

vi) Current transformer characteristic shall provide satisfactory performance for burdens ranging from 25% to 100% of rated burden over a range of 10% to 100% rated current in case of metering core and up to knee point voltage in case of protection core.

- **Terminals**

i) Primary terminals shall be made of non-ferrous corrosion resistant material and provided with bimetallic terminal connectors.

ii) Secondary terminals shall be brought out to a terminal box and suitable for connection to 1100 V grade, steel wire armoured, PVC sheathed 5 x 4 mm^2 stranded copper conductors. The terminal box shall be provided with a removable cable gland plate at the bottom for mounting five cable glands suitable for aforementioned cables.

iii) All primary and secondary terminals shall be clearly and indelibly identified as per relevant standard.

iv) The terminal box shall be of 3 mm thick sheet steel, IP-55, weather proof and dust-tight, complete with gasketted front access cover and removable gland plate at bottom for cable entry.

- **Grounding**

i) Each current transformers shall be provided with two ground pads on the opposite sides of the tank, for connection to station ground mat. The grounding conductor shall be MS flat of size 75 mm x 10 mm.

ii) The ground pad shall comprise buffed metal surface with two holes, M10 G.I. bolts and spring washers to receive G.I. flat of approved size.

D. 198KV and 30KV Lightning arrestors

Type, rating, connections etc. Of the equipment shall be as detailed in the annexures. The equipment shall be offered in strict compliance with the same.

The quantity of each type of Lightning arrestors are as follows:-

i) Three (03) nos of 198KV Lightning arrestors
ii) Six (06) nos of 30KV Lightning arrestors

The equipment will be used in 33KV switchyard having characteristics as listed in the Annexure-A. The equipment shall be furnished with fittings & accessories as listed in the Annexure-B.

- The equipment shall be capable of withstanding the dynamic and thermal stresses of listed short circuit current without any damage or deterioration.
- There shall be no radio interference when the equipment is operated at maximum service voltage.
- The safety clearances of all live parts of the equipment shall be as per relevant standards.
- Arresters shall be designed with sufficient cantilever strength to meet with stress due to wind pressure and short circuit forces arising from rated short time current.
- The lightning arrester shall be installed as close to the equipment as possible and also on the line entrance.
- Lightning arrester shall be station class, heavy duty, metal oxide gapless type with ratings as detailed in the Annexure-A.
- The arrester shall have adequate thermal discharge capacity for severe switching surges, long duration surges and multiple strokes.

- **Constructional Features**

i) The arrester shall be single pole, hermetically sealed, of robust construction with excellent electrical, thermal and mechanical characteristics even after repeated operation.

ii) Insulator shall be wet process porcelain, brown glazed and free from imperfections. All metal parts and hardware shall be hot dip galvanised.

iii) Creepage distance shall correspond to heavily polluted atmosphere. Grading ring, if required, shall be provided to maintain voltage gradient within permissible limit.

iv) The arrester shall be provided with pressure relief device to prevent shattering of porcelain in case excessive gas pressure builds up.

- **Accessories**

i) Lightning arrester shall be furnished complete with insulating base, arrester disconnector, surge counter leakage current monitor and anchoring hardware for mounting on steel structure.

ii) The surge counter shall be suitably enclosed for outdoor duty and be mounted at a convenient height for reading. Counter terminals shall be such as to permit connections with minimum possible bends. No auxiliary power supply or battery shall be required for operation of counter.

iii) A leakage current detector shall be furnished with the counter as an integral part. This is for monitoring the leakage to indicate any possible breakdown. Readings of milliammeter and counter shall be visible through inspection glass panel.

iv) A suitably sized by-pass shunt along with necessary terminals shall be furnished for bypassing the discharge counter if required.

v) Grading ring/corona ring as applicable for the particular voltage class of arrester shall be provided.

- Terminals

i) All connection terminals shall be of corrosion resistant material and complete connection hardware.

ii) All ground terminals shall have provision of connection to G.I. flat of approved size.

E. Grounding Transformer

This specification is intended to cover the design, engineering, manufacture, testing at manufacturer's works of 3 ph, Copper wound, oil immersed 33KV Earthing transformers for efficient and trouble free operation as specified herein. The neutral of the earthing transformer shall be solidly earthed to provide earthed neutral in the 33 KV systems. The Earthing Transformer shall have impedance to restrict earth fault current.

The earthing transformer covered by this specification shall be complete in all respect. Any material or accessories which may not specifically mentioned here but which is usual and necessary for satisfactory and trouble free operation and maintenance of the transformer shall be supplied without any extra charge.

- Type, rating, connections etc. of the equipment shall be as detailed in the annexures..

The scope of work under this Specification shall essentially comprise of but not limited to the following:

i) One (01) no, oil filled ONAN, gronding transformer.

- Transformer shall be furnished completed with:
- Fittings and accessories
- Cooling & Auxiliary equipment
- First filling of oil including 10% extra
- Protection & metering devices
- All relevant drawings, data and instruction manuals.
- Commissioning spares and recommended spare part list for three (3) years operation.

Brief description of the Transformer : As per design calculation.

General Design Criteria :

(a) The transformer will be installed at outdoor. All equipment accessories and wiring shall be provided with tropical finish to prevent fungus growth.

(b) If not specifically mentioned in BOQ, the transformer shall be capable of withstanding a fault current of 300 Amps at rated voltage and frequency through the neutral for a time duration of 30 seconds without using neutral grounding resistor and without exceeding the temperature of 250° C for copper. Ultimate temperature rise during fault should be restricted to 200°C. To achieve this required current density for 30 seconds is to be maintained.

(c) The earthing transformer shall be capable of withstanding the mechanical and thermal stresses caused by the rated short time current flowing in the windings under fault conditions. This shall be determined by tests as per relevant IS and the results furnished along with the bid.

(d) The maximum flux density in any part of the core and yokes, at normal voltage and frequency of each transformer shall be consistent with the material used. The maximum flux density shall be 1.7 Tesla.

(e) The thermal ability to withstand short circuit shall be proved by calculation and shall be furnished along with the drawings.

(f) The transformer shall be free from annoying hum or vibration. The design shall be such as not to cause undesirable interference with radio or communication circuit.

- Type & Rating :

a) The Earthing Transformer shall be of 33 KV, 3-phase, 50 c/s Copper wound, oil-immersed, ONAN type. The earthing transformer shall have impedance to allow rated earth fault current at rated system voltage in the event of occurrence of a solid single phase to ground fault. The fault KA rating of the earthing transformer shall be 25KA for duration of 30 seconds.
b) The rating and other guaranteed particulars of the earthing transformer shall be as per specific technical parameters of this specification, submitted G.T.P. and relevant IS.

- Terminal Bushing :

The terminals shall be brought out through outdoor type bushings on HV side conforming to IS: 2099 and provided with suitable Bi-metallic terminal connectors for phases and suitable size copper flat for neutral.

The bushing shall have high factors of safety against leakage to ground and shall be so located as to provide adequate electrical clearances between bushings and grounded parts. Bushings of identical voltage rating shall be interchangeable. All bushings shall be equipped with suitable terminals of approved type and size. The insulation class of the high voltage neutral bushing shall be properly coordinated with the insulation class of the neutral of the high voltage winding.

Each bushing shall be so coordinated with the transformer insulation that all flash-over will occur outside the tank.
All porcelain used in bushings shall be homogeneous and free from cavities or other flaws. The glazing shall be uniform in colour and free from blisters, burns and other defects.
All bushings shall be porcelain shed type. The neutral bushings shall be insulated for 33 KV. Bushings shall conform to IS: 3347, IS: 2099 and IEC:

137. Main terminals shall be solder less. The spacing between the bushings must be adequate to prevent flashover between phases under all conditions of operation.

All bushings shall be suitable for heavily polluted atmosphere.

- Core :

a) The material circuit of the earthing transformer shall be constructed from high quality, low loss and high permeability cold rolled grain oriented silicon steel laminations especially suitable for transformer core.

b) Inter-laminar insulation shall be coated over laminations during manufacturing process.

c) The legs and yokes of cores shall have similar section to minimise heating and noise. Necessary cooling ducts shall be provided for heat dissipation.

d) The whole core shall be electrically connected by copper strip of not less than 6.25 sq.mm cross section to the tank inside for being earthed to drain off any electrostatic potential that may build up.

e) Each core bolt and part of the core clamping frame work shall be insulated from the core lamination. The core shall be tested to withstand a voltage of 2500 volts AC for a duration of one minute.

- Winding :

a)Earthing Transformer with single inter-star connected windings shall consist of two distinct sections, each representing one half of each inter-star winding and shall be rated for one-third of the line voltage.

b)The winding shall be made of paper insulated continuous and smooth electrolytic copper conductor and shall be so designed that all the coil assemblies of identical voltage rating shall be interchangeable and field repairs to the winding can be made without special equipment. The insulation of the coils and assembly of windings shall be insoluble, non-catalytic, chemically inactive in the hot transformer oil & shall not be adversely affected under the operating conditions.

c)The insulation of the windings shall withstand the impulse and power frequency test voltages as specified in technical parameters.

d)Windings shall be designed to withstand the Electromechanical stresses exerted during the short circuit conditions as per IS:2026.

e)Liberal ducts shall be provided for oil circulation and prevention of any hot spot temperature in the winding that may affect the life of the transformers. All leads and connections shall be mechanically strong,

heavily insulated and rigidly clamped, so as to withstand stresses due to terminal short circuit.

- Tank :

  a)Tank shall be of welded construction and fabricated from good quality sheet steel of adequate thickness. The thickness of top, bottom and side plates shall be stated by the bidder. The tank shall be so shaped as to reduce welding to a minimum. All seams shall be double welded for absolute oil tightness.

  b)Bushing turret covers, access-holes covers, pockets of thermometer shall be so designed to prevent any ingress of water. The conservator shall be liberally dimensioned so that oil level remains above the bushing top at the lowest ambient temperature and no-load, and the oil shall not spill into the breather pipe, or the exterior as waste. The conservator shall be provided with a window type oil gauge. The tank shall withstand specified pressure and vacuum tests without any deformation in excess of the permissible deflections.

- Insulating Oil :

  The transformer oil shall be duly filled in with required quantity for first filling and to supply 10% extra . The oil shall conform to IS:335. The transformer should be filled in with oil having dielectric strength 60 KV (rms) minimum after filtration .The oil in the transformer being supplied shall be provided with test result conforming to IS:335.

- Cooling Equipment :

  Transformer shall be suitable for 100% continuous maximum current rating with ONAN Cooling within the specified maximum temperature rise of 50°C by oil & 55°C rise by winding . The transformer if required, shall be fitted with radiators of tubular construction. Thickness of radiator tubes should not be less than 2.5 mm and material should be mild steel.

- Current Transformer for E/F protection:

  Outdoor type current transformer conforming to IS-2705 as per annexure shall be provided by the manufacturer for 33 KV neutral bushing.

- Fittings & Accessories :

  The Earthing Transformer shall be complete with necessary fittings and accessories, but not limited to the following:

  a) Conservator with filling hole, cap and drain valve having flanged terminal.

  b) Conservator and supporting bracket for mounting on transformer tank.

c) Isolation valve for the conservator.

d) Magnetic oil level gauge with low oil level alarm contacts.

e) Silica gel breather with oil seal and connecting pipe for non-inert gas sealed transformer .

f) Pressure relief pipe, double diaphragm type, complete with port-hole type oil gauge for indication of the puncture of lower diaphragm and necessary air equalizer connection between the conservator and the pressure relief pipe.

g) Access holes/Inspection holes with bolted covers for access to inner ends of bushing.

h) Lifting eyes for cover, core and winding and lifting lugs for the complete transformer.

i) Air release plugs on top of cover and bushing turrets.

j) Upper & Bottom filter valve and Drain valve flanged with oil sampling device.

k) Jacking pads with hauling holes.

l) Flat roller wheels.

m) Two nos. tank earthing terminal.

n) Buchholz (gas) relay, double float type with one set of alarm contacts and one set of trip contacts and a testing cock. The contacts shall be wired up to terminal cabinet with insulted cables.

o) Dial type thermometer for oil temperature indication complete with two sets of alarm and trip contact.

p) Pocket for inserting alcohol thermometer for oil temperature with necessary thermometer.

q) Rating plate and Diagram plate.

r) Rigid type terminal connectors on the HV bushing.

s) Insulating oil required for first filling.

t) Other attachment/accessories required to complete the equipment for satisfactory operation.

- Painting :

All steel surfaces shall be cleaned by sand blasting or chemical process as required to produce a smooth surface, free of scale, grease and rust. Steel surface in contact with insulating oil shall be painted with heat resistant oil insoluble insulating varnish. External surfaces shall be given a coat of high quality red or yellow chromate primer and finished with gray colour (IS:631) with two coats of synthetic enamel paints. Paints shall be carefully selected to withstand tropical heat, rain etc. The paint shall not

scale off or crinkle or be removed by abrasion due to normal handling. Sufficient quantity of touch up paint shall be furnished by application at site.

- Equipment foundation and steel structure :
  a) The earthing transformers shall be furnished complete with base frame, anchor/ foundation bolts and hardwares
  b) The equipment shall be designed for mounting on concrete base.
- Tests

  Only type tested Earthing transformer are to be offered conforming to technical specification, and relevant IS and IEC.

  During manufacture and on completion, all transformers shall be subjected to the routine tests in accordance with latest IEC 60076 and its different parts.

  In addition, the following tests shall be performed on each transformer:
  a) Measurement of Zero-sequence impedance
  b) Measurement of no-load loss and no load current.
  c) Measurement of winding resistance.
  d) Measurement of insulation resistance.
  e) Induced voltage withstand test.
  f) Separate source voltage withstand test.

- Test Witness

  Tests shall be performed in presence of Owner/Purchaser's representative if so desired by the Owner/Purchaser. The Contractor shall give at least seven (7) days' advance notice of the date when the tests are to be carried out.

- Test Certificates

  a)Certified reports of all the tests carried out at the works shall be furnished in six (6) copies for approval of the Owner/Purchaser.

  b)The equipment shall be dispatched from works only after receipt of Owner/Purchaser's written approval of the test reports.

  c)Type test certificates on any equipment, if so desired by the Owner/ Purchaser, shall be furnished. Otherwise the equipment shall have to be type tested, free of charge, to prove the design.

d)Porcelain bushing, Bushing current transformers, winding temperature indicating device, Dial Thermometers, Double float type Buchholz relays, Insulating oil and other accessories to be supplied by the manufacturer shall be tested by the manufacturer in accordance with the relevant I.S. Publication. Six (6) copies of test reports of each of the component shall be furnished along with the test certificate of the main equipment.

- Following drawings, leaflets and test reports shall be submitted for approval-

  (a) Dimensional general arrangement drawing transformer showing constructional features and dispositions of various fittings and accessories.

  (b) Technical leaflets on transformer and accessories explaining the functions and special features.

  (c) Type test certificates on similar transformers.

  (d) Transport/shipping dimensions with weights.

  (e) Dimensional general arrangement and sectional view with plan and elevation of bushing with technical parameters.

  (f) Foundation and anchor details including dead-load and impact load with direction.

  (g) Assembly drawing for erection at site with part numbers and schedule of materials.

  (h) Electrical schematic and wiring diagram.

  (i) Any other relevant drawings and data necessary for erection, operation and maintenance.

  (j) Instruction manuals and data sheets for each piece of equipment. The manuals shall clearly indicate the installation methods, checkups and tests to be carried out for covering the equipment and maintenance procedure.

  (k) Rating and diagram plate of the transformer.

F. ACSR Conductor

- The Aluminium Stranded Conductor and steel reinforced shall have the technical parameters matching with the requirements given in Annexure-A. For all constructions, each alternate layer shall be stranded in opposite direction. The final layer of wires shall be right hand lay. These conductors will be utilised for stringing various buses & equipment connections both in

switchyard area and transformer yard area. ACSR conductors shall conform to the latest revision of IS-398.

- The Aluminium strands of the Steel-Aluminium conductor shall be hard drawn from 99.5% pure electrolytic aluminium rods of E.C. Grade. The steel wire strands shall be drawn from high carbon steel rods procured by acid or the basic open-hearth process, the electric furnace process or the basic oxygen process. The Zinc used for galvanising shall be electrolytic high-grade zinc of 99.95% purity.
- All aluminium and strands shall be smooth and free from all imperfections such as spill & splits, die marks, scratches etc. The steel strands shall be hot-dip galvanized and shall have a zinc coating of minimum 260 gms/sq.m. The zinc coating shall be smooth and uniform thickness.

  No joints shall be permitted in the individual wires in the outermost layer of the finished conductor. However joints in the 12 wire and 18 wire layers of the conductor shall be allowed, but the joints shall be made by cold pressure butt welding method and shall be such that no two joints are within 15 m of each other in the complete stranded conductor.

K. Clamps and Connectors

- All clamps, connectors and hardwares shall be designed, manufactured and tested as per relevant standards. All connectors shall be IS-5561 or equivalent IEC and shall of the type most suitable for the purpose they are intended to be. The materials with which they are made shall be :

i) Aluminium alloy to Grade AG of IS 617-1959

ii) Brass to grade 3 of IS 292-1961

iii) Aluminium bronze to Grade 2 of IS 305-1961

iv) Copper laminations for flexible connector Grade FRTP-2 of IS 191-1967

- All clamps & connectors for connection with equipment or ACSR conductors shall have high tensile aluminium alloy body. U-bolt and nut for the clamp shall be made of non-magnetic material e.g. chromium steel. The connectors shall be free from cavities blowholes and such other defects. All sharp edges and corners shall be blurred and rounded off. All connectors shall be designed corona free.

- Bolt, nut, washer, shackle, etc. required for other purpose shall be of forged steel with adequate strength and the surface shall be so protected as to offer maximum resistance to corrosion. Malleable iron wherever used for any part shall be of best quality and shall correspond to latest amendments of relevant IS. Bolts shall be so located that pressure is uniformly distributed from bolts over the contact surface.
- Various fittings & accessories of the clamps & connectors shall be so designed as to eliminate sharp edges & maintain bright smooth surface. All bolts, nuts, rivets etc. shall have round profiles. For bimetallic clamps, copper alloy linear or minimum thickness of 4 mm shall be cast integral with the aluminium body.

L. Disc Insulator

- All disc insulators shall be dimensioned appropriately so as to have the required Electro - Mechanical strength for EHV outdoor duties.
- Suspension & Tension string assembles shall have adequate number of insulator discs in order to ensure high creepage distance for heavily polluted atmosphere and rain. The same shall be of anti-fog type.
- Suspension and Tension string assembles shall be supplied as per details given in Annexure-A. All Insulators and fittings shall generally be supplied as per relevant IS amended up-to-date.

M. Post Insulator Stack

- Post insulator stack shall be used to support either the ACSR conductor or tubular Aluminium bus of Outdoor EHV switchyard. Insulators shall be solid core polycone type and composed of stacked units. Insulators of identical rating shall be interchangeable.
- Insulator having sufficient cantilever strength shall be of wet process porcelain, brown glazed and free from all blemishes. Metal parts and hardwares shall be hot-dip galvanised.
- Insulator shall have adequate mechanical strength and rigidity to withstand the duty involved.
- When operated at maximum system voltage, there shall be no electrical discharge. Corona/grading ring if necessary, shall be provided with the post insulator.

- Each post insulator will be mounted on steel structure and shall be complete with necessary fixing clamp at top for clamping of ACSR conductor or tubular Aluminium bus. The insulators shall be provided with necessary nuts, bolts & washers.
- Post insulator shall conform to the latest amended IS requirements and technical particulars of the stack are given in the enclosed Annexure-A.

N. Tubular Aluminium Bus

- The material of tubular aluminium bus shall be E - 91E grade or equivalent having best possible combination of Electrical and Mechanical properties.
- Rigid type tubular Al bus bar arrangement supported on post insulators at intervals is used in outdoor EHV substation. Technical parameters of tubular bus-bar are given in the enclosed Annexure-A.
- Tube buses are provided with fixed clamp at one end & sliding/flexible type clamp on the other end for taking care of thermal expansion. Long run of tubular buses shall be complete with suitable internally mounted vibration dampers at intervals in order to achieve quick damping of vibrations arising out of Electro-mechanical forces.

O. Bundle Spacers

- The spacers shall be provided at a suitable longitudinal spacing in each phase of the line as recommended by the manufacturer of giving most satisfactory performance.
- Bundle spacers shall have enough strength so as to restore normal spacing of conductors after displacement by winds, short circuits etc. without damage or permanent deformation. The spacers shall have long life without fatigue or wear and shall have gentle but firm grip on conductor. They shall be able to withstand all the electromagnetic and electrostatic forces under different operating conditions including dead short circuit.
- They shall be of one piece construction and shall not have separate small components.
- The materials used in spacers shall be corrosion resistant and made of aluminium alloy of an approved type.
- The spacers shall be flexible enough so as to avoid distortion or damage to the conductor or themselves. Rigid spacers are not acceptable.
- The spacers shall be capable of being installed or removed from the energised line by means of hot line tools without completely separating the components.

- The spacers shall not have any projection cuts, abrasions etc. which may cause corona radio interference. They shall have enough strength to resist any deformation, which may cause their RI performance to change. The units shall be corrosion resistant. Ferrous parts, if used, shall have magnetic losses not more than 5 watt for 600 Amp 50 Hz AC. Elastomers if used shall be resistant to ozone, sunshine and ageing.

P. Junction Box for CT connection

- A suitable weather proof and dust proof kiosk of suitable thickness (not less than 3 mm) shall have to be installed at each bay near the position of CT installation at the switchyard for termination of all the CT secondary connections. This kiosk shall be provided with terminal block for such CT connections. Arrangement is to be provided at the CT terminal block for shorting of the secondary terminals while the CT is in energized condition for testing and other purposes, if necessary.
- Star/Delta connection of the CT secondary terminal from Red, yellow and Blue are to be made here and necessary shorting links are to be provided in the said terminal block for each connection. Connections made from respective marshalling Kiosk after those terminal are connected either in Star/Delta.
- 10 mm wide plastic plates bearing identification mark shall be fixed under each connection at the marshalling kiosk to indicate the CT secondary circuit used for different protections. The CT secondaries used for metering shall also be marked similarly.
- The marshalling kiosk shall be placed at such a height that it becomes convenient for any person to work on the CT secondary terminal block. Sufficient space shall be provided so that all terminals become easily accessible. All incoming and outgoing connections in the marshalling kiosk shall be properly marked with ferrules. 20% terminals are to kept as spare. It shall be provided with hinged door at the front of the terminal block for easy inspection.
- The terminal block to be used shall be of best quality, rust proof and suitable for climatic conditions at site as mentioned in the general condition of site. The outside of the kiosk shall be coloured with same colour as that of control panel. The size of the kiosk shall be determined as per requirement.
- The enclosure of marshalling box shall provide with a degree of protection of not less than IP-55 as per IS-2147 and one marshalling box shall be type tested for the same.

Q. Marshalling Kiosk for AC Auxiliary Power Distribution in the Switchyard:

- Each bay shall be provided with a suitable weather and dust proof kiosk of thickness not less than 3 mm to be required for supply of auxiliary AC supply to isolators, breakers, switchyard lighting etc. This kiosk is to be provided with terminal block and also fuse and link to be used for different circuits. Normally there will be two end feeding of the incoming supply to each kiosk by interconnection. This incoming supply shall be brought to the terminal at the kiosk through links. So that in case of emergency one faulty incoming supply can be isolated. The outgoing circuits from the terminals of the Kiosk shall be through fuse and link.
- This kiosk shall be placed at a convenient position in each bay.
- 10 mm wide plastic plates bearing identification mark shall be fixed suitably under each circuit. Each control cable shall be properly marked with ferrules. 20% of the terminal block including fuse and link unit shall be kept as spare.
- The rating of the fuse shall be such as it can maintain a coordination between itself and the fuse unit provided in the AC control board for local fault. The size of the kiosk shall be determined as per requirement.
- The enclosure of marshalling box shall provide with a degree of protection of not less than IP-55 as per IS-2147 and one marshalling box shall be type tested for the same.
- Suitable space heaters with thermostat shall be provided to prevent condensation and maintain a cubicle temperature approximately 10°C. above ambient.
- Illumination lamp with door switch shall be provided. A 230 V, AC, 5A/15A combined socket and switch shall also be provided.

R. Grounding

- GI Flats shall be provided at intervals for serving as ground mat riser to which earth connections for different equipment will be made, as per I.E. Rules.
- Grounding mat for different systems shall be interconnected between themselves.
- Switchyard ground grid will be connected to the main plant grid with multiple connections.
- Earth mat within the new bay of switchyard has to be extended by 1 metre beyond the fence, so as to ensure that the area in the vicinity of the substation fence is safe.
- New bay of switchyard shall be surfaced with gravel, 150 mm deep, over concrete which will be extended 1 metre beyond the switchyard fence. Existing concrete road also to be extended to cover the additional bay.

- The underground mat will be made of mild steel rods laid underground in length and breadth of the area at a depth of 500mm below grade level. All crossings and straight run shall be arc welded for good electrical continuity. Ground conductors, when crossing underground trenches, directly laid underground pipe and equipment foundation, if any, shall be at least 300 mm below the bottom elevation of such trenches/pipes.
- Ground electrodes will be 3 metres long M.S. rod of adequate size. These are to be fabricated and driven into the ground by the side of mat conductors. All connections to the conductors shall be done by arc welding process.
- Risers are required for connecting the equipment and structures with the ground mat. These will be of M.S. rod, laid from ground mat to above ground level properly clamped or supported along the outer edge of the concrete foundation. Connection to the ground mat shall be done by arc welding and the other end is to be kept free, at least 300 mm above ground level.
- All non-current carrying steel/metal parts in the switchyard shall be connected to the grounding grid at two points including equipment except LAs which shall be earthed directly through earth electrodes. These electrodes shall in turn be connected to the ground grid. All steel structures are required to be grounded from ground mat. Laying, supporting along with foundation connecting at ground mat are within the scope of this specification.
- For rust protection the welds shall be treated with Barium Chromate, welded surfaces shall be painted with red lead and bitumen. All exposed steel conductor shall be protected with bituminous paint.

S. Shielding

The lightning protection system shall be comprising of shield wire, shielding mast, down conductor, riser and other accessories required for complete protection of the switchyard.

The lightning conductor shall be as straight as possible. Sharp bends shall be avoided.

The connections between the conductors shall be electrically continuous.

T. Tropical Protection

All equipment, accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects & corrosion.

Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent entry of insects.

U. Painting

The panels/switchgear shall be finished in light grey (IS Shade # 631) with two coats of synthetic enamel paint.

5.13.7.3.6 TESTS

a. Routine Test

During manufacture and on completion, all equipment, clamps, connectors and accessories shall be subjected to the Routine Tests as laid down in latest revision of IEC/IS.

In addition to above tests specified by IEC/IS, the following tests also have to be carried out for specific equipment :

i) The speed curves for 33 KV circuit breaker shall 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.)

ii) Mechanical operation test (routine test) on 33 KV disconnecting witches (Main switch and earth switch).

b. Type Test

All equipment to be supplied shall be of type tested design. During detailed engineering, the bidder shall submit Type test reports all equipment viz. circuit breaker, disconnecting switch, CT & LA shall carried out as stipulated in relevant IEC/Indian Standards. (not more than ten year old from the date of bid opening) to prove the capability and suitability of these equipment. of his Type tests on Test certificates for type tests, as stipulated in Indian Standards carried out on similar equipment clamps, connectors etc. shall be furnished. If type test certificate is not available or it is found during engineering stage that the submitted test reports are not meeting the NIT requirement, the equipment shall have to be type tested, free of charge, to prove the design.

- Apart from the above requirement, following additional type tests are to be conducted for 33 KV circuit breaker:

  i) Out of phase closing test as per IEC-267 & IEC-62271-100.

  ii) Line charging breaking current test. The breaker shall be able to interrupt the line charging current with a test voltage of 1.4p.u. instead of 1.2 p.u. as per IEC-62271-100.

c. Special Tests

Special tests listed under shall be carried out in presence of purchasers representative if valid certificate of CPRI /NABL is not available of last 7 years from the date of Techno commercial Bid of this project.

i) 33 KV disconnecting switch
   a) Test on insulators [as per IS:2554; IEC:168].
   b) Test on terminal connectors [as per IS:5561].
   c) Test on galvanised components [as per IS:2633].
   d) Stalled torque test on motor operating mechanism [at 110% of supply voltage].

ii) 33 KV Lightning arrestor
   a) Special thermal stability tests to be conducted on lightning arresters according to IEC, as an acceptance test.
   b) Temperature cycle test on the porcelain housing of the arrester to be conducted as per IS/IEC.
   c) The artificial pollution test shall be carried out as per applicable standards.
   d) The galvanisation test on metal parts shall be carried out as acceptance test.
   e) The functional (operational) acceptance tests shall be carried out on the surge counter.

d. Tests Witness

Tests shall be performed in presence of Employer's representative if so desired by the Employer. The Contractor shall give at least fifteen (15) days' advance notice of the date when the tests are to be carried out.

- To be furnished after award of contract
  - Calculations
    i) Parameter for 132 KV CT and PT
    ii) Direct stroke lightning protection
    iii) Stresses in rigid conductor and forces on support & equipment and check for deflection
    iv) Sag tension
    v) Short circuit force on strung bus and spacer span
    vi) Temperature rise of bus bar (Rigid and strung)
    vii) Tubular bus bar ampacity
    viii) Corona / voltage gradient & SC Thermal withstand capability of 132 KV bus system
    ix) ACSR conductor ampacity

x) Grounding including step potential & touch potential.
xi) Cable schedule & interconnection chart
xii) DC & AC system sizing calculation
xiii) Power cable sizing calculation
xiv) Relay co-ordination chart & setting

- Drawings

i) SLD for switchyard, AC & DC Aux. System
ii) Switchyard layout plan & section
iii) Electrical clearance diagram
iv) Direct stroke lightning protection layout of switchyard and lightning protection of control room
v) Earthing layout for switchyard & control room
vi) Cable trench layout for switchyard & control room
vii) Illumination layout for switchyard & control room
viii) Metering & protection diagram of different bays
ix) Notes & details for cabling, illumination, earthing & lightning protection
x) Control & interlock logic diagram

- Circuit breaker

i) Dimensional general arrangement drawing showing disposition of various fittings.
ii) Foundation plan and loading.
iii) Control schematic and wiring diagram.
iv) Instruction manual on circuit breaker and its accessories. The manual shall clearly indicate method of installation, check ups and tests to be carried out before commissioning of the equipment.

- Disconnecting switch

i) Dimensioned general arrangement drawing showing disposition of various fittings.
ii) Transport/shipping dimensions with weights.
iii) Foundation plan and loading.
iv) Assembly drawing for erection at site with part numbers and schedule of materials.
v) Control schematics and wiring diagram.
vi) Instruction manuals on disconnecting switch.

- Current transformer

  i) Dimensional general arrangement drawing of C.T. showing disposition of various fittings.

  ii) Dimensional general arrangement drawing of Terminal Connectors and Master Terminal Box.

  iii) Foundation plan and loading.

  iv) Wiring diagram of C.T.s showing all the windings, cores and earthing along with terminal details.

  v) Magnetisation Curves.

  vi) Instruction manuals on the equipment and its various accessories.

- Lightning arrestor

  i) Dimensioned general arrangement drawing showing disposition of various accessories and safety clearances.

  ii) Foundation plan and loading.

  iii) Characteristic curves for insulation coordination.

  iv) Instruction manuals on the equipment and its various accessories. The manual shall clearly indicate method of installation, check-ups and tests to be carried out before commissioning f the equipment.

- Potential Transformer

  i) Dimensioned general arrangement drawing showing disposition of various fittings.

  ii) Dimensioned drawing of terminal box and terminal connectors.

  iii) Foundation plan and loading.

  iv) Assembly drawing for erection at side with part numbers and schedule of materials.

  v) Wiring diagram showing all the windings and earthing with terminal details.

  vi) Another relevant drawing or data necessary for satisfactory installation, operation and maintenance.

- Switchyard Hardwares

  i) Consolidated Bill of Materials.

  ii) Transport/Shipping dimensions with weights.

  iii) Foundation Plan and Loadings.

  iv) Assembly drawing for erection at site with part numbers.

  v) Data Sheet and technical leaflets on each piece of equipment, clamps, connectors, hardwares, insulators, conductors etc.

ANNEXURE-A

RATINGS AND REQUIREMENTS

1.0 CIRCUIT BREAKER

Sl. No.	Description	33KV
A.	Type	VCB
B.	Service	Outdoor
C.	Pole	3
D.	Rated frequency (Hz)	50Hz ± 5%
E.	i) Nominal system voltage (KV r.m.s)	33
	ii) Rated voltage (KV r.m.s)	36
F.	System Neutral Earthing	NEE through Earthing Transformer
G.	Standard to be followed	IS:13118/IEC-56
H.	Insulating level (KVp) 1.2/50 micro- Sec impulse withstand volt. a) between line terminals and ground (KVP)	±170
I.	1 min power frequency withstand voltage (KV rms)(dry & wet) a) between line terminals and ground	70
J.	Corona extinction voltage (KV rms) with CB open or close.	As per IS/IEC
K.	Max. radio interference voltage (micro volts) between 0.5 MHZ and 2 MHZ in all position of equipment	As per IS/IEC
L.	**Rated Normal Current** i) Continuous at $50^{o}C$	1250
M.	**Rated Breaking Capacity**	
	i) Short-circuit breaking current (Symmetrical)	25KA

	ii) Percentage D.C. component	As per IEC
	iii) Rated short-circuit making current (KA peak)	100
	iv) Rated peak withstand current (KA peak)	100
	v) Rated short time with- stand current	25 KA for 3 seconds
	vi) Out of phase breaking Current (KA r.m.s)	As per IEC
N.	Rated line charging interrupting current at 90° leading power factor- The breaker shall be able to interrupt the rated line charging current with a test voltage immediately before opening equal to U/ _3 x 1.5 as per IEC.	As per IEC
O.	Rated line charging breaking current (Amps)	As per IEC
P.	Rated cable charging breaking current (Amps)	50
Q.	Rated small inductive current switching capability with over-voltage less than 2.3pu.	0.5A to 10A
R.	Rated operating sequence (O – Operating, C – closing)	O-0.3 sec- CO – 3.0 min-CO
S.	First pole to clear factor	1.3
T.	Operating mechanism	Spring/Spring
U.	Mode of operation	Individual Pole /Gang Operated
V.	No. of trip coils	2 common for 3 pole
W.	Minimum Creepage distance	900mm
X.	Total break time (ms)	Not exceeding 60 millisec
Y.	Closing time	Not exceeding 120 millisec
Z.	Phase to phase clearance between	1500mm

	bus	
AA.	Minimum clearance of live parts in air and ground (mm)	3700mm
BB.	Auxiliary Voltage	
	i) Closing	220 VDC(85% to 110%)
	ii) Tripping	222 VDC (70% to 110%)
	iii) Spring Charge Motor	220V DC(85% to 110%) / 240 V±10%, 1-Phase, 50 Hz
	iv) Heater/Lamp/Socket	240 V±10%, 1-Phase, 50 Hz
CC.	Auxiliary contacts	
	i) Rating of auxiliary contacts	10A 132V DC
	ii) Breaking capacity of auxiliary contacts	2A DC with circuit time constant not less than 20 ms.
DD.	Mounting	On Galvanized steel structure
EE.	Seismic Accleration	0.3g horizontal

2.0 **DISCONNECTING SWITCH**

Sl. No.	Description	33KV
A.	Type	Motor operated, double end break, center post rotating type
B.	Service	Outdoor
C.	Pole	3
D.	Rated frequency (Hz)	50Hz ± 5%
E.	i) Nominal system voltage (KV r.m.s)	33
	ii) Rated voltage (KV r.m.s)	36
F.	System Neutral Earthing	NEE through Earthing Transformer
G.	Standard to be followed	IS:13118/IEC-56
H.	Insulating level (KVp) 1.2/50 micro- Sec impulse withstand volt.	

	a) between line terminals and ground (KVp)	±170
	b) between line terminals with isolator open(KVp)	±195
I.	1 min power frequency withstand voltage (KV rms)(dry & wet) a) between line terminals and ground	
	a) between line terminals and ground	70
	b) between line terminals with isolator open(KVp)	80
J.	**Rated Normal Current** i) Continuous at 50°C	1250
K.	Short time withstand current	25kA for 3 sec
L.	Peak withstand current KA (P)	100
M.	Short circuit making current for Earth Switch. KA (P)	100
N.	Creepage distance (mm)	900
O.	Operating Mechanism	
	i) Main blade	A.C. motor and manual
	ii) Earth Switch	Manual
	iii) Mode of operation	Gang Operated
P.	Auxiliary Voltage	
	i) Motor	415V ±10%, 3 Ph, 50Hz ± 5%
	ii) Control & Interlock	220V DC(80% to 110%)
	iv) Heater/Lamp/Socket	240 V±10%, 1-Phase, 50 Hz
Q.	Mounting	Galvanized Steel structure.
R.	Phase to phase spacing (mm)	1500
S.	Operating Time of isolator and Earth switch.	Less than 12 seconds
T.	Seismic acceleration	0.3g horizontal

3.0 **CURRENT TRANSFORMER**

Sl. No.	Description	33KV
A.	Type	Oil filled, self cooled hermetically sealed, Pedestal type
B.	Service	Outdoor, heavily polluted atmosphere with dust
C.	Nos. of phases	3
D.	Rated frequency (Hz)	50Hz ± 5%
E.	i) Nominal system voltage (KV r.m.s)	33
	ii) Rated voltage (KV r.m.s)	36
F.	System Neutral Earthing	NEE through Earthing Transformer
G.	Standard to be followed	IS/IEC
H.	Insulating level (KVp) 1.2/50 micro- Sec impulse withstand volt.	±170
I.	1 min power frequency withstand voltage (KV rms)	IS/IEC
	a) between HV terminal & earth	70
	b) between LV terminal & earth	4
	c) between secondary wiring & earth	2
J.	**Rated Normal Current** i) Continuous at 50^{o}C	1250
K.	Rated continuous thermal current (A)	120%
L.	Short time withstand current	25kA for 3 sec
M.	Rated dynamic current	100 KA peak
N.	Creepage distance (mm)	900
O.	Mounting	Galvanised Steel structure.

P.	Phase to phase spacing (mm)	1500
Q.	Insulation medium	Oil
R.	Type of Tank	Dead Tank
S.	Insulator	Oil filled condenser type porcelain bushing/Insulator
T.	Instrument security factor	Less than 5 for metering core
U.	Partial discharge level (PC)	Not exceeding 10 PC

CT RATINGS

Sl. No.	Description	No of Core	Core No.	Application	Current Ratio	Output Burden (VA) at Lower Ratio	ISF (Max)	Accuracy class	Min Knee point Voltage (V)	Maximum Excitation Current Ie (mA) at Knee point voltage at higher ratio	Maximum Secondary Resistance Rct (Ohm) at higher ratio
1	**132 KV CT**	5	1	Protection	**1200-600-300/1A**	*	*	PS Class	1200/600/300V	20/40/80 mA	6/3/1.5 Ohms @ 75°C
			2	Protection	**1200-600-300/1A**	*	*	PS Class	1200/600/300V	20/40/80 mA	6/3/1.5 Ohms @ 75°C
			3	Metering	**1200-600-**	40VA	<5	0.2	*	*	*

					300/ 1A						
			4	Protection	**1200-600-300/ 1A**	*	*	PS Class	1200/ 600/ 300V	20/40/ 80 mA	6/3/ 1.5 Ohms @ 75°C
			5	Protection	**1200-600-300/ 1A**	*	*	PS Class	1200/ 600/ 300V	20/40/ 80 mA	6/3/ 1.5 Ohms @ 75°C
2	**33 KV CT**	4	1	Metering	1200-800-400/ 1A	30	<5	0.2	*	*	*
			2	Protection	1200-800-400/ 1A	*	*	PS Class	*	*	*
			3	Protection	1200-800-400/ 1A	*	*	PS Class	*	*	*
			4	Protection	1200-800-400/ 1A	*	*	PS Class	*	*	*
3	**GR. TRANF. NEUTRAL SIDE CT**		1	Protection	500/ 1	*	*	PS Class / 5P20	*	*	*
			2	Protection	500/ 1	*	*	PS Class / 5P20	*	*	*

(*) - To be decided by the Bidder

The CT ratio, class and burden are tentative only. Shall be decided during detail engineering.

4.0 LIGHTNING ARRESTER

Sl. No.	Description	33KV
A.	Type	Station class, Heavy duty, Gapless
B.	Service	Outdoor, heavily polluted atmosphere with dust
C.	Nos. of phases	3
D.	Rated frequency (Hz)	50Hz ± 5%
E.	Highest system voltage	36 KV
F.	System Neutral Earthing	NEE through Earthing Transforme
G.	Standard to be followed	IS/IEC
H.	L.A. rating	
	Rated Arrester Voltage	30KV
	Nominal discharge current	10 KA (heavy duty)
	Long duration discharge class	3
	Pressure relief class	A
I.	Insulating level (KVp) 1.2/50 micro- Sec impulse withstand volt.	170
J.	1 min. p.f. withstand (KVrms) voltage (dry & wet) for arrestor housing	70
K.	Maximum residual voltage at 10 kA discharge current with 8X20 microsecond wave (KV peak)	84
L.	(Minimum) High Current Impulse withstand (4/10 micro second wave) KA (peak)	100
M.	Creepage distance (mm)	900
N.	Mounting	Galvanised Steel structure.
O.	Phase to phase spacing (mm)	1500
P.	Pressure relief Current	25kA
Q.	Partial discharge level (PC)	Not exceeding 10 PC
R.	Ground terminal	Suitable for 75 x 12 mm G.I. flat

S.	Surge monitor	Yes

5.0 GROUNDING/EARTHING TRANSFORMER

Sl. No.	Description	
A.	Type	250KVA, 33KV/0.415KV, 50Hz., Oil filled, Copper wound natural air cooled (ONAN),ZNyn11, 3ph, Earthing transformer, Class-A insulation for winding.
B.	Service	Outdoor, heavily polluted atmosphere with dust
C.	Zero sequence Impedance (Ohm) per phase. (tolerance +20%, - 0%)	As per design
D.	Maximum permissible neutral current for single phase to ground fault (amps) for 30 secs.	300
E.	Basic Insulation level (a) Winding (b) Bushing	 170 KVp 170 KVp
F.	Power frequency withstand voltage Dry one minute (i) HV Winding (ii) HV Bushing	 70 KV (rms.) 70 KV (rms.)
G.	Temperature rise over ambient (50°C) for continuous rating (a) Winding, by resistance (b) Oil by thermometer (c) Core	 55°C 50°C As permitted by adjacent winding
H.	Flux density	1.7 tesla. In the event of over

		voltage to the extent of 12.5%, the core shall not get saturated
I.	Whether uniformly insulated or graded	Uniformly Insulated

6.0 **DISC. INSULATOR STRING**

Sl. No.	Description	132KV	33KV
A.	Nom./Highest System Voltage..KVrms	132/245	33/36
B.	1.2 x 50 µs Impulse Withstand voltage .KVp	1050	170
C.	Wet 1 min. 50 Hz withstand voltage .KVrms	460	70
D.	Corona Extinction voltage, KV (r.m.s) min	266	
E.	Total no.of discs for string (nos.)	16	4
F.	Electro-Mechanical Strength (KN)	120	70
G.	Reference standard	IS : 3188	

7.0 **POST INSULATOR STRING**

Sl. No.	Description	132KV	33KV
A.	Nom./Highest System Voltage..KVrms	132/245	33/36
B.	1.2 x 50 µs Impulse Withstand voltage .KVp	1050	170
C.	1 min. 50 Hz withstand voltage .KVrms		
	i) Dry	460	70

	ii) Wet	460	70
D.	Corona Extinction voltage, KV (r.m.s) min	266	
E.	Creepage Distance (mm)	6125	900
F.	Insulator Mounting	Steel Structure	
G.	Cantilever Strength (Per Stack)..KN	8	
H.	Reference standard	IS : 2544	

8.0 **ALUMINIUM CONDUCTOR STEEL REINFORCED (A.C.S.R)**

Sl. No.	Description	132KV	33KV
A.	Code Name	ACSR Moose	
B.	Copper Equivalent Area (Sq.mm)	322.6	
C.	Aluminium Net Area (Sq.mm)	528.5	
D.	Overall Diameter.(mm)	31.77	
E.	Stranding no.& Wire Diameter(mm)	Al=54/3.53 Steel=7/3.53	
F.	Approx. Weight of Conductor (Kg/m)	2.004	
G.	Ultimate Strength. (Kg)	16270	
H.	Reference standard	IS: 398	

9.0 **ALUMINIUM TUBULAR BUS-BAR**

Sl. No.	Description	132KV	33KV
A.	Reference standard	Al. alloy as per IS:5082	
B.	Normal size	2.5”	1.5”
C.	Aluminium Area (Sq.mm)	1454.19	699.03
D.	Overall Diameter (mm)	73.03	48.26
E.	Approx. Weight	3.94	1.87

	(Kg/m)		
F.	Grade	EHIPS , E-91E, Sch.80	

10.0 **TENSION/SUSPENSION CLAMP ASSEMBLY**

Sl. No.	Description	
A.	Material	Aluminium Alloy
B.	Ball Socket Dimension	To be co-coordinated with Ball-socket Dimension of Insulator
C.	Short time current carrying capacity	According to voltage and system fault current & duration
D.	Reference standard	IS : 2486

11.0 **CONNECTORS/P.G. CLAMP ASSEMBLY**

Sl. No.	Description	
A.	Material	Aluminium Alloy
B.	Ball Socket Dimension	To be co-coordinated with Ball-socket Dimension of Insulator
C.	Short time current carrying capacity	According to voltage and system fault current & duration
D.	Rated current	Depend upon point of application (shall be same as connected equipment rated current)
E.	Max. Temp. rise above ambient temp. 50°C	35°C at rated current
F.	Current density (A/sq.mm.)	0.75(for Al. alloy)/ 1.75 for copper
G.	Minimum thickness of bi-metal in bimet-allic connections	2 mm
H.	Reference standard	IS : 5561

ANNEXURE-B

FITTINGS & ACCESSORIES

A. **Circuit Breaker**

A.I Each Circuit Breaker shall be furnished complete with fittings and accessories as listed below :

1. Operating mechanism complete with all accessories, fittings and double tripping coils and closing coil, pole discrepancy feature and low pressure blocking device etc. As required.
2. Type : Outdoor 33 kV VCB.
3. Pedestal for O&M activity at VCB Control cubical.
4. Two ground pads per pole suitable for termination of 75 x 10 mm GS flats.
5. Base frame and anchor bolts and nuts.
6. Set of valves, pressure gauges and pressure switches as required.
7. Auxiliary contacts and relays.
8. LOCAL/REMOTE Selector switch, TRIP/CLOSE Push Buttons.
9. Manual tripping devices with protective flap.
10. Mechanical ON-OFF indicator.
11. Operation counters.
12. Weatherproof outdoor type control cubicle and pole boxes having IPW55 enclosure.
13. Set of MCB and switch fuse units for A.C. and D.C. supply.
14. Space heater with thermostat and ON-OFF switch.
15. Cubicle illumination lamp with ON-OFF switch.
16. 3 Pin 5A Socket with ON-OFF Switch.
17. Terminal blocks and internal wiring - lot as required.
18. Set of pre-fabricated copper pipe with fittings, clamps, and hardware for connection between control cubicle and pole boxes as required.
19. Interconnecting wires, G.I. conduits and accessories for connection between control cubicle and pole boxes.
20. Other standard accessories which are not specifically mentioned but supplied with breakers of similar type and rating for efficient and trouble-free operation.
21. Bimetallic terminal connectors. (Suitable for Al tube / ACSR / AAC – Horizontal / vertical).
22. Supporting galvanized steel structure.

B. **Disconnecting switch**

Each disconnecting switch shall be furnished complete with fittings and accessories as listed below :

1. Clamp-type bimetallic terminal connector for conductor.
2. Ground pads for 75x10 mm flat.
3. Base frame with anchor bolts, nuts and washers.

4. Operating mechanism with all accessories including operating rod of required length, for disconnect switch and for earth switch

5. Starters, relays and auxiliary switches.

6. Local / Remote selector switch.

7. Open / Stop / Close push buttons.

8. Spare auxiliary switches 6 NO + 6 NC.

9. Mechanical ON-OFF indicator

10. Weather-proof mechanism box with lock and key for disconnect switch and for earth switch.

11. Set of MCB and switch fuse units for A.C. and D.C. supply.

12. Space heater with thermostat and ON-OFF switch.

13. Internal illumination lamp with ON-OFF switch.

14. 3 pin 5A socket outlet with ON-OFF switch.

15. Terminal blocks and wiring - lot.

16. Earthing switch, if specified, complete with safety interlocks and 4 NO + 4 NC spare auxiliary switches.

17. Flexible copper braid for grounding of operating rod.

18. Other standard accessories, which are not specifically mentioned but are usually

provided with Disconnecting Switch of such type and rating for efficient and trouble free operation.

C. **Current transformer**

Each Current Transformer shall be furnished complete with the accessories as listed

below :

1. Base frame with anchoring bolts, nuts etc. for fixing the equipment on to structure.

2. Two grounding pads with bolts and spring washers.

3. Lifting Lugs.

4. Clamp type bimetallic terminal connectors.

5. Weather-proof secondary terminal box with set of terminals.

6. Grading ring, if necessary.

7. Oil level gauge and pressure relief device.

8. Oil sampling valve.

9. Spark gap arrangement.

10. Nitrogen sealing hole cover where inert gas cushion provided.

11. Other standard accessories, which are not specifically mentioned but are usually

provided with current transformers of such type and rating for efficient and trouble free operation.

D. **Lightning arrestor**

Each Lightning Arrester shall be furnished complete with the accessories as listed below :

1. Insulating Base with anchoring bolts, nuts etc. for fixing the equipment on to structure.
2. Surge counter with integral leakage current monitor.
3. By-pass shunt with connection provision.
4. Clamp type bimetallic terminal connectors.
5. Ground terminals.
6. Grading ring, if necessary.
7. Other standard accessories which are not specifically mentioned but are usually provided with Lightning Arrester of such type and rating for efficient and trouble-free operation.

5.13.8.1 OTHER REQUIREMENTS:

i. All switchyard structure should be lattice mild steel structure hot dip galvanized.

ii. All the buses should be adequately sized for fault and continuous current requirement.

iii. For 33kv bus, suitably supported single “Moose” conductor will be used in each phase.

iv. The bus bar fittings, connectors etc will be of suitable aluminium alloy having desired mechanical strength and electrical properties.

v. The contractor shall be fully responsible for carrying out all co ordination and liaison work with electrical inspectors and other statutory bodies for implementation of the work, as and when required.

vi. The relay for the switchgear units shall have all the features as specified under **Cl. no. 5.13.11** of, Sec-V of the Technical Specification.

vii. The scopes which are mentioned above are only for indicative purpose only. The contractor to supply all equipment which are also required for successful completion of the work.

5.13.8.2 Approval

Before starting manufacturing any equipment, the contractor shall have to take approval of relevant drawings and data from the purchaser.

5.13.8.3 OTHER REQUIREMENTS:

- All switchyard structure should be lattice mild steel structure hot dip galvanized.
- All the buses should be adequately sized for fault and continuous current requirement.
- For 33kv bus, suitably supported single “Moose” conductor will be used in each phase.
- The bus bar fittings, connectors etc will be of suitable aluminium alloy having desired mechanical strength and electrical properties.
- The contractor shall be fully responsible for carrying out all co ordination and liaison work with electrical inspectors and other statutory bodies for implementation of the work, as and when required.
- The relay for the switchgear units shall have all the features as specified under Cl. no. 5.13.11 of, Sec-V of the Technical Specification shall also be considered.
- The scopes which are mentioned above are only for indicative purpose only. The contractor to supply all equipment which are also required for successful completion of the work.
- 33 kV Switchyard shall be provided with fencing as per IE rule. Fencing shall be properly earthed according grounding stipulation mentioned elsewhere in this specification. Necessary doors shall be provided in the fencing with road connectivity for entry and exist of equipment.

- Bidder has to do all the necessary retrofitting jobs of existing 33 kV Switchyard while integrating new 132 /33 kV transformer and 33 kV New feeder coming from Solar Plat as per detail engineering.

5.13.8.4 Approval

Before starting manufacturing any equipment, the contractor shall have to take approval of relevant drawings and data from the purchaser.

5.13.8 STATION AUXILIARY TRANSFORMER

5.13.8.1 SCOPE

This section covers the activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at Project site, storage, erection, testing, commissioning of 33 / 0.415 kV Oil type one number station auxiliary transformers and associated equipment as detailed hereunder.

Capacity of Transformer shall not be less than 400 kVA.

The scope of supply shall also include necessary spares required for normal operation & maintenance of transformers for a period of 5 (five) years & special tools & plants required for erection & maintenance. Corresponding parts of all the equipment & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

The transformers and associated equipment shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

5.13.8.2 STANDARDS

The equipment and materials covered by this specification shall conform to the latest edition of following Indian Standards or equivalent IEC standards except where specified otherwise in this specification:

Sl. No.	Standards	Description
1	IS: 2026 (Part I to IV) /IEC 76	Power Transformer
2	IS: 2099/IEC 137	Transformers bushings

Sl. No.	Standards	Description
3	IS: 2705/IEC 185	Current transformers
4	IS: 1180	Three phase distribution transformer
5	IS: 6088	Dimensions for porcelain transformer bushings
6	IS: 3347	Loading guide for oil-immersed transformers
7	IS: 335	Transformer oil
8	CBIP No. 295	CBIP Manual on Transformers Publication

Equipment meeting with other authoritative standards which ensure an equal or better quality is also acceptable. Where the equipment conforms to any other authoritative standard, the salient points of difference between the standard adopted and IS/IEC shall be clearly brought out in the tender. Complete set of documents and standards in English shall be supplied by the bidder without any extra charge. It shall, however, be ensured that equipment offered comply with one consistent set of standards except in so far as they are modified by the requirement of this specification.

5.13.8.3 TECHNICAL REQUIREMENTS

- Bidder shall provide Baffle walls to meet the Statutory and TAC requirement.
- HT side of the transformer shall be connected to the 33 kV Bus through an indoor VCB and LT side shall be terminated to the Station Service Board (SSB)/ 415 V LT Switchgear.
- SAT shall be installed at the Transformer Yard adjacent to the Inverter Duty Transformer as per TAC guideline.
- The transformer shall be able to perform satisfactorily under voltage variation limit of +/- 10 % and frequency variation limit of +/- 5 %.
- Vector group of the transformer shall be Dyn11
- Off Circuit Tap changer (-10% to +10% @1.25% steps) shall be provided with the transformer. Owner will take final decision regarding this based on the proposal submitted by the contractor.
- % Impedance, type of bushing, class of insulation, temperature rise etc. shall be as per relevant Indian Standard.

- The transformers shall be suitable for co-ordination and integration with SCADA System and necessary contacts and/or ports for the purpose shall be provided.
- Earthing arrangement of the transformers shall be provided as per the relevant Indian Standard.
- Necessary protection arrangement like should be provided in the transformer.
- Construction of different parts of the transformer shall conform to the latest edition of relevant Indian Standard.
- Fittings and accessories shall be provided as per relevant Indian Standard code.
- Transformer oil shall conform to latest edition of IS 335.
- 415V side of the transformer shall be terminated through cable with the new extended section of the LT Switchgear.

5.13.8.4 APPROVAL

The Detailed Design Report Submitted by the contractor to WBPDCL must contain but not limited to the following details of the transformers:

- Detailed specification
- Fittings and Accessories
- Necessary Drawings shall contain but not limited to the following:
  - Outline dimension drawings of transformers and fittings/accessories
  - Assembly drawings and weight of main components.
  - Transport drawings, showing main dimensions and weight of each package.
  - Foundation details
  - Tap-changing equipment
  - Name-plate diagrams
  - Schematic control and wiring diagrams for all aux. equipment etc.
- Tools and spare parts etc.
- Type Test Reports and certificates etc.

A joint inspection and testing will be done by owner and the authorized representatives of the contractor at the manufacturer's workshop, if desired so by the owner. Testing will be done as per relevant IS Code.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Test Reports for routine and acceptance tests etc.

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBPDCL.

5.13.8.5 SIZING CRITERIA FOR TRANSFORMER

Sizing of LT Transformer shall take into consideration of following aspects:

a) Maximum continuous running load of operation i.e. according to the maximum demand at most stringent condition.

b) Lighting, Ventilation & other on line equipment in service.

c) Loads like receptacles not to be considered.

d) 20% design margin over maximum consumed power shall be considered.

f) Transformers shall be provided with Two 160 kW Motor Feeder where one running and standby.

5.13.8.6 TEST

- **Type test:**
  During detailed engineering, the contractor shall submit all the type test reports including temperature rise test and surge withstand test carried out within last ten years from the date of LOA of this project for Owner's approval.
- **Routine test:**
  All routine tests shall be carried out in accordance with IEC 60076 (part 1 to 3).

5.13.9 LT SWITCHGEAR

5.13.9.1 SCOPE

The scope of work under this specification covers the design, manufacture, assembly, testing at manufacturer's works, transportation, transit insurance, delivery at site, storage, installation, testing, and commissioning of indoor type following 415V LT Switchgear complete with all accessories and spares.

The Scope shall include supply of 415 V (3 phase, 1 neutral and single phase for lighting etc.) transmission line (all Al conductor) for the entire area from the LT switchgear at both site with necessary breaker, switch fuse unit as and when required, Boards as above along with gland plates for all power and control cables, base frames, special tools i.e. operating handles, trolley necessary for removing the circuit breakers for maintenance etc. Isolators should be provided

in the line to connect or isolate the connection from both the station auxiliary transformer.

The scope shall include all associated devices, components, relays, contactors, switches etc. required for satisfactory operation of the switch boards as per the proposed logic control scheme. The scope of supply shall also include necessary spares required for operation & maintenance of switchgear equipment for a period of 5 (five) years & special tools & plants required for erection & maintenance.

Corresponding parts of all the equipment & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

Table for new 415 kV LT Switchgear

Sl	Description	Quantity
1.	Incoming feeder (ACB)	2 Nos, (630 A Capacity).
2.	Bus-coupler	1 No. (630 A Capacity).
3.	Outgoing ACB operated Fire water Pump source (Motor feeders) of capacity 160 kW each	2 nos. (1R + 1S)
4.	Outgoing feeders	as per load list
5.	Draw out type Line PT and Bus PT	One no. each bus section.

5.13.9.2 STANDARDS

The equipment covered under this chapter shall comply with the requirement of latest edition of following IS/BS/IEC specifications as amended up to date except where specified otherwise.

Sl. No.	Standards	Description
1	IS: 13947 (Part 1 to 5)	Specification for Low-Voltage Switchgear and Control gear.
2	IS: 10118 (Part 1 to 4)	Code of practice for selection, installation and maintenance of switchgear & control gear.
3	IS: 1248	Specifications for Electrical Indicating Instruments
4	IS: 2633	Hot dip Galvanizing

5	IS: 2705	Current Transformers
6	IS: 3156	Voltage Transformers
7	IS: 3231	Electrical Relays for Power System Protection
8	IS: 5082	Wrought Aluminium and Aluminium Alloy bars, tubes and sections for electrical purposes.
9	IS: 8623	General requirement for factory built assemblies up to 1000V.
10	IS: 8828	Circuit breakers for over current protection for household and similar installations
11	IS: 13703	Low Voltage fuses for voltages not exceeding 1000V AC
12	IS: 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.

Equipment meeting any other authoritative national or international standards that ensure equal or better quality than the standards mentioned above are also acceptable. Where the equipment conforms to any other standards than those mentioned above, salient points of difference between the standards adopted and standards mentioned above shall be brought out in the tender.

The electrical installation shall meet the requirement of Indian Electricity rules and other statutory regulations as amended up to date and relevant BIS code of practice.

5.13.9.3 TECHNICAL REQUIREMENTS

- Main Incoming A.C. circuits on Station service Board shall be controlled through microprocessor based numerical relay with draw out type Air Circuit Breaker. Type and capacity of the breakers shall be proposed by the bidders in their bid considering the total auxiliary load of the plant.
- The LT switchgears shall be suitable for indoor installation in the control room.
- LT switchgears shall be placed in each site control room and shall be connected to each other by means of 415 V (3 phase, neutral) transmission line along the whole area. LT switchgear at main control room shall be connected with Station Auxiliary Transformer 1 (as mentioned in the chapter "Station Auxiliary Transformer") and LT switchgear of a local control room placed at a suitable distance away from the Main Control Room shall be connected with Station Auxiliary Transformer 1 (as mentioned in the chapter "Station Auxiliary Transformer").
- The Station Service Board shall be sectionalized in two parts through sectionalizing breakers of equivalent capacity and protection of incomers on the bus to ensure continuity of supply to the auxiliaries in case of

failure/fault on one section. This Switchboard shall be considered as two Incomers and one Bus-coupler method with a castle key interlock.

- For interconnection with various boards and all outgoing feeder circuits, 50 kA, 3 pole draw-out type MCCBs with adjustable current setting shall be provided.
- The Air Circuit Breakers, Boards etc. shall have at least the following ratings:

o No. of phases	:	Three
o Rated voltage	:	1.1 kV
o Service voltage	:	415 V ± 10%
o Frequency	:	50 Hz. ± 5%
o Rated short time current rating switchgear	:	50 kA for 1 sec. for bus &
o Normal control voltage	:	220V DC
o Degree of Protection	:	IP 42 or higher

- The following equipment at LT switchgear shall be monitored from SCADA /DCS.

  1) All Air Circuit breaker – On & Off status, test, service, spring charged, TCS healthy, 86 operated, DC fail etc.

  2) All ACB - On and Off command from DCS /SCADA

  3) Energy meters

  4) Voltmeters-from transducer

  5) Ammeters-from transducer

  6) Numerical Relays should also be integrated with SCADA.

- The 415V switchboards shall be metal-enclosed draw out type, free standing, self-supporting, floor mounted, indoor type, totally enclosed and compartmentalized to house the switchgear. Circuit breakers and other switchgear components shall be arranged in compartments, vertically in a multi-tier formation. All metering and protection equipment associated with a particular circuit shall be housed in separate and independent compartment earmarked for particular circuit and in the fixed portion of the vertical panel in case of breaker panels.
- Construction of all the switchboards and equipment shall conform to the latest edition of relevant IS codes.
- All cable glands and aluminum crimping type cable lugs for all power and control cables shall be in the bidder's scope of supply. Panels shall be suitable for bottom entry of cable unless otherwise specified.

- The bidder shall indicate clearly the de-rating factors, if any, employed for each component and furnish the basis for arriving at these de-rating factors duly considering the specified current ratings, ambient temperature etc.
- The equipment shall comply with all safety requirements during erection and operation as per relevant standards.
- The neutral of the incoming transformer secondary shall be connected to the neutral bus of the auxiliary boards. The neutral shall be connected to the common earthing system of the switchyard/control room.
- All auxiliary devices for control, indication, measurement and protection such as push buttons, control and selector switches, indicating lamps, Power monitors, kWh meters and protective relays shall be mounted on the front side of the respective compartment. The design shall be such that unless required for maintenance / inspection purposes, all power ON/OFF or START / STOP and relay reset operations shall be performed without opening the panel door.
- The switchboard panels shall be provided with thermostatically controlled space heaters to prevent moisture condensation.
- Tube light / CFL lamp fittings along with necessary isolating switches shall be provided for illumination inside the panels. Each panel shall be provided with an industrial grade power socket as well.
- The 415V bus shall be of suitable cross-section so as to be able to carry the required continuous and short circuit currents within the limits of temperature rise for the site conditions.
- Control and selector switches shall be rotary type with escutcheon plates clearly marked to show the function and positions. The switches shall be of sturdy construction suitable for mounting on panel front.
- AC Distribution Board is to be provided in the main switchgear room and in the particular local control room having auxiliary transformer as per requirements.
- Instrument transformers shall be provided and shall conform to the relevant standard.
- The relay for the switchgear units shall have all the features as specified under Cl. no. 5.13.11 of, Sec-V of the Technical Specification.
- All relays shown in the drawing and others required for operation of the system as per the specification shall be included in the scope of supply. The

relays shall be of electromagnetic/ static/numerical type/ microprocessor based conforming to the requirements of IS: 8686 or IEC: 255.

- All instruments and meters shall be suitable for operation under the climatic conditions prevailing at site. The instrument cases shall be dust-proof, water tight, vermin proof, specially constructed to adequately protect the instruments against damage or deterioration due to high ambient temperature and humidity.
- The VA burden of instrument coils/elements shall be as low as possible, consistent with the best modern design.
- Watt hour meter shall be suitable for 3-Phase, 4-wire unbalanced system and shall comply generally with the requirements of relevant IS code and shall be of first grade for the purpose of accuracy classification. Watt hour meters shall be provided in each LT switchgears as well as each 33 kV switchgears.
- Panels shall be supplied completely wired internally to equipment and terminal blocks for connection to external cables entering the panel from the bottom. Terminal blocks shall be complete and provided with necessary terminal accessories for cable ends.
- Engraved PVC labels shall be provided on incoming and all outgoing breaker compartments, the exact details of legend to be engraved shall be furnished later to the contractor.
- All vertical cubicles shall be connected to earth bus bar running throughout the length of the switchboard. All doors and movable parts shall be connected to the earth-bus with flexible copper connections. Provision shall be made to connect the earthing bus bar to the main earthing grid at two ends. All non-current carrying metallic parts of the mounted equipment shall be earthed. Earthing bolts shall be provided to ground cable armours.
- Finishing work like painting etc. for switchgears should be as per relevant IS.

5.13.9.4 APPROVAL

The Detailed Design Report submitted by the contractor to WBPDCL must contain but not limited to the following details of the LT Switchgear:

- Detailed specification of all the items.
- All necessary drawings
- All necessary test certificates and approvals etc.

Prior to the delivery of the product, the contractor shall submit but not limited to the following documents:

- Guarantees
- Instructions for installation and operation, manual
- Electrical diagrams
- Safety precautions
- Detailed schematics of all power instrumentation and control equipment and subsystems along with their interconnection diagrams. Schematics shall indicate wiring diagrams, their numbers and quantities, type and ratings of all components and subsystems etc

The contractor can deliver the product to the site only after receiving such approval against their prayer in writing from WBPDCL.

5.13.10 DC BATTERY, BATTERY CHARGING EQUIPMENT & DCDB

5.13.10.1 SCOPE

The scope of work under this specification covers the design, manufacture, assembly, testing at manufacturer"s works, transportation, transit insurance, delivery at site, storage, installation, testing, and commissioning of D.C equipment comprising of 220 V D.C Battery Bank Plante type of suitable designed capacity complete with battery charging equipment, D.C. Distribution Board and other auxiliary equipment.

The equipment shall be offered in strict compliance with the same.

a) 220V DC station battery for Plant Water System of Plante Type: Two (02) sets.

b) 220V Dual Float cum boost battery charger (2 x 100% Float Cum Boost Charger) : Two (02) sets.

following equipment/item shall also be provided:

i. One DCDB with two Incomer and one bus-coupler.

ii. DC fuse board at output of each battery with Fuse monitoring relay, indication facility.

iii) Tools and tackles.

The scope shall include all associated devices, components, relays, contactors, switches etc. required for satisfactory operation of the DC equipment as per the proposed logic control scheme.

The scope of supply shall also include necessary spares required for normal operation & maintenance of DC equipment for a period of 5 (five) years and special tools & plants required for erection & maintenance.

Corresponding parts of all the equipment & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the