

220KV GIS and Pothead yard of 240 MW Heo Hydro Electric Project, Arunachal Pradesh.		Technical Specification
		Volume II Section-I
		Sub Sec. 2 Pothead Yard Equipment

Volume-II

Section I Sub-Section 2 Pothead Yard Equipment

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1. POTHEAD YARD EQUIPMENTS

1.1. Scope

This specification covers the design, manufacturing or manufacture co-ordination, testing at manufacturer's works, ex-works supply, loading at manufacturer's works, insurance, transportation, and destination store delivery, erection testing & commissioning of following equipment along with their accessories for 220 kV pothead yard near Power House. All the required accessories, documents & equipment whether specified herein or not shall be in the scope of the bidder.

The scope shall also include supply of special tools & plants required for the erection, testing and commissioning of 220 kV pothead yard equipment and also supply of mandatory spares required for maintenance of supplied equipment for five years trouble free operation. The manufacturer shall also recommend the additional spares required for efficient and trouble-free operation of the pothead yard:

The pothead yard is planned to include two-line bays: one outgoing line to Tato-1 HEP, one outgoing line to kaying PS, and two future bays.

Pothead Yard Equipment (for each bay):

- i) Disconnecter with Earth Switches;
- ii) Capacitive voltage Transformers;
- iii) Surge Arresters;
- iv) Line Trap;
- v) Bus Post Insulators;
- vi) Pothead yard Structures;
- vii) Conductor;
- viii) Fencing.

All equipment/ components shall be suitable for operation at an altitude above 1000m above MSL.

1.2. Standards

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

The equipment to be furnished under this specification shall conform to latest issue with all amendments of standard specified under respective Chapters of the specification.

In addition to meeting the specific requirements called for in the respective sections of the

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Technical Specification, the equipment shall also conform to the general requirement of the relevant standards, which shall form an integral part of the specification.

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

The Bidder shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.

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

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

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

Disconnecter & Earth Switches		
IS: 9920 (P1 to P4)	:	Specification for switches and switch Isolator Switches for voltage above 1000V
IS: 9921 (Part-1)	:	Specification for alternating current disconnecter and earthing
IS: 9921 (Part-2)	:	Specification for alternating current disconnecter and earthing switches for voltages above 1000 V (Rating)
IS: 9921 (Part-3)	:	Specification for alternating current disconnecter and earthing switches for voltages above 1000 V (Design & construction)
IS: 9921 (Part-4)	:	Specification for alternating current disconnecter and earthing
IS: 13947 (P1 to P3)	:	Specification for low voltage switchgear and control gear
IEC: 60	:	High voltage test technique
IEC: 71	:	Insulation co-ordination
IEC: 129	:	Alternating current disconnectors and earth switches
IEC: 168	:	Tests on indoor and outdoor post insulators of ceramic material or glass for system voltage greater than 1000V
IEC: 265 (Part1&2)	:	High voltage switches
IEC: 62271-001	:	High Voltage Switchgear and Control gears
IEC: 62271-100	:	High Voltage alternating current disconnectors and earthing switches
IEC: 62271-104	:	High Voltage switches for rated voltages of 52 kV and above

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IEC: 273	:	Characteristics of indoor and outdoor post insulators for systems with nominal voltage greater than 1000V
IEC: 439	:	Low voltage switchgear and control gear assemblies
IEC: 507	:	Artificial pollution test on high voltage insulators to be used on ac
IEC: 694	:	Common specification for high voltage switchgear and control gear standards
IEC: 815	:	Guide for the selection of insulators in respect of polluted conditions
IEC: 947	:	Degree of protection provided by enclosures
IEC: 1129	:	Alternating current earthing switches: induced current switching
Capacitive Voltage Transformer		
IS: 5	:	Shade 697 Colour of Ready Mixed paint & enamels
IS: 335	:	Insulating Oil for CVT
IS: 613	:	Copper rods and bars for electrical purposes
IS: 2071 (Part 1)	:	Method of High Voltage Testing : General Definition & Test Requirement
IS-2071 (Part 2)	:	Method of High Voltage Testing : Test Procedures
IS: 2099	:	Bushing for alternating voltages above 1000V
IS: 2147	:	Degree of protection provided by enclosure of low voltage switchgear and control gear
IS: 2629	:	Recommended practice for hot dip galvanizing on iron & steel
IS: 3156 (Part-I)	:	Specifications for potential transformers: General Requirements
IS: 3156 (Part-II)	:	Specifications for measuring potential transformers
IS: 3156 (Part-III)	:	Specification for protection potential transformers
IS: 3716	:	Application guide for insulation co – ordination
IS:4146	:	Application guide for Voltage Transformers
IS: 4800 (Part 1)	:	Enameled round winding wires
IS: 5039	:	Distribution pillars for voltage not exceeding 1000 V AC and 1200 V DC
IS: 5561	:	Electric power connectors
IS: 5621	:	Hollow insulators for use in electrical equipment
IS: 8623	:	Low voltage switchgear and control gear assemblies
IS: 10601	:	Dimensions for terminals for high voltage switchgear and control gear

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IS: 11322	:	Method of partial discharge measurement in instrument transformers
IEC-358	:	Coupling Capacitor & Capacitor divider
IEC: 44-2	:	Instrument Transformer: Part 2 – Inductive Potential Transformer
IEC: 44-3	:	Instrument Transformer: Part 3 – Combined Instrument Transformer
IEC: 44-4	:	Instrument Transformer: Part 4 – Measurement of Partial Discharge
IEC: 44-5	:	Instrument Transformer: Part 5 – Capacitor Voltage Transformer
IEC-71-1	:	Insulation Coordination Part 1 – Definition principles and rules
IEC-71-2	:	Insulation Coordination Part 2 – Application Guide
ANSI-C5713	:	Requirements of Instrument Transformer
ANSI C 92.2	:	Power line Coupling Voltage Transformer
ANSI C 93.1	:	Requirements for Power Line Carrier Coupling capacitor
IEC: 44-2	:	Instrument Transformer: Part 2 – Inductive Potential Transformer
IEC: 44-3	:	Instrument Transformer: Part 3 – Combined Instrument Transformer
IEC: 44-4	:	Instrument Transformer: Part 4 – Measurement of Partial Discharge
IEC: 60	:	High Voltage Test Technique
IEC-71-1	:	Insulation Coordination Part 1 – Definition principles and rules
IEC-71-2	:	Insulation Coordination Part 2 – Application Guide
IEC: 137	:	Insulated Bushings for alternating current above 1000V
IEC: 186	:	Specification for potential transformers
IEC:439	:	Low voltage switchgear & control gear assemblies
NEMA CC1	:	Electric power connectors
Surge Arresters		
IS : 3073 (Part-III) (1993)	:	Lightning arresters for alternating current systems: Metal oxide lightning arresters without gaps
IS: 722	:	Electrical relays for power system protection
IS: 1248	:	Electrical relays for power system protection
IS: 3231	:	Electrical relays for power system protection

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ANSI-C62.1	:	IEE Standards for Surge Arresters for AC Power circuits
NEMA-LA 1	:	Surge Arresters
IEC99-4	:	Surge Arresters Part 4 - Metal oxide surge arresters without gaps
IEC99-5	:	Surge Arresters Part 5 – Selection & application recommendations
ANSI-C39	:	Electric Measuring instrument
ANSI-C83	:	Components for Electric Equipment
Wave Trap		
IS: 8792 (1994)	:	Line traps for AC power system
IS:8793 (1978)	:	Methods of tests for Line traps
IS:3070-Part I (1974) / IEC-99-I (1970)	:	Part Lightning arrestor for A.C. system
IS: 5561	:	Electrical Power Connectors
IS: 3231 Part 1/Sec-2	:	Insulation test of electric relays for Power system protection
IS: 5802 / IEC: 96- 2	:	Flexible coaxial radio frequency Cables with characteristic impedance 75 ohm
IEC-353 (1989)	:	Line traps for A.C. power system
IEC: 71-1	:	Insulation Coordination Part 1 – Definition principles & rules
IEC: 71-2	:	Insulation Coordination Part 2 – Application guide
IEC: 358	:	Coupling Capacitors & Capacitor Divider
IEC: 481	:	Coupling Devices for Power line Carrier Systems
Insulators		
IS: 209-1997	:	Specification for Zinc
IS: 731-1996	:	Porcelain insulators for overhead Power lines with a nominal voltage greater than 1000 V
IS: 2004-1991	:	Specification for carbon steel forging for general engineering purpose
IS: 2071 Part (I)-1993	:	Methods of High Voltage testing: General definitions and test procedures
IS: 2071 Part (III)-1996	:	Methods of High Voltage testing: Measuring devices
IS: 2486	:	Specification for Insulator fittings for overhead Power Lines with a nominal voltage greater than 1000 V
IS: 2544-1996	:	Specification for Porcelain Post Insulators for Systems with nominal voltage greater than 1000 Volts

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IS: 2629 - 1998	:	Recommended Practice for Hot, Dip Galvanization for iron and steel
IS: 2633-1998	:	Testing of Uniformity of Coating of zinc coated articles
IS: 3188-1999	:	Dimensions for Disc Insulators
IS: 6745-1998	:	Determination of Weight of zinc coating on zinc coated iron and steel articles.
IS: 7814-1996	:	Specification for Phosphor bronze sheet, strips & foils coated iron and steel articles.
IS: 8263-1999	:	Methods of RI Test of HV insulators
IS: 8269-1990	:	Methods for switching impulse test on HV insulators
IEC: 273	:	Dimensions of indoor and outdoor post insulator units for systems with nominal voltages greater than 1000V
IEC: 383-1993	:	Tests on insulators of Ceramic material or glass for overhead lines with a nominal voltage greater than 1000 V
IEC: 433	:	Characteristics of string insulator units of the long rod type
IEC: 575	:	Thermal Mechanical Performance test and mechanical performance test on string insulator units.
IEC: 797-1984	:	Residual strength of string insulator units of glass or ceramic material for overhead lines after Mechanical Damage of the Dielectric
IEC: 815 – 1986	:	IEC: 815 – 1986
Hardware Fittings		
IS: 209-1997	:	Specification for Zinc
IS: 398-1996 Part-I	:	Specification for Aluminium Conductors for Overhead Transmission Purposes
IS: 398-1996 Part-II	:	Aluminum Conductor Galvanized Steel Reinforced
IS: 617-1999	:	Aluminium and Aluminium Alloy ingots and castings for general engineering purpose
IS: 739-1996	:	Wrought Aluminium and Aluminium wire for general engineering purposes
IS: 731-1996	:	Porcelain insulators for overhead power lines with a Nominal voltage greater than 1000 V
IS: 800-1998	:	Code of practice for general construction in steel

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IS: 1521-1991	:	Method of Tensile Testing of Steel Wire
IS: 1573-1986	:	Electroplated Coating of Zinc on Iron and Steel
IS: 2004-1991	:	Carbon steel Forgings for general engineering purposes
IS: 2016-1996	:	Specifications for plain washers
IS: 2062-1999	:	Steel for general structural purposes
IS: 2121	:	Specification for Conductor and earth wire accessories for Overhead Power lines
IS: 2486	:	Specification for Insulator Fittings for overhead Power Lines with Nominal Voltage greater than 1000 V
IS: 3188-1999	:	Dimensions for Disc Insulators
IS: 4759-1999	:	Hot dip zinc coatings on structural steel and other allied products
IS: 4826-1998	:	Galvanized Coating on Round Steel
IS: 5082-1998	:	Wrought Aluminium and Aluminium Alloy bars, rods, tubes and sections for electrical purposes
IS: 6051-1999	:	Code for designation of Aluminium and its alloys
IS: 6603-2001	:	Stainless steel bars and flats
IS: 6639-1995	:	Hexagonal Bolts for Steel Structures
IS: 6745-1998	:	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles
IS: 7814-1996	:	Phosphor Bronze steel and strip
IS: 8263-1999	:	Method of Radio Interference Tests on High Voltage Insulators
IS: 9708-1999	:	Specification for Stock Bridge Vibration Dampers for power head Power Lines
IS: 9567-2001	:	Specifications for tin or tin lead coated copper wire
IS: 10162-1996	:	Specification for Spacers & Dampers for Twin Horizontal Bundle Conductors
IS: 14329-1996	:	Malleable iron castings
IEC: 372-1984	:	Locking devices for ball and socket couplings of string insulator units Dimensions and tests
IEC: 61897-1998	:	Requirements and tests for Stockbridge type aeolian vibration dampers
ASTM: D1171	:	Test method for rubber deterioration- surface ozone cracking outdoors or chambers conductor

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Conductors		
IS: 209-1997	:	Specification for zinc
IS: 398-1996, Part -I	:	Specification for Aluminium Conductors for Overhead Transmission Purposes
IS: 398-1996, Part-II	:	Aluminium Conductor Galvanized Steel Reinforced
IS: 1521-1991	:	Method of Tensile Testing of Steel Wire
IS: 1778-1980	:	Reels and Drums for Bare Conductors
IS: 2629-1998	:	Recommended Practice for Hot Dip Galvanizing of Iron and Steel
IS: 2633-1998	:	Method of Testing Uniformity of Coating on Zinc Coated Articles
IS: 4826-1998	:	Galvanized Coating on Round Steel Wires
IS: 6745-1998	:	Methods of Determination of Weight of Zinc Coating of Zinc Coated Iron and Steel Articles
IS: 8263-1999	:	Method of Radio interference Tests on High Voltage Insulators
IS: 5561-1982	:	Specification for Electric Power Connectors
Structures		
IS: 802(Part-I)- 1977	:	Code of Practice for use of structural steel in over head transmission line Towers: Loads, materials,
IS- 802(Part-I,sec.-2) 1992	:	permissible stresses
IS- 802(Part-II) 1991	:	Fabrication, galvanising, inspection and packing
IS: 808-1976 Part – V Part - VI	:	Specification for Rolled Steel Beams, Channel and Angle Sections, Equal Leg Angles, Unequal Leg Angles
IS: 875-1992	:	Code of Practice for Design loads (other than earthquakes) for buildings and structures
IS:1200-1992 (part-1)	:	Method of Measurement of Building and Civil Engineering Works: Earthwork
IS:1340-1977	:	Chromatic conversion coating on Zinc and cadmium coated articles and zinc base alloys
IS-1363-1992	:	Hexagonal head bolts, screws and nut of product grade C
IS-1367	:	Technical supply conditions for threaded steel fasteners
IS:1489-1991.	:	Pozzolana cement.
IS:1573-1986	:	Specification for Electro-Plated Coating for Zinc on Iron and steel

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IS: 1893-1984.	:	Criteria for Earthquake Resistant Design of Structures.
IS:2016-1996	:	Specification for Plain Washers.
IS:2062-1999	:	Specification for weldable structural steel.
IS:2629-1998	:	Recommended Practice for Hot-Dip Galvanizing of iron and steel
IS:2633-1998	:	Methods of Testing Uniformity of Coating on Zinc Coated Articles.
IS:3043-1991	:	Code of practice of earthing
IS:3063-1994	:	Specification for Single Coil Rectangular Section, Spring Washers for Bolts, Nuts & Screws
IS:4091-1995	:	Code of Practice for Design and Construction of Foundations for Transmission Line Towers and Poles
IS:4759-1999	:	Specification for Hot-Dip Zinc Coating on Structural Steel and Other Allied Products
IS:5358-1969/ IS: 1367 (Part 13)	:	Specification for Hot Dip Galvanize Coating to Fasteners.
IS:6610-1996.	:	Specification for Heavy Washers for Steel Structures.
IS:6639-1995	:	Specification for Hexagonal Bolts for Steel Structures.
IS: 6745-1998.	:	Specification for Methods for Determination of Weight of Zinc Coating on Zinc Coated Iron and Steel Articles.
IS:7215-1991	:	Specification for Tolerance for Fabrication of Steel Structures.
IS: 7205-1991	:	Safety code of erection of structural steel work
IS: 10238-1989	:	Step Bolts for Steel Structures

1.3. Disconnectors & Earth Switches

1.3.1.Design Criteria

Disconnectors and earthing switches shall be in accordance with IS: 9921 & IEC 62271-102 including all amendments. The 220 kV disconnectors shall be of the center or double break type equipped with motorized drive. Manual operation shall be possible in case of emergencies. The disconnectors shall be mounted on a common support and operated three-phase by a common operating mechanism.

The disconnector poles shall be so coupled mechanically as to ensure synchronism of the switching motions under all conditions. The disconnectors shall be designed for the specified rated currents.

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They shall be suitable for off-load isolation at the maximum permissible continuous operating voltage and capable also of withstanding the short circuit forces specified.

All disconnectors shall be electrically interlocked (solenoid type) with the corresponding circuit breakers (**if required**). Furthermore, they shall be interlocked (mechanically and electrical solenoid) with their associated earthing switches in such a manner as to allow the disconnector to be closed only if the corresponding earthing switches are open and to allow the earthing switch to be closed only if the corresponding disconnectors are open. In addition, the line earthing switches shall only be allowed to close if a no-volt relay connected to the line CVT's signalize a dead OHL (the relay shall be connected to the same CVT core as the distance protection to make use of the fuse failure relay).

The disconnectors and earthing switches shall have the necessary number of auxiliary contacts for the control circuits, which shall easily be convertible from normally closed to normally open and vice versa. Minimum 5 NC + 5 NO contacts shall be available as spare for use of Employer. Auxiliary switches on the frame of disconnectors & earth switches shall be suitably protected against accidental arcing from the main contacts.

All fittings, accessories or apparatus which may not have been specifically mentioned in this specification but are necessary for the satisfactory working of disconnector Switches and earth switches shall be deemed to have been included in the scope of supply. All equipment shall be complete in all details whether such details are mentioned in this specification or not.

Disconnectors and earth switches shall be capable of withstanding the dynamic and thermal effects of the maximum possible short circuit current of the system in their closed position. They shall be constructed such that they do not open accidentally under influence of specified short circuit current.

The disconnectors shall be capable of making / breaking normal current when no significant change in voltage occurs across the terminals of each pole of disconnector on account of make/break operation.

The earthing switches shall be capable of discharging trapped charges of the associated lines.

1.3.2.Operation of Disconnectors and Earth Switches

Three phase disconnectors and earth switches shall be gang operated for 245 kV. The operating mechanism of the three poles shall be well synchronized and interlocked. Bidders offering gang operated disconnectors or earth switches shall submit the details of their experience with gang operated disconnectors with 4.5 m pole spacing along with the justification for the rating of drive in the additional information schedule.

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The design shall be such as to provide maximum reliability under all service conditions. All operating linkages carrying mechanical loads shall be designed for negligible deflection.

The manual operating handle shall have provision for padlocking. The operating handle shall be located at a height of 1000 mm from the base of disconnector support structure.

All rotating parts shall be provided with grease packed roller or ball bearings in sealed housings designed to prevent the ingress of moisture, dirt or other foreign matter. Bearings pressure shall be kept low to ensure long life and ease of operation. Locking pins wherever used shall be rustproof.

Signaling of closed position shall not take place unless it is certain that the movable contacts, will reach a position in which rated normal current, peak withstand current and short time withstand current can be carried safely. Signaling of open position shall not take place unless movable contacts have reached a position such that clearance between contacts is at least 80% of the isolating distance.

The position of movable contact system (main blades) of each of the disconnectors and earthing switches shall be indicated by a mechanical indicator at the lower end of the vertical rod of shaft for the disconnectors and earthing switch. The indicator shall be of metal and shall be visible from operating level.

The bidder shall furnish the details along with quality norms, during detailed engineering stage as under:

- Current transfer arrangement from main blades of disconnector along with main voltage drop immediately across transfer point;
- Details to demonstrate smooth transfer of rotary motion from motor of box to the insulator along with stoppers to prevent over travel.

1.3.3.Key Interlocks

The disconnectors shall be provided with a key interlock system that shall prevent any accidental operation of the switch under load. The key interlock shall permit switch operation only when the related circuit breaker is in the opened position.

1.3.4.Constructional Features of Disconnectors

The features and construction details of Horizontal center or double break type with open by jerk type disconnectors, earth switches and accessories shall be in accordance with requirements stated hereunder.

1.3.5.Main Contacts:

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- The contact system shall be made out of electrolytic grade copper. Arcing contacts wherever provided shall close first & open last. The contact surface shall be silver plated with a minimum coating up to 20 -25 microns & shall be made with suitable zig to avoid deviations during production.

All Isolators shall have heavy duty, self-aligning and high-pressure line type dust-free jaw contacts made of high conductivity, corrosion resistant, hard-drawn electrolytic copper strips of proper thickness and contact area. Fixed contact should consist of loops of above copper strips suitable for 3150 Amps ratings for 220 KV Isolators. The hard drawn electrolytic copper strips should be silver plated 25micron thickness and fixed contacts should be backed by powerful phosphor bronze/stainless steel springs of suitable numbers. The main contacts should be preferably of tulip type design. However, the thickness and contact area of the contact should conform to the drawing approved during type test. Moving contact with moving arm should be of hard- drawn electrolytic copper of proper thickness and contact area.

These fixed and moving contacts shall be able to carry the rated current continuously and the maximum fault current of 50 KA for for 3 seconds without any appreciable rise in temperature. The Isolator blades shall retain their form and straightness under all conditions of operation including all mechanical stress arising out of operation as well as under rated short circuit condition.

- The male & female contact assembly shall be of suitable and proven design;
- The contacts shall be self-aligning and self-cleaning and so designed that binding cannot occur after remaining closed for prolonged periods of time in a heavily polluted atmosphere;
- No undue wear or scuffing shall be evident during the mechanical endurance tests. Contacts and spring shall be designed so that readjustments in contact pressure shall not be necessary throughout the life of the disconnecter or earthing switch. Each contact or pair of contacts shall be independently sprung so that full pressure is maintained on all contacts at all time;
- Contact springs shall not carry any current and shall not loose their characteristics due to heating effects.

1.3.6. Auxiliary Contacts

Each disconnecter Switch shall be provided with minimum ten (10) N.O. and ten (10) N.C. contacts auxiliary contacts for Employer's use. The contacts shall be rated at 10 A at 220 V DC. The contacts shall be individually adjustable in the "make before break" or "break before make" fashion. Auxiliary contacts shall be fail safe and tamper proof. Auxiliary switches shall not be

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used as limit switches. Details of make, rating and type of limit switch shall be furnished in the offer.

1.3.7.Base

Each single pole of the disconnecter shall be provided with a complete galvanized steel base provided with holes and designed for mounting on a supporting structure.

1.3.8.Blades

All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic copper. Bolts, screws and pins shall be provided with lock washers, keys or equivalent locking facilities. All bolts, screws, pins, keys and lock washers if provided on current carrying parts, shall be made of copper silicon alloy or stainless steel or equivalent. The bolts or pins used in current carrying parts shall be made of non-corroding material. All ferrous castings if any, shall be made of malleable cast iron or cast-steel. No grey iron shall be used in the manufacture of any part of the disconnecter.

The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shields shall be provided. Corona shields / rings etc. shall be made up of aluminium / aluminium alloy.

Disconnectors and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism.

Disconnectors shall be designed such that no lubrication of any part is required except at very infrequent intervals. Lubrication shall be required only after every 1000 operations or after 5 years whichever is earlier.

In the three-pole operation of the disconnectors, all the three poles should operate simultaneously. There shall not be any time gap between the opening/closing the contacts of all the three poles. If there is any such discrepancy in the operation of the disconnecter, it shall be indicated as the discrepancy in the C & R Panel located in the control room.

1.3.9.Mounting of Contacts

Fixed contacts shall be mounted on a block or channel welded to 8 -10 mm. thick MS plate with holes for fixing on disconnectors. Slots shall be provided for marginal adjustment of height of contacts. The contacts shall rest on a brass block and with initial tension. Suitable device shall be provided to prevent dashing. Fabrication welding shall be done in suitable zig to avoid deviations during production.

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1.3.10. Bearing

Rotating insulator shall be mounted on housing with bearings. The housing shall be made of gravity die cast metal with smooth surface and suitably machined for seating the bearing. Two (2) Nos. of bearing with adequate diameter & distance between the bearing shall be provided to avoid wobbling during the operation. The bearing, bushes, joints, springs etc. shall be so designed that no lubrication is required during the service of the disconnector. Complete details of bearing, bushes, joints, springs etc. shall be furnished with the tender documents.

1.3.11. Balancing of Height

Fixed insulators shall be provided with elevator base plate with four studs for balancing of heights of disconnectors for rated voltage. Thickness of plate & diameter of stud shall be at least 10 mm & 25 mm respectively. Adequate no. of nuts, locknuts & washers shall be provided. Taper washer shall be provided to match inclined surface of steel sections.

1.3.12. Earthing Switches

Where earthing switches are specified these shall include the complete operating mechanism and 5 Nos. each of NO & NC auxiliary contacts for the Employer's use in future.

The earthing switches with operating mechanism and auxiliary contacts shall form an integral part of the disconnector and shall be mounted on the base frame of the disconnector.

Earthing switches shall be locally operated.

The earthing switches shall be motor operated & shall be constructionally interlocked with the disconnector so that the earthing switches can operate only when the disconnector is open and vice versa.

The constructional interlocks shall be built in construction of disconnector and shall be in addition to the electrical and mechanical interlocks provided in the operating mechanism.

Each earth switch shall be provided with flexible Copper braids for connection to earth terminal. These braids shall have the same short time current carrying capacity as the earth blade.

The plane of movement and final position of the earth blades shall be such that adequate electrical clearances are obtained from adjacent live parts in the course of its movement between ON and OFF position.

The frame of each disconnector and earthing switches shall be provided with two reliable earth terminals for connection to the earth mat.

Disconnector design shall be such as to permit addition of earth switches at a future date. It

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should be possible to interchange position of earth switch to either side.

The earth switch should be able to carry the same fault current as the main blades of the disconnectors and shall withstand dynamic stresses.

The earth switches shall also comply with the requirements IEC: 1129 in respect of induced current switching duty as defined for Class - B earthing switches.

1.3.12.1. Operating Mechanism of Earth Switches

The bidder shall offer motor operators for both disconnectors and earth switches. However, these motor operator switches shall also permit manual operation.

Limit switches for control shall be fitted on the disconnector / earth switch shaft, within the cabinet to sense the open and close position of the disconnectors and earth switches.

After final adjustment, no part of the mechanism shall be capable of displacement at any point during its travel to an extent that could cause improper operation of the disconnector during opening or closing at any operating speed.

All holes in cranks, linkage etc. having moving pins shall be drilled accurately so as to maintain the minimum amount of slack and lost-motion in the entire mechanism.

➤ Control Cabinets / Operating Mechanism Box

- All the controls shall be mounted in enclosed Control cabinets / operating mechanism box with IP: 55 degree of protection. It should be possible to operate the disconnector only after opening the cabinet. Provision shall be made in the control cabinet to disconnect power supply to prevent local / remote operation in the form of a LOCAL – DISTANCE Selector.

➤ Motor

Motor shall be a 415 V AC, 3 phases conforming to the requirements of relevant Indian Standards / International Standard & as per requirements specified in General Technical Requirements. The supplier shall get the make of the assembled parts & the equipment approved from the Employer. The rating of motor shall have sufficient overload capacity. Calculation shall be approved by the Employer. The motor shall, in all other respects, conform to the requirement of I.S. 325. Suitable relay/device shall be provided to prevent over loading of the motor. Single phase preventer (for 3 phase meter) shall be provided to operate on open circuiting of any phase and shall trip off the motor. Complete details of the devices shall be furnished in the offer.

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➤ GEAR

- Suitable reduction gearing shall be provided between the motor and the drive shaft of the disconnecter. The mechanism shall stop rapidly when motor supply switches off. If necessary a quick electro-mechanical brake shall be fitted on the higher speed shaft to effect rapid braking;
- Gear should be of forged material suitably chosen to avoid ending/ jamming on operation after a prolonged period of non-operation. Also, all gear and connected material should be so chosen / surface / treated to avoid rusting;
- Manual operation facility should be provided with necessary interlock to disconnect motor;
- Motor operated mechanism shall be subjected to blocked rotor test as sample test / type test at no extra cost to Employer.

➤ SPACE HEATER

- Space heaters suitable for 1 phase 240V AC supply shall be provided for each motor operated operating mechanism to prevent condensation and shall be operated by MCB.

➤ TERMINAL BLOCK AND WIRINGS

- Each operating mechanism shall be provided with 1100V grade ring type terminal block. All auxiliary switches, spare contact of the contactors, interlocks and other terminals shall be wired up to terminal block. The terminal block shall have at least 20% extra terminals. All wiring shall be carried out with 1.1KV grade PVC insulated 2.5 sq.mm. copper wires.

➤ CONTROL AND AUXILIARY SUPPLY:

- A 3-phase switch with MCB for phases and link for neutral, shall be provided for power supply and a 2 pole MCB shall be provided for control supply.

1.3.13. Tests

In continuation to the requirements stipulated under GTR, disconnecter along with its earthing switch and operating mechanism shall conform to type test and shall be subjected to routine tests and acceptance tests in accordance with IS: 9921 (Part– IV) / IEC:129. Minimum 50 nos. mechanical operations shall be carried out on one (1) disconnecter out of every ten (10) disconnecter Switches assembled completely with all accessories, as acceptance test for the lot.

1.3.13.1. Type Tests

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- In continuation to the requirements stipulated under GTR, disconnecter along with its earthing switch and operating mechanism shall be subjected to the following type tests as specified in the latest edition of IS: 9921 (Part-IV)/IEC:129 in presence of Employer's representatives, if so desired by the Employer. The equipment shall be subjected to routine tests in accordance with IS: 9921/IEC: 129;
- During the type test the disconnecter shall be mounted on its own supports & installed with its own operating mechanism to make the type tests representative;
- Drawing of equivalent support structure if any & mounting arrangements made for type tests shall be furnished for Employer's approval before conducting the type tests;
- The type tests shall be conducted on the disconnecter Switches along with the approved insulators & terminal connectors;
- Mechanical endurance test shall be conducted on completely assembled disconnecter pole as well as earth switch of each type;
- Opening and Closing of switch under adverse condition, including with accumulation of at least 25 mm of ice.

1.3.13.2. Normal Type Test

- Surge impulse test
- Power frequency voltage test as per IS: 2071 (Part-2)
- Test on auxiliary and control circuits
- Temperature rise tests of main circuit (for disconnecter Switches only)
- Temperature rise tests of auxiliary circuits
- Measurement of resistance of main circuit
- Short time withstand and peak withstand current tests
- Test for short circuit making performance of earth switch
- Operating and mechanical endurance test

1.3.13.3. Special Type Test

- Test for satisfactory operation at minimum and maximum temperature limits
- Artificial pollution test

1.3.13.4. Routine / Acceptance Tests

Following Routine tests as per IS: 9921(Part IV) / IEC: 129 shall be carried out on each disconnecter in the presence of Employer's representative. Minimum 50 nos mechanical operations will be carried out on one disconnecter assembled completely with all accessories, as acceptance test.

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- Power frequency voltage dry test on the main circuit
- Voltage tests on auxiliary and control circuit
- Measurement of resistance of main circuit
- Mechanical operating test

1.3.13.5. Site Tests

All routine tests including 50 operation tests, except power frequency dry voltage withstand test on disconnector shall be repeated on completely assembled disconnector of each type at site.

1.3.14. Testing and Commissioning

An indicative list of tests on disconnector and earth switch is given below. Bidder shall perform any additional test based on specialties of the items as per the filed Q.P./instructions of the equipment supplier or Employer without any extra cost to the Employer. The Bidder shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

- Insulation resistance of each pole.
- Manual and electrical operation and interlocks.
- Insulation resistance of control circuit and motors.
- Contact resistance
- Proper alignment to minimize extreme possible vibration during operation.
- Measurement of operating and interlocks coils.
- Functional check of the control schematic and electrical & mechanical interlocks.

1.3.15. Technical Parameters for 220 disconnector Switches

S. No	Particulars	Details
1.	Type	Outdoor, 3 phase type
2.	Temperature range	-10 deg.C to +50 deg.C
3.	Operation	center or horizontal double break
4.	Rated Frequency	50 Hz.
5.	System neutral earthing	effectively grounded
6.	Normal system voltage	220 kV _{rms}
7.	Highest System Voltage	245 kV _{rms}
8.	Basic Insulation level	

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S. No	Particulars	Details
a)	Lightning impulse withstand voltage i) between line terminal and ground ii) between terminals with disconnector open	1050* kV _p 1050* kV _p
b)	Power frequency withstand voltage i) between line terminal and ground ii) between terminals with disconnector open	460* kV _{rms} 460* kV _{rms}
9.	Max. radio interference voltage for freq. between 0.5 MHz and 2 MHz at 156 kV _{rms} in all positions of the equipment	1000 μV
10.	Operating time	2 Cycles
11.	Rated normal current (for disconnector only) at rated ambient temperature	3150 A
12.	Rated short time withstand current of disconnector and earth switch	50 kArms for 1 sec.
13.	Temperature rise over design ambient temperature	As per Table-4 of IS:9921 Part-2
14.	Rated mechanical terminal load	As per Table-7 of IS:9921 Part- 2
15.	Operating mechanism of disconnector and earth switch	AC motor operated at 415 V, single phase, 50Hz
16.	Control voltage	220 V DC
17.	Auxiliary contacts:	
a)	Continuous thermal rating	10A at 220 V DC
b)	Breaking capacity	2A DC with circuit time constant not less than 20ms.
18.	No. of auxiliary contacts on each disconnector	10 NO + 10 NC contacts wired to terminal block.
19.	No. of auxiliary contacts on each earthing switch	5 NO + 5 NC contacts wired to terminal block.
20.	Number of terminals in control cabinet	All contacts and control circuits are to be wired up to control cabinet plus 20% spare terminals evenly distributed.

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S. No	Particulars	Details
21.	Creepage distance of insulators	31mm/kV
22.	Phase to phase spacing	4500* mm
23.	Ground Clearance	5500* mm (Min.)
24.	Mechanical Endurance	Class M2

*- The adequate consideration for temperature rise, insulation level, clearances etc., as per Lightning Overvoltage / insulation coordination study, at higher altitude (greater than 1000 meters) and ambient temperature shall be taken care by the Contractor.

1.4. Capacitive Voltage Transformers

1.4.1. Construction Features

The features and constructional details of Capacitor Voltage Transformers shall be in accordance with requirements stipulated hereunder:

- Capacitor voltage transformers shall be suitable for connecting the carrier terminals to double circuit transmission line for voice communication, protective relaying, data transmission and telemetering services. They shall be of wide band designed to pass all frequencies between 40 kHz to 500 kHz. The natural frequency of capacitors used for carrier frequency shall be appreciably higher than the carrier frequency range indicated above;
- Each capacitor voltage transformer shall be suitable for connection directly to the line without the use of auxiliaries such as isolating switches or fuses. The capacitors of the unit shall be so designed that the application of impulse voltage shall not damage the internal working elements or cause a change in their electrostatic capacitance;
- The primary and secondary capacitors shall be housed in entirely sealed off and oil filled porcelain insulator to eliminate breathing and prevent air and moisture entering the assembly. Provision shall however be made to accommodate the expansion and contraction of oil;
- The magnetic type intermediate transformer shall be of oil immersed and self-cooled design and shall be suitable for metering, relaying and synchronizing services. The core of this transformer shall be of high grade, non-ageing, cold rolled, laminated, electrical silicon steel of low hysteresis loss and high permeability so as to ensure high accuracy at normal and high over-voltage. The primary winding shall be connected through a compensating reactor between phase and neutral with the neutral point solidly grounded. An oil level gauge and metal bellows are provided to compensate for the variation in volume of oil because of changes in temperature or a pressure relief device capable of releasing internal pressures shall be provided;

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- CVTs shall be suitable for high frequency (HF) coupling, required for power line carrier communication. The carrier signal must be prevented from flowing into potential transformer (EMU) circuit by means of a RF choke/reactor, suitable for effectively blocking the carrier signal over the entire carrier frequency range i.e. 40 to 500 KHZ. Details of the arrangement shall be furnished along with the bid. HF terminal of the CVT shall be brought out through a suitable bushing and shall be easily accessible for connection to the coupling devices of the carrier communication equipment, when utilized. The bushing shall be fully protected against rain and vermin so as to avoid the possibility of short circuits to earth. An earthing link with fastener shall be provided for HF terminal. Test tap for Tan- delta and capacitance shall be provided
- Fuses shall be provided on secondary side of CVT in the secondary box. A removable gland plate of adequate size shall be provided at the bottom of the box for cable terminations;
- Bellows, if used to cater for expansion of insulating oil, shall be tested in accordance with relevant standards. The details shall be subject to the approval of the purchaser.
- A protective surge Arrester/spark gap shall be provided to prevent break down of insulation by incoming surges and to limit abnormal rise of terminal voltage of shunt capacitor/primary winding, tuning reactor/RF choke etc. due to short circuit in transformer secondaries. Surge arrester shall be provided in the secondary winding also.
- The design of capacitors shall generally be based on the following requirements:
 - ❖ Comparatively low specific voltage between capacitor foil;
 - ❖ Low dielectric loss over a wide frequency band;
 - ❖ Low variation of capacitance due to changes of temperature;
 - ❖ Very high natural frequency;
 - ❖ Corona free design of terminal connectors to keep the noise level of carrier frequency link low;
 - ❖ Low stray capacitance to ground to reduce the carrier frequency energy losses in the neighborhood of carrier connection;
 - ❖ High mechanical strength porcelain and its fastenings to ensure that it is resistant against bending stresses which might occur at the site;
 - ❖ Design of the potential unit of the CVTs shall be based on the following requirements in connection with protective relaying;
 - ❖ They must transmit accurately sudden drops of primary voltages;
 - ❖ The measuring errors on the three phases of a set of CVTs should not exceed ± 10 minutes and these should be matched in accuracy;
 - ❖ The CVT must not enter into sub-harmonic resonance and transient oscillations during

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energization;

- ❖ They must have sufficiently low short-circuit impedance as seen from secondary;
- ❖ They shall be suitable for rapid reclosing service.
- ❖ It shall be ensured by the bidder in the offer that the connection of carrier, frequency coupling device across the CVT will not affect the designated accuracy class of the CVT windings.

1.4.2. Transient Response

The design of CVT shall satisfy all standard requirements of the transient response during a primary short-circuit as per latest issue of IEC-186. Following a short-circuit of the supply at primary and earth terminals, the secondary output voltage of a capacitor voltage transformer shall decay within one cycle of rated frequency to a value less than 10% of the peak value before short-circuit.

1.4.3. Ferro-Resonance and Damping Device

Each capacitor voltage transformer shall be provided with suitable damping device so that the Ferro resonance oscillations due to saturation of iron core of transformer or of any inductance by either over voltage on the network side or any opening of the short circuited primary or secondary voltage which may arise as a result or break down of primary voltage due to short-circuits shall not affect the proper working of protective relays.

The design of the compensating reactor and the intermediate transformer as well as of the additional damping devices inserted in the secondary of intermediate transformers shall be such that the phenomenon of Ferro resonance cannot occur. This shall further conform to provisions contained in latest issue of IEC-186. The damping device shall have no influence on the metering properties under normal conditions.

1.4.4. Stray Capacitance and Conductance

The terminal design and arrangement in respect of the CVT shall be so chosen that even under adverse atmospheric conditions, the stray capacitance and conductance of the low voltage terminal with respect to the earth terminal shall not be higher than 200pF and 20micro-siemens respectively.

1.4.5. Temperature Rise

Maximum temperature attained by any part of the equipment when in service at site under full load conditions and exposed continuously to the direct rays of sun at 50°C shall not exceed the permissible limits fixed by latest edition of IEC-186 when connected for the difference in ambient temperature given in IEC-186. The correction for temperature rise shall be stated in the tender

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and shall be subject to the approval of the Employer. The temperature rises at 1.1 times rated primary voltage when applied continuously at rated frequency and rated burden shall not exceed the limits specified above and the temperature rise at 1.5 times primary voltage when applied for 30 seconds shall not exceed the temperature limits specified in latest issue of IEC-186.

1.4.6.Porcelain Housing

The insulating casing of the CVT shall be made of wet process electrical porcelain, free from cavities and other flaws and properly vitrified. The porcelain and porcelain housing shall conform to an authoritative standard which shall be specified by the bidder in his tender. The shell design shall be such as to minimize surface contamination by natural action of wind, fog and rains. The CVT shall be hermetically sealed with oil resistant and weather proof gaskets.

1.4.7.Earth Connection

Low Voltage terminal shall be earthed with distinct earthing pad on the tank for system grounding and tank shall be earthed separately with another earthing stud with proper earth sign for safety purpose. It shall be possible to connect to earth in a reliable way any metal parts or termination of the CVT which are at earth potential in normal service. Capacitor shack shall be earthed through the line matching unit when provided.

1.4.8.Metal Parts

All ferrous parts of CVTs shall be heavily hot dip galvanized. Bolts, nuts, screws, pins, washers etc used on these equipment shall also be galvanized. All current carrying parts shall be designed to eliminate sharp points, edges and sharp faces. The galvanizing shall conform to the relevant IEC.

1.4.9.Marshalling Boxes

The marshalling boxes including cable glands for terminating multicore control cable and power cables shall be provided wherever required and regroup each set of CVT. The supply shall include necessary connecting materials for mounting of the cable boxes on the respective equipment. Mounting of the cable boxes shall be in accessible positions clear of the floor level to make the jointing work easy. The marshalling boxes shall be provided with switches to isolate the circuits.

1.4.10. Tests

1.4.10.1. Type Tests

Each Capacitor Voltage transformers shall be subjected to the following type tests as specified in the latest edition of IEC-358 and 186 / IS: 3156 in presence of Employer's representatives, if so

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desired by the Employer. The equipment shall be tested as per IEC / IS and shall be subjected to routine tests in accordance with IEC 44-1 / IS : 2705 and IEC 186 / IS : 3156 respectively.

- High frequency capacitance and equivalent series resistance measurement.
- Stray capacitance and stray conductance measurement of low voltage terminals.
- A.C. voltage test, dry and wet between terminals.
- Discharge test
- Determination of temperature coefficient.
- Short circuit withstand capability test
- Determination of errors.
- Cantilever test
- Surge impulse voltage test.
- Temperature rise test.
- Ferro resonance test.
- Transient response test.

The following additional type tests are also proposed to be conducted, whose price shall be quoted along with other type tests as per IS and IEC in the relevant schedule:

- Switching impulse voltage test procedure as per IEC-60
- Radio interference test - As per IS: 8263

1.4.10.2. Routine Tests

The capacitor voltage transformer shall be subjected to the following routine as per IEC: 186, IEC: 44-1 / IS: 2705 and IEC 358/IS: 3156. All the test reports shall be submitted and shall be got approved from the Employer before dispatching the equipment.

- Capacitance measurement at power frequency before and after high voltage test.
- Capacitor loss measurement test before and after high voltage test.
- A.C. voltage test between the low voltage terminals and the earth terminals.
- A.C. voltage test between the terminals.
- Sealing test.
- Verification of terminal marking.
- Power frequency withstand test on secondary windings.
- Power frequency withstand test between sections.
- Power frequency withstand test on primary windings.
- Partial discharge measurement.
- Determination of errors.

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The following additional routine test shall also be conducted along with the other routine test as per IEC/IS in the relevant schedule.

- High voltage inter test - As per BS: 3938.
- Oil leakage test.
- Measurement of tan delta at 0.3,0.7, 1.0 and 1.1 $U_m/3$
- Natural frequency of capacitor unit determination (Resonant frequency of capacitor units).

1.4.11. Testing and Commissioning at Site

An indicative list of tests is given below. Bidder shall perform any additional test based on specialties of the items as per the field Quality Plan/instructions of the equipment supplier or Employer without any extra cost to the Employer. The Bidder shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.

- Insulation resistance test for primary and secondary;
- Polarity test;
- Dielectric test of oil;
- Secondary winding resistance measurement.

1.4.12. Technical Parameters For 245 kV CVT

S. No.	Particulars	Details
1.	Rated primary voltage (kV rms)	220
2.	Rated frequency	50Hz
3.	System neutral earthing	Effective earthed
4.	System fault level	50 KA for 1 sec.
5.	Type	Single phase capacitor VT
6.	No. of secondaries / No of Core	3
7.	Rated voltage factor	1.2 –continuous 1.5 - 30 seconds
8.	Phase angle error	± 10 minutes (For metering core)
9.	Capacitance (pf)	4400/6600/8800 (as applicable) + 10% 5%
10.	Standard reference range of frequencies for which the accuracies are valid	96% to 102% for protection and 99% to 101% for measurement

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11.	High frequency capacitance for entire carrier frequency range.	within 80% to 150% of rated capacitance
12.	Equivalent series resistance over the entire carrier frequency range	Less than 40 ohms.
13.	Stray capacitance and stray conductance of the LV terminal over entire carrier frequency range	As per IEC: 358
14.	One Minute Power Frequency withstand voltage i) Between LV (HF) ii) For secondary winding	10 kV (rms) for exposed terminal and earth Terminal and 4 kV (rms) terminal for terminal enclosed in a weatherproof box. 3 kV (rms)
15.	Maximum temperature rise over design ambient Temperature.	As per IEC: 186
16.	Number of terminals in control Cabinet	All terminals of control circuits wired upto marshalling box plus 20% terminals spare.
17.	Partial discharge level	10 pico Coulombs (max)
18.	Highest System Voltage	245 KV
19.	Basic Insulation Level (BIL)	1050* KVp
20.	Power Frequency Withstand Voltage	460* KV
21.	Radio Interference voltage at 156 kV (rms)	1000 micro volts (max.)
22.	Creepage distance of Insulators	31mm/kV
23.	Rated Voltage Factor	1.9-30 sec.
24.	Phase spacing	4500* mm
25.	Ground clearance to live parts	5500* mm (Min.)

*- The adequate consideration for temperature rise, insulation level, clearances etc., as per Lightning Overvoltage / insulation coordination study, at higher altitude (greater than 1000 metres) and ambient temperature shall be taken care by the Contractor.

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CVT Rating:

	Application	Voltage Ratio	Accuracy class	Output burden (VA)
Core-I	Metering.	220KV/Sqrt3/110/Sqrt 3	0.2	30
Core-II	Protection	220KV/Sqrt3/110/Sqrt 3	3 P	30
Core-III	Protection	220KV/Sqrt3/110/Sqrt 3	3 P	30

** Output burden (VA) is tentative and shall be finalized during detail engineering.

DOCUMENT:

The supplier shall furnish four sets of following drawings/documents along with his offer.

- ❖ General outline and assembly drawings of the Inductive Voltage Transformers/ Capacitive
- ❖ Voltage Transformers.
- ❖ Sectional views showing:
 - i) General constructional features.
 - ii) Materials/gaskets/sealing used.
 - iii) The insulation of the winding arrangements, method of connection of primary/secondary winding to the primary/secondary terminals etc.
- ❖ Schematic drawing.
- ❖ Rating & diagram plate as per relevant IEC/ISS (e)Secondary Terminal Box.
- ❖ Assembly Sectional view of Primary terminal/capacitor voltage divider
- ❖ Assembly drawing for secondary terminal
- ❖ The detailed dimensional drawing of Porcelain Housing such as ID, OD, thickness and insulator details such as height, profile of petticoats, angle of inclination and gap between successive petticoats, total creepage distance etc.
- ❖ Sectional view of pressure release device.
- ❖ Drawing showing details of Oil level.
- ❖ All type test reports relating to the tests as specified above.
- ❖ Ratio and phase angle error curves for IVTS/ CVTS
- ❖ Magnetization characteristic curves such as B-H curves and Sp. Loss vs. Flux density curves for core material, used for IVT & EMU unit of CVT.
- ❖ Sectional view of EMU unit of 220KV&132KV CVT.
- ❖ Schematic diagram showing the working of CVT in PLCC.

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1.5. Surge Arresters

1.5.1.Design Criteria

The surge arrester shall conform to IS 15086 Part-4 / IEC: 60099-4 except to the extent modified in the specification.

Arresters shall be hermetically sealed unit, self-supporting construction, suitable for mounting on tubular support structure to be supplied by the bidder.

The surge arresters shall be capable to operate satisfactorily in a temperature range varying from - 30°C to +50°C.

The surge arresters shall be of heavy-duty station class and gapless type without any series or shunt gaps.

The reference current of the arrester shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

The surge arrester shall be suitable for circuit breaker duty cycle in the given system. It shall be thermally stabilized to take care of the site condition and direct solar radiation.

The surge arrester shall be capable of withstanding meteorological and short circuit forces under site condition.

The surge arresters shall provide protection to the following equipment whose insulation level are indicated in the table given below:

Equipment to be protected	Lightening impulse (kVp) for 220 kV system
Instrument transformers	+/- 1050*
Disconnectors	+/- 1050*
Across open contacts	+/- 1050*

*- The adequate consideration for temperature rise, insulation level, clearances etc., as per Lightning Overvoltage / insulation coordination study, at higher altitude (greater than 1000 meters) and ambient temperature shall be taken care by the Contractor.

The duty cycle of circuit breakers installed in 220 kV system of the Employer shall be 0- 0.3 sec. - CO - 3 min - CO. The lightening arrester shall be suitable for such circuit breaker duties in the system.

1.5.2.Constructional Features

The surge arrester shall have non-linear, metal oxide resistors connected in series or in parallel without any integrated series or parallel spark gaps.

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The non-linear block shall be provided in such a way as to obtain robust construction with excellent electrical and mechanical properties even after repeated operation.

Each Surge Arrester shall be fitted with pressure relief devices for relieving internal pressure of the arrester and prevent violent shattering of the housing following prolonged passage of the fault current or internal flash over of the arrester.

The arrester shall not fail due to arrester porcelain contamination.

Seals shall be provided in such a way that these are always effectively maintained even when discharging rated lightning current.

Porcelain housing shall be so coordinated that external flash over will not occur due to application of any impulse or switching surge voltage upto the maximum design value of arrester.

The end fitting shall be made of nonmagnetic and corrosion proof material and preferably be nonmagnetic.

The nameplate shall carry the name of the manufacturer /trade mark, type and year of manufacturing. The nameplate shall confirm to the requirement of relevant IEC.

The heat treatment cycle details along with necessary quality checks used for individual blocks along with insulation layer formed across each block are to be furnished.

The bidder shall furnish data for rejection rate of ZnO blocks during manufacturing / operation for last three years.

The Surge Arresters shall be suitable for giving satisfactory service when the system frequency varies by $\pm 5\%$ from normal 50Hz.

1.5.3.Fittings & Accessories

Surge arresters shall be complete with insulating base having provision for bolting to the flat surfaces of the structure. Self-contained discharge counters, suitable enclosed for outdoor use and requiring no auxiliary or battery supply for operation shall be provided for each single pole unit along with necessary connection. Suitable leakage current meters should be supplied within the same enclosure. The reading of leakage current meter counters shall be visible through an inspection glass panel. The terminals shall be robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The design of the surge monitor shall be such that it is possible to tilt the surge monitor downwards by an angle of up to 45 degrees from Horizontal plane. There shall be a provision for putting ammeter to record the current/alarm contacts suitable for communication to SCADA in the control room if the leakage current exceeds the permitted value. Similar provision shall be considered for surge

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counter also.

Surge monitor consisting of Discharge counters and millimeters should be suitable to be mounted on support structure of the arrester and should be tested for IP: 55 degree of protection. The standard supporting structure for surge arrester should be provided with a standard mounting pad, for fixing the surge monitor. The surge monitor should be suitable for mounting on this standard mounting pad. Also, all nuts, bolts, washers etc. required for fixing the surge monitor shall have supplied by the Bidder.

Grading / corona rings shall be provided on each complete arrester unit as required. The Bidder shall supply suitable terminal connectors.

1.5.4.Tests

Surge arresters offered shall be type tested as per latest IEC: 99-4 / IS: 3070(part 3) and shall be subjected to routine and acceptance tests in accordance with IEC document. In the switching surge operating duty test, the samples shall be pre heated to 70°C prior to application of long duration surges for contamination test procedures outlines in ANSI- 062-11-1987 may be followed until IEC brings out alternate test procedure for the same.

1.5.4.1. Type Tests

The following type tests shall be conducted on each type of surge arrester

- Insulation withstand test
- Residual voltage test
- Long duration current impulse withstand test
- Operating duty test
- Pressure relief test
- Artificial pollution test
- Temperature cycle test
- Porosity test
- Galvanizing test

The following additional type tests are proposed to be conducted whose price shall be quoted along with other type tests as per IEC - 99 in the Price Schedules.

- Radio interference voltage test:
- Contamination test.
- Temporary over voltage withstand test (procedure to be mutually agreed).

Bidder shall submit type test procedures along with the bid. Each metal oxide block of surge

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arresters shall be tested for the guaranteed specific energy capability in addition to the routine / acceptance test as per IEC -99.

1.5.4.2. Acceptance Test

- Measurement of power frequency reference voltage of arrester units.
- Surge Impulse Residual Voltage on arrester units.
- Internal Ionization or partial Discharge test.

1.5.4.3. Special Acceptance Test

- Thermal stability test on three sections (IEC 7.2.2)
- Aging & Energy Capability test on block (procedure to be mutually agreed).
- Watt loss test.

1.5.4.4. Routine Tests

- Measurement of Reference test
- Residual voltage test of arrester unit.
- Internal Ionization test or partial discharge test.
- Sealing test.
- Vertically check on completely assembled Surge arrester as a sample test on each lot.

1.5.4.5. Test on Surge Monitors

The Surge monitors shall also be connected in series with the test specimens during residual voltage and current impulses withstand tests to verify efficacy of the same. Additional routine / functional tests with one 100 A and 10 kA current impulse, (8/20 micro sec.) shall also be performed on the Surge monitor.

All routine tests shall be conducted on the hollow column insulators as per IEC - 233. The following additional tests shall be carried out on Insulators:

- Ultrasonic test as a routine test.
- Pressure test as a routine test.
- Bending load test in 4 directions at 50% specified bending load as a routine test.
- Bending load test in 4 directions at 100% specified bending load as a routine test.
- Burst pressure test as a sample test on each lot.

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1.5.5. Technical Parameters for Surge Arrester

S. No.	Particulars	Details
1.	Maximum continuous operating voltage (MCOV)	198 kV _{rms}
2.	Nominal System Voltage (Un)	220 kV
3.	Highest System Voltage	245 kV
4.	Frequency	50 Hz
5.	Rated Arrester voltage (Ur)	212 KV
6.	Lightning impulse withstand voltage for insulation	1050* kVp
7.	Power frequency withstand voltage for insulation	460* kV _{rms}
8.	Creepage distance	31mm/kV
9.	System fault current	50 kA
10.	Discharge current at which insulation coordination is done	20 KA of 8/20 μ s wave
11.	RIV (Radio Interference Voltage) at 156 kV	Less than 500 micro volts
12.	Nominal discharge Current	20 KA of 8/20 μ s wave
13.	Energy Capability	10.8 kJ/kV of Ur
14.	Short-circuit/Pressure relief capability	50 kA symmetrical
15.	Ambient temperature	-10 deg. C to +40 deg. C
16.	Long duration discharge class	4
17.	System neutral earthing	Effectively earthed

*- The adequate consideration for temperature rise, insulation level, clearances etc., as per Lightning Overvoltage / insulation coordination study, at higher altitude (greater than 1000 metres) and ambient temperature shall be taken care by the Contractor.

1.6. Line Traps

1.6.1. Design Criteria

Wave Trap shall be inserted into high voltage transmission lines to prevent undue loss of carrier signal power in the range of 30 kHz to 500 kHz under all power system conditions and to minimize interference from carrier signaling system on adjacent transmission lines. Its impedance shall be negligible at power frequency (50 Hz) so as not to disturb power transmission but shall be relatively high over the frequency band appropriate to carrier transmission.

Line trap shall be broad band tuned for its entire carrier frequency range. Resistive component of impedance of the line trap within its carrier frequency blocking range shall be adequate for 220 kV systems.

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The surge arrester provided with the line trap of each rating shall fully comply with the requirements of IS: 3070-Part I (1974) / IEC-99-I (1970) Part I. It shall conform to type tests as applicable and type test certificate for the same shall be submitted by the Bidder.

The surge arrester provided with the line trap shall be subject to routine and acceptance tests as per IEC-99-1 (1970) (Part-I).

Line trap shall conform to IEC 353 (latest) fulfilling all technical requirements. The rated short time current for 1 Second shall be 50 kA

The self-resonant frequency at which the combination of true inductance and self-capacitance becomes resonant shall always be higher than 500 kHz except for line traps having a rated inductance greater than 0.5 mH where it may not be possible to achieve such a high frequency because of the physical construction of the main coil. However, the value of minimum blocking resistive component shall be less for small inductance of the coil for the same frequency range. Therefore, the mH rating shall be 0.5 or 1.0 mH depending on frequency plan and techno-economical considerations. The bidder shall indicate continuous current rating of the line trap at 40 deg. C ambient. The asymmetrical peak value of the first half-cycle of the short-circuit current shall be 2.55 times the rms steady state short circuit current. The bidder shall indicate tapping loss in the GTPs. The rated voltage of the arrestor shall be 10% greater than the voltage developed across the main coil. Corona rings shall be provided.

1.6.2. Construction Details

Line trap shall consist of a main coil in the form of an inductor designed to continuously carry the rated current without exceeding the limit of temperature rise. It shall be supplemented with a protective device and tuning device. The tuning device connected across the main coil ensures, with proper adjustment, that the line trap presents relatively high impedance at the carrier frequency band while its impedance is negligible at power frequency.

Tensile strength of suspension system:

The suspension system of a line trap shall be designed for a tensile stress of at least twice the mass of the line trap in kilograms, multiplied by 9.81 to convert to newtons, plus 5000 N.

1.6.3. Tuning Device

Each line trap shall be broad band tuned for its blocking range of 30 kHz to 500 kHz.

The tuning device shall consist of capacitors, inductors and resistors connected across the main coil as required. All of these components may not be present at one time, which will depend on the carrier frequency requirements of the line trap. The tuning capacitors and resistors shall have

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high stability, low losses and a high withstand test voltage. All capacitors shall be tested with 50Hz voltage at a value higher than the firing potential of the surge arrester with a good margin. The test shall have duration of one minute and during this the condensers shall be checked for glow free operation.

1.6.4.Coordination with Existing Equipment

The Line traps shall be installed at the generating end. Line traps and Coupling devices shall be mount in the pothead yard and PLCC terminal equipment shall be installed in the pothead yard control-room. Bidder shall also be responsible for collecting all the necessary information / data from pooling sub-station from concerned authority for the installation of the equipment.

1.6.5.Over Voltage Protection

Line trap shall be provided with a protective device in the form of modern surge arresters which shall be designed and arranged such that neither significant alteration in its protective function nor physical damage shall result from either temperature rise or the magnetic field of the main coil at continuous rated current or rated short time current The protective device shall neither enter into operation as a result of the power-frequency voltage developed across the line trap by rated short-time current nor shall it remain in operation after a response to a transient over-voltage which is immediately followed by the power frequency voltage developed across the line trap by the rated short time current. The protective device shall be shunt connected to the main coil and tuning device. The inherent leakage capacitance of the surge arrester itself shall be taken into account for the design of the tuning unit.

The surge arrester shall be station class that employs the extremely non-linear metal oxide varistors. The surge arresters shall be specifically designed for operation in the strong magnetic field which prevail inside of the Line Trap. In particular, they shall not contain any unnecessary metal parts in which the magnetic field would induce eddy currents and cause an inadmissible temperature rise.

Its rated discharge current shall be equal to or greater than that of station arresters installed behind the line trap i.e. 10 kA or more. Co-ordination, however, shall be done by taking 20 kA at 8/20 micro-sec. discharge current into account. The rated voltage of this arrester shall be 10% greater than the voltage developed across the coil under short circuit condition as per clause 10.1 of IEC 353-1983.

All ferrous parts of the line traps shall be heavily hot dipped galvanized.

Line trap shall be spray painted with light grey paint (shade 631-of IS:5).

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1.6.6. Tests

1.6.6.1. Type Tests

The following type tests as per latest IEC-353 shall be performed on each type of line trap in presence of the Employer's authorised representative and test reports shall be approved before shipment of the equipment.

- Measurement of rated inductance of the main coil;
- Measurement of power frequency inductance of the main coil;
- Measurement of blocking impedance/resistance and blocking impedance;
- Measurement of tapping loss and tapping loss based on blocking resistance;
- Measurement of temperature rise (Employer reserves the discretion to get the following type tests conducted at the cost of Bidder/ supplier);
- Insulation tests;
- Impulse voltage test;
- Power frequency dielectric withstand test on tuning device;
- Short time current test;
- Measurement of main coil true inductance (at 100 Hz and 100 kHz);
- Spark over test of auxiliary protection devices;
- Measurement of tuning device component values.

The following additional type tests are also proposed to be conducted on line traps along with other type tests mentioned in IEC-353.

- Corona Extinction Voltage Test;
- Radio Interference Voltage Measurement.

Procedure for these tests shall be mutually agreed.

1.6.6.2. Routine Tests

The line traps shall be subject to the following routine tests as per IEC-353

- Measurement of rated inductance of the main coil.
- Measurement of power frequency inductance of the main coil
- Measurement of blocking resistance and blocking impedance
- Measurement of tapping loss and tapping loss based on blocking resistance
- Power frequency voltage test on tuning device.

The bidder must enclose with his bid the reports of type and routine tests conducted on similar

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equipment earlier as per IEC-353.

1.6.7. Terminal Connectors

The line traps shall be suitable for connection to ACSR MOOSE twin conductor/AL59 twin conductor/HTLS conductor. Necessary connector shall be supplied by the Bidder.

Line traps shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The clamps and connectors shall meet the requirements as given in General Technical Requirements.

Bird barriers: The bird barrier design shall be such that no entrance to the line trap shall admit a sphere having a diameter of 16 mm

1.6.8. Technical Parameters for Line Trap

Wave Trap shall be outdoor pedestal mounting type suitable for erection on top of the CVTs.

Wave Trap shall conform to IEC 353 fulfilling the following technical particulars:

- Temperature range -10°C to +50°C;
- Elevation < 200 m;
- Rated power frequency 50Hz;
- Rated system voltage 220Kv;
- Highest system voltage 245kV;
- Rated continuous current at 40°C ambient 800 Amp;
- Rated short time current for 1 sec. 50kA;
- Rated system frequency 50Hz;
- Asymmetric peak value of the first half wave of rated Short time current 102kA;
- Carrier frequency blocking range 30kHz to 500kHz;
- Nominal discharge current of protective device at 8/20 μ Sec 10kA;
- Minimum blocking resistance 570 Ohm;
- Type of tuning Broad Band;
- Inductance 1.0 mH or 0.5 mH;
- Tapping Loss <2.6 dB.

The Bidder shall indicate continuous current rating of the Wave Trap at 65°C ambient.

1.7. Bus Work Material, Insulators and Installation Hardware

1.7.1. Disc Insulator

The insulators for suspension and tension strings shall conform to IS: 731. Insulator hardware

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shall conform to IS: 2486.

1.7.1.1. Construction Features

Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or strain strings. Each insulator shall have rated strength markings on porcelain printed and applied before firing.

Porcelain used in insulator manufacture shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

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

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

The design of insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2629. The zinc used for galvanizing shall be of grade Zn-99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains bulky white deposits and blisters.

Bidder shall make available data on all the essential features of design including the method of assembly of discs and metal parts, number of discs per insulator string, the manner in which mechanical stresses are transmitted through discs to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength any special design or arrangement employed to increase life under service conditions.

Insulator hardware shall conform to the requirements stipulated for clamps and connectors.

Insulator hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

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1.7.1.2. Tests

The suspension and tension strings, insulator discs and hardware shall be subjected to the following type tests, acceptance tests and routine tests.

Type Tests

- Type Tests on Insulator Strings
 - Dry and wet power frequency voltage withstand test with corona control rings;
 - Surge Impulse voltage withstand test (dry) with corona control rings;
 - Corona test (dry);
 - RIV Test (Dry);
 - Mechanical strength test.
- Type Test on Disc Insulators (As per IS: 731)
 - Visual examination;
 - Verification of dimensions;
 - Visible discharge test;
 - Impulse voltage with stand test;
 - Wet power-frequency voltage withstand test;
 - Temperature cycle test;
 - Electromechanical failing load test;
 - 24 hours mechanical strength test;
 - Puncture test;
 - Porosity test;
 - Galvanizing test.

Acceptance Tests

- Acceptance Tests for Disc Insulators:
 - Visual examination;
 - Verification of Dimensions as per Cl no. 10.5 of IS: 731;
 - Temperature cycle test as per Cl no. 10.6 of IS: 731;
 - 24 hours mechanical strength test;
 - Electromechanical failing load test;
 - Puncture Test as per Cl no. 10.10 of IS: 731;
 - Porosity test as per Cl no. 10.11 of IS: 731;
 - Galvanizing Test as per Cl no. 10.12 of IS: 731;

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- Test on locking device as per IEC-372.

Routine Tests

➤ Routine Tests on Disc Insulator

- Visual Inspection as per Cl.10.13 of IS: 731
- Mechanical Routine Test as per Cl. 10.14 of IS: 731.
- Electrical Routine Test as per Cl. 10.15 of IS: 731

1.7.1.3. Technical Parameters

A. Disc Insulators

Type of insulators	Anti Fog type
Size of insulator units(mm)	255x145
Electro mechanical strength	120 kN
Creepage distance of individual Insulator units (minimum and as required to meet total creepage distance)	430 mm
Markings	Markings on porcelain printed and applied before firing
Power frequency flashover voltage	1.3 times the actual wet withstand voltage

B. Insulator String

Power frequency withstand voltage of the complete string with Corona Control ring(wet)	460* kV rms
Surge impulse withstand voltage of string with corona Control rings (dry)	±1050* kVp
Minimum corona extinction voltage level of string with Corona Control rings(dry)	156 kV rms
RIV level in micro volts of string with Corona Control rings at 156 kV(rms) for 220 kV string across 300 Ohms resistor at 1 MHz	1000(Max)
Total creepage distance of the insulator String (mm)	7595
Total no. of discs per string	15

*- The adequate consideration for temperature rise, insulation level, clearances etc., as per Lightning Overvoltage / insulation coordination study, at higher altitude (greater than 1000 metres) and ambient temperature shall be taken care by the Contractor.

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Note: For tension purpose, double insulator strings and for suspension purpose single suspension insulator string shall be used.

1.7.2. Hardware Fitting

Insulator hardware shall conform to IS: 2486, IS: 10136, IS: 2121.

1.7.2.1. Construction Features

Insulator hardware shall conform to the requirements stipulated for clamps and connectors.

Insulator hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

The tension Insulator hardware assembly shall be designed for 11500 Kg tensile load.

The tension string assemblies shall be supplied along with suitable turn buckle. Sag compensation springs if required may also be provided.

All hardware shall be bolted type.

1.7.2.2. Tests

The suspension and tension strings, insulator discs and hardware shall be subjected to the following type tests, acceptance tests and routine tests.

Type Tests

- Corona test (Dry);
- RIV Test (Dry);
- Mechanical strength test.

Acceptance Test on Hardware Fitting

- Visual Examination as per Cl. 5 & 6 of IS: 2486 (Part-I)
- Verification of Dimensions as per Cl. 8 of IS: 2486 (Part-I)
- Chemical Composition test as IS: 2486 (Part-I)
- Galvanizing/Electroplating tests as per Cl. 9.4 of IS: 2486(Part-I)
- Slip strength test as per Cl. 11.1 of IS: 2486 (Part-I)
- Shore hardness test for the Elastometer (if applicable as per the value guaranteed by the Bidder)
- Mechanical strength test for each component (including corona control rings and arcing horns):

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- The load shall be so applied that the component is stressed in the same way as it would be in actual service and the procedure as given in 3.3.1(c) above should be followed.
- Test on locking devices for ball and socket coupling as per IEC: 372

Routine Tests on Hardware Fittings

- Visual examination as per Cl. 5 & 6 of IS: 2486 (Part-I)
- Mechanical strength Test as per Cl. 11.3 of IS: 2486(Part-I)

1.7.3. Spacers, Corona Bells etc. (If Required)

Spacers shall conform to IS: 10162. The spacers are to be located at a suitable spacing to limit the short circuit forces and also to avoid snapping of sub conductors during short circuit conditions. Necessary spacers span calculation shall be provided by the Bidder during detailed engineering for the approval of Employer.

Specifications of ACSR MOOSE twin conductor/AL59 twin conductor/HTLS conductor for which these spacers are required are described separately.

1.7.3.1. Constructional Features

No magnetic material shall be used in the fabrication of spacers except for GI bolts and nuts. Only bolted type spacers should be offered.

Spacer design shall be made to take care of fixing and removing during installation and maintenance.

The design of the spacers shall be such that the conductor does not come in contact with any sharp edge.

1.7.3.2. Tests

Each type of spacers shall be subjected to the type tests, acceptance tests and routine tests as per IS: 10162.

1.7.4. Clamps, Connectors etc.

These shall conform to IS: 5561. The rated current capacity of these power connectors should not be less than 3150 Amp. The material shall conform to following tests as per IS: 5561:

1.7.5. Busbar Conductor

The Conductor shall conform to IS: 398 (part V) - 1992 except where otherwise specified herein.

The details of the conductor are tabulated below:

ACSR MOOSE twin conductor/AL59 twin conductor/HTLS conductor

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➤ The details of aluminium strand are as follows:

Minimum breaking load of strand before stranding	1.57 kN
Minimum breaking load of strand after stranding	1.49 kN
Maximum D.C. resistance of strand at 20°C	2.921 Ohms/km

➤ The details of steel strand are as follows:

Minimum breaking load of strand before stranding	12.86 kN
Minimum breaking load of strand after stranding	12.22 kN
Minimum number of twist to be withstood in torsion test when tested on a gauge length of 100 times diameter of wire	18 - before stranding 16 - after stranding

1.7.5.1. Tests

The following type, acceptance & routine tests and tests during manufacturing shall be carried out on the conductor.

Type Tests

The following type tests shall be conducted on samples of conductor. The number of samples shall be mutually agreed between Bidder and Employer.

- UTS test on stranded conductor
- Corona extinction voltage Test (dry)
- Radio Interference voltage Test (dry)
- DC resistance test on stranded Conductor
- Surface Condition test

Acceptance Tests

- Visual check for joints, scratches etc. and lengths of conductor.
- Dimensional check on steel aluminium strands)
- Check for lay ratios of layers
- Galvanising test on steel
- Torsion and Elongation test steel strands
- Breaking load test on steel and strands
- Wrap test on steel and aluminium Strands

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- DC resistance test on aluminium strands
- UTS test on welded joint of strands

Note: All the above tests except test mentioned at (i) shall be carried out on aluminium and steel strands after stranding only.

Routine Tests

- Check to ensure that the joints are as per specification.
- Check that there are no cuts, fins etc. on the strands.
- All acceptance test as mentioned above to be carried out on each coil.

1.7.6. Bus Post Insulators

The post insulators shall conform in general to latest IS: 2544, IEC-168 and IEC-815.

1.7.6.1. Constructional Features

- Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.
- All bolts and nuts shall be of steel with well-formed hexagonal heads forged from the solid and shall be hot dip galvanized. The nuts shall be good fit on the bolts and two clear threads shall show through the nut when it has been finally tightened up.

Bidder shall make available data on all the essential features of design including the method of assembly of shells and metals parts, number of shells per insulator, the manner in which mechanical stresses are transmitted through shells to adjacent parts, provision for meeting expansion stresses results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

1.7.6.2. Tests

The post insulators shall be subject to type, acceptance, sample and routine tests as per IS: 2544 and IEC-168.

In addition to acceptance/sample/routine tests as per IS: 2544 and IEC-168, the following tests shall also be carried out.

- Ultrasonic test as an acceptance test
- Soundness test, metallurgical tests and magnetic test on MCI caps and pedestal tests as acceptance test.
- All hot dip galvanised components shall be subjected to check for uniformity of thickness and

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weight of zinc coating on sample basis.

- The bending test shall be carried out at 50% minimum failing load in four directions as routine test and at 100% minimum failing load in four directions as an acceptance test.
- Acceptance norms for visual defects allowed at site and also at works shall be agreed in the Quality plan.

The post insulators shall be subjected to the following tests as per IS; 2544:

Type Tests

- Visual Examination
- Verification of dimensions
- Visible discharge test
- Impulse Voltage withstand test
- Dry Power frequency voltage withstand test
- Wet Power frequency voltage withstand test
- Temperature Cycle test
- Test for mechanical strength
- Puncture test
- Porosity test
- Galvanizing test

Acceptance Tests

- Verification of dimensions
- Temperature Cycle test
- Test for mechanical strength
- Puncture test
- Porosity test
- Galvanizing test

Routine Tests

- Visual Examination
- Routine Electrical tests
- Routine Mechanical tests

27.7.6.1 Technical parameters

Technical Parameter of Bus Post insulators shall be as per GTR.

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If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Bidder.

The Bidder shall furnish supporting calculations to show adequacy of design parameters for Cantilever strength of post insulator.

The supporting structures on which the BPI shall be erected are also included in the scope of supply. The Bidder is required to design the foundations for the same and submit the same to Employer for approval.

The scope of supply also includes BPI connectors for connecting Conductor, ACSR MOOSE Conductor or Al59 or HTLS conductor.

1.8. Pothead Yard Structures

Structures & girders shall be lattice type structure fabricated from structural steel conforming to IS: 2062 (latest). If a higher section is required from design point of view the same shall be provided by the supplier.

The scope shall include all types of fabricated members bolts, nuts, hangers, shackles (wherever required), step bolts, gusset plates, structure earthing bolts, foundation bolts, & templates, spring washers, fixing plates and any other items as required to complete the job including design of foundations.

The connection of all structures to their foundations shall be by base plates and embedded foundation bolts. All steel structures and anchor / foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 0.610 kg/m² for anchor bolts and for structural members. One additional nut shall be provided below the base plate, which may be used for the purpose of leveling. The bidder shall get the name of the bidders approved from the Employer.

1.8.1.Design Criteria

The bidder shall indicate the methods he intends to use for the design of the structures specified in this tender specification.

Any computer program to be employed shall be prepared or approved by a recognized institution & the particular & the name of the computer program shall be clearly indicated in the bid. The bidder shall supply the list of the customers to whom similar structures have been supplied, based on the above-mentioned program. The Employer shall check the design after the award of the contract to the bidder. If as per checking any member is required to be modified the same shall be incorporated by the bidder without any extra cost to the Employer.

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1.8.2. Foundations and Trenches

Foundations

The foundations for structures and supports shall be constructed according to Bidder's requirements by others. The Bidder shall provide layout of the structure and support base plates and bolting requirements. The Bidder shall provide the anchor bolts to the foundation Bidder as well as all constraints that the foundations are required to support.

Trenches

All trenches shall be designed and constructed by others as shown on the drawings but considering the Bidder's final layout arrangement and particular requirements.

1.8.3. Steel Structures

For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS: 875-1987. Wind on wire & structure shall be considered as per IS: 802 Part 1)-1977.

Wind pressure on conductor & ground wire shall be considered as 45 Kg. /sq. m on full projected area of conductor & ground wire under full wind condition & 30 Kg/sq. m under 2/3 of full wind condition respectively.

Wind on structure shall be considered as 195 Kg. /sq. mtr & 130 Kg. /sq. mtr. on 1.5 times the projected area of windward face under full wind condition & 2/3 full wind condition respectively. Wind on projections of members on longitudinal face should be taken as 1.0 times of the projected area.

Wind on structure should be applied on each panel of the column.

Wind on insulator shall be calculated as per IS: 802 (Part 1)-1977.

Seismic forces as per IS: 1893 (Latest) shall be taken into consideration for seismic zone V.

For materials and permissible stresses IS: 802, Part-1, Section-2, 1992 shall be followed in general however additional requirements given in following paragraphs shall be considered.

Steel Sections for the members to be used for various parts of steel sections shall conform to IS: 2062 grade A. Only equal angles shall be used. Properties of the steel sections shall be as per IS: 808.

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Minimum thickness of galvanized structural member shall be as follows:

Members	Minimum thickness (mm)
Leg members, Ground wire Peak members/ Main members	5
Other members	4
Redundant members	4
Gussets	5

The gussets which are transferring load to other members should have thickness of 2 mm. more than the member from which load is to be transferred.

Maximum slenderness ratios (KL / r):

- Leg members & peak members 120
- Lattice & other design members 200
- Secondary members 250

As per IS-802 Part-1, Section-2, 1992.

Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each gantry shall be provided with step bolts not less than 16 mm diameter & 175mm long spaced-not more than 450 mm apart, staggered on faces on one leg extending from about 0.5 meters above ground level to the top of the Structure. The step bolt shall conform to IS: 10238.

All structures shall be designed for the worst combination of dead loads, live loads, wind loads, loads due to deviation of conductor & ground wire, load due to unbalanced tension in conductor & ground wire, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including "snatch" in the case of bundled conductor etc. Short circuit forces shall be calculated considering a fault level of 50 kA.

The conductor used shall be ACSR MOOSE twin conductor/AL59 twin conductor/HTLS conductor as indicated in the drawings enclosed herewith. The GSS Ground wire used shall be 7/3.15 mm. CIGRE Guide No. 7.0 and IEC 865 may be followed for evaluation of the short circuit forces.

Pothead yard gantry structures shall be designed for the two conditions i.e. normal conditions and short circuit condition. In both conditions the design of all structures shall be based on the condition where stringing is done only on one side i.e. all the three (phase) conductors broken on

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the other side. Factor of safety of 2.0 under normal conditions and 1.5 under short circuit/broken wire conditions shall be considered.

In case of transverse loads due to wind on wires of actual wind span, no shielding effect of conductors shall be considered.

Vertical load of half the span of conductor / string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures. For beam design 150 kg/phase (Total=450kg). Insulator string consists of 25 discs of 120 kN/string (Double Tension String). Weight of insulator shall be calculated accordingly.

Unbalanced longitudinal load as tabled below should be considered:

Case	Wind Pressure kg/ m ²	Unbalanced/Longitudinal Load / Sub conductor	Unbalanced/Longitudinal Load / Ground wire
1	45	820 kg.	435 kg.
2	30	1000 kg.	440 kg.

Terminal take off gantries shall be designed for a minimum conductor & ground wire tension of 1 metric tonnes per sub conductor & 440 Kg respectively. The maximum distance between terminal gantry and dead-end Structure shall be taken as 100meters.

The design of these terminal gantries shall also be checked considering +/- 30 deg. deviation of conductor & ground wire in both vertical and horizontal planes.

The girders shall be connected with lattice columns by bolted joints.

Foundation loads shall be calculated as per above mentioned loads & anchor bolts shall be designed accordingly.

The bidder shall submit the loads on each structure along with the bid.

1.8.4.Bolts & Nuts

Bolts & Nuts shall conform to IS: 6639. All bolts & Nuts shall be galvanized & shall have hexagonal heads being forged out of the solid truly concentric & square with the shank which must be perfectly straight.

The minimum bolt diameter shall be 16 mm & property class 5.6 as specified in IS 1367 (Part 3) & matching nut of property class as specified in IS: 1367 (Part 6).

Every bolt shall be provided with a spring washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.

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All steel items, bolts, nuts and washers shall be hot dip galvanized.

2.5 % extra bolts, nuts and washers shall be supplied for erection. The supplier shall get the make of Steel supplier, Nuts & Bolts supplier approved with the Employer.

1.8.5.Fabrication of Steel Structures

The supplier shall bear all the expenditure at all stages on account of losses and damages for all materials upto the fabrication yard/shop & upto the delivery of the structures to the Employer. The unit rates shall be deemed to be inclusive of all such incidental expenses and nothing extra shall be payable on any account in this regard.

The fabrication and erection works shall be carried out generally in accordance with relevant parts of IS: 802. A reference however may be made to IS: 800 in case of nonstipulation of some particular provision in IS: 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

Maximum length of any member shall not exceed 6.0 Mtrs.

1.8.6.Earthng Connections

To facilitate the making of earth connections, two holes of 17.5 mm diameter at a point preferably 230mm above the bottom end of the structures are to be provided. The holes are to be provided on any diagonally placed two legs.

1.8.7.Galvanizing

All structural steel works shall be galvanized after fabrication. Zinc required for galvanizing shall have to be arranged by the manufacturer. Purity of zinc to be used shall be 99.5% as per IS: 209 (latest revision). The Supplier shall be required to make arrangement for frequent inspection by the Employer as well as continuous inspection by the representative of Employer.

1.9. Drawings and Design Calculations

Supplier shall provide its drawings in conjunction with its calculations as well as references, showing the detailed design of 220 kV Outdoor equipment and structures as required by engineer for its review / approval.

Supplier shall furnish six sets of all the drawings for approval in hard copy as well as one set in soft copy. After approval and after work completion at site six sets of as built drawings and one set of drawings in soft editable format shall be supplied.

Drawings

The Supplier shall submit the all the drawings and documents as required by Employer /

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Engineer. These drawings and documents should include at least the following:

- General arrangement, outline and foundation drawings;
- Detailed information and descriptive literature, explaining various safety, protective and regulation features of equipment / components;
- Drawings, showing general arrangement, sections of all major assemblies, sub-assemblies and major components;
- Control schematic drawings;
- Electrical drawings;
- Erection, commissioning, operation and maintenance;
- Quality assurance plan (QAP);
- Guaranteed Technical particulars (GTPs) of different items;
- Relay protection settings calculation and co-ordination chart for the system.

Design memorandum

The Supplier shall prepare and submit to the Employer a “Design Memorandum” of the proposed equipment / system fulfilling the contract specification / requirement given in the section for approval prior to submission of any drawings and documents. The memorandum shall include the design philosophy, methodology, system description, input parameters for design, standard and codes, design and selection criteria, equipment data, material specification, major technical features, basic arrangement / layout etc.

1.10. Name Plate & Labels

All the outdoor 220 kV equipment and their operating devices shall be provided with a nameplate. The nameplate shall be weather proof and corrosion resistant. It shall be mounted in a position that it shall be visible in the position of normal service and installation. The nameplate shall conform to the requirements of relevant IEC / IS and as per stipulations of General Technical Requirements and shall incorporate the following information:

- Manufacturer’s Name or trade Mark;
 - Type Designation or Serial Number;
 - Applicable Rated values;
 - Relevant Standard.
- All name plates shall be of non-rusting metal or three (3) ply laminated with white engraved lettering on black back ground, inscription and lettering sizes shall be subjected to Employer’s approval;

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- Caution name plate “Caution Live Terminals” shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end.

1.11. Packing & Transportation

All the outdoor 220 kV equipment and supporting structures shall be suitably packed as per the standard practice, while dispatching from the works. Although the method of packing is left to the discretion of the manufacturer, it should be robust enough for rough handling as the equipment shall be moving in hilly region. Manufacturer shall take additional care in packing of material for transportation, so that it does not get damaged during transit due to vibration / jerks / tilting, etc normally encountered during transportation by sea / road / rail in hilly terrain.

All accessories shall be dispatched in suitable boxes or crates. They shall be securely bound with wire and shall have all descriptive marking stamped thereon.

1.12. Painting

All metal surfaces shall be chemically cleaned, degreased and pickled in acid to produce a smooth clean surface, free of scale, grease and rust.

After cleaning, phosphating and passivation treatment, the surface shall be given two coats of zinc rich epoxy primer and baking in the oven.

After primer, it shall be given two coats of stoving type epoxy based paint (Shade RAL-7032 Siemens Grey). Alternatively powder coating can be offered.

Sufficient quantity of touch-up paint shall be furnished for application at site.

1.13. Spare Parts and Special Tools

Contractor shall supply separately the price of additional spare parts and special recommended tools. Each item shall be clearly described.

All spare parts shall be identical electrically and mechanically to corresponding parts of the equipment supplied and shall be suitably packed and clearly marked, ready for long term indoor storage.

If dismantling of certain parts requires the use of special tools, Contractor shall supply them with the equipment. Each tool shall be described and its unit price indicated in the Tender.

Purchaser reserves the right to purchase or not the spare parts and special tools covered in this chapter.

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1.13.1. Mandatory Spares Parts

The following spare-parts shall be mandatorily included in the supply.

S. No	Description of Equipment	Unit	QTY.
1.	245 kV Disconnecter		
a	One complete pole of 245kV, 3150 A Isolator with one E/S along with support insulator & operating mechanism for main isolator and earth switch and excluding support structure.	No	1
b	Terminal connector	Nos	2
c	Terminal pads	Nos	2
d	Relays, Power contactors, switch fuse units, MCB, limit switches, push buttons, resistor, timers, key interlock Aux switches for electrical control circuit as per approved schematic. (1 no. of each type in operating cubicle of isolator)	Set	1
2.	245 kV Capacitive Voltage Transformers		
a	245 kV, 4400 pF, 3 Core CVT complete in all respects including terminal connectors and support stool for erecting on standard support structure.	No.	1
b	Terminal connector	Nos	2
c	Terminal pads for CVT	Nos	2
3.	Surge Arrester		
a	Surge Arrester complete	No.	1
b	Surge counter	Nos	2
c	Terminal connector	Nos	2
4.	Surge Arrester		
a)	Terminal connector	Nos	2

If any additional spare-parts required for trouble free operation are recommended by bidder, these shall be listed and the unit price shall be quoted in the price schedule. The Employer reserves the right to order any or all of such spares.