

LOT. NO. 11 TECHNICAL SPECIFICATIONS FOR INDOOR SWITCHGEARS

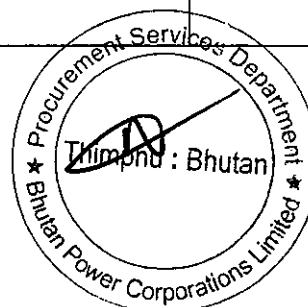
1. 33 kV AND 11 kV INDOOR SWITCHGEAR

- 1.1 33 kV and 11 kV indoor switchgears shall comply with latest revision/amendments of the following International Standards, including those referred to therein.

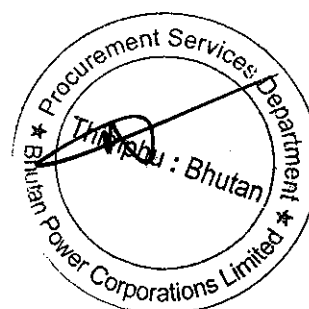
Metal enclosed switchgear	IEC : 62271-200
Arrangement for switchgear busbars, main connection and auxiliary wiring	IS: 5578,11353
Busbar support insulators	IS : 9431
Degree of protection	IS : 3427
Current transformers	IS : 2705
Potential transformers	IS : 3156
A.C. electricity meters	IS : 722
Electrical indicating instruments	IS : 1248
Electrical relays for power system protection	IS : 3231
Code of practice for phosphating iron and steel	IS : 6005

- 1.2 The technical parameters/data sheet of the MV Switchgear shall be as below:

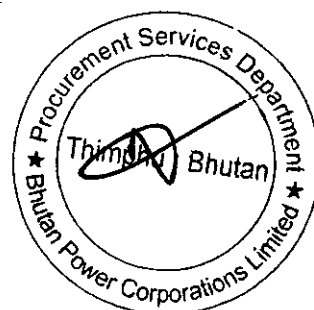
Description	Unit	33 kV Switchgear	11 kV Switchgear
General			
Rated voltage, no. of phases and rated frequency	kV / - / Hz	36 kV, 3 Phase, 50Hz	11 kV, 3 Phase, 50 Hz
Number of panels and configuration		As per BOQ	As per BOQ
Type		Indoor, Metal-enclosed, compartmentalized, draw-out type	Indoor, Metal-enclosed, compartmentalized, draw-out type
System neutral earthing		Effectively Earthed	Effectively Earthed
Rated Insulation Levels given below is upto 1000 m (shall be corrected for the mentioned altitude)			
Rated short duration power frequency withstand voltage	kV (rms)	70	28



Rated lightning impulse withstand voltage	kV (peak)	170	75
Rated normal current of busbars under design ambient temperature of 30°C and material of busbar	A / -	630,800, 1250 Copper	630, 800, 1250 Copper
Rated short-time withstand current and time	kA (rms) / sec	25 kA for 3 sec	18 kA for 3 sec
Dynamic rating	kA (peak)	62.5	62.5
Constructional Requirements			
Minimum thickness of sheet steel in mm Cold rolled (Frame/Enclosure/Covers)	mm	Frame & LT Compartment Doors– 2.5	Frame & LT Compartment Doors– 2.5
Degree of protection of enclosure		IP-4X	IP-4X
Colour finish shade - Interior & Exteriors		RAL 7032	RAL 7032
Cable connection		Bottom entry and exit	Bottom entry and exit
Circuit Breakers			
Type		Vacuum, SF6	Vacuum, SF6
Rated current inside the cubicle under design ambient temperature at 40°C	A	630, 800, 1250	630, 800, 1250 (As required at Site)
Rated operating sequence		0.3 Sec–CO-3 Min–CO	0.3 Sec –CO-3 Min-CO
Rated short time breaking current	kA	25	25
Rated short time making current	kA (peak)	62.5	62.5
Rated short-time withstand current and time	kA (rms) / sec	25 kA for 3 sec	25 kA for 3 sec
Rated peak withstand current	kA (peak)	62.5	62.5



Description	Unit	33 kV Switchgear	11 kV Switchgear
Min. no. of spare auxiliary contacts		6 NO + 6 NC after internal use by manufacturer	6 NO + 6 NC after internal use by manufacturer
Type of operating mechanism			
- Normal		Spring charging for closing and tripping	Spring charging for closing and tripping
- Emergency		Manual & Spring charged for closing and tripping	Manual & Spring charged for closing and tripping
Auxiliary control voltage		As per the site availability of DC supply	
- Closing coil / Tripping coil	V	110V DC	110V DC
- Spring charging motor	V	110V DC	110V DC
- Space heater and lighting	V	230V AC	230V AC
Earthing switch		Earthing Trunk to be provided	Earthing Trunk to be provided
Current and Voltage Transformers			
Details of ratio, taps, burden, accuracy		As per Single Line Diagram and BOQ (ratio to be decided during detail engineering)	As per Single Line Diagram and BOQ (ratio to be decided during detail engineering)
Protective Relays			
Type		Numerical	Numerical
Auxiliary supply	V	110 V DC	110 V DC
Details of protective relays		As per Single Line Diagram and specifications	As per Single Line Diagram and specifications
Meters			
Type		Multi-Function	Multi-Function
Details of meters		As per Single Line Diagram and specifications. 3 phase 4 wire, RS 485 port and optical port.	As per Single Line Diagram and specifications. . 3 phase 4 wire, RS 485 port and optical port.



**** Note:**

- a. 11 kV switchgear shall have provision of extension from both sides.
- b. Interlocking shall be provided based on the system operation which will be discussed during detail engineering.

1.3 Busbars

1.3.1 Material of main and tap off busbars shall be of electrical grade and be of Copper.

1.3.2 Busbars shall be rated in accordance with the service conditions and the rated continuous and short time current ratings specified in technical particulars/data Sheet. Maximum temperature of the main busbars and busbar connections, under operating conditions, when carrying rated normal current at rated frequency shall not exceed 90 Deg. C for joints/connections. Busbar temperature limits shall be adhered to without forced cooling method. For tap off busbars, the current rating shall be at least equal to corresponding breaker(s) rating.

1.3.4 Busbars shall be adequately supported on insulators, to withstand dynamic stresses due to short circuit current. Busbar support insulators shall conform to IS 9431.

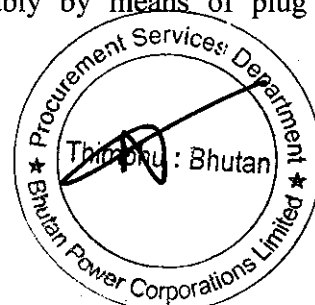
1.4 Circuit breakers

1.4.1 Circuit breakers shall be Vacuum type or SF6. Circuit breaker along with its operating mechanism shall be mounted on a wheeled carriage moving on guides, designed to align correctly and allow easy movement. Plugs and sockets for power circuits shall be silver faced and shall be insulated with suitable insulating material shrouds. All corresponding components of circuit breaker cubicles of same rating shall be interchangeable with one another.

1.4.2 There shall be 'Service', 'Test' 'Fully withdrawn' positions for the breakers. In the 'Test' position the circuit breaker shall be capable of being tested for operation without energizing the power circuits, i.e. the control circuits shall remain undisturbed while the power contacts shall remain disconnected. Separate limit switches, each having a minimum of 2 'NO' + 2 'NC' contacts, shall be provided for both 'Service' and 'Test' positions of the circuit breakers for future use.

1.4.3 Electrical tripping shall be performed by shunt trip coils. "Local/Remote" selector switch lockable with keys in "Local" position shall be provided on the cubicle door. 'Red' and 'Green' indicating lamps shall be provided on cubicle door to indicate breaker close and open positions. Breaker "Service" and "Test" positions shall be indicated by separate indicating lamps on the cubicle door. Indicating lamps shall be provided for "R", "Y" "B" phase indication, trip circuit healthy indication and spring charged indication for circuit breaker.

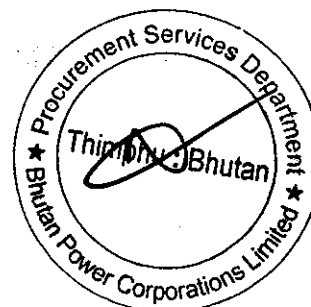
1.4.4 Connection of the control / interlocking circuits between the fixed portion of the cubicle and the breaker carriage shall be preferably by means of plug socket arrangement.



1.4.5 Operating mechanism control

- a) Circuit breakers shall be operated by a motor spring charging type of mechanism. The mechanism shall be complete with motor, opening spring, closing spring and all accessories to make the mechanism a complete operating unit.
- b) Operating mechanism shall normally be operated from the breaker cubicle itself.
- c) The tripping spring shall be charged by the closing action, to enable quick tripping. Closing of the circuit breaker shall automatically initiate recharging of the springs to enable the mechanism to be ready for the next closing stroke. Charging time for the springs shall not exceed 30 seconds. It shall be possible to manually charge the springs in an emergency. Transfer from motor to manual charging shall automatically disconnect the charging motor. All operating mechanisms shall be provided with "ON" - "OFF" mechanical indication. The charging mechanism shall be provided with mechanical indicators to show "charged" and "discharged" conditions of the spring. Failure of any spring, vibration or mechanical shock shall not cause tripping or closing of the circuit breaker.
- d) Only one closing operation of the circuit breaker shall result from each closing impulse (manual or electrical), even if the breaker trips while the control device (manual or electrical) is being held in the "close" position.
- e) The circuit breaker mechanism shall make one complete closing operation, once the push button (PB) or control switch has been operated and the first device in the control scheme has responded, even though the PB or control switch is released before the closing operation is complete, subject to the condition that there is no counter- impulse for tripping.
- f) Means shall be provided to manually open and close the breakers slowly, when the operating power is not available, for maintenance and adjustments. A local manual trip device shall also be provided on the operating mechanism.
- g) Circuit breaker control shall be on 110 V as per the availability of DC supply at the site. Closing coils and other auxiliary devices shall operate satisfactorily at all voltages between 85-110 % of the control voltage. Trip coils shall operate satisfactorily between 70 -110 % the rated control voltage.

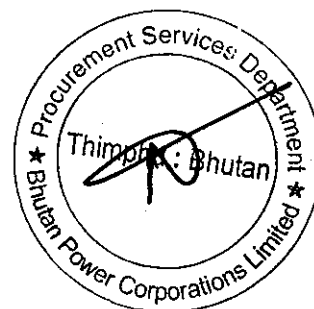
1.4.6 Safety interlocks and features



- a) Withdrawal or engagement of a circuit breaker shall not be possible unless it is in the open position.
- b) Operation of a circuit breaker shall not be possible unless it is in service position, withdrawn to test position or fully drawn out. It shall not be possible to close the circuit breaker electrically in the service position, without completing the auxiliary circuit between the fixed and moving portions.
- c) Circuit breaker cubicles shall be provided with safety shutters operated automatically by the movement of the circuit breaker carriage to cover the stationary isolated contacts when the breaker is withdrawn. Padlocking facilities shall be provided for locking the shutters positively in the closed position. It shall, however, be possible to open the shutters intentionally against spring pressure for testing purposes.
- d) The circuit breaker carriage shall be earthed before the circuit breaker reaches the test position from fully withdrawn position. In case of breakers with automatic disconnecting type of auxiliary disconnects, the carriage shall be earthed before the auxiliary disconnects are made and the carriage earthing shall break only after the auxiliary disconnects break.
- e) Caution nameplate, "Caution Live Terminals" shall be provided at all points where the terminals are likely to remain live and isolation is possible only at remote end, i.e. incomer to the switchboard. Suitable interlock shall be wired for the purpose.

1.5 Current and Voltage Transformers

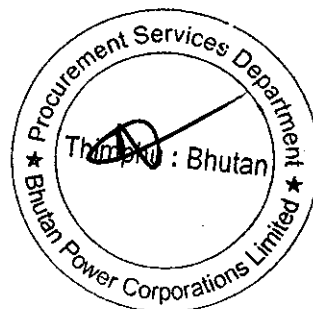
- 1.5.1 CTs and VTs shall have polarity marks indelibly marked on each transformer and at the associated terminal block. Facility shall be provided for short circuiting and earthing the CT secondary at the terminal blocks.
- 1.5.2 CT shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit current. Core laminations shall be of high-grade silicon steel.
- 1.5.3 VTs shall be of the single-phase type and mounted on a drawout trolley. VTs shall be protected on their primary sides by 3A HT fuses. MCB having auxiliary contact shall be provided on secondary. Primary side fuses shall be replaceable only in the de-energised position.
- 1.5.5 Identification labels giving type, ratio, output and serial numbers shall be provided for CTs and VTs.
- 1.5.6 The CT ratios shall be furnished during detail engineering after the award of the work. All the breakers including bus couplers are to be provided with the CTs.



1.6 Constructional Features of Switchboard

(Applicable for other types of panels/distribution boards etc)

- 1.6.1 Switchboard manufacturing shall be CNC machine based. Switchboard design shall comprise metal enclosed, fully compartmental execution having separate sections for each circuit. Compartments with doors for access to operating mechanism shall be so arranged as not to expose high voltage circuits. Switchboard cubicle shall be provided with hinged door on the front with facility for locking door handle.
- 1.6.2 Switchgear shall be dust and vermin-proof and shall have a degree of protection of enclosure of IP 4X.
- 1.6.3 All removable covers shall be gasketed all around with neoprene or superior gaskets.
- 1.6.4 Instruments, relays and control devices shall be flush-mounted on hinged door of the metering compartment located in the front portion of cubicle. The metering compartment shall be properly shielded to prevent mal-operation of electronic equipment such as numerical / static relays due to electro-magnetic fields. Separate signal earth shall be provided for such devices, if necessary.
- 1.6.5 Each switchboard cubicle shall be fitted with a label on the front and rear of the cubicle. Each switchboard shall also be fitted with label indicating the switchboard designation, rating and duty. Each relay, instrument, switch, fuse and other devices shall be provided with separate label. The labels shall be of Anodized Aluminum.
- 1.6.6 Sheet steel used for fabrication of switchboards, control cabinets, marshalling boxes, etc shall be cold rolled.
- 1.6.7 All panels, cabinets, kiosks and boards shall comprise rigid welded/bolted structural frames made of structural steel sections or of pressed and formed cold rolled sheet steel of thickness not less than 2.5 mm. Stiffeners shall be provided wherever necessary.
- 1.6.8 All removable covers, gland plates, etc. shall be of at least 2 mm thickness and shall be gasketed all round the perimeter. All the doors shall be of 2.5 mm thickness.
- 1.6.9 All floor mounted panels / boards shall be provided with a channel base frame.
- 1.6.11 It shall be possible to extend the switchboard on both sides.
- 1.6.12 The fully draw-out modules shall have all the circuit components mounted on withdraw-able type steel chassis. All power and control connections shall be of the draw-out type. It shall be possible to withdraw the chassis mounted circuit components without disconnecting any connections. All draw-out contacts shall be of silver plated copper.



1.6.15 After isolation of the power and control connections of a circuit, it shall be possible to carry out maintenance in a compartment safely, with the busbars and adjacent circuits alive.

1.6.16 Compartments with doors for access to operating mechanism shall be so arranged as not to allow access to high voltage circuits. Switchgear cubicle shall be provided with hinged door on the front with facility for padlocking door handle.

1.7 Earthing

1.7.1 An earthing bus of 50 x 6 sq.mm copper shall be provided and extended throughout the length of the switchboard. It shall be bolted to the framework of each unit and brazed to each breaker earthing contact bar. It shall be located at the bottom of the board.

1.7.2 The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault current for at least 1 second without exceeding maximum allowable temperature rise. The earth bus shall be properly supported to withstand stresses induced by the momentary short circuit current.

1.7.3 Suitable clamp type terminals at each end of the earth bus shall be provided to suit the size of the earthing conductors.

1.7.4 Bolted joints, slices, taps, etc. to the earth bus shall be made with at least two bolts.

1.7.5 Positive earthing of circuit breaker frame shall be maintained when it is in the connected position and in all other positions whilst the auxiliary circuits are not totally disconnected.

1.7.6 Hinged doors shall be earthed through flexible earthing braid of adequate cross section.

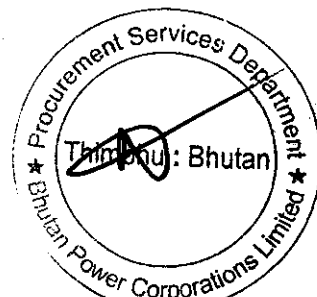
1.7.7 All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus.

1.7.8 Positive connection of the frames of all the equipment mounted in the switchboard to the earth busbar shall be maintained through insulated conductors of size equal to the earth busbar or the load current carrying conductor, whichever is smaller.

1.7.9 All instrument and relay cases shall be connected to earth busbar by means of 650/1100 V grade, green coloured, PVC insulated, FRLS stranded, copper, 2.5 sq. mm conductor looped through each of the earth terminals.

1.8 Circuit / busbar earthing facility

1.8.1 It shall be possible to connect each circuit or set of 3 phase busbars of the switchboard to earth through earthing switches.



- 1.8.2 Earthing switches / earthing devices shall be mechanically interlocked with the associated breakers to prevent accidental earthing of live circuit or busbars.
- 1.8.3 In case the earthing facility comprises earthing trucks to be inserted in place of circuit breakers, separate earthing trucks shall be supplied for each type / size of breaker without any cost implication to BPC.
- 1.8.4 The earthing facilities proposed to be provided by the Bidder shall be clearly detailed in the Bid and shall be subject to Employer's approval.
- 1.8.5 Auxiliary contacts (min. 2 NO + 2 NC) shall be provided on each earth switch / earthing device and shall be wired to the terminal block for interlocking purpose.

1.9 Instruments

- 1.9.1 All electrical instruments and meters shall comply with IS 722.
- 1.9.2 All indicating and recording instruments shall be flush mounted in dust proof cases complying with IEC 60068 and dimensions to IEC 61554.

1.9.3 Metering and indicating instruments

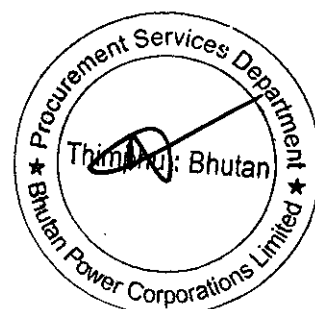
Multifunctional meter for functions as shown in the single line diagram/specifications shall be provided. It shall be 3 phase 4 wire with **RS 485** port and **optical port**. It shall be provided with separate 3 phase 4 wire type test blocks for the testing of meters without disturbing the CT and VT secondary connections. The accuracy of the meters shall be 0.5 or better and capable of displaying maximum demand (kW/kVA).

1.10 Control and Selector Switches

- 1.10.1 Control and instrument switches shall be rotary type, provided with escutcheon plates clearly marked to show operating position and suitable for semi-flush mounting with only the switch front plate and operating handle projecting out. The connections shall be from the back. The contact assembly at the back of the switch shall be enclosed in dust tight removable covers.
- 1.10.2 Contacts of the switches shall be spring assisted and contact faces shall be of silver / silver alloy. Springs shall not be used as current carrying parts. Contact rating and configurations of the switches shall be adequate for the functions desired.

1.11 Indicating lamps / pilot lights

- 1.11.1 Cluster type LED lamps of 22 mm dia. of suitable voltage shall be provided.
- 1.11.2 The basis of colours shall be as follows:



Red	: Flow of energy.
Green	: No flow of energy.
White	: Supervision of power available, relay coil healthy, etc.
Amber	: Disagreement with original condition, 'abnormal' condition or 'sequence-on' condition.

1.12 Push buttons

1.12.1 Push buttons shall be of momentary contact type with rear terminal connections. All push buttons shall have independent, potential free, 2NO + 2NC contacts. The contact faces shall be of silver / silver alloy. The contacts shall be rated 10A and capable of breaking inductive load of 1A at 110V DC.

1.12.2 Push button for emergency tripping of the circuit breaker shall be provided.

1.13 Space Heaters

1.13.1 Adequately rated anti-condensation space heaters shall be provided for each switchboard / cubicle.

1.13.2 Space heater shall be of the industrial strip continuous duty type of rating 100 w (minimum), rated for operation on a 230 V, 1 phase, 50 Hz, AC system.

1.13.3 Space heater shall be provided with a single pole MCB with overload and short circuit release, a neutral link and a thermostat.

1.14 Cubicle Lighting / Receptacle

1.14.1 Each cubicle shall be provided with interior lighting by means of 11W CFL lighting fixture. An MCB shall be provided for the lighting circuit. The lighting fixture shall be suitable for operation from a 230 V, 1 ph, 50 Hz, AC supply.

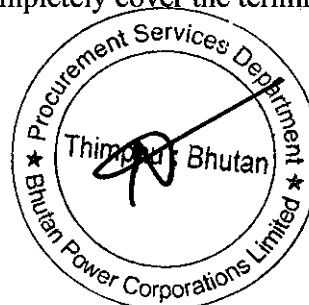
1.14.2 A 230 V, 1 phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with an MCB.

1.15 Power and Control Cable Terminations

1.15.1 Terminals for power connections shall be complete with adequate phase segregating insulating barriers, shrouds and suitable crimping type of lugs for terminating the cables.

1.15.2 Double compression type glands with armour and bonding clamps for the termination of all solid dielectric multicore cables shall be provided.

1.15.3 Cable terminations for MV cables shall be heat shrinkable type. Adequately sized shrouds / bolts shall be provided at connections to completely cover the terminations.



1.16 Wiring for Control and Protective Circuits

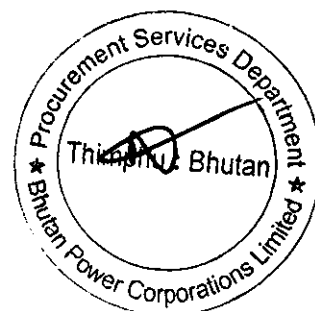
- 1.16.1 All low voltage wiring for control, protection and indication circuits shall be carried out with 650/1100 V grade, PVC insulated cable with stranded, copper conductor of minimum 1.5 sq. mm size. The size of conductor for CT circuits shall be minimum 2.5 sq. mm.
- 1.16.2 All wiring shall be run on the sides of panels and shall be neatly bunched and cleated without affecting access to equipment mounted in the panel.
- 1.16.3 The wiring shall be bound and supported by clamping, roughing or lacing. Spiral wrapping will not be accepted. Wireways shall not be more than 50% full. Adequate slack wire shall be provided to allow for one restripping and reconnection at the end of each wire. Screened cables or wires are necessary; an insulating sheath shall be included.
- 1.16.4 Wiring and supports shall be of fire resistant material.
- 1.16.5 Wiring shall only be jointed or teed at terminals. Terminals of the clamp type shall not have more than two wires connected.

1.17 Terminations and Ferrules

- 1.17.1 Engraved core identification ferrules, marked to correspond with the wiring diagram, shall be fitted to each wire and each core of multicore cables terminated on the panels.
- 1.17.2 Moisture and oil resisting insulating material shall be used. The ferrules shall be of the interlocking type and shall grip the insulation firmly without falling off when the wire is removed.
- 1.17.3 All wires forming part of a tripping circuit shall be distinctively marked.
- 1.17.4 Spare auxiliary contacts of electrical equipment shall be wired to terminal blocks.

1.18 Control Wiring Terminal Blocks

- 1.18.1 Terminal blocks shall be of 1000 V grade and stud type. Brass stud of at least 6 mm dia. with fine threads shall be used and securely locked within the mounting base to prevent turning. Each terminal shall comprise two threaded studs, with a link between them, washers, and matching nuts and locknuts for each stud. Connections to the terminals shall be at the front.
- 1.18.2 Terminals shall be numbered for identification, grouped according to function. Engraved 'black on-white' labels shall be provided on the terminal blocks describing the function of the circuit.



- 1.18.3 Terminals for circuits with voltage exceeding 110 V shall be shrouded. Terminal blocks at different voltages shall be segregated into groups and distinctively labeled.
- 1.18.4 Terminals used for connecting current transformer secondary leads shall be 'disconnecting and shorting' type with a facility for earthing the secondary.
- 1.18.5 Terminal blocks shall be arranged with 100 mm clearance, between any two sets.
- 1.18.6 Separate terminal stems shall be provided for internal and external wiring respectively.

1.19 Electronic Equipment

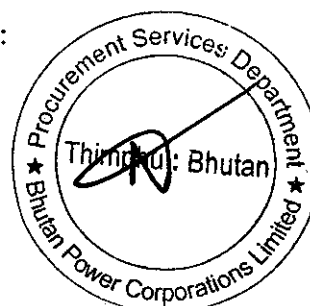
- 1.19.1 Electronic equipment shall be capable of withstanding randomly phased transient over voltages of either polarity on the power supply or interruptions of the power supply without damage or impairment to the equipment's subsequent performance. In the case of controls, no mal-operation shall occur.
- 1.19.2 Where manufacturers require that electronic equipment supplied under this Contract should not be subjected to insulation resistance tests ('Meggering'), suitable warning notices shall be provided and installed in appropriate locations. When specified by manufacturers, separate shield / signal earthing shall be provided.
- 1.19.3 It shall be possible to remove / replace cards from / to electronic equipment without damage and without interfering with the operation of the rest of the equipment or system. If necessary, consideration should be given to switching off the supplies locally to a card to prevent inadvertent interference to the equipment or system during removing / replacing a card.

1.19.4 Setting-Up and Maintenance Facilities

- a) All equipment shall be provided with sufficient easily accessible test points to facilitate setting-up and fault location together with maintenance aids such as extension boards, jumper leads and special maintenance tools.
- b) Pin or terminal numbering of all cards in all crates shall be consistently uniform throughout. Power supplies shall use the same pin positions on all cards in an equipment or system.

1.19.5 Component Identification

- a) A component reference number shall be marked adjacent to each component. Where this is impossible, components shall be identifiable from the layout drawings provided.
- b) The following shall be marked in all instances:



- i. MCBs
The rating and the circuit identification of each fuse shall be marked adjacent to the MCBs base.
 - ii. Control, Protection and Indication Devices
The function of each control, protection and indication device shall be marked. The caption and its arrangement shall be subject to the approval of the Engineer.
 - iii. Connectors
The diagram reference number shall be marked on or adjacent to each connector.
- c) Test points shall be individually marked with the diagram reference number.

1.20 Test Terminal Blocks

Test terminal blocks, if any, shall be provided for secondary injection and testing of relays/meters.

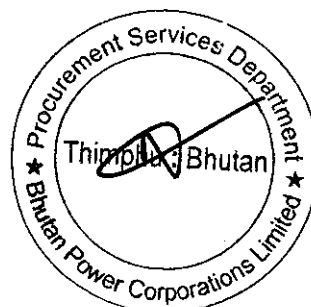
1.21 MCBs

Each control panel shall be provided with the necessary arrangement for receiving, distribution and isolation for DC and AC supply for various control, signaling and lighting. It is proposed to have MCBs only instead of fuses. An indication for the PT MCB failure shall be provided.

2. Relay and Protection

2.1 General requirements of protection

- a) The price of the bid shall include whether explicitly mentioned or not, all the elements necessary to coordinate and assure the correct functioning of the protection, high reliability, selectivity, very short fault clearance time, and precisely dimensioned to the protected objects these tender specifications and scope of work.
- b) Modern relays employing state of the art technology & proven numerical design shall be offered by the bidder. They shall be of standard construction and supplied by an experienced and reliable manufacturer indicated in the list of approved vendors. The relays shall be designed for use with modern digital telecommunication system conforming to ITU-T recommendations and fibre optic medium.

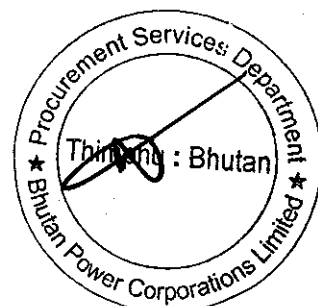


- c) The type of relays/ devices, which are implemented to perform a particular function, shall be the same for all feeders in each system voltage level within the contract in question.
- d) Combination of two or more types of relays in a single unit is not normally acceptable since any fault or component failure may lead to loss of both or all functions respectively. However, when a modern integrated Numerical Multifunction Combined Protection equipment is offered, 100% redundancy shall be provided against the contingencies which lead to the loss of whole protection system.
- e) In addition to all components, the contractor shall supply the necessary documents and calculations of settings to guarantee the correct functioning of the protection equipment without exceeding the safe limits of the system operation or the equipment condition. Before the production of the current transformer commences, the Contractor shall submit for approval a verifiable calculation based on the design short circuit level of the substation, 18 kA at 11 kV, 25 kA at 33 kV and a network time constant not lower than 80 msec. to demonstrate that the offered protection, will be stable for faults outside the zone, will trip on the range of required tripping time and that the protection has sufficient sensitivity to work together with the offered CTs.

2.2

Features of Numerical Relays

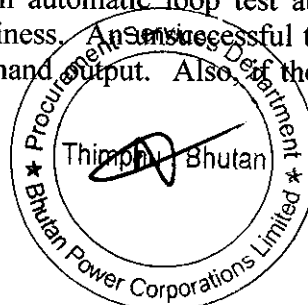
- a) The connection from the relays to the communication multiplexer shall be a 64 kbps. Channel, complying with G703 or RS422. The bidder shall indicate the maximum permissible distance and type of cable for this type of connection. Bidder shall provide two ports for the same.
- b) An additional electrical or optical port shall be provided for the relays, to directly connect the signal to auxiliary channel of OLTE (optical line terminal equipment) bypassing the multiplexer or for redundancy purpose.
- c) The relays shall have communication port for remote monitoring, programming and control. Bidder shall indicate the type of protocol for this connectivity.
- d) It shall be possible to programme and set the relays locally as well as from remote end. It shall also be suitable for serial interfaces and software shall be provided to achieve this function through personal computer (PC). This shall have facility for both hand- held programmable device as well as PC based unit with necessary software.



- e) The sampling frequency for analog signals shall be minimum 2 kHz. Filtering and measuring techniques shall be used to ensure correct performance during all operating and transient conditions.
- f) The output and input sections shall be electrically isolated.
- g) Under 'alarm' conditions of outputs, programmable options shall be available to set the output to trip /inactive/ none/ previous state condition.
- h) The relays shall be provided with fault disturbance recorder event recorder, which can store 500 time tap events, and fault recorder with date and time stamping.
- i) The relay shall have remote communication facility. The interface shall ensure high dependability for genuine tripping signals and high security against spurious trip signals necessary in protection applications even if communication channel is disturbed.
- j) Bidder shall advise the Employer on the details of error performance characteristic and protocols used to ensure error free operation.
- k) Additional potential free contacts for all the Relay output i.e. trip as well as alarm signals shall be provided for connection to SCADA in the future.
- l) The modules shall have transmit and receive counters for each command such that the counter is incremented by actual output command. This shall help in analysis of problems. The counter information shall be in a non-volatile memory. Resetting the counter shall be possible only with authorized access.
- m) The relay shall have continuous automatic self-monitoring and alarming facilities. The above feature shall not affect the relay availability i.e. when an actual fault occurs in the system during the checking cycle, the above cycle shall be immediately interrupted and the relay shall check and respond to the system fault. The system shall have the following visual indications for supervision of each command channel.

Input activated at transmit end, Command transmitted and received, Equipment in local and remote loop test, Test pass, Test fail, General alarm, and Equipment in synchronism.

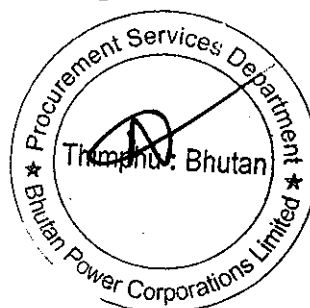
- n) Each protection channel shall run an automatic loop test at regular intervals to monitor operational readiness. An unsuccessful test shall signal the alarm and block the command output. Also, if the system



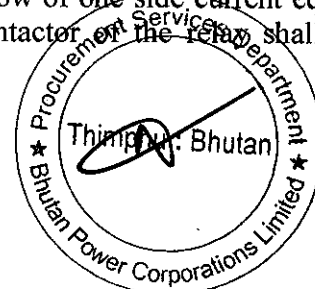
monitor detects any fault in the transmission, the protection command shall be blocked and alarm signaled.

- o) Suitable event logs memory and down loading facility shall be available.

- 2.3 Miniature circuit breakers (MCBs) shall be used in VT secondary circuits, they shall have 2 NO and 2 NC auxiliary contacts for blocking trip circuits of voltage dependent protection and annunciation. Where high-speed protection is involved, the speed of operation of MCB shall be less than 5 milli seconds.
- 2.4 The DC distribution system which feeds the protection shall be proper so that, the rating of the up-stream MCBs shall be chosen higher than that for the down- stream ones and the coordination between the up-stream MCBs with the down-stream ones shall exist. DC supply to trip coils shall be separately fused in case of single DC supply. Two independent feeders from the independent batteries shall be provided. An auto-changeover facility shall be provided so that in case of failure of one power source, other shall cut in automatically.
- 2.5 Both positive and negative of the auxiliary voltage shall be switched when trip or close operation is executed in the substation switchgear.
- 2.6 The external protection circuits shall use the standard available substation battery voltages. The voltage of the protection DC/DC converters shall never be used for external protection circuitry.
- 2.7 The new protection system shall be completely wired, tested and inspected at the factory. The only work to be performed at site shall be the connection to external devices, the commissioning procedure and site tests.
- 2.8 The continuity of all tripping circuits shall be continuously supervised for both close and open breaker status. The failure of any component of the supervision shall lead to trip the breaker. The lock out relays shall also be supervised.
- 2.9 No time delay for the tripping contacts will be acceptable. Where a master trip relay, lock-out relay or any auxiliary relay is utilized, it shall have a maximum tripping time equal to or less than 10 ms. To avoid the additional time delay of the above relay on the total tripping time of the main protection, an arrangement shall be made so that the main protection shall perform the circuit breaker tripping along with energizing the lock-out relay in a parallel circuit arrangement.
- 2.10 The tripping of the back-up protection of each feeder shall be relayed by different control cables and as far as applicable, through different routes.

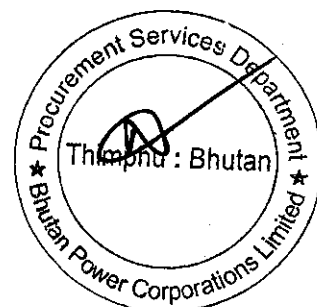


- 2.11 All relays shall have clear identification on the associated panel by well-written inscription plates. Where indications are provided by flag relays or LEDs, these shall also be specifically identified by permanently fixed inscription adjacent to them.
- 2.12 The supervision relays shall indicate an alarm and also a visual indication in the case of trip operation of the relay, DC supply failure, DC/DC converter failure, interruption in the trip circuit wiring and all alarm signals of the relay.
- 2.13 The tripping contacts of the protection relays shall reset automatically if no further fault conditions are present, whereas the signaling and blocking close order of the circuit breaker remains until the operator resets the relay manually.
- 2.14 Each indicator, whether of the electrical or mechanical type shall be capable of being easily reset by hand without special tools, opening the relay cover, bridging of some back/internal terminals or drawing-out the relay.
- 2.15 Before starting with the wiring diagrams, the contractor shall supply block diagrams in one drawing for each type of feeder and protection. These drawings shall include information concerning control circuits, tripping scheme, interlocking scheme, secondary circuits of voltage and current transformers, DC power supply, supervisory alarms and tele-protection circuits. These block diagrams shall be updated during the factory testing, erection and commissioning phases.
- 2.16 The contractor shall supply the setting data sheets of the supplied protection equipment showing the coordination with the rest of the network one-month before commissioning.
- 2.17 **Specific description of protection**
- 2.18 **Transformer differential protection for 10 MVA, 33/11 kV transformer only.**
- 2.19 This protection shall trip for all the phase and earth faults inside the zone and shall have to be stable for all faults outside the zone limited by the current transformers. This protection shall have restrained inrush-proof feature, which shall never prevent operation for tripping in case if a real fault exists within the relay zone during energization of the power transformer.
- 2.20 This protection shall be immune to the zero sequence current, which may circulate, during certain conditions through the neutral of only one side of the transformer. It shall be a modern phase segregated relay of low burden with absolute stability at switchgear designed short circuit current rating and tripping time of not more than 25 m.sec, at flow of one side current equal to twice the nominal current. The tripping contactor of the relay shall have

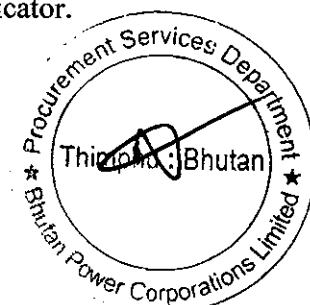


sufficient number of contacts of suitable switching capacity to trip all the circuit breakers which are supposed to be tripped through this protection and initiate the lock-out relay.

- 2.21 The setting of bias and basic setting must be adjustable in steps in order to cover the maximum mis-match between the HV and LV due to error of the CT's and range of regulation of the tap changer.
- 2.22 This protection should be wired to enable the measurement of differential and stabilization current in service without any possibility of causing open circuits on the secondary side of the current transformers.
- 2.23 It shall have a visible annunciator, which will be reset by push button and shall be located on the relay.
- 2.24 Although the CT ratio and vector diagram correction for the input currents to be performed within the relay itself. External interposing current transformers is not required.
- 2.25 **Restricted Earth Fault Protection 10 MVA, 33/11 kV transformer only.**
- 2.26 The restricted earth fault relay shall be operated from a completely separate core of line and neutral current transformers. The dedicated CTs shall be of class PS or X and have same magnetization characteristics with a knee emf value higher than the highest possible setting of the relay. Intermediate CTs for ratio correction are not acceptable. CT sizing shall be matched with requirements from the relay. 2.27 For this protection, 1-phase high impedance relay will be provided and all the aspects regarding stability of the protection, dimensioning of current transformer, considering the peak short circuit current, etc. and all the auxiliary equipment such as non-linear VDR resistor for voltage limiting, filter for harmonics and DC component suppression and variable shunt resistor for sensitivity adjustment if required shall be considered for the tender. The total fault clearing time shall not exceed 20 m.sec. at $3I_N$.
- 2.28 Tripping of this protection shall activate all the circuit breakers surrounding the power transformer and all the material such as surge-proof inter-tripping relays if necessary, cables, test terminals, erection work, etc. is part of the scope of this protection.
- 2.29 The stability of this protection against out-zone faults shall be confirmed. A calculation to show the proper dimensioning of the relay upto the maximum short circuit of the switchgear shall be submitted.



- 2.30 **Overcurrent/ Earth Fault Protection (for Transformer, Incoming and outgoing line feeders and Bus coupler)**
- 2.31 This relay shall be of the electronic/numeric multi-characteristics type which has a flexible mode selection facility so that, it shall be possible to select a certain mode for the over current elements and a one for the earth fault element.
- 2.32 Phase current range shall cover at least 50-300% of I_N in steps of not more than 10% while the earth current range shall cover at least 5-100% of I_N in steps of not more than 5%.
- 2.33 The time setting range of the definite time mode shall not be less than 5 seconds in steps each of 0.1 second.
- 2.34 The time multiplier setting for the inverse time-current characteristic modes shall have a range not less than 0.05- 1.6 in steps each < 0.05 .
- 2.35 Overcurrent and earth fault relays shall have separate timers and operation indicators.
- 2.36 The high set element shall have a range of 2 - 15 times the nominal current at least in steps of 1 I_N shall be of low transient overreach, with a tripping time of less than 25 ms and possible to be selected on "blocked" position. Reset time shall be not more than 50 ms for both elements.
- 2.37 The relays, which shall be installed on the transformer neutral side, shall be from single-phase version, but they shall have the same characteristics as the phase ones. The transformer neutral earth fault relay shall trip both transformer breakers.
- 2.38 **Auxiliary Relay**
- 2.39 Voltage operated relays with sufficient contacts to initiate tripping, alarm, annunciation and logging for various trip functions like Buchholz relay operation, high oil temperature, high winding temperature, pressure relief valve operation, etc. shall be provided. Each relay shall have four (4) pairs of self-reset contacts except for Buchholz and "PRD" trip, which shall have hand, reset contact. The relays shall have hand reset operation indicators.
- 2.40 Voltage operated relays with sufficient contacts to initiate alarm and data logging for various alarm functions for transformers, etc. shall be provided. Each relay shall have four (4) normally open self-reset contacts. The auxiliary relay for Buchholz alarm shall be slugged to have delay on drop off at 100 ms. The relays shall have hand reset operation indicator.



2.41 **Bus/ Line under voltage relays**

2.42 Suitable voltage operated relays for sensing no voltage buses/lines, shall be provided. The relay shall have a drop off to pick up ratio of the order 90%. The relays shall be fast operating type and shall be fitted with operation indication. The indication shall come on drop off or loss of voltage.

2.43 Additional potential free contacts for all the Relay output i.e. trip as well as alarm signals shall be provided for connection to SCADA in future.

2.44 **Specific protection requirements for the breakers**

11 kV incomer, outgoing feeders, bus coupler 11 kV – 50/51 (Definite-time over current, Inverse-time over current), 49 (thermal overload), 37(3 phase under current), 46 (negative phase sequence over current), 50 N/51N (Earth fault directional over current, Earth over current), 86 (Output relay latching) protections.

Master trip relay – for all the breakers.

Trip Circuit Supervision – for all the breakers.

2.45 **Tests**

All routine tests shall be carried out on the assembled switchboard / panel during inspection at the manufacturer's works as per applicable standards. Test reports for bought out items shall be presented for review/acceptance during testing. The bidder shall submit type test reports during the detail engineering which is less than 5 years old.

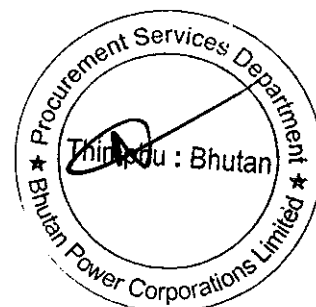
3. METER SPECIFICATIONS FOR THE 33 KV & 11 KV BREAKERS

Multifunctional meter for functions as shown in the single line diagram/specifications shall be provided. It shall be 3 phase 4 wire with **RS 485** port and **optical port**. It shall be provided with separate 3 phase 4 wire type test blocks for the testing of meters without disturbing the CT and VT secondary connections. The accuracy of the meters shall be 0.5 or better and capable of displaying maximum demand (kW/kVA). The detail specifications of meter are as follows:

1. Applicable Standards

The bidder shall supply Fully Static Intelligent Energy Meter with GSM/GPRS support. The static meter shall be manufactured and tested in accordance with the latest edition of the following standards:

- a. IEC 60687: Alternating current static watt-hour meters for active energy (classes 0.2 S and 0.5 S)
- b. IEC 61036: Alternating current static watt-hour meters for active energy (classes 1 and 2)



- c. IEC 61268: Alternating current static var-hour meters for reactive energy (classes 2 and 3)
- d. IEC 61107: Data exchange for meter reading, tariff and load control direct local data exchange

2. Service conditions and installation

The static meter (The meter) shall be dust-proof type and installed in a cabinet, and suitable for operation under the following conditions:

Altitude	: As per altitude mentioned in the Contract Document
Ambient air temperature	: from -10 up to 40°C
Average Daily Ambient Air Temperature	: 25°C
Relative humidity	: from 20% – 100%
Climatic condition	: Varied, from tropical to severe winters
Average Annual Rainfall (mm)	: 1390 mm

The overall climate condition is moderately warm, dusty and humid, conducive to rust and fungus growth.

3. General Features.

- a) Accuracy class shall be class 0.5 or better.
- b) Measurement mode shall be able to measure the power for 3 phase 4 wire and 3 phase 3 wire.
- c) CT range – 1/5 Amps.
- d) Data storage shall be through Flash RAM.
- e) Equipment Failure Alarms shall be provided.
- f) The meter shall be bidirectional.
- g) The meter shall have capability for programming from the remote to change the various parameters such as tariffs.
- h) The energy value shall be directly computed without having to put the multiplying factor.

4. Mounting provision

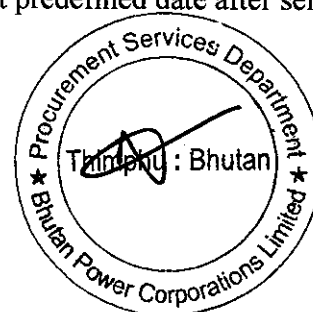
The meter is to be mounted on the panels.

5. Mechanical requirements

a. Maximum demand zero reset

The maximum demand zero reset shall be manually initiated via the sealable demand reset button.

The maximum demand shall be automatically reset at predefined date after self-reading.



b. **Terminal and terminal block**

Terminals shall be of high-conductivity brass with nickel plated or tin plated and suitable for the sizes of insulated cables to suit the site requirements.

c. **Potential circuit (direct-connected type)**

The connection point(s) of potential circuit, test link(s), shall be only made inside the meter cover.

d. **Meter and Terminal cover**

The meter shall have provision for sealing and anti-theft features. The terminal cover shall be suitable for incoming and outgoing cables.

e. **Nameplate**

The inscription on nameplate shall be marked in English according to the relevant standard, and marked with three (3) additional marks as follows:

- i. SUPPLIED BY:
- ii. BPC No.: (The number to be marked on the nameplate shall be given by BPC after the final of bid consideration.)
- iii. Barcode shall be the similar ones used by the billing and shall be given to the supplier.

6. **Register unit**

The register unit shall be an all solid-state microprocessor based register with internal memory of programmable and reprogrammable type. The internal memory shall be non-volatile semi-conductor type.

The register display shall be at least 6-digit LCD display with three (3) decimal points for power and two (2) decimal points for energy (programmable). The dimension of LCD display and number on LCD display shall be as per IEC standard.

The register unit shall be able to process data in at least two (2) following programmable modes:

- (i) To display the real time data and check the status of the meter
- (ii) To store and display the billing data for at least 60 days and the same shall be retained in case of power failure.

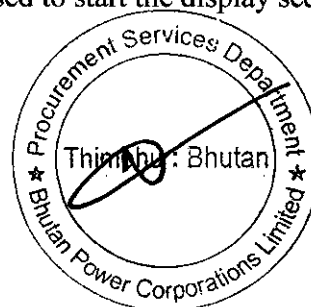
The register unit shall have the following display operating modes:

(i) **Scroll mode**

The selected display data such as kW, kVar etc. shall be continuous sequence to display each data automatically for a programmable display scroll time up to 15 seconds.

(ii) **Manual operating mode**

The push button/switch on the panel shall be used to start the display sequence and to display the various stored data.



The register unit shall display at least the following real time data:

- (i) Current date/time
- (ii) Maximum kW demand rate (Max 4 rates)
- (iii) Maximum kVar demand rate (Max 4 rates)
- (iv) Cumulative kW demand rate (Max 4 rates)
- (v) Cumulative kVar demand rate (Max 4 rates)
- (vi) Total kWh
- (vii) kWh rate(Max 4 rates)
- (viii) Total kVarh
- (ix) kVarh rate (Max 4 rates)
- (x) Per phase voltage and current (Instantaneous)
- (xi) Per phase power factor or phase angle (Instantaneous)
- (xii) System kW, kVar, and kVA (Instantaneous)
- (xiii) System power factor or phase angle (Instantaneous)

The display sequence and identified code can be independently specified by the user (programmable). The identified code shall be at least three (3) digits.

The display shall have symbols for indicating the operation of the meter, and also both import and export direction of measured active and reactive energy.

The display shall be able to indicate a unit of measure and the symbol of Electricity Rates.

7. Function for checking

The meter shall be able to indicate defects, by displaying on LCD display, as follows:

- a) In case the meter is damaged or has internal defects (e.g. clock fail, memory fail, etc.).
- b) In case the meter measures in reverse direction, or energy flows in reverse direction.
- c) In case the voltage at any phase is lost or under the setting value.
- d) In case of low battery

8. Real time clock and calendar

The meter shall have an internal real time clock and/or a crystal-controlled time clock, supplied from the Lithium back-up battery in case of power supply failure, for providing calendar functions (i.e. the time of day, date, weekday, weekend, holiday, year). The Lithium back-up battery shall be socket type.

9. Power supply

The auxiliary power supply for the meter shall be derived from PT & CT.



10. Load profile function

The meter shall be able to record load profile data of no less than two (2) channels, kW and kVar demand, every 15 minutes for at least 40 days in each channel. Load profile data shall not be effected when the power is lost.

11. Security system

The meter shall have a sophisticated security system to prevent fraudulent interference i.e. changing the tariff data or changing the meter reading.

The meter shall have at least three (3) following groups of accessible password:

- i. Group 1: Password for administrators to write the software and set the system of the meter.
- ii. Group 2: Password for programmers to program the operating functions of the meter
- iii. Group 3: Password for readers to read the stored data, including to correct the time of the meter

12. Communication system

Each meter shall have at least two (2) following communication systems:

- i. Optical port, easily accessed through the front of the meter cover, for data retrieval and program of all major operating characteristics of the meter.
- ii. RS232/RS485 for connecting with modem.

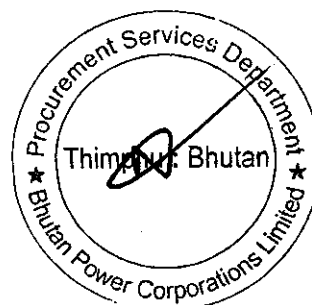
13. CT Ratios

Meters should have dual CT ratio of 1/5 Amps. The change in the CT ratio can be made only through a software and password authentications.

14. Tests and test reports

The meter shall pass the manufacturer's standard routine tests. The following type tests shall be in accordance with the latest relevant IEC or ANSI:

- Test of insulation properties:
 - impulse voltage test
 - A.C. voltage test
- Influence of short-time over currents
- Influence of heating:
 - windings, if any
 - external surface
- Electromagnetic compatibility (E.M.C.):
 - radio interference measurement
 - fast transient/burst test
 - immunity to electromagnetic HF field test
 - immunity to electrostatic discharge test



- Others according to manufacturer's standard
- Heating (permissible temperature rise) of:
 - windings, if any, in K
 - external surface in K

The acceptance inspection shall be according to the latest relevant IEC or ANSI

15. Medium Voltage Load Break Switches

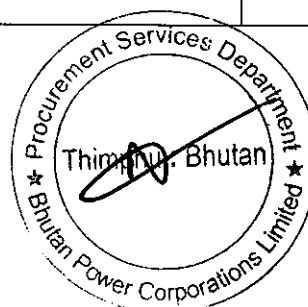
Pole mounted load break switches are used for sectionalising 33 kV and 11 kV feeders but are no longer used in distribution substations. They shall be air break, three pole, single throw, quick acting and fitted with load break heads.

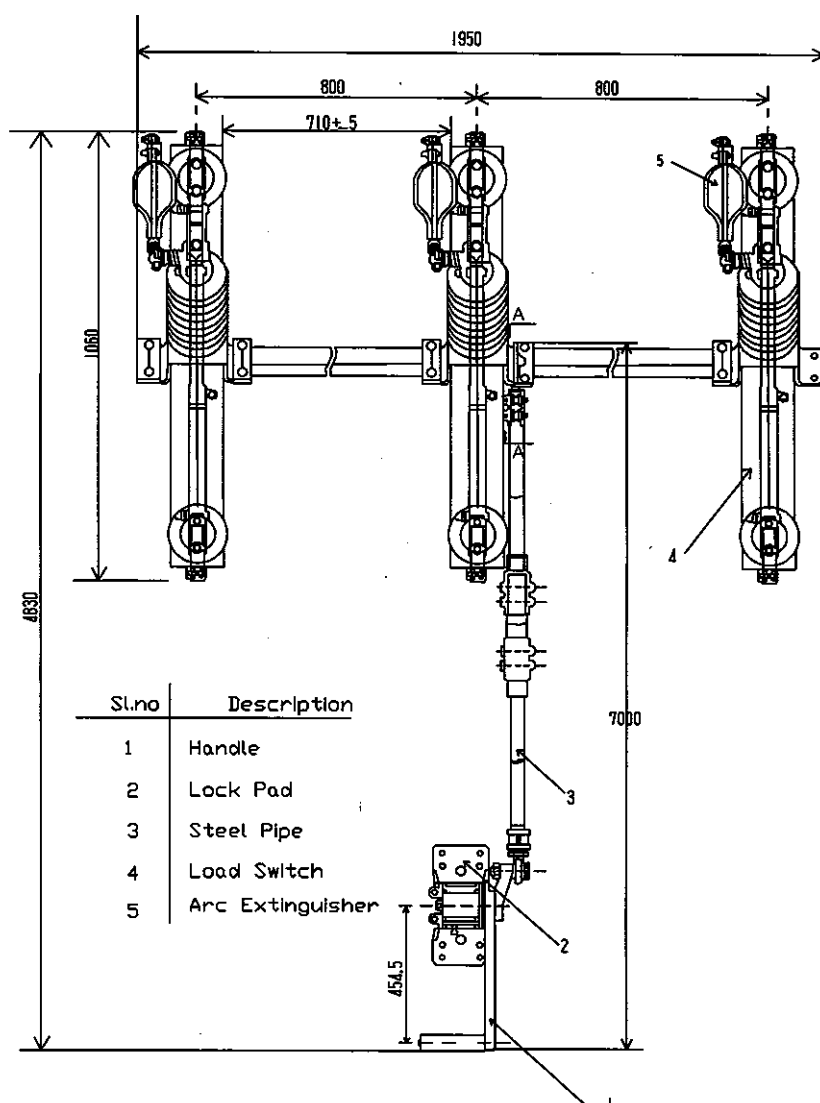
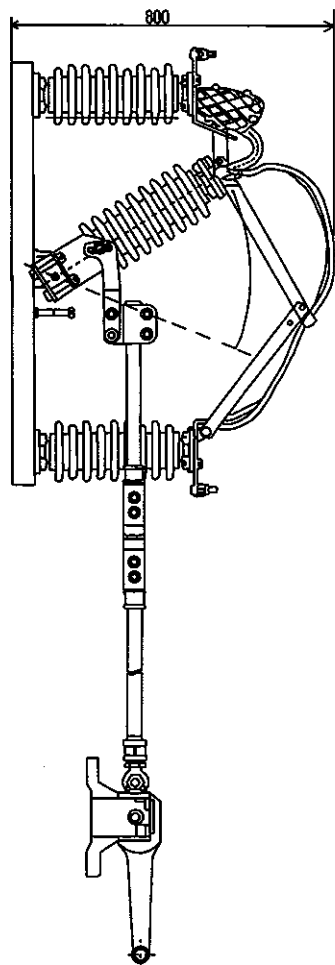
15.1 Load Break Switch (LBS)/ Air Break Switch

Load Break Switch / Air Break Switch is a manually operated switch used for breaking and making the circuit on load without damage to the switching equipment. This switch is supplied fitted with 96 Distribution Design & Construction Standard - December 2020 load break arc interrupters to allow the switch to be used to interrupt load currents in accordance with IEC 60265-1. Air break switches are generally used outdoor for circuits of medium capacity such as long lines supplying a village/industrial /commercial loads from main line/feeder for isolation and switching. LBS should be installed at start of a spur line for isolation and safety. Typical Drawing of LBS/ABS is given on drawing no. BPC-DDCS-2022-29.

Table for Standard Specification for Medium Voltage Load Break Switches

Parameter	33 kV	11 kV
Applicable standard	IEC 60271-102 and IEC 60265-1	
Rated normal current (A)	630	630
Rated 3 sec withstand current (kA)	16	20
Rated peak withstand current (kA)	40	40
Rated power frequency withstand voltage		
1. Across open contacts (kV)	80	32
2. To Earth and Between poles (kV)	70	28
Rated impulse withstand voltage		
1. Across open contacts (kV)	195	85
2. To Earth and Between poles (kV)	170	75





Sl.no	Description
1	Handle
2	Lock Pad
3	Steel Pipe
4	Load Switch
5	Arc Extinguisher

Rated Voltage:
 Rated short time Withstand current for 1 sec.
 Current Rating:
 Diameter and Length of the GI operating Pipe
 Size & Length of the channel for mounting
 Minimum clearances between phases
 Type of mounting
 Power frequency withstand Voltage
 1) Across Isolating Distance
 2) To earth and between poles
 Lightning impulse withstand Voltage
 1) Across Isolating Distance
 2) To earth and between poles
 Type of Insulator

11kV
 20kA
 630A
 25mm NBx6 mtr. Length
 75mmx40mmx660mm Long
 800mm
 vertical

32kV
 28kV

85kV
 75kV

Post Type with alternating shed

33kV
 16kA
 630A
 32mmx7 mtr. Length
 75mmx40mmx660mm Long
 800mm
 vertical

80kV
 70kV

195kV
 170kV

Post type with alternating shed



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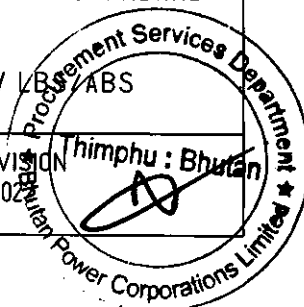
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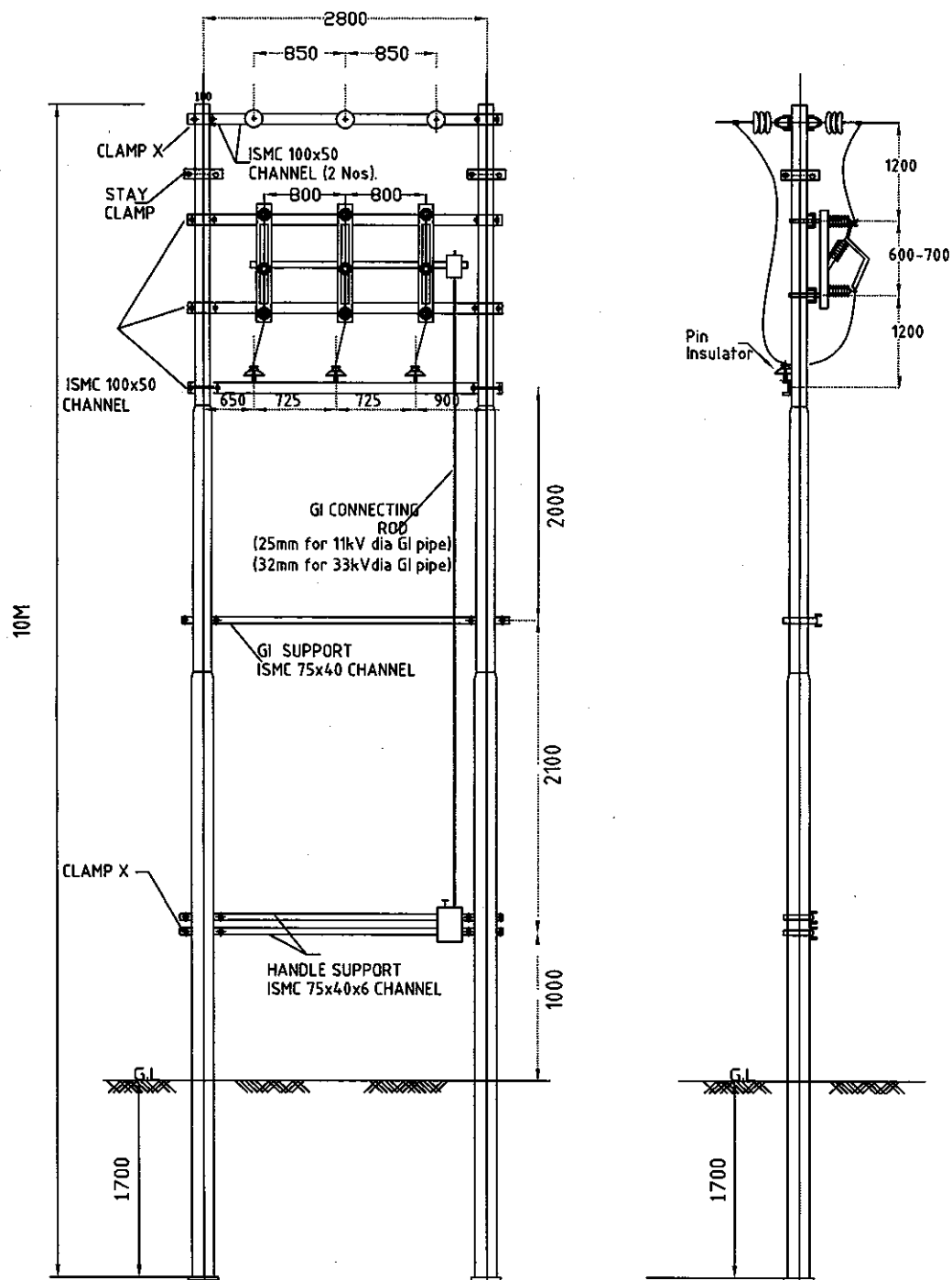
Typical Arrangement of 11kV & 33 KV LB/ABS

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APPROVED BY		

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CORPORATION LIMITED

ENGINEERING AND RESEARCH DEPARTMENT

DISTRIBUTION DESIGN & CONSTRUCTION STANDARD

11 & 33kV AIRBREAK SWITCH ARRANGEMENT

STEEL TUBULAR POLE

DRAWING NO. BPC-DDCS-2022-18/8-11

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