VACUUM CIRCUIT BREAKERS

This chapter consist of four sections as per details follows:

- Specification of 36 KV outdoor type Porcelain clad vacuum circuit breakers (PCVCB).
- Specification of 12 KV outdoor type Porcelain clad vacuum circuit breakers (PCVCB).
- Specification of 36 KV Indoor Switchgear (VCB Type).
- Specification of 12 kV indoor Switchgear (VCB Type)

Kindly refer to the relevant portion, required as per BPS

SECTION 1

SPECIFICATION OF 36 KV OUTDOOR TYPE PORCELAIN CLAD VACUUM CIRCUIT BREAKERS (PCVCB)

1. GENERAL TECHNICAL REQUIREMENTS

1.1. INTRODUCTION

1.1.1. The circuit breakers should be complete in all respects with insulators, bimetallic connectors, interrupting chamber, operating mechanism control cabinet, interlocks, auxiliary switches indicating devices, supporting structures, accessories, etc., described herein and briefly listed in the schedule of requirements. The scope of supply shall also include necessary special tools and plants required for erection as indicated, if any.

1.2. STANDARDS

1.2.1. The circuit breaker shall conform in all respects to the requirements of latest issue of IS/IEC specifications except for modifications specified herein. The equipment manufactured according to any other authoritative standards which ensure an equal or better quality than the provision of

IS/IEC specifications shall also be acceptable. The salient point of difference between the proposed standard and provision of these specifications shall be clearly brought out in the tender. A copy of English version of such specifications shall be enclosed with the tender.

1.2.2. The list of standards mentioned in this specification and to which the circuit conform is given below:

1.	IEC-62271-100	High Voltage A.C. Circuit Breakers
2.	IEC-60137	Bushing for alternating Voltages above 1000 volts
3.	IEC-60071	Insulation Co-ordination
4.	IEC-60694	Common clauses for high voltages switchgear and control gear standards
5.	IEC-60815	Specification for Creepage distances
6.	IS-13118	Specifications for high voltage alternating current circuit breakers
7.	IS-2099	High voltages porcelain bushings
8.	IS-4379	Identification of the contents of industrial gas cylinders
9.	IS-3072	Installation and maintenance of switchgear
10.	IEC-60267	Guide for testing of circuit breakers with respect to out of phase switching
11.	IS-802	Code of practice for use of structural steel in overhead transmission lines
12.	IEC-17A Study Group Dec.1981	Sealing of interrupters / breakers
13.	IS-1554	PVC insulated cables upto and including 1000 volts
14.	IS-5	Colors for ready mixed paints and channels
15.	Ref.Standard IES	Internal Electro-Technical Commission Bureau Central Data Commission, Elecro Technique International, 1, Ruede Verembe, Geneva,

		Switzerland
16.	IS	Indian Standard Bureau of India Standard, Manak Bhawan 9, Bahadurshah Zafar Marg, New Delhi – 110 002, India

1.3. SERVICE CONDITONS

1.3.1. CLIMATIC CONDITONS

The breakers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation as per section-I.

1.3.2. AUXILIARY POWER SUPPLY

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

a)	Power Devices (like motors)	:	415 V, 3 phase 4 wire 50 hz, neutral grounded AC supply
b)	DC Alarm, Control and Protective Devices	:	220/110 V/30 V DC, ungrounded 2 wire (Substation wise exact details shall be furnished by the successful bidder after survey)
c)	Lighting	:	240 V, single phase 50 Hz AC supply

Bidder's scope includes supply of interconnecting cables, terminal boxes, etc. The above supply voltage may vary as indicated below and all devices shall be suitable for continuous operation over the entire range of voltages

i)	AC Supply	Voltage + 10% -15% Frequency ± 5%
ii)	DC Supply	-15% to + 10%

1.4. GENERAL REQUIREMENT OF 36 KV/OUTDOOR VACUUM CIRCUIT BREAKERS

The vacuum type circuit breaker shall have vacuum interrupters, designed to provide a long contact life at all currents upto rated making and breaking current during switching operation. The vacuum interrupters sealed for life shall be encapsulated by porcelain insulators for out door installation requirement of the circuit breakers. The offered breakers shall be suitable for out door operation under climatic conditions specified without any protection from sun, rain and dust storm.

The vacuum interrupters of each phase shall be housed in a separate porcelain insulator. The three identical poles shall be mounted on a common base frame and the contact system of three poles should be mechanically linked to provide three pole gang opening/closing for all type of faults.

i) The offered equipment shall be practically maintenance free over a long period.

ii) All mechanical parts and linkages shall be robust in construction and maintenance free, over at least 10,000 switching operations, except for lubrication of pins/articulated joints at interval of 5 years or 5000 operations.

iii) Similar parts shall be strictly interchangeable without special adjustment of individual fittings. Parts requiring maintenance shall be easily accessible, without requiring extensive dismantling of adjacent parts.

iv) The operating mechanism will be self maintained and of proper operation endurance not less than the mechanical life of circuit breaking unit. It shall be spring operated type described hereinafter.

v) The circuit breaker shall be supplied complete with all auxiliary equipment, meant necessary for the safe operation, routine and periodic maintenance. All internal wiring including those of spare auxiliary contacts shall be complete and wired upto terminal blocks.

vi) The breaker shall be totally re-strike free under all duty conditions. The details of any device incorporated to limit or control the rate of rise of re-striking voltage across the circuit breaker contacts shall be stated.

vii) The breaker shall be reasonably quiet in operation and the noise level shall not exceed 140 decibels.

viii) The breaker shall be suitable for three phase re-closing operation.

ix) An operation counter, visible from the ground level even with the mechanism housing closed shall be provided.

1.4.1. FIXED AND MOVING CONTACT

The fixed and moving contacts of the breaker have to ensure permanent full contact during closing. All making and breaking contacts shall be hermetically sealed and free from atmospheric effects.

The main contacts should have low contact resistance.

1.4.2. RECOVERY VOLTAGE AND POWER FACTOR

The circuit breaker shall be capable of interrupting rated power with recovery voltage equal to the rated maximum line to line service voltage at rated frequency and at a power factor equal to or exceeding 0.15. In case of multiple break circuit breaker, devices/method adopted for ensuring uniform voltage distribution across all the breaks shall be indicated and actual voltage distribution recorded during interruption tests shall be furnished with the bid.

1.4.3. RESTRIKING RECOVERY

The complete data for the phase factor, amplitude factor, etc., for rate of rise of re-striking voltage shall be furnished in the tender.

1.4.4. LINE CHARGING INTERRUPTING CAPACITY

The circuit breaker shall be designed so as to be capable of interrupting line charging currents without undue rise in the voltage on the supply side without re-strike and without showing sign of undue strains.

The maximum permissible switching over voltage shall not exceed 2.5 p.u. The guaranteed over voltage, which will not be exceeded while interrupting the rated line charging current for which the breaker is designed to interrupt shall also be stated. The results of the tests conducted along with the copies of the oscillographs to prove ability of the breakers to interrupt the rated as well as lower values of the line charging current shall be furnished with the tender.

1.4.5. TRANSFORMER CHARGING CURRENT BREAKING CAPACITY

The breaker shall be capable of interrupting inductive currents, such as those occurring while switching off unloaded transformers, without giving rise to undue over voltage and without re-strikes. The maximum over voltage value, which will not be exceeded under such conditions shall be stated in the tender.

1.4.6. BREAKING CAPACITY FOR SHORTLINE FAULTS

The interrupting capacity of the breaker for short line faults shall be stated in the tender. The details of the test conducted for proving the capability of the breaker under a short line fault occurring from one phase to earth conditions shall also be stated in the tender. The rated characteristics for short line faults shall be in accordance with stipulation contained in clause 4.105 of IEC 62271-100.

1.4.7. AUTOMATIC RAPID RECLOSING

1.4.8. 36 kV circuit breaker shall be suitable for 3 pole rapid re-closing.

1.4.9. OUT OF PHASE SWITCHING

The circuit breaker shall be capable of satisfactory operation even under conditions of phase opposition that may arise due to faulty synchronization. The maximum power that the breaker can satisfactorily interrupt under “Phase Opposition” shall be stated in the bid”.

1.5. TEMPERATURE RISE

The maximum temperature attained by any part of the equipment when in service at side and under continuous full load conditions and exposed to the direct rays of the sun shall not exceed the permissible limits fixed by IEC. When the standards specify the limits of temperature rise these shall not be exceeded when corrected for the difference between ambient temperature specified in the approved specification.

The limits of temperature rise shall also be corrected for altitude as per IEC and stated in the bid.

1.6. INSULATORS SUPPORTS AND HOUSING

The porcelain used shall be homogenous, free from cavities and other flaws. The insulators shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above.. The puncture strength of bushing shall be greater than the flash over value. The design of bushing shall be such that the complete bushing in a self-contained unit and no audible discharge shall be detected at a voltage upto a working voltage (Phase Voltage) plus 10%. The support insulator shall conform to IEC-60137. Minimum clearance between phases, between live parts and grounded objects shall be as per IS-3072-1975 and should conform to Indian Electricity Rules-1956. The minimum creepage distance for severely polluted atmosphere shall be 25 mm/KV as per IEC-815-1985.

The details for atmospheric pollution of various sub-stations where these breakers are to be installed shall be as per Clause 1.3.1 of this specification. The air clearance of bushing should be such that if the bushings were tested at an altitude of less than 1000 meters, air clearance would withstand the application of higher voltages (IS-2099-1973 para 6.1). In order to avoid breakdown at extremely low pressures the support insulators should not be covered by moisture and conducting dust. Insulators should therefore be extremely clean and should have antitracking properties. Sharp contours in conducting parts should be avoided for breakdown of insulation. The insulators shall be capable to withstand the seismic acceleration of 0.3 g in horizontal direction.

1.7. OPERATING MECHANISM GENERAL REQUIREMENTS

The operating mechanism shall be stored energy type and capable of giving specified duty of the breaker (sequence of opening and closing) as specified under O-0.3 sec-CO-3 min-CO. The breaker shall also pass the operational test which ascertains the capabilities of operating mechanism. The operating mechanism shall be capable to perform the following functions efficiently.

i) To provide means where the circuit breaker can be closed rapidly, at all currents from zero to rated making current capacity.

ii) To hold the circuit breaker in closed position by toggles or latches till the tripping signal is received.

iii) To allow the circuit breaker to open without delay immediately on receiving tripping signal.

iv) To perform auto re-closure duty cycle.

v) To perform the related functions such as indication, contacts, etc.

Operating mechanism should also be suitable for three phase auto re-close duty. The closing spring shall be automatically charged by motor immediately after closing operation. In case of failure of supply to the spring charging motor, the spring shall be chargeable by hand-crank.

a) TRIPPING/CLOSING COILS

The circuit breakers shall be provided with two trip coils and one closing coil per breaker. First trip coil shall be utilized for tripping the breaker on main protection fault detection. Whereas second trip coil shall be used to trip the breaker when first trip coil fails to trip the breaker and backup protection comes into operation and shall also be used to trip the breaker on command. Provision shall be given for trip circuit supervision both in pre close and post close condition of the breaker. All the breakers shall have provision for independent electrical operation of trip coils from local as well as remote through local/remote selector switch.

b) TRIP FREE FEATURES

When the breaker has been instructed to close by manual instructions using push button, the operating mechanism will start operating for closing operations. If in the mean time a fault has taken place, the relay provision shall be such that it should close the trip circuit simultaneously interrupting the live circuit of closing coil which has been instructed for close command.

The trip free mechanism shall permit the circuit breaker to be tripped by the protective relay even if it is under the process of closing. An anti-pumping device to prevent the circuit breaker from reclosing after an automatic opening shall be provided to avoid the breaker from pumping i.e., anti pumping relay should interrupt the closing coil circuit.

c) Controls

The circuit breaker shall be controlled by a control switch located in the control cabinet . The control arrangement shall be such as to disconnect the remote control circuits of the breaker, when it is under

test. Local control devices, selector switch and position indicator shall be located in weather and vermin-proof cabinet with degree of protection not less than IP-55. The circuit breaker control scheme shall incorporate trip circuit supervision arrangement. Local/remote selector switch shall be provided for all breakers for selection of "Local" control/remote control.

Provision shall be made for local manual, electrical and spring controls. Necessary equipment's for local controls shall be housed in the circuit breaker cabinet of weather-proof construction. In addition to this, a hand closing device for facilitating maintenance shall also be provided.

Each circuit breaker shall have a mechanical open/closed and spring charge indicator in addition to facilities for provisions for semaphore indicators for breakers which are required for the mimic diagram in the control room. Lamps for indicating, `close/open' position of the breaker shall also be provided.

The contact pressure spring and tripping spring shall be chargeable during closing operation to ensure the breaker is ready to open. Mechanically ON/OFF indicator, spring charged indicator and operation counter shall be provided on the front of the control cubicle. For tripping, the spring provided shall ensure the trippings

Mechanical indicator, to show the 'open' and 'close' position of the breaker shall be provided in a position where it will be visible to a man standing on ground with mechanism housing open. An operation counter, visible from the ground even with the mechanism housing closed, shall be provided. Electrical tripping of the breaker shall be performed by shunt trip coils.

Closing coil shall operate correctly at all value of voltage between 85% and 110% of the rated voltage. Shunt trip coils shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity and at all values of supply voltage between 85% and 110% of rated voltage. The variation in A.C. supply voltage shall be –15%to +10% while variation in frequency shall be ±3. Working parts of the mechanism shall be non-corrosive material. Bearings which require grease shall be equipped with pressure type fillings.

Bearing pins, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the circuit breaker. It shall be possible to trip the circuit breaker even in the event of failure of power supply.

Operating mechanism and all accessories shall be enclosed in control cabinet. A common marshalling box for the three poles of the breaker shall be provided, along with supply of tubing, cables from individual pole operating boxes to the common marshalling box, local.

1.7.1. SPRING OPERATED MECHANISM

The motor compressed spring mechanism shall consists of a closing spring which is wound or compressed by an electric motor immediately after the breaker closes.

After the breaker has tripped, the tripping spring shall remain in the released position as long as the breaker is open, but the closing spring shall remain wound and ready for closing operation. The operating mechanism shall have all the necessary auxiliaries, apparatus for operation and supervision, like motor starter with thermal overload release, one closing coil, two trip coils, push button for local electrical operation, local/remote control selector switch, push button for direct mechanical tripping, auxiliary switches, antipuming contactors, operation counter, socket for inspection, lamp and heater with switch. Spring charging motor shall be standard single phase universal motor suitable for 220 volts supply.

i) Operating voltages for closing/tripping coils shall be 220/110/30 Volts DC **or as per actual DC voltage available at existing substations**

ii) Operating voltages for heater elements shall be 220V AC 50 HZ. Other features of the spring operated mechanism shall be as follows.

a) The spring operating mechanism shall have adequate energy stored in the operating to close and latch the circuit breaker against the rated making current and also to provide the required energy for tripping mechanism in case the tripping energy is derived from the operating mechanism.

b) The mechanism shall be capable of performing the rated operating duty cycle of O-0.3Sec-CO-3 Min-CO...

c) The spring charging motor shall be AC or DC operated and shall not take more than 30 sec., to fully charge the closing spring made for automatic charging. Charging of spring by the motor should not interfere with the operation of the breakers.

d) The motor shall be adequately rated to carry out a minimum of one duty cycle. Also provision shall be made to protect the motor against overloads.

e) In case of failure of power supply to spring charging motor, the mechanism shall be capable of performing one open-close-open operation.

f) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of the closing springs when the breaker is already in closed position. Provision shall be made to prevent a closing operation to be carried out with the spring partially charged.

g) Facility shall be provided for manual charging of closing springs.

1.7.2. CONTROL CABINET

The switchgear operating mechanism, the control equipment such switch for closing and tripping the breakers, various control relays, antipuming device, a set of terminal blocks for wiring connections, MCB's for disconnecting the control auxiliary power supplies including relays, etc., shall be enclosed in a cabinet to be mounted on a suitable structure at a convenient working height at the end of the breaker in the outdoor switchyard. The supporting structure and the enclosure shall be capable of withstanding the typical tropical climatic conditions, change of ambient temperature, severe dust-storms, very high relative humidity those are prevailing at the site of location of switchgear.

i) ENCLOSURE

The enclosure shall be made out of stretched level steel plates not less than 3 mm thick and of light section structural steel. It should be weather proof as well as vermin proof.

The enclosure shall provide protection against dust and foreign objects. Each cabinet section shall have full width and full length hinged doors mounted on the front that swing fully open. The doors shall be provided with latches to securely hold it with the cabinet. Doors shall be of sturdy construction, with resilient material covering, fully perimeterically contacting the cabinet frame to provide dust protection and prevent metal to metal contact except at the latch points. Filtered ventilation shall be provided along with the rigid supports for control and other equipment, measuring instruments, mounting cabinet members and equipment shall not restrict easy

access to terminal blocks for terminating and testing external connection or to equipment for maintenance.

All screws and bolts used for assembling and mounting wire and cable termination, supports, devices and other equipment shall be provided with lock washers or other locking devices. All metal parts shall be clean and free of weld splatter, rust and mill scale prior to application of double coat of zinc chromate primer which should be followed by an under coat to serve as base and binder for the finishing coat. The shade of exterior and interior shall be as per GTR.. The mounting structure shall be galvanized and shall be as per IS-802-II-1978.

ii) HEATERS

Suitable heaters shall be mounted in the cabinet to prevent condensation. Heaters shall be controlled by thermostat and shall be provided with ON/OFF switches and fuses. .Heaters shall be suitable for 240 V AC supply voltage.

iii) LIGHTING

At least one 13 watt CFL fixture and lamp working on 240 V 50 c/s AC supply shall be provided in each switchgear control cubicle section and shall be located suitably to provide adequate interior lighting of the cubicle. A single-pole 6 Amp. lighting switch shall be provided for each cubicle alongwth 5/15 amp..

The lighting and convenient outlet circuits shall be completely wired in conduit and terminated on cubicle terminal blocks.

iv) WIRING AND CABLING

a) Unless otherwise specified control wire shall be stranded tinned copper switchboard wire with 1.1 kV PVC insulation conforming to the requirements of IS-1554.

b) All the control circuit and secondary wiring shall be wired completely and brought out to terminal block ready for external connections in the control cabinet. The cross-section of control wire shall not be less than 2.5 mm2 copper (14 SWG).

c) All spare auxiliary contacts of the circuit breaker shall be supplied wired upto terminal block. Each terminal in terminal block shall be suitable for at least 2 x 2.5 mm^2 copper conductor.

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d) All wiring termination on terminal blocks shall be made through lugs.

e) All wires shall be identified with non-metallic sleeve or tube type markers at each terminations.

f) Terminal blocks shall be made up of moulded non-inflammable plastic material with blocks and barriers moulded integrally have white marking strips for circuit identification and moulded plastic covers. Disconnecting type terminal blocks will be provided.

v) GROUNDING

A ground bus of copper bar not less than 6 mm by 25 mm shall be provided for grounding the cabnet.

1.8. ACCESSORIES

Each circuit breaker assembly shall be supplied with the following accessories.

i) Line and earthing terminals and terminal connectors.

ii) Control housing with:

a) One auxiliary switch with adequate number of auxiliary contacts, but not less than 20 nos. (10 NO + 10 NC) for each breaker. These shall be over and above the No. of contacts used for closing, tripping and re-closing and interlocking circuit of the circuit breaker. All auxiliary contacts shall be capable of use as “Normally closed” or “Normally open” contacts. Special auxiliary contacts required for the re-closing circuit if any, shall also be provided. There shall be provision, to add more auxiliary contacts at a later date, if required.

b) Operation counter

c) Position indicator (Close/Open)

d) Necessary cable glands

e) Fuses

f) Manual trip device and local test push buttons

g) Terminal blocks and wiring for all control equipment and

h) Adequate number of heaters for continuous operation to prevent moisture condensation in the housing of operating mechanism

i) Selector switch for local/remote control.

1.9. SUPPORTING STRUCTURE

The circuit breakers shall be supplied complete with necessary galvanized steel supporting structures, foundation and fixing bolts, etc., the galvanizing shall be as per IS. The mounting of the breaker shall be such as to ensure the safety of the operating staff and should conform to Indian Electricity Rules, 1956. Minimum ground clearance of live part from ground level shall be 3700 mm from finished ground level.

The bidder shall submit detailed design calculations and detailed design calculations and detailed drawings in respect of supporting structures suitable for the equipment offered.

All material for making connections between the circuit breaker and its control shall also be included in the scope of supply. Facility to earth the circuit breaker structure at two points shall be provided.

1.10. SURFACE FINISH

1.10.1. All interiors and exteriors of tanks, control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulation oil, as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paint.

1.10.2. All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

1.10.3. All ferrous hardware, exposed to atmosphere, shall be hot dip galvanized.

1.11. GALVANISING

1.11.1. All ferrous parts including all sizes of nuts, bolts, plain and spring washers, support channels, structures, shall be hot dip galvanized conforming to latest version of IS:2629 or any other equivalent authoritative standard.

1.12. CABLE TERMINATION

Suitable cable glands for terminating the multicore cable, shall be provided wherever required.

1.13. TERMINAL CONNECTIONS AND EARTH TERMINALS

1.13.1. Each circuit breaker connected with incoming and outgoing feeders shall be provided with solderless clamp type connectors suitable for ACSR conductor.

1.13.2. Each circuit breaker pole and control cabinet shall be provided with appropriate number of grounding terminals and clamps for receiving ground connections.

1.13.3. Each circuit breaker pole and control cabinet shall be provided with appropriate number of grounding terminals and clamps for receiving ground connections.

1.14. INTERLOCKS

Necessary interlocks to prevent closing or opening of the breaker under low pressure of the contact spring and devices for initiating alarm shall be provided. The detailed interlocking scheme based upon single line diagram as applicable for the substation shall be provided by the contractor

Requirement of interlock shall be as given below:

i) Isolator should not be operated unless the associated breaker is in open position.

ii) The circuit breaker shall close only after all isolators associated with it have been in closed position.

In case of double bus bar arrangement following additional requirement for interlocking shall be provided.

i) One bus bar selector isolator of any bay excepting the bus coupler bay shall close only when,

   a) The circuit breaker of corresponding bay is open and locked.

   b) The other bus isolator of that bay is open.

ii) When one bus isolator of any bay excepting the bus coupler bay is closed. The other shall close only when the bus coupler circuit breaker and both the bus isolators are closed.

iii) Bus isolator of bus coupler bay shall operate only when the bus coupler breaker is open.

iv) The bypass isolator of feeder shall close when the feeder circuit breaker and its adjoining isolators are closed.

1.15. EARTHING SYSTEM

All switchgear enclosures should be bolted metal to metal and should carry the full earth return current. Connection between phases at the earthing points shall be dimensioned for carrying full earth return current i.e., actual service current not rated current.

1.16. VACUUM INTERRUPTER ASSEMBLY

Each pole of the circuit breaker shall be provided with vacuum interrupter, one for each phase, hermetically sealed for life and encapsulated by ceramic insulators. The interrupter shall be provided with steel chromium are chamber to prevent vaporized contact material being deposited on the insulating body. A further shield giving protection to the metal bellows shall also follow the travel of the moving contacts to seal the interrupter against the surroundings atmosphere.

It shall have high and consistent dielectric strength of vacuum unaffected by environment and switching operations. Bronzed joints should ensure retention of vacuum for life time. It shall have low and stable contact resistance due to absence of oxidation effects and shall ensure low power loss. The arcing voltage shall be low and minimum contact erosion.

1.17. GUARANTEED TECHNCIAL PARTICULARS

Guaranteed and technical particulars as called for in Section-II shall be furnished along with the tender. Particulars which are subject to guarantee shall be clearly marked.

1.18. TESTS

1.18.1. TYPE TESTS

Each circuit breaker shall comply with requirements of type tests prescribed in IEC publication No. 62271-100

i) Short time and peak withstand current test .
ii) Short circuit breaking capacity and making capacity.
iii) Capacitive current switching test : Cable charging current breaking test(Ur less than or equal to 52 kV).
iv) Dielectric test i.e., power frequency withstand and impulse withstand test
v) Temperature rise test.
vi) Mechanical Endurance Test at ambient temperature.
vii) Measurement of resistance of the main circuit.

1.19. ROUTINE TESTS

Routine Tests as per IEC- 62271-100 shall be carried out on each breaker in presence of purchaser's representative at the manufacturer's expenses at his works except, where agreed to otherwise. All test reports should be submitted and should be got approved from the purchaser before despatch of the equipment.

1.20. SITE TESTS ON CONTROL AND AUXILIARY CIRCUIT

The following tests shall be conducted at site.

i) Voltage tests on control and auxiliary circuit.
ii) Measurements of resistance of the main circuit.
iii) Mechanical Operation Tests.

1.21. NAME PLATE

1.21.1. Equipment should be provided with name plate giving full details of manufacture, capacities and other details as specified in the relevant ISS or other specification stipulated.

1.22. TECHNICAL PARAMETERS

1.22.1. 36 KV CIRCUIT BREAKERS

S. NO.	DESCRIPTION		VALUES
i)	Rate voltage (KV rms)	:	36 KV
ii)	Rated frequency (Hz)	:	50
iii)	System neutral earthing	:	Solidly grounded system
iv)	Type of arc quenching medium	:	Vacuum
v)	Rated normal current at site conditions (Amps)	:	1250 Amps
vi)	Number of poles	:	3
vii)	Installation	:	Outdoor type
viii)	Temperature rise	:	As per IEC 56 (Table-4) Page-19
ix)	Rated short circuit	:	
	a) Interrupting capacity at 36 KV	:	25 KA
	b) The percentage DC components	:	As per IEC-62271-100
	c) Duration of short circuit	:	3 Sec.
x)	Rated short circuit making	:	62.5 KA
xi)	First pole to clear factor	:	1.5
xii)	Rated short time current	:	25 KA
xiii)	Rated duration of short circuit	:	3 Seconds
xiv)	Total break time for any current upto the rated breaking current with limiting condition of operating and quenching media pressure (ms)	:	< 80 ms
xv)	Closing time (ms)	:	< 150 ms
xvi)	Mounting	:	Hot dip galvanized lattices steel support structured bolted type

S. NO.	DESCRIPTION		VALUES
xvii)	Phase to phase spacing in the switch yard i.e, interpole spacing for breaker (min) in mm	:	400
xviii)	Required ground clearance from the lowest line terminal if both the terminals are not in same horizontal plane (cum)	:	**3700**
xix)	Height of concrete plinth (mm)	:	**300**
xx)	Minimum height of the lowest part of the support insulator from ground liner (mm)	:	2550
xxi)	Minimum creepage distance of support insulator (mm)	:	900
xxii)	Minimum corona extinction voltage (kv rms)	:	92
xxiii)	Standard value of rated transient recovery voltage for terminal fault	:	As per IEC-62271-100
xxiv)	Standard value of rated line Characteristics for short line faults	:	As per IEC-62271-100
	RRRV	:	kV/ms=0.214
	Peak Factor		K=1.6 A
	Surge Impedance	:	450
xxv)	Rated operating duty cycle	:	O-0.3 Second - CO-3 Minutes-CO
	b) Auto reclosing	:	Suitable for three phase Auto reclosing duty
xxvi)	Rated insulation level under heavy pollution condition 1.2/50 micro second lightening Impulse withstand voltage (KV peak)to earth	:	170 KV
xxvii)	Power frequency withstand voltage KV (rms) to earth (KV rms)	:	70 KV
xxviii)	Rated characteristic for out of Phase breaking	:	
	a) Out of phase breaking	:	25% of rated breaking capacity

S. NO.	DESCRIPTION		VALUES
	capacity		
	b) Standard values of transient recovery	:	As per IEC-56
	c) Operating mechanism	:	Spring operated, Anti pumping and Trip free mechanism
	d) Power available for operating mechanism	:	Three phase 415 Volts 50 C/S or single phase 50 C/S 240 volts
xxix)	a) Rated supply voltage of closing and operating devices and auxiliary circuits	:	1) 220 V DC/30 VDC 2) 240 Volts AC 50 C/S single phase 3) 415 volts 50 Hz three phase
	b) Permissible voltage variation	:	1) In case of DC Power supply voltage variation shall be between 85% to 110% of normal voltage. 2) In case of AC power supply voltage variation shall be of the normal voltage as per IS- 15% to +10%.
	c) Permissible frequency	:	± 3% from normal 50 Hz as per IS 2026 part-I 1977 para 4.4
	d) Combined variation of frequency and voltage	:	± 10%
xxx)	Auxiliary contacts (number & rating)	:	12 NO and 12 NC on each pole having continuous current rating of 10 Amps. DC breaking rating capacity shall be 2 Amps with circuit time constant less than 20 ms at 220/30 volts DC
xxxi)	Number of trip coils	:	Two trip coils and 1 close coil with anti-pumping arrangement
xxxii)	Rated terminal load	:	100 kg. Static. The breaker shall be designed to withstand the rated terminal load, wind, load, earthquake load and short circuit forces
xxxiii)	Noise level of the equipment	:	No exceeding 140 db

1.23. DRAWINGS AND INSTRUCTION MANUALS

Following drawings for each item are to be supplied as part of the contract.

i) General outline drawings, showing dimensions, front and side elevations and plan of the circuit breaker and its local control panel.

ii) Outline drawing of bushings showing dimensions and number of sheds and creepage distance.

iii) Assembly and sub-assembly drawings with numbered parts.

iv) Sectional views showing the general constructional features, operating mechanism and are extinguishing chamber, etc.

v) Dimension and assembly of important auxiliaries.

vi) Detailed drawings of operating mechanism. And inter-phase mechanism.

vii) Test certificates and oscillographs.

viii) Detailed drawings of mounting structure.

ix) Spare parts and catalogue

x) Wiring diagram showing the local and remote control scheme of breaker including alarms indication devices instruments relay and timer wiring.

xi) Write up on working of control schematic of breaker.

xii) Foundation plan including weights of various components and impact loadings for working foundation design. Three copies for each pkg. of the above drawings and instruction manuals covering instructions for installations, operation and maintenance shall be supplied by the contractor(s) without any extra cost.

SECTION- 2

SPECIFICATION OF 12 KV OUTDOOR TYPE PORCELAIN CLAD VACUUM CIRCUIT BREAKERS (PCVCB)

2.1 INTRODUCTION

2.1.1 This section of specification covers the specification of 12 KV outdoor type vacuum circuit breakers.

2.1.2 The circuit breakers should be complete in all respects with insulators, bimetallic connectors, interrupting chamber, operating mechanism control cabinet, interlocks, auxiliary switches indicating devices, supporting structures, accessories, etc., described herein and briefly listed in the schedule of requirements. The spares/attachments which are meant necessary for the smooth functioning of the equipment and specifically are not mentioned here shall be assumed to be included the scope of supply. The scope of supply shall also include necessary special tools and plants required for erection as indicated, if any.

2.2 STANDARDS

2.2.1 The circuit breaker shall conform in all respects to the requirements of latest issue of IS/IEC specifications except for modifications specified herein. The equipment manufactured according to any other authoritative standards which ensure an equal or better quality than the provision of IS/IEC specifications shall also be acceptable. The salient point of difference between the proposed standard and provision of these specifications shall be clearly brought out in the tender. A copy of English version of such specifications shall be enclosed with the tender.

2.2.2 The list of standards mentioned in this specification and to which the circuit conform is given below:

1.	IEC-62271-100	High Voltage A.C. Circuit Breakers
2.	IEC-60137	Bushing for alternating Voltages above 1000 volts
3.	IEC-60071	Insulation Co-ordination
4.	IEC-60694	Common clauses for high voltages switchgear and control gear standards
5.	IEC-60815	Specification for Creepage distances
6.	IS-13118	Specifications for high voltage alternating current circuit breakers
7.	IS-2099	High voltages porcelain bushings
8.	IS-4379	Identification of the contents of industrial gas

		cylinders
9.	IS-3072	Installation and maintenance of switchgear
10.	IEC-60267	Guide for testing of circuit breakers with respect to out of phase switching
11.	IS-802	Code of practice for use of structural steel in overhead transmission lines
12.	IEC-17A Study Group Dec.1981	Sealing of interrupters / breakers
13.	IS-1554	PVC insulated cables upto and including 1000 volts
14.	IS-5	Colors for ready mixed paints and channels
15.	Ref.Standard IES	Internal Electro-Technical Commission Bureau Central Data Commission, Elecro Technique International, 1, Ruede Verembe, Geneva, Switzerland
16.	IS	Indian Standard Bureau of India Standard, Manak Bhawan 9, Bahadurshah Zafar Marg, New Delhi – 110 002, India

2.3 SERVICE CONDITONS

2.3.1 CLIMATIC CONDITONS

The breakers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation as per Section-I.

2.3.2 AUXILIARY POWER SUPPLY

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

a) Power Devices (like motors) — 415 V, 3 phase 4 wire 50 hz, neutral grounded AC supply

b) DC Alarm, Control and Protective Devices — 220/110V/30 V DC, ungrounded 2 wire (Substation wise exact details shall be furnished to the successful bidder)

c)	Lighting	240 V, single phase 50 Hz AC supply

Bidder's scope include supply of interconnecting cables, terminal boxes, etc. The above supply voltage may vary as indicated below and all devices shall be suitable for continuous operation over the entire range of voltages

i)	AC Supply	Voltage + 10% -15% Frequency ± 5%
ii)	DC Supply	-15% to + 10%

2.4 GENERAL REQUIREMENT OF 12 kV/OUTDOOR VACUUM CIRCUIT BREAKERS (PCVCB)

The vacuum type circuit breaker, shall have vacuum interrupters, designed to provide a long contact life at all currents upto rated making and breaking current during switching operation. The vacuum interrupters sealed for life shall be encapsulated by porcelain insulators for out door installation requirement of the circuit breakers. The offered breakers shall be suitable for out door operation under climatic conditions specified without any protection from sun, rain and dust storm.

The vacuum interrupters of each phase shall be housed in a separate porcelain insulator. The three identical poles shall be mounted on a common base frame and the contact system of three poles should be mechanically linked to provide three pole gang opening/closing for all type of faults.

i) The offered equipment shall be practically maintenance free over a long period.

ii) All mechanical parts and linkages shall be robust in construction and maintenance free, over at least 10,000 switching operations except for lubrication of pins/articulated joints at interval of 5 years or 5000 operations.

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iii) Similar parts shall be strictly interchangeable without special adjustment of individual fittings. Parts requiring maintenance shall be easily accessible, without requiring extensive dismantling of adjacent parts.

iv) The operating mechanism will be self maintained and of proper operation endurance not less than the mechanical life of circuit breaking unit. It shall be spring operated type described hereinafter.

v) The circuit breaker shall be supplied complete with all auxiliary equipment, meant necessary for the safe operation, routine and periodic maintenance. All internal wiring including those of spare auxiliary contacts shall be complete and wired upto terminal blocks..

vi) The breaker shall be totally restrike free under all duty conditions. The details of any device incorporated to limit or control the rate of rise of restriking voltage across the circuit breaker contacts shall be stated.

vii) The breaker shall be reasonably quiet in operation and the noise level shall not exceed 140 decibels.

viii) The breaker shall be suitable for three phase re-closing operation.

ix) An operation counter, visible from the ground level even with the mechanism housing closed shall be provided.

2.4.1 FIXED AND MOVING CONTACT

The fixed and moving contacts of the breaker have to ensure permanent full contact during closing. All making and breaking contacts shall be hermetically sealed and free from atmospheric effects.

The main contacts should have low contact resistance.

2.4.2 RECOVERY VOLTAGE AND POWER FACTOR

The circuit breaker shall be capable of interrupting rated power with recovery voltage equal to the rated maximum line to line service voltage at rated frequency and at a power factor equal to or exceeding 0.15. In case of multiple break circuit breaker, devices/method adopted for ensuring uniform voltage distribution across all the breaks shall be indicated and actual voltage distribution recorded during interruption tests shall be furnished with the bid.

2.4.3 RESTRIKING RECOVERY

The complete data for the phase factor, amplitude factor, etc., for rate of rise of re-striking voltage shall be furnished in the tender.

2.4.4 LINE CHARGING INTERRUPTING CAPACITY

The circuit breaker shall be designed so as to be capable of interrupting line charging currents without undue rise in the voltage on the supply side without re-strike and without showing sign of undue strains.

The maximum permissible switching over voltage shall not exceed 2.5 p.u. The guaranteed over voltage, which will not be exceeded while interrupting the rated line charging current for which the breaker is designed to interrupt shall also be stated

2.4.5 TRANSFORMER CHARGING CURRENT BREAKING CAPACITY

The breaker shall be capable of interrupting inductive currents, such as those occurring while switching off unloaded transformers, without giving rise to undue over voltage and without restrikes. The maximum over voltage value, which will not be exceeded under such conditions shall be stated in the GTP.

2.4.6 BREAKING CAPACITY FOR SHORTLINE FAULTS

The interrupting capacity of the breaker for short line faults shall be stated in the **GTP**. The details of the test conducted for proving the capability of the breaker under a short line fault occurring from one phase to earth conditions shall also be stated in the **GTP**. The rated characteristics for short line faults shall be in accordance with stipulation contained in clause 4.105 of IEC-62271-100.

2.4.7 AUTOMATIC RAPID RECLOSING

12 KV circuit breaker shall be suitable for 3 pole rapid reclosing.

2.4.8 OUT OF PHASE SWITCHING

The circuit breaker shall be capable of satisfactory operation even under conditions of phase opposition that may arise due to faulty synchronization. The maximum power that the breaker can satisfactorily interrupt under “Phase Opposition” shall be stated in the bid”.

2.5 TEMPERATURE RISE

The maximum temperature attained by any part of the equipment when in service at side and under continuous full load conditions and exposed to the direct rays of the sun shall not exceed the permissible limits fixed by IEC. When the standards specify the limits of temperature rise these shall not be

exceeded when corrected for the difference between ambient temperature specified in the approved specification.

The limits of temperature rise shall also be corrected for altitude as per IEC and stated in the GTP.

2.6 INSULATORS SUPPORTS AND HOUSING

The porcelain used shall be homogenous, free from cavities and other flaws. The insulators shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above. The puncture strength of bushing shall be greater than the flash over value. The design of bushing shall be such that the complete bushing in a self-contained unit and no audible discharge shall be detected at a voltage upto a working voltage (Phase Voltage) plus 10%. The support insulator shall conform to IEC-137. Minimum clearance between phases, between live parts and grounded objects shall be as per IS-3072-1975 and should conform to Indian Electricity Rules-1956. The minimum Creepage distance for severely polluted atmosphere shall be 25 mm/KV as per IEC-60815-1985.

The details for atmospheric pollution of various sub-stations where these breakers are to be installed shall be as per Clause 1.3.1 of this specification. The air clearance of bushing should be such that if the bushings were tested at an altitude of less than 1000 meters, air clearance would withstand the application of higher voltages (IS-2099-1973 para 6.1). In order to avoid breakdown at extremely low pressures the support insulators should not be covered by moisture and conducting dust. Insulators should therefore be extremely clean and should have antitracking properties. Sharp contours in conducting parts should be avoided for breakdown of insulation. The insulators shall be capable to withstand the seismic acceleration of 0.3 g in horizontal direction.

2.7 OPERATING MECHANISM GENERAL REQUIREMENTS

The operating mechanism shall be stored energy type and capable of giving specified duty of the breaker (sequence of opening and closing) as specified O-0.3 sec-CO-3 min-CO. The breaker shall also pass the operational test which ascertain the capabilities of operating mechanism. The operating mechanism shall be capable to perform the following functions efficiently.

i) To provide means where the circuit breaker can be closed rapidly, without hesitation at all currents from zero to rated making current capacity.

ii) To hold the circuit breaker in closed positions by toggles or latches till the tripping signal is received.

iii) To allow the circuit breaker to open without delay immediately on receiving tripping signal.

iv) To perform auto re-close duty cycle.

v) To perform the related functions such as indication, contacts, etc.

Operating mechanism should also be suitable for three phase auto reclose duty. The closing spring shall be automatically character by motor immediately after closing operation. In case of failure of supply to the spring charging motor, the spring shall be chargeable by hand-crank.

The supply of auto reclosing scheme control circuit equipment does not form the part of this specification. The supplier shall however be required to co-ordinate for the same with the supplier of control and relay panels.

i) **TRIPPING/CLOSING COILS**

The circuit breakers shall be provided with two trip coils and one closing coil per breaker. First trip coil shall be utilized for tripping the breaker on main protection fault detection. Whereas second trip coil shall be used to trip the breaker when first trip coil fails to trip the breaker and backup protection comes into operation and shall also be used to trip the breaker on command. The trip coils shall be suitable for preclosing and after closing trip circuit supervision. All the breakers shall have provision for independent electrical operation of trip coils from local as well as remote through local/remote selector switch.

ii) **TRIP FREE FEATURES**

When the breaker has been instructed to close by manual instructions by pushing of push button, the operating mechanism will start operating for closing operations. If in the mean time a fault has taken place, the relay provision shall be such that it should close the trip circuit simultaneously interrupting the live circuit of closing coil which has been instructed for close command.

The trip free mechanism shall permit the circuit breaker to be tripped by the protective relay even if it is under the process of closing. An anti-pumping device to prevent the circuit breaker from reclosing after an automatic opening shall be provided to avoid the breaker from pumping i.e., anti pumping relay should interrupt the closing coil circuit.

iii) **CONTROLS**

To control the circuit breaker, a C&R panel shall be provided in the control room. The control arrangement shall be such as to disconnect the remote control circuits of the breaker, when it is under test. Local control devices, selector switch and position indicator shall be located in weather and vermin-proof cabinet. The circuit breaker control scheme shall incorporate trip circuit supervision arrangement. Local/remote selector switch shall be provided for all breakers for selection of "Local" control/remote control.

Provision shall be made for local manual, electrical and spring controls. Necessary equipment's for local controls shall be housed in the circuit breaker cabinet of weather-proof construction. In addition to this, a hand closing device for facilitating maintenance shall also be provided.

The contact pressure spring and tripping spring shall be chargeable during closing operation to ensure the breaker is ready to open. Mechanically ON/OFF indicator, spring character indicator and operation counter shall be provided on the front of the control cubicle. For tripping, the spring provided shall ensure the trippings.

Each circuit breaker shall have a mechanical open/closed and spring charge indicator in addition to facilities for provisions for semaphore indicators for breakers which are required for the mimic diagram in the control room. Lamps for indicating, `close/open' position of the breaker shall also be provided.

Mechanical indicator, to show the `open' and `close' position of the breaker shall be provided in a position where it will be visible to a man standing on ground with mechanism housing open. An operation counter, visible from the ground even with the mechanism housing closed, shall be provided. Electrical tripping of the breaker shall be performed by shunt trip coils.

Closing coil shall operate correctly at all value of voltage between 85% and 110% of the rated voltage. Shunt trip coils shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity and at all values of supply voltage between 85% and 110% of rated voltage. The variation in A.C. supply voltage shall be –15%to +10% while variation in frequency shall be ±3. Working parts of the mechanism shall be non-corrosive material. Bearings which require grease shall be equipped with pressure type fillings.

Bearing pins, bolts, nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the circuit breaker. It shall be possible to trip the circuit breaker even in the event of failure of power supply.

Operating mechanism and all accessories shall be enclosed in control cabinet. A common marshalling box for the three poles of the breaker shall be provided, along with supply of tubing, cables from individual pole operating boxes to the common marshalling box, local.

2.7.1 SPRING OPERATED MECHANISM

The motor compressed spring mechanism shall consists of a closing spring which is wound or compressed by an electric motor immediately after the breaker closes.

After the breaker has tripped, the tripping spring shall remain in the released position as long as the breaker is open, but the closing spring shall remain wound and ready for closing operation. The operating mechanism shall have all the necessary auxiliaries, apparatus for operation and supervision, like motor starter with thermal overload release, one closing coil, two trip coils, push button for local electrical operation, local/remote control selector switch, push button for direct mechanical tripping, auxiliary switches, antipuming contactors, operation counter, socket for inspection, lamp and heater with switch. Spring charging motor shall be standard single phase universal motor suitable for 220 volts supply.

i) Operating voltages for closing/tripping coils shall be 220/110/30 Volts DC or as per actual DC voltage available at existing substations.

ii) Operating voltages for heater elements shall be 220V AC 50 HZ. Other features of the spring operated mechanism shall be as follows.

a) The spring operating mechanism shall have adequate energy stored in the operating to close and latch the circuit breaker against the rated making current and also to provide the required energy for tripping mechanism in case the tripping energy is derived from the operating mechanism.

b) The mechanism shall be capable of performing the rated operating duty cycle of O-0.3Sec-CO-3 Min-CO.

c) The spring charging motor shall be AC or DC operated and shall not take more than 30 sec., to fully charge the closing spring made for automatic charging. Charging of spring by the motor should not interfere with the operation of the breakers.

d) The motor shall be adequately rated to carry out a minimum of one duty cycle. Also provision shall be made to protect the motor against overloads.

e) In case of failure of power supply to spring charging motor, the mechanism shall be capable of performing one open-close-open operation.

f) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of the closing springs when the breaker is already in closed position. Provision shall be made to prevent a closing operation to be carried out with the spring partially charged.

g) Facility shall be provided for manual charging of closing springs.

2.7.2 CONTROL CABINET

The switchgear operating mechanism, the control equipment such switch for closing and tripping the breakers, various control relays, antipuming device, a set of terminal blocks for wiring connections, MCB's for disconnecting the control auxiliary power supplies including relays, etc., shall be enclosed in a cabinet to be mounted on a suitable structure at a convenient working height at the end of the breaker in the outdoor switchyard. The supporting structure and the enclosure shall be capable of withstanding the typical tropical climatic conditions, change of ambient temperature, severe dust-storms, very high relative humidity those are prevailing at the site of location of switchgear.

i) ENCLOSURE

The enclosure shall be made out of stretched level steel plates not less than 3 mm thick and of light section structural steel. It should be weather proof as well as vermin proof.

The enclosure shall provide protection against dust and foreign objects. Each cabinet section shall have full width and full length hinged doors mounted on the front that swing fully open. The doors shall be provided with latches to securely hold it with the cabinet. Doors shall be of sturdy construction, with resilient material covering, fully perimeterically contacting the cabinet frame to provide dust protection and prevent metal to metal contact except at the latch points. Filtered ventilation, shall be provided along with the rigid supports for control and other equipment, measuring instruments, mounting cabinet members and equipment shall not restrict easy access to terminal blocks for terminating and testing external connection or to equipment for maintenance.

All screws and bolts used for assembling and mounting wire and cable termination, supports, devices and other equipment shall be provided with lock washers or other locking devices. All metal parts shall be clean and free of weld splatter, rust and mill scale prior to application of double coat of

zinc chromate primer which should be followed by an under coat to serve as base and binder for the finishing coat. The mounting structure shall be galvanized and shall be as per IS-802-II-1978.

ii) HEATERS

Suitable heaters shall be mounted in the cabinet to prevent condensation. Heaters shall be controlled by thermostat ON/OFF switches and fuses shall be provided. Heaters shall be suitable for 240 V AC supply voltage.

iii) LIGHTING

At least one 13 watt CFL fixture and lamp working on 240 V 50 c/s AC supply shall be provided in each switchgear control cubicle section and shall be located suitably to provide adequate interior lighting of the cubicle. A single-pole 6 Amp. Lighting switch shall be provided for each cubicle along with 5/15 amp.

The lighting and convenient outlet circuits shall be completely wired in conduit and terminated on cubicle terminal blocks.

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iv) WIRING AND CABLING

g) Unless otherwise specified control wire shall be stranded tinned copper switchboard wire with 1.1 kV PVC insulation conforming to the requirements of IS-1554.

h) All the control circuit and secondary wiring shall be wired completely and brought out to terminal block ready for external connections in the control cabinet. The cross-section of control wire shall not be less than 2.5 mm2 copper (14 SWG).

i) All spare auxiliary contacts of the circuit breaker shall be supplied wired upto terminal block. Each terminal in terminal block shall be suitable for at least 2 x 2.5 mm^2 copper conductor.

j) All wiring termination on terminal blocks shall be made through lugs.

k) All wires shall be identified with non-metallic sleeve or tube type markers at each termination.

l) Terminal blocks shall be made up of moulded non-inflammable plastic material with blocks and barriers moulded integrally have white marking strips for circuit identification and moulded plastic covers. Disconnecting type terminal blocks will be provided.

a) GROUNDING

A ground bus of copper bar not less than 6 mm by 25 mm shall be provided for grounding the Control Cabinet.

2.8 ACCESSORIES

Each circuit breaker assembly shall be supplied with the following accessories.

i) Line and earthing terminals and terminal connectors.

ii) Control housing with:

a) One auxiliary switch with adequate number of auxiliary contacts, but not less than 20 nos. (10 NO + 10 NC) for each breaker. These shall be over and above the No. of contacts used for closing, tripping and `reclosing' and interlocking circuit of the circuit breaker. All auxiliary contacts shall be capable of use as "Normally closed" or "Normally open" contacts. Special auxiliary contacts required for the reclosing circuit if any, shall also be provided. There shall be provision, to add more auxiliary contacts at a later date, if required.

b) Operation counter

c) Position indicator (Close/Open)

d) Necessary cable glands

e) Fuses

Manual trip device and local test push buttons

f) Terminal blocks and wiring for all control equipment and accessories

g) Adequate number of heaters for continuous operation to prevent moisture condensation in the housing of operating mechanism

h) Selector switch for local/remote control.

2.9 SUPPORTING STRUCTURE

The circuit breakers shall be supplied complete with necessary galvanized steel supporting structures, foundation and fixing bolts, etc., the galvanizing shall be as per IS. The mounting of the breaker shall be such as to ensure the safety of the operating staff and should conform to Indian Electricity Rules, 1956. Minimum ground clearance of live part from ground level shall be as per IE Rules.

The bidder shall submit detailed design calculations and detailed design calculations and detailed drawings in respect of supporting structures suitable for the equipment offered.

All material for making connections between the circuit breaker and its control shall also be included in the scope of supply. Facility to earth the circuit breaker structure at two points shall be provided.

2.10 SURFACE FINISH

2.10.1 All interiors and exteriors of tanks, control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulation oil, as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paint.

2.10.2 All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

2.10.3 All ferrous hardware, exposed to atmosphere, shall be hot dip galvanized.

2.11 GALVANISING

2.11.1 All ferrous parts including all sizes of nuts, bolts, plain and spring washers, support channels, structures, shall be hot dip galvanized conforming to latest version of IS:2629 or any other equivalent authoritative standard.

2.12 CABLE TERMINATION

Suitable cable glands for terminating the multi core cable shall be provided wherever required.

2.13 TERMINAL CONNECTIONS AND EARTH TERMINALS

2.13.1 Each circuit breaker connected with incoming and outgoing feeders shall be provided with solderless clamp type connectors suitable for ACSR conductor/ IPS Aluminium tube.

2.13.2 Each circuit breaker pole and control cabinet shall be provided with appropriate number of grounding terminals and clamps for receiving ground connections.

2.13.3 Each circuit breaker pole and control cabinet shall be provided with appropriate number of grounding terminals and clamps for receiving ground connections.

2.14 INTERLOCKS

Necessary interlocks to prevent closing or opening of the breaker under low pressure of the contact spring and devices for initiating alarm shall be provided. The detailed interlocking scheme based upon single line diagram as applicable for the substation shall be supplied with the write-up. Requirement of interlock shall be as given below:

i) Isolator should not be operated unless the associated breaker is in open position.

ii) Line isolator shaft close only when the corresponding circuit breaker of the corresponding line are open.

iii) The circuit breaker shall close only after all isolators associated with it have been in closed position.

In case of double bus bar arrangement following additional requirement for interlocking shall be provided.

i) One bus bar selector isolator of any bay excepting the bus coupler bay shall close only when,

   a) The circuit breaker of corresponding bay is open.

   b) The other bus isolator of that bay is open.

ii) When one bus isolator of any bay excepting the bus coupler bay is closed. The other shall close only when the bus coupler circuit breaker and both the bus isolators are closed.

iii) Bus isolator of bus coupler bay shall operate only when the bus coupler breaker is open.

iv) The bypass isolator of feeder shall close when the feeder circuit breaker and its adjoining isolators are closed.

2.15 EARTHING SYSTEM

All switchgear enclosures should be bolted metal to metal and should carry the full earth return current. Connection between phases at the earthing points shall be dimensioned for carrying full earth return current i.e., actual service current not rated current.

2.16 VACUUM INTERRUPTER ASSEMBLY

Each pole of the circuit breaker shall be provided with vacuum interrupter, one for each phase, hermetically sealed for life and encapsulated by ceramic insulators. The interrupter shall be provided with steel chromium are chamber to prevent vaporized contact material being deposited on the insulating body. A further shield giving protection to the metal bellows shall also follow the travel of the moving contacts to seal the interrupter against the surroundings atmosphere.

It shall have high and consistent dielectric strength of vacuum unaffected by environment and switching operations. Bronzed joints should ensure retention of vacuum for life time. It shall have low and stable contact resistance due to absence of oxidation effects and shall ensure low power loss. The arcing voltage shall be low and minimum contact erosion.

2.17 GUARANTEED TECHNCIAL PARTICULARS

Guaranteed and technical particulars as called for in Section-II shall be furnished along with the tender. Particulars which are subject to guarantee shall be clearly marked.

2.18 TESTS

2.18.1 TYPE TESTS

Each circuit breaker shall comply with requirements of type tests prescribed in IEC publication No. 62271-100

i) Short time and peak withstand current test.
ii) Short circuit breaking capacity and making capacity.
iii) Capacitive current switching test: Cable charging current breaking test(U_r less than or equal to 52 kV).
iv) Dielectric test i.e., power frequency withstand and impulse withstand test
v) Temperature rise test.
vi) Mechanical Endurance Test at ambient temperature.
vii) Measurement of resistance of the main circuit.

2.19 ROUTINE TESTS

Routine Tests as per IEC- 62271-100 shall be carried out on each breaker in presence of purchaser's representative at the manufacturer's expenses at his works except, where agreed to otherwise. All test reports should be submitted and should be got approved from the purchaser before despatch of the equipment.

2.19.1 SITE TESTS ON CONTROL AND AUXILIARY CIRCUIT

The following tests shall be conducted at site.

i) Voltage tests on control and auxiliary circuit.

ii) Measurements of resistance of the main circuit.

iii) Mechanical Operation Tests.

2.20 NAME PLATE

2.20.1 Equipment should be provided with name plate giving full details of manufacture, capacities and other details as specified in the relevant ISS or other specification stipulated. The Purchase Order No. and date and year of supply.

2.21 TECHNICAL PARAMETERS

2.21.1 11 KV CIRCUIT BREAKERS

S. NO.	DESCRIPTION		VALUES
i)	Rate voltage (KV rms)	:	11 KV
ii)	Rated frequency (Hz)	:	50
iii)	System neutral earthing	:	Solidly grounded system
iv)	Type of arc quenching medium	:	Vacuum
v)	Rated normal current at site conditions (Amps)	:	630 Amps
vi)	Number of poles	:	3
vii)	Installation	:	Outdoor type

S. NO.	DESCRIPTION		VALUES
viii)	Temperature rise	:	As per IEC 56 (Table-4) Page-19
ix)	Rated short circuit	:	
	a) Interrupting capaxcity at 36 KV	:	25 KA
	b) The percentage DC components	:	As per IEC 56 & (Ref.Page51 21 of IEC)
	c) Duration of short circuit	:	3 Sec.
x)	Rated short circuit making	:	62.5 KA
xi)	First pole to clear factor	:	1.5
xii)	Rated short time current	:	25 KA
xiii)	Rated duration of short circuit	:	3 Seconds
xiv)	Total break time for any current upto the rated breaking current with limiting condition of operating and quenching media pressure (ms)	:	As per IS/IEC
xv)	Closing time (ms)	:	As per IS/IEC
xvi)	Mounting	:	Hot dip galvanized lattices steel support structured bolted type
xvii)	Phase to phase spacing in the switch yard i.e, interpole spacing for breaker (min)	:	As per IS and IE Rule
xviii)	Required ground clearance from the lowest line terminal if both the terminals are not in same horizontal plane (cum)	:	As per IS and IE Rule
xix)	Height of concrete plinth (mm)	:	As per IS and IE Rule
xx)	Minimum height of the lowest part of the support insulator from ground liner (mm)	:	As per IS and IE Rule
xxi)	Minimum Creepage distance of support insulator (mm)	:	300
xxii)	Minimum corona extinction voltage (kv rms)	:	As per IS and IE Rule
xxiii)	Standard value of rated transient	:	As per IEC-62271-100

S. NO.	DESCRIPTION		VALUES
	recovery voltage for terminal fault		
xxiv)	Standard value of rated line Characteristics for short line faults	:	
	RRRV	:	KV/ms=0.214
	Peak Factor	:	K=1.6 A
	Surge Impedance		Z(ohms) = 450
xxv)	Rated operating duty cycle	:	0-0.3 Second - CO-3 Minutes-CO
	a) Auto reclosing	:	Suitable for three phase Auto re-closing duty
xxvi)	Rated insulation level under heavy pollution condition 1.2/50 micro second lightening Impulse withstand voltage (KV peak)to earth	:	75 KV
xxvii)	Power frequency withstand voltage KV (rms) to earth (KV rms)	:	28 KV
xxviii)	Rated characteristic for out of Phase breaking	:	
	a) Out of phase breaking capacity	:	25% of rated breaking capacity
	b) Standard values of transient recovery	:	As per IEC-56
	c) Operating mechanism	:	Spring operated, Anti pumping and Trip free mechanism
	d) Power available for operating mechanism	:	Three phase 415 Volts 50 C/S or single phase 50 C/S 240 volts
xxix)	a) Rated supply voltage of closing and operating devices and auxiliary circuits	:	4) 110V DC/30 VDC 5) 240 Volts AC 50 C/S single phase 6) 415 volts 50 Hz three phase
	b) Permissible voltage variation	:	3) In case of DC Power supply voltage variation shall be between 85% to 110% of normal voltage. 4) In case of AC power supply voltage variation shall be of

S. NO.	DESCRIPTION		VALUES
			the normal voltage as per IS-15% to +10%.
	c) Permissible frequency	:	± 3% from normal 50 Hz as per IS 2026 part-I 1977 para 4.4
	d) Combined variation of frequency and voltage	:	± 10%
xxx)	Number of auxiliary contacts	:	10 NO and 10 NC on each pole Continuous current rating 10 Amps, DC breaking rating capacity shall be 2 Amps with circuit time constant less than 20 ms at 220/30 volts DC
xxxi)	Number of trip coils	:	2 (Two) trip coils and 1 close coil with anti-pumping arrangement
xxxii)	Rated terminal load	:	100 kg. Static. The breaker shall be designed to withstand the rated terminal load, wind, load, earthquake load and short circuit forces
xxxiii)	Noise level of the equipment	:	Not exceeding 140 db

2.22 -DRAWINGS AND INSTRUCTION MANUALS

2.22.1 Soon after the award of the contract. The manufacture shall supply six sets of drawings which will describe the equipment in details, for the approval of purchaser. All the drawings and manuals should be in English Language and dimensions and weights shall be in MKS units.

Following drawings for each item are to be supplied as part of the contract.

i) General outline drawings, showing dimensions, front and side elevations and plan of the circuit breaker and its local control panel.

ii) Outline drawing of busings showing dimensions and number of sheds and creepage distance.

iii) Assembly and sub-assembly drawings with numbered parts.

iv) Sectional views showing the general constructional features, operating mechanism and are extinguishing chamber, etc.

v) Dimension and assembly of important auxiliaries.

vi) Detailed drawings of operating mechanism and inter-phase mechanism.

vii) Test certificates and oscillographs.

viii) Detailed drawings of mounting structure.

ix) Spare parts and catalogue

x) Wiring diagram showing the local and remote control scheme of breaker including alarms indication devices instruments relay and timer wiring.

xi) Write up on working of control schematic of breaker.

xii) Foundation plan including weights of various components and impact loadings for working foundation design. Three copies for each Pkg. of the above drawings and instruction manuals covering instructions for installations, operation and maintenance shall be supplied by the contractor(s) without any extra cost.

SECTION 3

SPECIFICATION OF 36 KV INDOOR SWITCHGEAR CUM C&R PANEL

3.1 GENERAL REQUIREMENTS

3.1.1 This section of specification covers the specification of 33kV Indoor switchgear Panel.

3.1.2 The equipment offered by the Bidder shall be complete in all respects. Any material and component not specifically stated in this specification but which are necessary for trouble free operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded. All such equipment/accessories shall be supplied without any extra cost. Also all similar components shall be interchangeable and shall be of same type and rating for easy maintenance and low spare inventory.

3.1.3 Specific reference in this pacification and documents to any Material by trade name, make, or catalogue number shall be constructed as establishing quality and performance requirements.

3.1.4 Equipment shall be installed in neat workman-like-manner so that it is levelled, plumbed, squared and properly aligned and oriented. Tolerances shall be as established on Contractor's drawings or as stipulated by Employer. No equipment shall be permanently bolted down/ tag welded to foundation until the alignment has been checked and found acceptable by the Engineer. Contractor shall be furnish all supervision labors, tools, equipment rigging materials, bolts, wedges, anchors, concrete inserts etc. in proper time, required to completely install, test and commission the equipment.

3.1.5 Manufacturer's and Employer's instructions and recommendations shall be correctly followed in handling, erection, testing and commissioning of all equipment.

3.1.6 Contractor shall move all equipment into the respective rooms through the regular door or openings specifically provided for this purpose. No parts of structure shall be utilized to lift or erect any equipment without prior permission of Engineer.

3.1.7 Switchgear shall be installed on finished surfaces, concrete or steel sills. Contractor shall be required to install and align any channels sills which form part of foundations. Circuit breaker trolley wheels shall move on channels which shall form part of floor. The channel length shall be minimum of 1 meter from the door of switchgear panel. Power bus enclosure, ground and control splices of conventional nature shall be cleaned and bolted together with torque wrench of proper size or by other approved means. Tape or compound shall be spilled where called for in drawings. Contractor shall take utmost care in handling instruments, relays and other delicate mechanisms. Wherever the instruments, and relays are supplied loose along with switchgear, they

shall be mounted only after the associated switchgear panels have been erected and aligned. The blocking materials, employed for safe transit of instrument and relays shall be removed after ensuring that panels have been completely installed and no further movement of the same would be necessary. Any damage shall be immediately reported to Engineer.

3.1.8 Foundation work for all switchgear panels will be carried out by contractor.

3.2 SWITCHGEAR PANEL (METAL CLAD)

3.2.1 The switchgear boards shall have a single front, single tier, fully compartmentalized, metal enclosed construction complying with clause No. 3 102.2 of IEC-60298, comprising of a row of free standing floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, Main bus bars and auxiliary control devices. The adjacent panels shall be completely separated by steel sheets expect in busbar compartments where insulated barriers shall be provided to segregate adjacent panels. However, manufacturer's standard switchgear designs without internal barriers in busbar compartment may also be considered.

3.2.2 The circuit breakers and Bus VTs shall be mounted on with draw able trucks which shall roll out horizontally from service position to isolated position.

For complete withdrawal from the panel, the truck shall rollout on the floor or shall roll out on telescopic rails. In case the Contractor Bidder for withdrawal and insertion of the truck from and into the panel. Testing of the breaker shall be possible in Isolated position by keeping the control plug connected.

3.2.3 The trucks shall have distinct SERVICE and ISOLATED positions. It shall be possible to close the breaker compartment door in Isolated position also, so that the switchgear retains its specified degree of protection. While switchboard designs with doors for breaker compartment would be preferred, standard designs of reputed switchgear manufacturer's where the truck front serves as the compartment cover may also be considered, provided the breaker compartment is completely sealed from all other compartments and retains the IP-42 degree of protection in the Isolated position. In case the later arrangement is offered, the Bidder shall explain how this sealing is achieved and shall include blanking covers one for each size of panel per switchboard in his total bid price.

3.2.4 The switchgear assembly shall be dust, moisture, rodent and vermin proof, with the truck in any position SERVICE, ISOLATED or removed, and all

doors and covers closed. All doors, removable covers and glass windows shall be gasketted all round with synthetic rubber or neoprene gaskets as specified in Section-I(Introduction and general technical requirements).

3.2.5 The bus VT/ relay compartments shall have degree of protection not less then IP: 52 in accordance with IS: 2147. However, remaining compartments can have a degree of protection of IP:42. All louvers if provided shall have very fine brass or GI mesh screen. IPH-2 degree of protection as per IS: 3427 to all live parts shall (whether isolated or removed from panel) even when the breaker compartment door is open. Tight fitting garments/gaskets are to be provided at all openings in relay compartment as specified in Section-I(Introduction and general technical requirements).

3.2.6 The switchgear construction shall be such that the operating personnel are not endangered by breaker operation and internal explosions, and the front of the panels shall be specially design to withstand these. Pressure relief device shall be provided in each high voltage compartment of a panel, so that in case of a fault in a compartment, the gases produced are safely vented out, thereby minimizing the possibility of it's spreading to other compartments and panels. The pressure relief device shall not however reduce the degree of' protection of panels under normal working conditions. To demonstrate that the pressure relief device operates satisfactorily the Contractor shall carryout test in line with IEC 298-1981 Appendix AA, as a type test However, such test at reduced prospective fault currents shall also be acceptable provided the satisfactory operation of pressure relief device can be demonstrated.

3.2.7 Enclosure shall be constructed with rolled steel sections and cold rolled steel sheets of at least 2.0 mm thickness, Gland plates shall be 2.5mm thick made out of hot rolled or cold rolled steel sheets and for non magnetic material it shall be 3.0 mm. However, if vendor has standardized the thickness of enclosure other than above mentioned and it meets the performance requirements and the design has been established through type test, the same shall be accepted.

3.2.8 The switchgear shall be cooled by natural air flow and cooling by any other method shall not be accepted.

3.2.9 Total height of the switchgear panels shall not exceed 2600 mm. The height of switches, pushbuttons and other hand operated devices shall not exceed 1800 mm and shall not be less than 700 mm.

3.2.10 Necessary guide channels shall be provided in the breaker compartments for proper alignment of plug and socket contacts when truck is being moved to SERVICE position. A crank or level arrangement shall preferably be

provided for smooth and positive movement of, truck between Service and Isolated positions.

3.2.11 Safety shutters complying with IEC-298 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to ISOLATED position. The shutters shall move automatically, through a linkage with the movement of the truck. Preferably it shall however, be possible to open the shutters of busbar side and cable side individually against spring pressure for testing purpose after defeating the interlock with truck movement deliberately. It shall also be possible to padlock shutters individually. In case, insulating shutters are provided, these shall meet the requirements of Clause 3.102.1 Note-2 of IEC-298 and necessary tests are per IEC-60298 Clause 5.103.1 shall be carried out. A clearly visible warning label "Isolate elsewhere before earthing" shall be provided on the shutters of incoming and the connections which could be energized from other end.

3.2.12 Switchgear construction shall have a bushing or other sealing arrangement between the circuit breaker compartment and the busbar/cable compartments, so that there is no air communication around the isolating contacts in the shutter area with the truck in service position

3.2.13 The breaker and the auxiliary compartments provided on the front side shall have strong hinged doors, busbar and cabling compartments provided on the rear side shall have bolted compartment covers with self retaining bolts. Breaker compartment doors shall have locking facility.

i) In the Service position, the truck shall be so secured that it is not displaced by short circuit forces. Busbars, jumpers and other components of the switchgear shall also be properly supported to withstand all possible short circuit forces corresponding to the short circuit rating specified.

ii) Suitable base frames made out of steel channels shall be supplied alongwith necessary anchor bolts and other hardware, for mounting of the switchgear panels. These shall be despatched in advance so that they may be installed and levelled when the flooring is being done, welding of base frame to the insert plates as per approved installation drawings shall also be provided.

iii) The switchboard shall have the facility of extension on both sides. Adopter panels and dummy panels required to meet the various busbar arrangement, cable/busduct termination and layouts shall be included in Bidder's scope of work.

3.3 CIRCUIT BREAKERS

3.3.1 The circuit breakers shall be of vacuum type and shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism.

3.3.2 Outgoing breakers shall be suitable for switching transformers and lines at any load. Unipolar over-voltage at the circuit breaker terminal shall not exceed two and half times nominal peak line to neutral voltage of the system, while switching on/off at any load. (The test procedure shall be as recommended in the document. CIRGE-WG-13.02, Chapter-3 Part A&B).

3.3.3 Circuit breaker shall be restrike free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An antipumping relay shall be provided for each breaker, even it has built-in mechanical anti-pumping features. An arrangement of two breakers in parallel to meet a specified current rating shall not be acceptable.

3.3.4 During closing, main poles shall not rebound objectionably and mechanism shall not require adjustments. Necessary dampers shall be provided to withstand the impact at the end of opening stroke. Slow closing facility shall preferably be provided for checking and adjustment of arc chutes and poles when the breaker is completely withdrawn and isolated.

3.3.5 Plug and socket isolating Contacts for main power circuit shall be silver plated, of self aligning type, of robust design and capable of withstanding the specified short circuit currents. They shall preferably be shrouded with an insulating material. Plug and socket contacts for auxiliary circuits shall also be silver plated, sturdy and of self -aligning type having a high degree of reliability. Thickness of silver plating shall not be less than 10 microns.

3.3.6 All working part of the mechanism shall be of corrosion resisting material. Bearings which require greasing shall be equipped with pressure type grease fittings. Bearing pins, bolts, nuts and other parts shall be adequately secured and locked to prevent loosening or change in adjustment due to repeated operation or change in adjustment due to repeated operation of the breaker and the mechanism.

3.3.7 The operating mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and shall not lead to closing or tripping of circuit breaker. Failure of any auxiliary spring shall also not cause damage to the circuit breaker or endanger the operator.

3.3.8 Mechanical indicators shall be provided on the breaker trucks to indicate OPEN/ CLOSED conditions of the circuit breaker, and CHARGED/DISCHARGED conditions of the closing spring. An operation

counter shall also be provided. These may be visible without opening the breaker compartment door.

3.3.9 The rated control supply voltage shall be 415V, 3-ph, 4 wire, 50 Hz, neutral grounded/240V, 1-ph, 50Hz AC supply. The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage with specified variation in voltage + 10% to -15% & frequency ± 5%.. The shunt trip coil shall operate satisfactorily under all operating conditions of the circuit breaker upto its rated short circuit breaking current at all values of control supply voltage between 70 and 110 percent of the rated voltage. The trip Coil shall be so designed that it does not get energised when its healthiness is monitored by two indicating lamps (Red) and one trip coil supervision relay.

3.3.10 The time taken for charging of closing spring shall not exceed 30 second. The spring charging shall take place automatically preferably after a closing operation. Breaker operation shall be independent of the spring charging motor, which shall only charge the closing spring. Operating spring. shall get charged automatically during closing operation. As long as power supply is available to the charging motor a continuous sequence of closing and opening operations shall be possible. One open-close-open operation of the circuit breaker shall be possible after failure of power supply to the motor.

Spring charging motors shall be capable of starting and charging the closing spring twice in quick succession without exceeding acceptable Winding temperature when the control supply voltage is any where between 85% and 110% of the rated voltage. The initial temperature shall be as prevalent in the switchgear panel during full load operation with 50 deg. C ambient air temperature. The motor shall be provided with short circuit protection.

3.3.11 Motor windings shall be provided with class E insulation or better. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in a hot, humid and tropical climate.

3.3.12 Circuit breaker may be provided with inter pole barriers of insulating materials, if the same is standard design of the manufacturer. But use of inflammable materials like Hylam shall not be acceptable.

3.4 CONTROL AND INTERLOCKS

3.4.1 The control switch located on the switchgear would normally be used for operation of circuit breaker in service/isolated position, and for tripping it in an emergency .

3.4.2 The Bidder shall study the basic control scheme as proposed to be adopted and clearly state in his bid the extent to which it can be complied with.

3.4.3 Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency. These facilities shall be accessible only after opening the compartment door.

3.4.4 Each panel shall have two separate limit switches, one for the Service position and the other for isolated position. Each of these limit switches shall have at least four (4) contacts which shall close in the respective positions

3.4.5 Auxiliary Contacts of breaker may be mounted in the fixed portion or in the with drawable truck as per the standard practice of the manufacturer, and shall be directly operated by the breaker operating mechanism.

Auxiliary contacts mounted in the portion shall not be operable by the operating mechanism, once the truck is withdrawn from the service position, but remain in the position corresponding to breaker open position. Auxiliary contacts mounted on the truck portion, and dedicated for use shall be wired out in series with a contact denoting breakers service position. With truck withdrawn, the auxiliary contacts shall be operable by hand for testing.

For Employer's use six (6) normally open (NO) and six (6) normally closed (NC) auxiliary contacts shall be provided for all feeder and shall be wired out to the terminal blocks.

Contact multiplication, if necessary to meet the above contact requirement, shall be done through suitable latch relay of English Electric type VAJC-11 or equivalent.

3.4.6 The contacts of all limit switches and all breaker/auxiliary contacts located on truck portion and fixed portion shall be silver plated, rated to make, carry and break 1.0 Amp 220 V DC (Inductive) 10 Amps. 240V AC. Contacts of control plug and socket shall be capable of carrying the above current continuously.

3.4.7 Movement of truck between SERVICE and ISOLATED positions shall be mechanically prevented when the breaker is closed. An attempt to withdraw a closed breaker shall not trip it.

3.4.8 Closing of the breaker shall be possible only when truck is either in ISOLATED or in SERVICE position and shall not be possible when truck is in between. Further, closing shall be possible only when the auxiliary

circuits to breaker truck have been connected up, and closing spring is fully charged.

3.4.9 Mechanical (Castle key) or a full proof electrical interlock shall be provided between the isolator and associated circuit breaker such that the former cannot be operated unless the later is open.

3.4.10 It shall be possible to easily insert breaker contactor of one feeder into any one of the panel meant for same rating but at the same time shall be prevented from inserting it into panels meant for a different type of rating.

3.4.11 Indicating lamps shall be provided in the panel front as brought out in subsequent section. It shall be possible to easily make out whether the truck is in SERVICE or ISOLATED position even when the compartment door is closed.

3.5 BUSBARS

3.5.1 All busbar and jumper corrections shall be of high conductivity aluminium alloy. They shall be adequately supported on insulators to withstand electrical and mechanical stresses developed during short circuit.

Busbar cross-section shall be uniform throughout the length of switchgear. Busbars and other high voltage connection shall be sufficiently corona free at maximum working voltage.

Contact surfaces at all joints shall be silver plated or properly cleaned and no oxide grease applied to ensure an efficient and trouble free connection. All bolted joints shall have necessary plain and spring washers. All connection hardware shall have high corrosion resistance. Suitable bimetallic connectors shall be used for aluminium to copper connections.

3.5.2 Successful Bidder shall furnish calculation establishing adequacy of busbar sizes for the specified continuous and short time current ratings.

3.5.3 All busbars shall be colour coded.

3.5.4 The temperature of the busbars and all other equipment, when carrying the rated current continuously shall be limited as per the stipulations of relevant Indian Standards, duly considering the specified ambient temperature (50 deg. C). The temperature rise of the horizontal and vertical busbars when carrying the rated current shall be in no case exceed 55 deg.C for silver plated joints and 35 deg. C for all other type of joints. The temperature rise at the switchgear terminals intended for external cable termination shall not

exceed 35 deg. C. Further the switchgear parts handled by the operator shall not exceed a rise of 5 deg.

3.6 INSULATORS

3.6.1 Busbar insulators shall be of arc and track resistant high strength, non-hygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Busbar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators. In case of organic insulator partial discharge shall be limited to 100 picocoulomb at rated voltage xl.1/√3. Use of insulators and barriers of inflammable material such as Hylem shall not be accepted.

3.7 EARTHING AND EARTHING DEVICES

3.7.1 A galvanized steel earthing bus shall be provided at the bottom and shall extend through out the length of each switch board. It shall be bolted/welded to the framework of each panel and each breaker earthing contact bar.

3.7.2 The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault currents to earth as indicated under switchgear parameters without exceeding the allowable temperature rise.

3.7.3 Suitable arrangement shall be provided at each end of the earth bus for bolting to earthing conductors. All joint splices to the earth bus shall be made through atleast two bolts and taps by proper lug and bolt connection.

3.7.4 All non- current carrying metal work switchboards shall be effectively bonded to the earth bus. Electrical continuity of the whole switchgear enclosure frame work and the truck shall be maintained even after painting.

3.7.5 The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker contactor frame shall be maintained in all positions i.e. SERVICE and ISOLATED as well as throughout the intermediate travel. The truck shall also get and remain earthed when the control plug is connected irrespective of its position.

3.7.6 All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq.mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with

suitable clamp connectors and soldering shall not be acceptable. Looping of earth connections which would result in loss of earth connection to other devices, when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths of earth bus is acceptable.

3.7.7 VT and CT secondary neutral point earthing shall be at one plate only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.

3.7.8 Built-in earthing facilities for the busbars and outgoing incoming connections shall be provided for maintenance work. The inbuilt earthing switches shall have provision for short circuiting. And earthing circuit intended to be earthed. These switches shall be quick make type, independent of the action of the operator and shall be operable from the front of the switchgear panel. These switches shall have facility for padlocking in the earthed condition.

3.7.9 Interlocks shall be provided to prevent:

i) Closing of the earthing switch if the associated circuit breaker truck is in Service position.

ii) Insertion of the breaker truck to Service position if Earthing switch is in closed position.

iii) Closing of the earth switch on a live connection. Three nos. voltage capacitive dividers shall be provided on each phase of the section intended for earthing and three nos. "RED' Neon lamps connected to these on the panel front for visual indication.

iv) Energizing and Earthed Section:
Complete details of arrangement offered shall be included in the bid describing the safety features and interlocks.

3.7.10 The earthing device shall have the short circuit withstand capability equal to that of associated switchgear panel suitable number of auxiliary contacts of the earthing device shall be provided for interlocking purpose.

3.7.11 All hinged doors shall be earthed through flexible earthing traid.

3.8 PAINTING

All sheet steel work shall be pre-treated in tanks, in accordance with IS: 6005. Degreasing shall be done by alkaline cleaning. Rust and scale shall

be removed by pickling with acid. After pickling, the parts shall be washed in running water. Then these shall be rinsed in slightly alkaline hot water and dried. The phosphated coating shall be Class 'C' as specified in IS: 6008. The phosphated surface shall the rinsed and passivated prior to application of stoved lead oxide primer coating. After primer application, two coats of finishing synthetic enamel paint on panels shall be applied. Finishing paint on panels shall be shade 692 (smoke grey) of IS:5 unless specified otherwise by the Owner. The inside of the panels shall preferably be glossy white. Each coat finishing shall be properly stoved. The paint thickness shall not be less than 50 microns. Finished parts shall be coated by peelable compound by spraying method to protect, finished surfaces from scratches, grease dirt and oily spots during testing, transportation, handling and erection.

3.9 INSTRUMENT TRANSFORMERS

3.9.1 All current and voltage transformers shall be completely encapsulated cast resin insulated type, suitable for continuous operation at the ambient temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated load and the outside ambient temperature is 50 deg. C. The class of insulation shall be E or better.

3.9.2 All instrument transformers shall withstand the power frequency and impulse test voltage specified for the switchgear assembly. The current transformer shall further have the dynamic and short time rating at least equal to those specified for the associated switchgear and shall safely withstand the thermal and mechanical stress produced by maximum fault currents specified when mounted inside the switchgear for circuit breaker modules.

The parameters of instrument transformer specified in this specification are tentative and shall be finalised by the Employer in due course duly considering the actual burden of various relays and other devices finally selected. In case the Bidder finds that the specified ratings are not adequate for the relays and other devices offered by him he shall offer instrument transformer of adequate ratings and shall bring out this fact clearly in his bid.

3.9.3 All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block.

3.9.4 Current transformers may be multi or single core and shall be located in the cable termination compartment. All voltage transformers shall be single phase type. The bus VTs shall be housed in a separate panel on a truck so as to be fully withdrawable.

3.9.5 All voltage transformers shall have suitable HRC current limiting fuses on both primary and secondary sides. Primary fuses shall be mounted on the withdraw able portion. Replacement of the primary fuses shall be possible with VT truck in ISOLATED position without requiring the trolley. The secondary fuses shall be mounted on the fixed portion and the fuses replacement shall be possible without drawing out the VT, truck from Service position.

3.10 Numerical Protection RELAYS (IEDs)

3.10.1 All the communicable numerical protection relays (IEDs) complying with IEC-61850 on all feeders which shall be networked on Ethernet to communicate with substation remote SAS/SCADA system on IEC-61850. These IEDs shall also be used for control & monitoring the switchgear from SAS. In addition to status of devices and equipment trip/alarms, Metering data shall also be made available to remote SAS/SCADA station from protection IEDs. Further, Trivector meters with Modbus protocol are also envisaged, which will be connected in daisy-chain-link to communicate to remote station SAS. Modbus to IEC 61850 converter shall be provided for integration with remote SAS.

3.10.2 It is also envisaged that required alarm /trip points related to equipments i.e. circuit breaker and transformer etc. from relay i/o point shall be wired to annunciation system.

The Bidder's scope shall include the followings:

a) Communicable Numerical Protection Relays (with IEC 61850) in each of the feeders.

b) IED's / Numerical Relays shall have Graphical Display to facilitate settings, relay operations and to view measurement, event and alarm etc.

c) Relays shall have built in Local/Remote Switch.

d) Cat5e Ethernet cable for connection of Numerical Relays (IEDs) to Ethernet switches. Optical cable shall be used between Ethernet switch and SDH Equipment and among Ethernet switch.

e) Required number of Ethernet switches mounted in Outdoor/Indoor Switchgear panels for communication with IEDs on IEC 61850 protocol.

f) The SAS/SCADA system has been envisaged as part of main EHVsubstation. Bidder shall facilitate in successful Integration of IED's to the remote SAS/SCADA system through Ethernet switches.

3.10.3 All Numerical relays shall be of types, proven for the application satisfying requirements specified elsewhere and shall be subject to Employer's approval. Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the Employer.

3.10.4 All numerical relays shall be rated for control supply voltage as mentioned elsewhere under system parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage.

3.10.5 All IEDs shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts as per approved scheme. These I/O points shall be used for wiring of status of devices (CBs/Isolators), equipment trip/ alarms status etc. Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.

3.10.6 Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping. Event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.

3.10.7 All Numerical relays shall have features for electrical measurements including voltage, current, power (active & reactive), frequency, power-factor and energy parameters.

3.10.8 All numerical relays shall have provision of both current (CT) and voltage (VT) inputs as required for protection & measurement purposes using protection cores[DO1].

3.10.9 All numerical relays shall have key pad / keys to allow relay setting from relay front. Relay to be self or hand reset type which shall be software selectable. Manual resetting shall be possible from remote.

3.10.10 Relays shall have suitable output contact for circuit breaker failure protection (LBB) logic.

3.10.11 Relays shall have self diagnostic feature with continuous self check for power failure, program routines, memory and main CPU failures and a separate output contact for indication of any failure.

3.10.12 Contractor shall submit applicable Type Test reports for Numerical relays as per IEC including report for IEC 61850 protocol from accredited lab.

3.10.13 IED shall be provided for protection, control and monitoring of the bay equipments. One no. IED shall be provided for each no. of switchgear panel/ bays.

3.10.14 Its control function shall include control & monitoring of Circuit breaker and monitoring of Isolator status.

3.10.15 It shall include protective function as mentioned for transformer / feeder numerical protection IED as applicable . Functional requirement, as applicable, of protective relays specified under clause 3.11 shall be met.

3.10.16 Each IED shall have communication port based on IEC61850 protocol for integration with SAS.

3.10.17 IED shall be capable of integration with the remote EHV (132/220kV) substation automation system based on IEC61850

3.10.18 The IED shall be of modular in construction with adequate capacity for the estimated binary hardwired Inputs & Outputs plus 20% spare capacity. Requirement for external IO modules shall be avoided as far as possible.

3.10.19 IEDs offered shall be of state of the art microprocessor based architecture and employ digital numerical technology. Following a power interruption and/or communications failure the IED shall be arranged to restart automatically.

3.10.20 Time synchronisation of IEDs with UTC time shall be done over the IEC61850 field LAN

3.10.21 It shall be suitable for analog inputs from current transformers with 1A / 5A rated secondary and voltage transformers with 63.5V (phase to neutral voltage) rated secondary.

3.10.22 The IED shall be able to integrate analog input channels and digital input / output channel as a minimum to meet the protection, control & monitoring scheme requirement for the bay.

3.10.23 Plant alarms and indications will be derived as digital input from volt free contacts.

3.10.24 The command outputs shall be designed to provide select and execute outputs. The period of the command pulse shall be configurable between 0.1 second and 15 seconds on point basis. The command pulses shall reset immediately after the command is executed. Controls transmitted between the operator workstation of remote SAS / SCADA and the IED shall comprise a select, check back & execute sequence (or other means of providing high message security).

3.10.25 Each IED shall be equipped with Local HMI facilities, enabling control of Circuit Breaker from IED whenever required. The Local HMI facilities preferably shall be accomplished by means of Graphical LCD display embedded into the front panel of the IED. Display will show simplified SLD diagram (with device identification number) showing status of bay switching equipment (circuit breaker & isolators). Other display type will be multiple displays of analog values readings / reports, Alarm panel displays, Diagnostic/ on-line configuration displays etc.

3.10.26 A common Audible alarm with accept / reset push button shall be provided for each IED which shall be initiated from respective IED on tripping event.

3.11 PROTECTION:

3.11.1 Numerical Transformer Protection Relay

a. The relay shall have instantaneous as well as time delayed three over current (50) and one earth fault (50N) protections.

b. The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current

c. The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current (IDMT)

d. For transformers of rating 5MVA and above, definite time delayed Stand by earth fault protection shall be provided having a pick up setting range of 10% to 40% with a timer delay of 0.3 sec to 3 sec.

e. Transformer troubles like Buchholz, Winding temperature, Oil temperature & Pressure Relief Device trips (as applicable) shall be wired to separate binary inputs of the relay and shall be configured to issue trip command to the breaker.

f. Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

g. Protection core of PT/VT shall also be wired to the protection relay.

3.11.2 Numerical Line Protection Relay

a. The relay shall have instantaneous as well as time delayed three over current (50) and one earth fault (50N) protections.

b. The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current.

c. The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current.

d. Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

e. Protection core of PT/VT shall also be wired to the protection relay.

3.12 Integration of IEDs with SAS of remote 132kV substation:

All protective relay (IEDs) shall be connected to Ethernet switch on IEC61850 which shall then be connected to local SDH equipment by optical fibre cable for integration to SAS server at a remote 132kV substation via WAN. It shall be responsibility of the Contractor to connect up to the local SDH equipment. SAS/SCADA at remote 132kV substation shall be in the scope of a separate contract. However, the Contractor will do all necessary coordination and extend all required inputs for successful integration of the substation IEDs in the SAS/SCADA of remote 132kV substation.

Each Ethernet switch shall have minimum 03 spare ports (at least one port of each type used) for future use.

Tri-vector meter are also envisaged to communicate with remote SAS/SCADA through MODBUS /IEC protocol convertor and all wiring etc. shall be in the scope of contractor

3.13 GENERAL FEATURES

3.13.1 All relays and timers in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent, dust tight cover, removable from the front. All protective relays shall have a drawout construction for easy replacement from the front. They shall either have built-in test facilities, or shall be provided with necessary test blocks and test switches located immediately below each relay. The auxiliary relays and timers may be furnished in non-drawout cases. The contact multiplying auxiliary relays if any may be located inside the auxiliary compartment and they may be of fixed type.

3.13.2 All relays and timers shall be rated for control supply voltage as mentioned in Section – GTR with specified variation. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Auxiliary seal in units if provided shall be of shunt reinforcing type.

3.13.3 The protective relays and timers shall have atleast two potential free output contacts. Auxiliary relays, shall have contacts as required. Contacts shall be silver faced and shall have spring action. Adequate number of terminals shall be available on the relay cases for applicable relaying schemes.

3.13.4 All protective relays, auxiliary relays and timers shall be provided with hand reset operation indicators (flags) for analysing the cause of tripping.

3.13.5 Timers shall be of electromagnetic or static type.

3.13.6 Failure of a control or auxiliary supply and de-energisation of a relay shall not initiate any circuit breaker contactor operation.

3.13.7 All relays shall withstand a minimum test voltage of 2kV AC rms for one minute.

3.13.8 The relay and timers used in protective circuits shall be of reputed makes and proven types which have been in successful operation for at least two (2) years and shall be subject to Owner's approval before procurement by the Contractor.

3.14 INSTRUMENTS AND METERS

3.14.1 Indicating instruments and integrating meters shall be flush mounted on panel front. The instruments shall be of at least 96mm square size with 240 deg. scales, shall conform to IS:1248 and shall have an accuracy class of 1.5 or better. The covers and cases of instruments and meters shall provide a dust and vermin proof construction.

3.14.2 Instruments shall have white dials with black numerals and lettering. Black knife edged pointer with parallax free details will be preferred.

3.14.3 Ammeters on motor feeders shall have a compressed scale at the upper current region to cover the motor starting without graduation from one to six times the rated CT secondary current. These shall be suitable to withstand the above current of motors which can last upto 30 seconds (under stalled condition) without any damage or loss of accuracy.

3.14.4 Ammeter and current coils of other instruments and meters shall withstand the rated CT secondary current continuously and ten times the rated CT secondary current for 0.5 second, without any loss of accuracy. The voltmeters and potential coils of instruments and meters shall withstand 120% of rated voltage continuously and twice the rated voltage for 0.5 second. The range and resolution of ammeter shall be suitable to monitor low value of loads on transformer and feeders.

3.14.5 Instruments and meters shall be compensated for temperature errors and factory calibrated to directly read the primary circuit quantities. Means shall be provided for zero adjustment without dismantling the instruments.

3.14.6 Watt-hour meters shall preferably be 3-phase two (2) element type suitable for measurement of unbalanced loads in three phase three wire system.

3.14.7 Watt-hour meters shall preferably be provided in drawout cases with built-in testing facilities. Alternatively, they may have test blocks to facilitate testing of meters without disturbing CT and VT secondary connections. The energy meter shall be as per Chapter 12 of this TS.

3.14.8 Digital display instruments in place of analog shall also be acceptable. The size of the digits shall be such that it is visible comfortably in the control room.

3.15 CONTROL AND SELECTOR SWITCHES

3.15.1 Control and selector switches shall be of heavy duty, rotary type with escutcheon plates clearly marked to show the operating positions and circuit designation plates. The switches shall be of sturdy construction suitable for flush mounting. Switches with shrouding of live parts and sealing of contacts against dust ingress shall be preferred.

3.15.2 On-Off control switches shall have three positions and shall be spring return to neutral from ‘close’ and ‘trip’ positions. They shall have two contacts closing in close position and two contacts closing in trip positions, and shall

have Pistol Grip handles. Lost motion feature shall be provided wherever required.

3.15.3 Selector switches shall have two or three stay put positions. They shall have two contacts for each of the three positions and shall have black Spade handled.

3.15.4 Ammeter and Voltmeter selector switches shall have four stayput positions with adequate number of contacts for three phase system. These shall have OVAL handles. Ammeter selector switches shall have make before break type contacts to prevent open circuiting of CT secondary.

3.15.5 Contacts of the switches shall be spring assisted and shall be of suitable material to give a long trouble free service. The contact rating shall be at least the following:

a. Make and carry continuously..... 10A

b. Breaking current at 220V DC..... 1A (Inductive)

c. Breaking current at 240V AC/110V DC 5A at 0.3 pf lag.

3.16 INDICATING LAMPS

3.16.1 Indicating lamps shall be of the panel mounting, LED type and low watt consumption. The lamps shall have escutcheon plates marked with its function, wherever necessary.

3.16.2 Lamps shall have translucent lamp-covers of the following colours, as warranted by the application:

RED	CLOSED
GREEN	OPEN
WHITE	DC healthy
BLUE	For all healthy conditions (e.g. . control supply, spring charged, and lock out relay coil healthy)
AMBER	For all alarm conditions (e.g. pressure low, over load) also for SERVICE and TEST

positions indication.

3.16.3 It shall be easily replaceable form the front of the cubicles. The method of mounting indicating lamps fittings on panels shall prevent their rotation under the action of lamp removal or replacement, reliance. upon the tightness of a ring-nut for the purpose is not sufficient.

3.16.4 Indicating lamps shall be located just above the associated push buttons/control switches. Red lamps shall invariably be located to the right of green lamps. In case a white lamp is also provided, it shall replaced between the red and green lamps along the centre line of control switch/push button pair. Blue and amber lamps shall normally be located above the red and green lamps.

3.16.5 When associated with push buttons, red lamps shall be directly above the green push button, and green lamp shall be directly above the red push-button.
All indicating lamps shall be suitable for continuous operation at 90 to 100% of their rated Voltage.

3.17 SPACE HEATER

3.17.1 Each switchgear panel shall be equipped with thermostatically controlled suitably located in breaker and cable compartments to prevent condensation within the enclosure. The space heaters shall be connected to 240 V single phase AC auxiliary supply available in the switchgear, through switches and fuses provided separately for each panel.

3.17.2 A 240V single phase 50 Hz AC plug point of duplex 5/15 amp. shall be provided in the interior of each cubicle with ON-OFF switch for connection of hand lamp.

3.18 TERMINAL BLOCKS

3.18.1 Terminal blocks shall be 650 Volts grade, 10 Amps rated, one piece moulded complete with insulating barriers. Clip on type terminals, washers, nuts and identification strips. Marking on terminal strips shall correspond to the terminal numbering in wiring diagram. It shall be similar to IGippon type RSFI (ELMEX type CSLT-I) with insulating material of Melamine conforming to ESI standard 12.1 or equivalent.

3.18.2 Terminal blocks for CT and VT secondary leads shall be provided with links to facilitate testing, isolation, star/delta formation and earthing. Terminal

blocks for CT secondary shall leave the short circuiting facility. It shall be similar to ELMEX CATD type.

3.18.3 At least 10% spare terminals for external connections shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks. Space for adding another 10% spare terminal. It shall also be available in each panel.

3.18.4 There shall be minimum clearances of 250 mm between the terminal blocks and the cable gland plate and 150 mm between two rows of terminal blocks.

3.18.5 All panel wiring for external connections shall terminate on separate terminal blocks which shall be suitable for connecting two (2) stranded copper conductors of 2.5 sq.mm. form each side.

3.19 SWITCHGEAR WIRING

3.19.1 All Switchgear panels shall be supplied completely wired internally upto the terminal block ready to receive external cabling. All inter cubicle wiring and connections between panels of same switchboard including all bus wiring for AC and DC supplies shall be provided by the Contractor.

3.19.2 All internal wiring shall be carried out with 650 V grade, single core, 1.5 sq.mm, stranded copper wires having minimum of seven strands per conductor and colour coded, PVC insulation. CT circuits shall be wired with 2.5 sq.mm. wires which otherwise are similar to the above. Extra flexible wires shall be used for wiring between fixed and moving parts such as hinged doors.

3.19.3 All wiring shall be properly supported neatly arranged, readily accessible and securely connected to equipment, terminals and terminal blocks. Wiring troughs or gutters be used for this purpose.

3.19.4 Internal wire terminals shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor. Insulation sleeves shall be provided over the exposed parts of lugs. The lugs related to CT secondary circuit wiring shall be of hole type.

3.19.5 Engraved core identification plastic ferrules marked to correspond with panel wiring diagrams shall be fitted at both ends of each wire Number 6 and 9 shall not be used for wire identification. Ferrules shall fit tightly on wires and shall not fall off when wire is, disconnected from terminal. All wires directly connected to trip the circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule.

3.19.6 Inter connection to adjacent panels shall be brought out to a separate set of terminal blocks located near the slots or holes, meant for the interconnecting wires. Arrangement shall permit neat layout and easy inter connections to adjacent panels at site and wires for this purpose shall be provided by Contractor looped and bunched properly inside the panels. The inter panel wires shall be cross ferruled i.e it shall have details of emanating terminal and also where it is terminated.

3.19.7 Contractor shall be fully responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment.

3.19.8 The Contractor shall provide the necessary clamps wiring troughs etc. for all wiring in side the switchgear enclosed including the power and control cables.

3.20 POWER CABLE TERMINATION

3.20.1 The Cable termination compartment shall receive the stranded Aluminium conductor, XLPE insulated, shielded, armoured/unarmoured, PVC jacketed, single core/three core unearthed/earthed grade power cable(s).

3.20.2 A minimum clearance of about 600 mm shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Interphase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirement besides facilitating easy connections and disconnections of cables. Dimensional drawing of cable connection compartment showing the location of lug, glands, CTS, gland plates etc. and the electrical clearances available shall be submitted for Employer approval during detailed engineering.

3.20.3 Cable termination compartment shall be complete with power terminals, power lugs and associated hardware and removable undrilled gland plates. For all single core cables gland plates shall be of nonmagnetic material.

3.20.4 Supply of the cable termination kit and cable terminations shall be in scope of contractor.

3.21 NAME PLATES AND LABELS

3.21.1 Each switchboard shall have a name plate for its identification. All enclosure mounted equipment shall be provided with individual engraved name plates for clear equipment identification. A.U panels shall be identified on front as well as backside by large engraved name plates giving

the distinct feeder description along with panel numbers. Back side name plates shall be fixed in panel frame.

3.21.2 Name plate shall be of non-rusting metal or 3-ply lamicoid with white engraved lettering, on black background. Inscriptions and lettering shall be subjected to Employer's approval.

3.21.3 Suitable stencilled paint mark shall be provided for identification of all equipment, located inside the enclosure, as well as for door mounted equipment, from the back side in addition to plastic sticker labels, if provided. These labels shall be located directly by the side of the respective equipment, shall be clearly visible and shall not be hidden by equipment wiring. Labels shall have device number as mentioned in wiring drawings. Type of labels and fixing of labels shall be such that they are not likely to peel or fall off during prolonged use.

3.22 33 KV INDOOR SWITCHGEAR CONFIGURATION

Sl.No.	Equipment	IP1 I/C	IP2 O/G	IP4 B/S
1.	36 kV, 1250A, 25KA 3 sec VCB	1	1	1
2.	36 kV, 300-150/1 CT	1	1	
3.	Ammeter	1	1	
4.	Voltmeter	-	1	-
5.	Watt meter	-	1	-
6.	Varmeter	-	1	-
7.	Control switch for breaker	1	1	1
8.	Mimic to represent SLD	1	1	
9.	Voltmeter selector switch	~~1~~	1	
10.	Ammeter selector switch	1	1	
11.	Flag relays, trip relays, Auxiliary relays timers etc (as per scheme requirement)	Lot	Lot	Lot
12.	Energy meters (kwhr 0.5 class accuracy)	1	1	-
13.	Annunciation Facia (as per requirement)	Lot	Lot	Lot
14.	Numerical protection relay (IED)	1	1	1
15.	Master Trip Relay (86)	1	1	1
16.	Semaphore Indicator for Line Isolator & Line Earth Switch	1	2	-
17.	LAN Switches and LAN/FO Cables	As per requirement		

Notes:

1. IP1: Panel for Transformer Incomer feeder (I/C)
2. IP2: Panel for outgoing Line Feeder (O/G)

3. IP3: Panel for LT Transformer feeder (LT TR)
4. IP4: Panel for Bus Sectionaliser (B/S)
5. Location of VT (I/C or B/S Module) shall be decided during detail engineering.
6. Numerical protection relay (IED) for all type of VCB module shall preferably be interchangeable.

For smooth function of system, any other item apart from above mentioned items if required then the same shall be provided by the Contractor without any additional financial burden to POWERGID.

3.23 TESTS

The design of circuit breaker shall be proven through all the routine and in accordance with IS 13118: 1991/IEC 56 and any amendment thereof. Photocopy of all the test reports must be enclosed with the tender. Type test report earlier than 7 year from the date of tender opening shall not be acceptable.

TYPE TESTS:

Each circuit breaker shall comply with requirements of type tests prescribed in IEC publication No.56.

- Short time and peak withstand current test.
- Short circuit breaking capacity and making capacity.
- Capacitive current switching test: Cable charging current breaking test (Ur less than or equal to 52 kV).
- Dielectric test i.e., power frequency withstand and impulse withstand test
- Temperature rise test.
- Mechanical Endurance Test at ambient temperature.
- Measurement of resistance of the main circuit.
- Internal arc test.

3.24 COMMISSIONING CHECKS/TESTS

After installation of panels, power and Control wiring and connect Contractor shall perform commissioning checks. as listed below to proper operation of switchgear/panels and correctness of all respects.

In addition the Contractor shall carry out all other checks and tests recommended by the manufacturers.

3.25 GENERAL

i) Check name plate details according to specification.

ii) Check for physical damage

iii) Check tightens of all bolts, clamps and connecting terminal

iv) Check earth connections.

v) Check cleanliness of insulators and bushings.

vi) Check heaters are provided.

vii) H.V. test on complete switchboard with CT & breaker/ contractor lubricated in position.

viii) Check all moving Parts are properly lubricated .

ix) Check for alignment of busbars with the insulators to ensure alignment and fitness of insulators.

x) Check for inter changeability of breakers.

xi) Check continuity and IR value of space heater.

xii) Check earth continuity of the complete switchgear board.

3.26 CIRCUIT BREAKER

i) Check alignment of trucks for free movement.

ii) Check correct operation of shutters.

iii) Check slow closing operation (if provided).

iv) Check control wiring for correctness of connections, continuity and IR values.

v) Manual operation of breakers completely assembled.

vi) Power closing/opening operation, manually and electrically at extreme condition of control supply voltage.

vii) Closing and tripping time.

viii) Trip free and anti-pumping operation.

ix) IR values, resistance and minimum pick up voltage of coils.

x) Simultaneous closing of all the three phases.

xi) Check electrical and mechanical inter locks provided.

xii) Checks on spring charging motor, correct operation of limit switches and time of charging.

xiii) Check vacuum (as applicable).

xiv) All functional checks.

3.27 Current Transformers

i) Megger between windings and winding terminals to body.

ii) Polarity tests.

a. Ratio identification checking of all ratios on all cores by primary injection of current.

b. Magnetization characteristics & secondary winding resistance.

iii) Spare CT cores, if any to be shorted and earthed.

3.28 VOLTAGE TRANSFORMERS

i) Insulation resistance

ii) Ratio test on all cores.

iii) Polarity test

iv) Line connections as per connection diagram.

3.29 CUBICLE WIRING

i) Check all switch developments.

ii) It should be ensured that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked.

iii) All the wires shall be meggered to earth.

iv) Functional checking of all control circuit e.g. closing, tripping, interlock, supervision and alarm circuit including proper functioning of component/ equipment .

v) Check terminations and connections. To check wiring related to CT and PT circuits, carryout primary injection and then check for secondary value at relay and metering instrument terminals.

vi) Wire ducting.

vii) Gap sealing and cable bunching.

3.30 RELAYS

i) Check internal wiring.

ii) Megger all terminal body.

iii) Megger AC to DC terminals

iv) Check operating characteristics by secondary injection.

v) Check minimum pick up voltage of DC coils.

vi) Check operation of electrical/ mechanical targets.

vii) Check CT connections with particular reference to their polarities for differential type relays.

viii) Relay settings.

3.31 INDICATING METERS

i) Megger all insulated portion.

ii) Check CT & VT connections with particular reference to their polarities for power type meter.

3.32 SYSTEM PARAMETERS:

1	Nominal System voltage	33 kV
2	Highest System voltage	36 kV
3	Rated Frequency	50 Hz

4	Number of phases/ poles	Three
5	System neutral earthing	As per Vector Group of Transformers
6	One minute power frequency withstand voltage	70
7	1.2/50 microsecond Impulse withstand voltage	170 kV (peak)
8	Short time rating for bus bars, CB, CT and switchgear Assembly..	25 kA (rms) for one (1) sec.
9	Dynamic withstand rating	62.5 kA (peak)
10	IAC Rating	25 KA , 3 sec
11	Control supply voltage	
12	- Trip and closing coils	As per Station DC Supply
	- Spring charging motor	As per Station DC Supply
13	Maximum ambient air temperature	50 deg. C

a)	**CIRCUIT BREAKERS**	
1.	Rated Voltage	33 kV
2.	CB rated Current	
a)	Incomer & Sectionaliser Breaker	1250A
b)	Line feeder Breaker	1250A
3.	Short circuit breaker Current	
a)	A.C. component	25 kA
b)	D.C. component	As per IS: 13118 or IEC-62271
4.	Short Circuit making current	62.5 kA (peak)
5.	Out of phase breaking Current capacity	As per IEC
6.	Rated line/cable charging Interrupting current at 90° Leading power factor angle	As per IEC
7.	Maximum allowable switching Over voltage under any switching Condition	As per IEC
8.	Rated small inductive current Switching capability with over Voltage less than 2.3 pu	As per IEC
9.	First pole to clear factor	1.5
10	Operating Duty	**O-0.3 Sec-CO-3 Min-CO**
11	Total break time	Not more than 4 cycles
12	Total make time	Not more than 5 cycles
13	Reclosing	3 phase auto reclosing

14	Max. difference in the instants of closing/opening contacts between poles at rated control Voltage and rated operating and quenching media pressures	As per IEC
15	Auxiliary contacts	6NO+6NC for Employers future use besides scheme requirement
16	Operating Mechanism	Motor wound spring charged stored energy type as per IEC-62271

b) CURRENT TRANSFORMER		**(Transformer Feeder)**			**(Line Feeder/Bus coupler)**	
1.	Rated primary voltage	**33kV**			**33kV**	
2.	Rated primary current	300A			300A	
3.	Type of CT	1-Phase			1-Phase	
4.	Max temp rise	As per IEC:60044-1			As per IEC:60044-1	
5.	Class of Insulation	Class E or better			Class E or better	
6.	One minute power frequency withstand voltage between secondary terminal & earth	2kV			2kV	
7.	No. of Secondary cores	3			2	
8.	Accuracy of Secondary core	Metering	O/C & E/F Protn.	Diff. Protn.	Metering	O/C & E/F Protn.
		0.5	5P10	PS	0.5	5P10
	Current Ratio	300-150/1	300-150/1	300-150/1	300-150/1	300-150/1

e) VOLTAGE TRANSFORMERS			
1.	Rated primary Voltage	33kV	
2.	Type	1-phase	
3.	Voltage ratio (kV)	$(33/\sqrt{3})/(0.11/\sqrt{3})$	
4.	Rated Voltage Factor	1.2 continuous and 1.5 for 30 seconds	
5.	Nos. of Secondary cores	2	
6.	Accuracy of Secondary core	Metering	Protn.
		0.5	3P
7.	Class of insulation	Class E or better	
8.	Rated output burden (Minimum)	20VA	

Notes: The ratings indicated for instrument transformers are tentative only and may be changed to meet the functional requirements.

SECTION 4

SPECIFICATION OF 11 KV INDOOR SWITCHGEAR CUM C&R PANEL

4.1. INTRODUCTION

4.1.1. The section covers the specification of metal clad indoor vacuum type switchgear unit with horizontal draw out circuit breaker as per IS 13118 [1991] / IEC 62271-100 or latest amendment thereof.

4.1.2. All the equipments shall be suitable for satisfactory operation in tropical climates and dry dust laden atmosphere prevailing in the location where it shall be used against the Contract. The equipment shall be able to with stand a wide range of temperature variation in the required location.

4.1.3. All the plant/apparatus/equipment supplied shall comply in all respect with the requirement of Indian Electricity Act 1910 and Indian Electricity Rule 1956/IS and latest amendment thereof during the execution of contract where-ever applicable.

4.2. STANDARDS.

The circuit Breaker shall confirm to the latest revision with amendment available of relevant standards, rules, and code. Some of which are listed herein for ready reference.

Sl. No.	Standard	Item

1.	IEC- 62271-100 /IS-13118(1991)	Switchgear
2.	IS-2705 (1992)	Current Transformer
3.	IS-3156 (1992)	Voltage Transformer
4.	IS-3231 (1987)	Relays
5.	IS-1248	Ammeter & Voltmeter
6.	IS-375	Arrangement of Breakers Bus Bars main connection and auxiliary wiring.
7.	IEC-60687/CBIP REPORT NO-88 (JULY) 1996)	Tri vector meter

4.3. CONSTRUCTION

4.3.1. The switchgear shall be of CRCA steel construction with sheet not less than 3mm thickness for load bearing section and not less than 2 mm thickness for non-load bearing and shall totally dust and vermin proof. However, if vendor has standardized the thickness of enclosure other than above mentioned and it meets the performance requirements and the design has been established through type test, the same shall be accepted. The panels shall be rigid without using any external bracings. The switchboard panels should comply with relevant IS/IEC and revision thereof and shall be designed for easy operation maintenance and further extension. Bus bar, metering circuit breaker chamber, cables and cable box chamber should have proper access for maintenance, proper interlocks should be provided. All instruments shall be non-draw out type and safe guard in every respect from damages and provided with mechanical indicator of connection and disconnection position. The switchgear shall be completed with all necessary wiring fuses, auxiliary contacts terminal boards etc.

4.3.2. The arcing contacts and bus bar should be rated for 350 MVA for 3 seconds. Bus bars shall be capable of connecting one switchgear panel to other through proper insulated arrangement, which does not decrease the insulation strength of the bus bar at the point of connection between two panels. The panels shall be modular in design.

4.3.3. The breakers should be able to be drawn out in horizontal position at ground level [with vertical/horizontal isolation] when breaker is drawn out in horizontal position none of the live components inside the 11 KV switchgear panel should be accessible. The safety shutters shall be robust and shall automatically cover the live components when the breaker is drawn out. The switchgear shall have complete interlocking arrangements at the fully inserted and fully drawn out and test positions.

Withdrawal of the breaker should not be possible in ON position, it should not be possible to close the circuit breaker in service unless the entire auxiliary and control circuit are connected.

4.3.4. Breaker should have three distinct positions inside the cubical; i.e. service, test and isolated.

4.3.5. Built-in/separate trolley mounted earthing switches for incomer and outgoing shall be provided.

4.3.6. All the high voltage compartments must have pressure discharge flap for the exit of gas due to internal are to insure operator safety. All the HV compartment design ensures conformity to IEC-60298 and must be type tasted for Internal Arc Test.

4.4. BUS BARS AND CONNECTORS

4.4.1. Bus bars and all other electrical connection between various components shall be made of electrolytic copper of rectangular cross sections. The bus bars section shall be ample capacity to carry the rated current of minimum 630 Amp continuously without excessive heating and for adequately meeting the thermal and dynamic stresses in the case of short circuit in the system up to full MVA rating.

4.4.2. All bus bars connections shall be firmly and rigidly mounted on suitable insulators to withstand short circuit stresses and vibrations.

4.4.3. Adequate clearance between 11 KV point and earth and between phase shall be provided to ensure safety as per provision in Indian Electricity Rule 1956 and its amendment thereof and also in accordance with the relevant Indian standard specification and the same shall be capable of withstanding the specified high voltage tests as per IS-13118/ IEC 62271-100 and amendment thereof.

4.4.4. Sharp edges and bends either in the bus bars or bus bar connections shall be avoided as far as possible. Wherever such bends or edges are un-avoidable, suitable compound or any other insulation shall be supplied to prevent local ionization and consequent flashover.

4.5. CIRCUIT BREAKER

4.5.1. The vacuum circuit breaker shall be draw out type suitable for installation in the switchgear cubicles (indoor). The breaker shall comply with IS-13118 (1991)/ IEC 62271-100 and latest amendment thereof. Construction of breaker shall be such that the points, which require frequent maintenance, shall be easily accessible.

4.5.2. The circuit breakers shall be spring operated, motor/manually charging of the spring feature, manually released. VCB shall have spring closing mechanism for 3 pole simultaneous operation. The speed of closing operation shall be independent of the speed of hand operating level. The indication device shall show the OPEN and CLOSE position of breaker visible from the front of cubical.

4.5.3. The breakers shall be capable of making and breaking the short time current in accordance with the requirement of IS 13118(1991)/ IEC 62271-100 and latest amendment thereof and shall have three phase rupturing capacity of 350 MVA for 3 second at 11 KV. The continuous current rating of breaker shall not be less than 630 Amp for all items. The total break/make time shall be not more than 4 cycles for break and 6 cycles for make time for all breakers.

4.5.4. The vacuum circuit breakers shall ensure high speed extinction and adequate control of pressure during breaking of current and also designed to limit excessive over voltages.

4.5.5. Comprehensive interlocking system to prevent any dangerous or inadvertent operation shall be provided. Isolation of circuit breaker from bus bar or insertion into bus bar shall only be possible when the breaker is in the open position.

4.5.6. Vacuum Circuit Breaker shall have completely sealed interrupting units for interruption of arc inside the vacuum. **The vacuum bottle sealed for life shall be provided with contact wear indicator.**

4.5.7. Vacuum interrupter should have an expected life of 10000 operations at rated current and should be capable for operating more than 100 times at rated short circuit current.

4.5.8. Vacuum interrupter technical data particularly provided by the manufacturer should also be provided with Bid.

4.6. Numerical Protection RELAYS (IEDs)

4.6.1. All the communicable numerical protection relays (IEDs) complying with IEC-61850 on all feeders which shall be networked on Ethernet to communicate with substation remote SAS/SCADA system on IEC-61850. These IEDs shall also be used for control & monitoring the switchgear from SAS. In addition to status of devices and equipment trip/alarms, Metering data shall also be made available to remote SAS/SCADA station from protection IEDs. Further, Trivector meters with

Modbus protocol are also envisaged, which will be connected in daisy-chain-link to communicate to remote station SAS. Modbus to IEC 61850 converter shall be provided for integration with remote SAS.

4.6.2. It is also envisaged that required alarm /trip points related to equipments i.e. circuit breaker and transformer etc. from relay i/o point shall be wired to annunciation system.

The Bidder's scope shall include the followings:

g) Communicable Numerical Protection Relays (with IEC 61850) in each of the feeders.

h) IED's / Numerical Relays shall have Graphical Display to facilitate settings, relay operations and to view measurement, event and alarm etc.

i) Relays shall have built in Local/Remote Switch.

j) Cat5e Ethernet cable for connection of Numerical Relays (IEDs) to Ethernet switches. Optical cable shall be used between Ethernet switch and SDH Equipment and among Ethernet switch.

k) Required number of Ethernet switches mounted in Outdoor/Indoor Switchgear panels for communication with IEDs on IEC 61850 protocol.

l) The SAS/SCADA system has been envisaged as part of main EHVsubstation. Bidder shall facilitate in successful Integration of IED's to the remote SAS/SCADA system through Ethernet switches.

4.6.3. All Numerical relays shall be of types, proven for the application satisfying requirements specified elsewhere and shall be subject to Employer's approval. Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the Employer.

4.6.4. All numerical relays shall be rated for control supply voltage as mentioned elsewhere under system parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage.

4.6.5. All IEDs shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts as per approved

scheme. These I/O points shall be used for wiring of status of devices (CBs/Isolators), equipment trip/ alarms status etc. Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.

4.6.6. Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping. Event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.

4.6.7. All Numerical relays shall have features for electrical measurements including voltage, current, power (active & reactive), frequency, power-factor and energy parameters.

4.6.8. All numerical relays shall have provision of both current (CT) and voltage (VT) inputs as required for protection & measurement purposes using protection cores[DO2].

4.6.9. All numerical relays shall have key pad / keys to allow relay setting from relay front. Relay to be self or hand reset type which shall be software selectable. Manual resetting shall be possible from remote.

4.6.10. Relays shall have suitable output contact for circuit breaker failure protection (LBB) logic.

4.6.11. Relays shall have self diagnostic feature with continuous self check for power failure, program routines, memory and main CPU failures and a separate output contact for indication of any failure.

4.6.12. Contractor shall submit applicable Type Test reports for Numerical relays as per IEC including report for IEC 61850 protocol from accredited lab.

4.6.13. IED shall be provided for protection, control and monitoring of the bay equipments. One no. IED shall be provided for each no. of switchgear panel/ bays.

4.6.14. Its control function shall include control & monitoring of Circuit breaker and monitoring of Isolator status.

4.6.15. It shall include protective function as mentioned for transformer / feeder numerical protection IED as applicable . Functional requirement, as applicable, of protective relays specified under clause 4.7 shall be met.

4.6.16. Each IED shall have communication port based on IEC61850 protocol for integration with SAS.

4.6.17. IED shall be capable of integration with the remote EHV (132/220kV) substation automation system based on IEC61850

4.6.18. The IED shall be of modular in construction with adequate capacity for the estimated binary hardwired Inputs & Outputs plus 20% spare capacity. Requirement for external IO modules shall be avoided as far as possible.

4.6.19. IEDs offered shall be of state of the art microprocessor based architecture and employ digital numerical technology. After a power interruption and/or communications failure the IED shall be arranged to restart automatically.

4.6.20. Time synchronisation of IEDs with UTC time shall be done over the IEC61850 field LAN

4.6.21. It shall be suitable for analog inputs from current transformers with 1A / 5A rated secondary and voltage transformers with 63.5V (phase to neutral voltage) rated secondary.

4.6.22. The IED shall be able to integrate analog input channels and digital input / output channel as a minimum to meet the protection, control & monitoring scheme requirement for the bay.

4.6.23. Plant alarms and indications will be derived as digital input from volt free contacts.

4.6.24. The command outputs shall be designed to provide select and execute outputs. The period of the command pulse shall be configurable between 0.1 second and 15 seconds on point basis. The command pulses shall reset immediately after the command is executed. Controls transmitted between the operator workstation of remote SAS / SCADA and the IED shall comprise a select, check back & execute sequence (or other means of providing high message security).

4.6.25. Each IED shall be equipped with Local HMI facilities, enabling control of Circuit Breaker from IED whenever required. The Local HMI facilities preferably shall be accomplished by means of Graphical LCD display embedded into the front panel of the IED. Display will show simplified SLD diagram (with device identification number) showing status of bay

switching equipment (circuit breaker & isolators). Other display type will be multiple displays of analog values readings / reports, Alarm panel displays, Diagnostic/ on-line configuration displays etc.

4.6.26. A common Audible alarm with accept / reset push button shall be provided for each IED which shall be initiated from respective IED on tripping event.

4.7. PROTECTION:

4.7.1. Numerical Transformer Protection Relay

h. The relay shall have instantaneous as well as time delayed three over current (50) and one earth fault (50N) protections.

i. The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current

j. The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current (IDMT)

k. For transformers of rating 5MVA and above, definite time delayed Stand by earth fault protection shall be provided having a pick up setting range of 10% to 40% with a timer delay of 0.3 sec to 3 sec.

l. Transformer troubles like Buchholz, Winding temperature, Oil temperature & Pressure Relief Device trips (as applicable) shall be wired to separate binary inputs of the relay and shall be configured to issue trip command to the breaker.

m. Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

n. Protection core of PT/VT shall also be wired to the protection relay.

4.7.2. Numerical Line Protection Relay

f. The relay shall have instantaneous as well as time delayed three over current (50) and one earth fault (50N) protections.

g. The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current.

h. The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current.

i. Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

j. Protection core of PT/VT shall also be wired to the protection relay.

4.8. Integration of IEDs with SAS of remote 132kV substation:

All protective relay (IEDs) shall be connected to Ethernet switch on IEC61850 which shall then be connected to local SDH equipment by optical fibre cable for integration to SAS server at a remote 132kV substation via WAN. It shall be responsibility of the Contractor to connect up to the local SDH equipment. SAS/SCADA at remote 132kV substation shall be in the scope of a separate contract. However, the Contractor will do all necessary coordination and extend all required inputs for successful integration of the substation IEDs in the SAS/SCADA of remote 132kV substation.

Each Ethernet switch shall have minimum 03 spare ports (at least one port of each type used) for future use.

Tri-vector meter are also envisaged to communicate with remote SAS/SCADA through MODBUS /IEC protocol convertor and all wiring etc. shall be in the scope of contractor

4.9. CURRENT TRANSFORMERS :

4.9.1. The requirement of ratio, VA capacity, class or accuracy, limit factor etc. for resin cast CTs installed in different type of units are tabulated below:

Item	Transformer Capacity-MVA(Amp-load current)	Core/CT	Ratio	VA Burden (min)	Knee Point Voltage	ALF	Class of accuracy
Transformer Panel	10(525)	Protection	600-300/1A (for differential proct.)	15	300 at 600/1A tap	10	PS
		Protection	600-300/5A	15	……..	10	5P
		Metering	600-300/5A	2.5	……..		0.5
Feeder Panel		Protection	400-200/5A	15	……	10	5P
		Metering	400-200/5A	2.5	……..		0.5
Transformer Panel	7.5(394)	Protection	600-300/5A	15	……..	10	5P
		Metering	600-300/5A	2.5	……..		0.5
Feeder Panel		Protection	400-200/5A	15	……	10	5P
		Metering	400-200/5A	2.5	……..		0.5
Transformer Panel	5(262)	Protection	400-200/5A	15	……..	10	5P
		Metering	400-200/5A	2.5	……..		0.5
Feeder Panel		Protection	300-150/5A	15	……	10	5P
		Metering	300-150/5A	2.5	……..		0.5
Transformer Panel	2.5(131)	Protection	200-100/5A	15	……..	10	5P
		Metering	200-100/5A	2.5	……..		0.5
Feeder Panel		Protection	200-100/5A	15	……	10	5P
		Metering	200-100/5A	2.5	……..		0.5

4.9.2. Short time rating of CTs shall be 18.4 KA for 3 second. CTs shall be double core and dual ratio. Saturation factor for metering core shall not exceed 2.5.

4.9.3. The designed accuracy should be available even at the lowest ratios and all CTs shall withstand fault current corresponding to 350 MVA for 3 sec.

4.9.4. The secondary terminal of the current transformers shall be such that effective and firm wire terminations are possible. Shorting links of adequate capacity shall be provided at the terminal blocks for sorting of the leads from secondary terminals of current transformers. The secondary terminal of the CTs shall be earthed at one point.

4.9.5. The secondary winding resistance of CTs shall be as low as possible but not greater than 0.2 ohms per 100 turns.

4.9.6. CTs shall confirm to IS 2705 with latest amendment, if any in all respect and will be subjected to all routine and type test specified in the IS.

4.10. CABLE GLANDS AND CLAMPING ARRANGMENT FOR HOLDING SUITABLE CABLE BOXES

4.10.1. Two nos, brass-wiping glands for each incomer and one no. Brass wiping gland for each outgoing panel of adequate dimension for XLPE cable of 3 cores up to 400 sq. mm size shall be supplied along with panels. For bus coupler no cable glands should be provided.

4.10.2. Suitable cable boxes as per requirement of cable shall be arranged by the purchaser at his end. The panel shall however provide a flat of size 50X6 mm^2 with suitable clamp made of 50X6 mm^2 flat along with Nuts Bolts and Washers for holding the cable boxes. The flat should be fitted at a suitable height with allotted arrangement for adjustment of height from 300mm to 500mm at site. The clamp and flat shall have suitable stud type arrangement for earthing cable and cable box.

4.10.3. All control cable/wire entries shall be by means of suitable cable glands, such glands shall be of brass and tinned.

4.11. AUXILIARY/CONTROL WIRING

All the secondary wiring in the panel shall have high quality PVC insulation and the same shall have conductor size of not less than 2.5 mm^2 of copper Colors of the secondary/auxiliary wiring should confirm to

IS 375/1963 and latest amendment thereof if any. All wiring shall be neatly run and group of wiring shall be securely fixed by clips so that wiring can be checked without necessity of removing the clamps. Wiring between fixed and moving portion of the panel shall be run in flexible tubes and the same shall be so mounted to avoid any damage to them due to mechanical movements. Ferrules with number shall be provided on both end of the wiring.

4.12. MARKING OF PARTS

For facilitating the erection, the several parts of the plant and equipment shall be suitably marked.

4.13. NAME PLATE AND DIAGRAM PLATES

All equipment shall have weather proof and non corrosive metal plates fixed in suitable position with full particulars engraved thereon with white letters against black background.

The firm shall affix a name plate on each Switchgear panel having following information:

1. Manufacturer's name and trade mark.
2. Unique No.
3. Type of Panel.
4. CT Ratio.
5. Rated Voltage.
6. Rated Insulation Level
7. Rated Frequency
8. Rated Normal Current
9. Rated Short Circuit Breaking Current.
10. Weight
11. Specification No.
12. Order No. and Date
13. Year of supply.
14. Property of SEBs/DISCOMS

4.14. PAINTING

All metallic surface [except enameled and bright parts] exposed to weather shall be given suitable primer coat and two coats of first quality paint of approved color. The supplier shall also supply adequate quantities of paints, Varnish etc. for use of finished cost and for use of patching up any scratches received during transport, handling erection testing and commissioning.

Instead of above proper powder coating after proper pre treatment is acceptable and in that case earlier condition will not applicable.

4.15. DETAILED FITTING AND MOUNTING

Detailed fittings and mountings of equipments in various switchgear panel shall be as follows:

4.15.1. **INDOOR SWITCHGEAR PANELS CONFIGURATION** (11kV)- Each panel shall consist of following:

S.NO.	Description	unit	11 kV transformer switchgear	11 kV feeder switchgear	11 kV Bus coupler
1.	All steel totally enclosed fully interlocked indoor industrial pattern, metal clad horizontal draw out, horizontal/vertical isolation, floor mounting switch unit complete with transportation truck having integral circuit breaker mechanism	Nos	1	1	1
2.	Fabricated sheet steel mounting	Nos	1	1	1
3.	Complete set of mechanical interlocks.	Nos	1	1	1
4.	Isolating plugs and sockets (rated for 800 Amp)with automatic safety shutters and pad locking arrangements. Facilities shall be provided for proper opening of the safety shutter for cleaning, inspection and testing.	Set	6	6	6
5.	630Amp triple pole VCB fitted with isolating sockets, spring operated, manually as well motor charged, manually/ electrically released spring closing mechanism with mechanical ON/OFF indicators suitable for a rupturing capacity of not less than 350 MVA at 11 kV for 3 seconds	Nos	1	1	1
6.	Auxiliary switch with minimum four normally closed and four normally opened contacts. The contact terminals shall be brought out and terminated at Terminal Board irrespective of whether terminals are used or not.	Nos	1	1	1

7.	A set of Red and Green pigmy lamps for indicating opened and closed position of breaker.	Nos	-------	-------	1
8.	A set of self aligning horizontal/vertical isolation type auxiliary plug and sockets.	Nos	-------	-------	1
9.	Double core resin cast current transformer of required Accuracy.	Nos	3	3	-------
10.	3 phase resin cast, draw out type bus bar connected potential transformers of Ratio 11000/110 volts class 0.5 accuracy having minimum 50 VA output/phase to operate the A.C. static H.T. Tri-vector meter, voltmeter etc. and complete with HT fuse and LT MCB with monitoring contacts.	Nos	1	1.	
11.	Voltmeter round flush pattern digital static suitably scaled to suit the PT ratio.	Nos	1		---------
12.	3-Way and off voltmeter selector switch for reading the voltage between any two phases on the voltmeter.	Nos	1		---------
13.	Static digital Tri-vector energy meter suitable for three phase 3 wire un-balanced load and CT, PT, ratio mentioned above, 0.5 accuracy class with load, survey and TOD/Tariff and MRI facility. TVM shall be as specification attached with this specification.	Nos	1	1	----
14.	Protection relay(IED's)	Nos	1	1	---------
15.	Indicating lamps operating at 230V AC single phase one colored RED and other GREEN to show the closed or open position of circuit breaker.	Nos	1	1	
16.	80 watts continuously rated tubular/strip type heater with manual ON/OFF switch working on 230 VAC single phase supply	Nos	1	1	1
17.	Set of copper bus bars of not less than 800 Amp. Continuous rating.	Nos	1	1	1
18.	Multi way plug box for secondary wiring between the fix and moving glands.	Nos	1	1	
19.	Set of independently operated automatic shutters for bus bar cable and voltage transformers orifices, which shall be clearly levelled and	Nos	1	1	

	individually pad-locked.				
20.	Sheet instruments panel mounted on the front of the unit with hinged access doors and totally enclosed wiring terminals mounted there.	Nos	1	1	1
21.	Complete set of self contained inter connectors, foundation bolts, fine Wiring, wiring terminals board, sundries to complete the unit.	Nos	1	1	
22.	Ethernet Switch per Substation as required per S/s for all 11kv switchgear.	Lot	As per requirements		
23.	Modbus-IEC61850 protocol convertor.	Nos	1	1	

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4.15.2. ADDITIONAL FEATURE IN 600-300/ 1A INCOMERS FOR 10 MVA AND HIGHER TRANSFORMERS (Applicable in case of installing 10MVA or above transformer).

This switchgear shall be used with 10MVA, 33/11 KV Transformer having delta in primary and grounded star in secondary, conventionally differential protections is essential for the transformer. For 11 kV side 3 nos. CTs of 600-300 /1 A [Class PS and appropriate knee point voltage] and matching inter posing CTs (if required) shall be provided in this switchgear panel. The mounting inter connection and termination etc. for these additional devices/relays shall be covered in scope of supply.

4.15.3. CLARIFICATION

The total requirement of CTs for incomer of ratio 600-300/5A is as follows:

- 3 CTs one for each phase of ratio 600-300/5A to connect to 3 nos., O/C relays.
- 2 nos. CTs one on R phase and other on B phase of ratio 600-300/5A for metering.

The HT chambers [adopter chamber] will be gasketed to make it vermin proof. The gasket shall be as specified in Section-I(Introduction and general technical requirements).

NOTE Separate spring charging handle shall be provided and supplied with each set of the VCB.

4.16. ANNUNCIATION SYSTEM

Alarm annunciation system shall be provided in the control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltages specified in this specification i.e. 30 Volt DC for new substation or as existing DC supply system of the utility (This shall be verified by the successful bidder before submission of the drawing for approval).

Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 240 Volts AC supply. On failure of the DC to the annunciation system for more than 2 or 3 seconds. (adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the supply to annunciation system is restored.

A separate voltage check relay shall be provided to monitor the failure of supply (240V AC) to the scheme mentioned in Clause above. If the failure of supply exists for more than 2 to 3 seconds. this relay shall initiate visual and audible annunciation. This annunciation shall operate on Annunciation DC and buzzer shall sound.

4.17. TESTS

The design of circuit breaker shall be proven through all the routine and in accordance with IS 13118: 1991/IEC 56 and any amendment thereof. Photocopy of all the test reports must be enclosed with the tender. Type test report earlier than 7 year from the date of tender opening shall not be acceptable.

TYPE TESTS:

Each circuit breaker shall comply with requirements of type tests prescribed in IEC publication No.56.

i. Short time and peak withstand current test.

ii. Short circuit breaking capacity and making capacity.

iii. Capacitive current switching test: Cable charging current breaking test (Ur less than or equal to 52 kV).

iv. Dielectric test i.e., power frequency withstand and impulse withstand test
v. Temperature rise test.
vi. Mechanical Endurance Test at ambient temperature.
vii. Measurement of resistance of the main circuit.
viii. Internal arc test.

4.18. COMMISSIONING CHECKS/TESTS

After installation of panels, power and Control wiring and connect Contractor shall perform commissioning checks. as listed below to proper operation of switchgear/panels and correctness of all respects.

In addition the Contractor shall carry out all other checks and tests recommended by the manufacturers.

4.18.1. GENERAL

i) Check name plate details according to specification.

ii) Check for physical damage

iii) Check tightens of all bolts, clamps and connecting terminal

iv) Check earth connections.

v) Check cleanliness of insulators and bushings.

vi) Check heaters are provided.

vii) H.V. test on complete switchboard with CT & breaker/ contractor lubricated in position.

viii) Check all moving Parts are properly lubricated .

ix) Check for alignment of busbars with the insulators to ensure alignment and fitness of insulators.

x) Check for inter changeability of breakers.

xi) Check continuity and IR value of space heater.

xii) Check earth continuity of the complete switchgear board.

4.18.2. CIRCUIT BREAKER

i) Check alignment of trucks for free movement.

ii) Check correct operation of shutters.

iii) Check slow closing operation (if provided).

iv) Check control wiring for correctness of connections, continuity and IR values.

v) Manual operation of breakers completely assembled.

vi) Power closing/opening operation, manually and electrically at extreme condition of control supply voltage.

vii) Closing and tripping time.

viii) Trip free and anti-pumping operation.

ix) IR values, resistance and minimum pick up voltage of coils.

x) Simultaneous closing of all the three phases.

xi) Check electrical and mechanical inter locks provided.

xii) Checks on spring charging motor, correct operation of limit switches and time of charging.

xiii) Check vacuum (as applicable).

xiv) All functional checks.

4.18.3. Current Transformers

i) Megger between windings and winding terminals to body.

ii) Polarity tests.

c. Ratio identification checking of all ratios on all cores by primary injection of current.

d. Magnetization characteristics & secondary winding resistance.

iii) Spare CT cores, if any to be shorted and earthed.

4.18.4. VOLTAGE TRANSFORMERS

i) Insulation resistance

ii) Ratio test on all cores.

iii) Polarity test

iv) Line connections as per connection diagram.

4.18.5. CUBICLE WIRING

i) Check all switch developments.

ii) It should be ensured that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked.

iii) All the wires shall be meggered to earth.

iv) Functional checking of all control circuit e.g. closing, tripping, interlock, supervision and alarm circuit including proper functioning of component/ equipment .

v) Check terminations and connections. To check wiring related to CT and PT circuits, carryout primary injection and then check for secondary value at relay and metering instrument terminals.

vi) Wire ducting.

vii) Gap sealing and cable bunching.

4.18.6. RELAYS

i) Check internal wiring.

ii) Megger all terminal body.

iii) Megger AC to DC terminals

iv) Check operating characteristics by secondary injection.

v) Check minimum pick up voltage of DC coils.

vi) Check operation of electrical/ mechanical targets.

vii) Check CT connections with particular reference to their polarities for differential type relays.

viii) Relay settings.

4.18.7. METERS

i) Megger all insulated portion.

Check CT & VT connections with particular reference to their polarities for power type meter.