

# **Technical Specification**

**for**

- 1. 420 kV, 245 kV & 145 kV SF<sub>6</sub> Circuit Breaker**
- 2. 36 kV Vacuum Circuit Breaker**

**Revision 1**

**January 2023**

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## **IMPORTANT INSTRUCTION**

**(Please read the following instructions carefully before submitting your bid)**

1. All the drawings, i.e. dimension, elevation, side view, front view, plan, cross sectional view, isometric view, important component drawing etc., in PDF along with AutoCAD format and manuals (Technical/Installation/Operation) in PDF format, for offered item shall be submitted. The hard copies as per specification also shall be submitted. All above documents should be legible.
2. The acceptability of type test report submitted by any bidder/EPC agency shall be strictly in adherence to the broad guidelines mentioned in clause no 2 of "GUIDELINES FOR THE VALIDITY PERIOD OF TYPE TEST(S) CONDUCTED ON MAJOR ELECTRICAL EQUIPMENT IN POWER TRANSMISSION" published in May 2020.
3. The Bidder/ EPC agency shall have to submit all the required type test reports for the offered item along with the accessories. In case of submission of soft copy of type test report, high resolution colour scan of the original test report must be submitted. Scanned copy of Xerox of type test reports shall not be entertained. If required, the firm has to show the original type test report for the purpose of verification. In absence of this, the evaluation shall be carried out accordingly as non-submission of type test reports. The type test report of Circuit Breaker submitted by the manufacturer shall be considered valid if the date of type test does not exceed 10 years as on the last date of submission of bid; provided:
  - a. There is no major changes introduced in the basic design / technology /material /mechanical /construction /functionalities /performance characteristics/ manufacturing process of the equipment.
  - OR
  - b. Until the relevant IS/IEC / statutory guidelines is revised which warrants fresh type tests because of introduction of new type tests even though there is no change in material/basic design of the equipment.
4. The Bidder/ EPC agency must fill up all the point of GTP for offered item/s. Instead of indicating "refer drawing, or as per IS/IEC", the exact value/s must be filled in. All the points other than GTP, which are asked to confirm in technical specifications must be submitted separately with the bid.
5. The Bidder/ EPC agency is required to impart training in view of manufacture, assembly, erection, operation and maintenance for offered item, at his works, to the person/s identified by OPTCL, in the event of an order, free of cost. The cost of logistics will be borne as per the clauses of respective purchase orders/work orders.
6. The discrepancies between the specification and the catalogues or literature, submitted as part of the offer or with prevalent standards or government guidelines shall not be considered as valid deviations unless otherwise the same deviations related to TS is brought out separately by the Bidder/ EPC agency in the pre-bid queries or in form of clarification.
7. If any modifications felt necessary to improve performance, efficiency and utility of equipment, the same must be submitted along with pre bid queries which reasons duly supported by documentary evidences and such modifications not mentioned in pre bid queries will not be considered.
8. For purpose of Agreement, the firm shall provide warranty as specified in the purchase order / tender document. Notwithstanding the foregoing, Supplier agrees to waive the expiration of the Warranty Period in the event where in a pattern of defect/trend of failure is observed after the Warranty Period in a significant portion of the supplied

quantity, or any critical defect discovered which, in Purchaser's opinion, constitutes a threat of damage to property or to the health and safety of any person.

9. Warranty certificate for purchase of any material, whether directly procured by OPTCL or through EPC agency, shall be issued directly in favour of OPTCL.

E&Q OPTCL

## **SECTION 1:**

### **420/245/145 KV RATED SF6 CB & 36 KV RATED VCB: SCOPE, STANDARDS, TOPOGRAPHICAL AND METROLOGICAL CONDITIONS, AUXILIARY POWER SUPPLY**

#### **1. SCOPE:**

- 1.1. This specification provides for the design, manufacture, inspection and testing before dispatch, packing and delivery F.O.R. (destination) by road transport only and supervision of erection, testing and commissioning, of outdoor 420/245/145 kV SF<sub>6</sub> circuit breakers and 36 kV Vacuum Circuit Breakers along with structures, all the accessories and auxiliary equipment and mandatory spares, described herein, required for their satisfactory operation in various substations of the state.
- 1.2. The circuit breaker shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of offer and purchaser shall have the power to reject any work or material, which, in his judgment, is not in full accordance therewith.

#### **2. STANDARDS:**

- 2.1. Except as modified in this specification, the circuit breakers shall conform to the latest revisions with amendments thereof, of following standards

##### **2.2.**

IS/IEC 62271-1	<i>High-voltage switchgear and controlgear – Part 1: Common specifications</i>
IS/IEC 62271-100	<i>High-voltage switchgear and controlgear – Part 100: Alternating-current circuit-breakers</i>
IEC 62271-110	<i>High-voltage switchgear and controlgear - Part 110: Inductive load switching</i>
IS/IEC 62271-300	<i>High-Voltage switchgear and controlgear - Part 300: Seismic Qualification of Alternating Current Circuit-Breakers</i>
IS/IEC TR 62271-301	<i>High-voltage switchgear and controlgear – Part 301: Dimensional standardisation of high-voltage terminals</i>
IEC TR 62271-310	<i>High-voltage switchgear and controlgear - Part 310: Electrical endurance testing for circuit-breakers above a rated voltage of 52 kV</i>
IS 7572	<i>Guide for Testing Single-phase AC and Universal Motors</i>
IS 5578	<i>Guide For Marking Of Insulated Conductors</i>
IEC 62155	<i>Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V</i>
IS 11353	<i>Guide for Uniform System of Marking and Identification of Conductors and Apparatus Terminals</i>
IS/IEC 60137	<i>Bushings for alternating voltages above 1 000 Volts</i>
IS/IEC 60947	<i>Low-voltage switchgear and controlgear</i>
IS 802	<i>Structural Steel in Overhead Transmission Line Towers</i>
IS 2629	<i>Recommended Practice for Hot-Dip Galvanizing of Iron and Steel</i>
IS 13072/ IEC 60376	<i>Specification of Technical Grade Sulphur Hexafluoride SF<sub>6</sub> for Use in Electrical Equipment purposes</i>
IS 4379	<i>Identification of the Contents of Industrial Gas Cylinders</i>
IS 1893	<i>Criteria for Earthquake Resistant Design of Structures</i>

- 2.3. Equipment meeting with the requirements of any other authoritative standards, which ensures equal or better quality than the standard mentioned above shall also be acceptable. If the equipment offered by the Bidder/ EPC agency conforms to other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. Two copies

of such standards with authentic English Translations shall be furnished along with the offer.

### 3. TOPOGRAPHICAL AND METROLOGICAL CONDITIONS:

Location	State of Odisha
Altitude	1000 m
Air Temperature	
Minimum	0 °C
Maximum	50 °C
Maximum Daily Average	35 °C
Maximum Humidity	99 %
Pollution Level	Heavy/Very Heavy
Airborne Contamination	Highly Polluted
Isoceraunic Level	70 day/annum
Average no. of dust storm days per annum	20 day/annum
Seismic withstand level	0.3 g
Wind velocity	55 m/s (Wind zone VI)
Average Annual Rain Fall	150 cm
Special Environmental Conditions	<ol style="list-style-type: none"> <li>1. In coastal areas of the state presence of salinity in air and exposure to moisture</li> <li>2. In industrial belts of the state excessive dust in air</li> </ol>

### 4. AUXILIARY POWER SUPPLY:

#### 4.1.

Type	Details	Purpose	Tolerance
Auxiliary AC	415 V, 50 Hz, 3Ø, 4 wire, neutral earthed	Lighting, Heater & Spring Charge Motor	Voltage $\pm 10\%$ , frequency $\pm 5\%$
DC Supply	220 V 2 wire DC	Protection, Control, Indication, Coil & Spring Charge Motor (During AC fail)	Voltage -15% +10%

4.2. Each of the foregoing supplies shall be made available by the Purchaser at the terminal point for each circuit breaker for operation of accessories and auxiliary equipment. Supplier's scope include supply of interconnecting cables (limb-limb, limb-control cabinet, internal wirings etc.), terminal boxes etc. The above supply voltage may vary as above and all devices shall be suitable for continuous operation over entire range of voltages & frequencies.

## **SECTION 2 :**

### **420/245/145 KV RATED SF<sub>6</sub> CIRCUIT BREAKERS: TECHNICAL DETAILS**

#### **1. GENERAL TECHNICAL REQUIREMENTS:**

- 1.1. The 420/245/145 kV circuit breakers offered shall be sulfur hexafluoride (SF<sub>6</sub>) type only. **Circuit breakers shall be of live tank design.**
- 1.2. Any part of the breaker, especially the removable ones, shall be freely interchangeable without the necessity of any modification at site.
- 1.3. Circuit breaker shall comprise of three identical single-pole units. For 420 /245 kV CB If the circuit breaker is not meant for single pole reclosure, these units shall be linked together electrically. Complete circuit breaker with all the necessary items for successful operation shall be supplied, including but not limited to the following:
  - 1.3.1. The circuit breaker shall be complete with operating mechanism, common control cabinet with foundation bolts, piping, inter-pole cables, internal cables, control cabinet – pole cables, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanized support structure with foundation bolts, platform with ladder for CB with foundation bolts (except concrete foundations) and all other accessories required for carrying out all the functions of the CB. All necessary parts to provide a complete and operable circuit breaker installation such as terminal pads, control parts and other devices shall be provided.
  - 1.3.2. Compressed SF<sub>6</sub> gas, spring-spring operated systems in complete shape including piping, fittings, valves and controls and etc.
  - 1.3.3. One central control cabinet for each breaker and one control box for each pole with all the required electrical devices mounted therein and the necessary terminal blocks for termination of interpole wiring. The necessary interpole cabling at site shall be done by the Purchaser based on the schematic, wiring diagram and termination schedule to be supplied by the Supplier.
  - 1.3.4. Instruments, pressure gauges and other devices like gas density monitor, temp. monitor & etc. for SF<sub>6</sub> gas pressure supervision.
  - 1.3.5. All necessary parts to provide a complete and operable circuit breaker installation such as main equipment, terminal, control parts, connectors and other devices, whether specifically called for herein or not.
- 1.4. The circuit breaker shall be designed for high speed single and three pole reclosing with and operating sequence and timing as specified in this specification.
- 1.5. The support structure of circuit breaker shall be hot dip galvanized. The minimum weight of zinc coating shall be 610 gram/sqm and minimum thickness of coating shall be 86 microns for all items. The control cabinet/mechanism box shall be stainless steel/aluminum alloy of minimum 2 mm / 3 mm thickness respectively.
- 1.6. Circuit breaker shall be suitable for hot line washing.
- 1.7. **All breakers shall be supplied with terminal connectors. The exact requirement of terminal connectors would be intimated to the supplier during detailed engineering (during drawing approval).**
- 1.8. CB Terminal pads shall have silver plating of at least 50 microns thickness. CB terminals shall be Eight hole HV terminal (2 × 4 hole pattern) as per IEC/TR 62271-301.

## 2. CONTACTS:

- 2.1. All making and breaking contacts shall be sealed free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacements due to excessive burning will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.
- 2.2. Main contacts shall be first to open and the last to close so that there will be little contact burning and wear. If arcing contacts are used, they shall be first to close and the last to open. Tips of arcing contacts and main contacts shall be as per the type tested design.
- 2.3. Any device provided for voltage grading to damp oscillations or to prevent restrike prior to the complete interruption of the circuit or to limit over voltages on closing shall have a life expectancy comparable to that of the breaker as a whole.
- 2.4. Contacts shall be kept permanently under pressure of SF<sub>6</sub> gas. The gap between the open contacts shall be such that it can withstand at least the rated phase to ground voltage continuously at zero-gauge pressure of SF<sub>6</sub> gas due to its leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lock out pressure continuously.
- 2.5. If multi-break interrupters are used these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/test reports in support of the same shall be furnished. The thermal and voltage withstands of the grading elements shall be adequate for the service conditions and duty specified.

## 3. PORCELAIN HOUSING:

- 3.1. The porcelains used shall be homogenous and free from cavities and other flaws. They shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above.
- 3.2. The porcelain housing shall be of single-piece construction without any joint or coupling. It shall be made of homogeneous, vitreous porcelain of high mechanical and dielectric strength. Glazing of porcelain shall be uniform brown or dark brown color with a smooth surface arranged to shed away rainwater or condensed water particles (fog). The type and profile of the porcelain insulator sheds shall be in accordance with IEC 60815 & IEC 62155.
- 3.3. The puncture strength of the bushings shall be greater than the flashover value.
- 3.4. The mechanical characteristics of insulators shall match with the requirements specified in this specification.
- 3.5. **The specific creepage distance of insulators shall be 25 mm/kV in general unless specifically called for 31mm/kV in the tender.**

## 4. ADDITIONAL REQUIREMENTS:

- 4.1. The circuit breakers shall be single pressure type, the design and construction of the circuit breaker shall be such that there is minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF<sub>6</sub> gas on the internal insulating surface of the circuit breaker.
- 4.2. **All sealing surfaces shall be smooth, straight, and reinforced, if necessary to minimize distortion and to make a tight seal. The operating rod connecting the operating mechanism to the arc chamber (SF<sub>6</sub> media) shall have adequate seals, Double –O—ring seals and test holes for leakage test of the internal seal shall be provided on each static joint. The O ring sealing shall have compression set of < 15% in adherence to ASTM D395-16. O rings shall be housed in CNC machined O ring groove.**



- 4.3. In the interrupter assembly, there shall be an absorbing product box to eliminate SF<sub>6</sub> decomposition products and moisture. The material used in the construction of the circuit breakers shall be fully compatible with SF<sub>6</sub> gas decomposition products.
- 4.4. Each pole shall form an enclosure filled with SF<sub>6</sub> gas independent of two other poles (for 420/245 kV CB). The SF<sub>6</sub> density of each pole shall be monitored and regulated by individual pressure switches for 420/245 kV CB. For 145 kV CB pressure switches shall be common for all 3 poles.
- 4.5. The SF<sub>6</sub> gas density monitor shall be adequately temperature compensated to model the pressure changes due to variations in ambient temperature within the body of circuit breaker. The density monitor shall meet the following requirements:
  - 4.5.1. It shall be possible to dismantle the density monitor for checking/replacement without draining the SF<sub>6</sub> gas or de-energizing the primary equipment by using suitable interlocked non-return couplings.
  - 4.5.2. It shall damp the pressure pulsation while filling the gas in service so that the flickering of the pressure switch contacts does not take place.
  - 4.5.3. A pressure indicator (pressure gauge) shall also be provided.
- 4.6. Facility shall also be provided to reduce the gas pressure within the breaker to a value not exceeding 8 millibars within 4 hours or less. Each circuit breaker shall be capable of withstanding this degree of vacuum without distortion or failure of any part.
- 4.7. Sufficient SF<sub>6</sub> gas shall be provided to fill all the circuit breakers installed. **In addition to this 20% of the total gas requirement per circuit breaker (3 limbs) shall be supplied in separate cylinders as spare requirement.**
- 4.8. Provisions shall be made for attaching an operation analyzer after installation at site to record contact travel speed, making measurement of operation timings, contact resistance and synchronization of contacts.
- 4.9. **The SF<sub>6</sub> gas leakage should not exceed 0.5% per year and the leakage rate shall be guaranteed during the warrantee period. In case the leakage under the specified conditions is found to be greater than 0.5% per year after commissioning of circuit breaker during the warrantee period, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during the warrantee period.**
5. **SULPHUR HEXAFLUORIDE GAS:**
  - 5.1. The SF<sub>6</sub> gas shall comply with IS 13072/ IEC 60376.
  - 5.2. The high pressure cylinders in which the SF<sub>6</sub> gas is shipped and stored at site shall comply with requirements of the following standards and regulations:
    - 5.2.1. IS:4379 Identification of the contents of industrial gas cylinders.
    - 5.2.2. Gas cylinders as per relevant Indian Standard.
    - 5.2.3. The cylinders shall also meet Indian Boiler regulations.
  - 5.3. **Test:** SF<sub>6</sub> gas shall be tested for purity, dew point, break down voltage, water contents, and decomposition products as per IS 13072/ IEC 60376 and test certificates shall be furnished to OPTCL for each lot of SF<sub>6</sub> cylinders provided with CB.
  - 5.4. OPTCL may ask for random re-testing of SF<sub>6</sub> to cross check quality of gas provided.
  - 5.5. The SF<sub>6</sub> gas leakage should not exceed 0.5% per year and the leakage rate shall be guaranteed during the warrantee period.
  - 5.6. SF<sub>6</sub> gas shall be supplied (in returnable cylinders) for all circuit breakers. However, SF<sub>6</sub> gas for spare circuit breakers and mandatory spare quantity of SF<sub>6</sub> gas shall be supplied in nonreturnable cylinders.
6. **DUTY REQUIREMENTS:**

- 6.1. The circuit breaker shall be totally restrike free under all duty conditions. Opening resistors shall not be used.
- 6.2. The circuit breaker shall meet the duty requirements for any type of fault or fault location, for line charging and dropping when used on an effectively grounded system and perform make and break operations as per stipulated duty cycles, satisfactorily.
- 6.3. It shall withstand the maximum expected dynamic loads (including the seismic) to which the circuit breaker may be subjected during its service life.
- 6.4. The circuit breaker shall be capable of:
- 6.4.1. Interrupting the steady and transient magnetizing current corresponding to Power transformers as follows:

CB Rating	Transformer Ratio	Transformer Rating
420kV	400/220	Upto 500 MVA
245 kV	400/220	Upto 500 MVA
	220/132	Upto 160 MVA
	220/33	Upto 63 MVA
145 kV	220/132	Upto 160 MVA
	132/33 kV	Upto 63 MVA

- 6.4.2. Interrupting line/cable charging current as per IEC without use of opening resistors. The breaker shall be able to interrupt the rated line charging current as per IEC-62271-100 with test voltage immediately before opening equal to the product of  $\frac{U_m}{\sqrt{3}}$  and 1.4.
- 6.4.3. Clearing short line fault (kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
- 6.4.4. Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.
- 6.4.5. Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. shall be designed for 2 p.u. across the breaker continuously, for validation of which a power frequency withstand test conducted for a duration of at least 15 minutes is acceptable).
- 6.4.6. Circuit breakers shall be able to switch in and out the 420 kV shunt reactor of rating 50 to 100 MVAR with max rise of over voltage of 2.3 p.u as per IEC-62271-110.
- 6.5. The critical current, which gives the longest arc duration at lockout pressure of extinguishing medium and the arc duration shall be indicated.
- 6.6. The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges.
- 6.7. The breaker shall also withstand the short time power frequency, impulse and switching voltages specified in **clause 23 Technical Requirements** of this specification.

## 7. TOTAL BREAK TIME:

- 7.1. The "Total Break Time" as specified in **clause 23 Technical Requirements** of this section shall not be exceeded under any of the following duties:
- Test duties T10, T30, T60, T100a, and T100s (with TRV as per IEC-62271-100).
  - Short line fault L90, L75 (with TRV as per IEC-62271-100).
- 7.2. The bidder/ EPC agency may please note that there is only one specified break time of the breaker which shall not be exceeded under any duty conditions specified such

as with the combined variation of the trip coil voltage, (70-110%) spring-spring operation and arc extinguishing medium pressure etc. while furnishing the proof for the total break time of complete circuit breaker, the bidder/ EPC agency may specifically bring out the effect of non-simultaneity between contacts within a pole or between poles and show how it is covered in the guaranteed total break time.

7.3. The break time discrepancy between poles shall be  $\leq 3$  ms.

7.4. The make time discrepancy between poles shall be  $\leq 5$  ms.

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

## **8. OPERATING MECHANISM AND ASSOCIATED EQUIPMENT:**

8.1. The circuit breaker shall be designed for electrical local as well as remote control. In addition there shall be provision for local mechanical control (emergency trip).

8.2. SPRING OPERATED MECHANISM: The operating mechanism for 420 kV/245 kV / 145 kV class breakers shall be of spring-spring type only operated by electrical/mechanical control. The mechanism shall be adequately designed for the specified tripping and re closing duty. The entire operating mechanism control circuitry etc as required, shall be housed in an outdoor type, Aluminum alloy (minimum 3mm thickness)/Stainless Steel (minimum 2 mm thickness) enclosure. This enclosure shall conform to the degree of protection IP - 55 of IS - 2147.

8.3. The common enclosure shall be mounted on a separate concrete plinth for 420/245 kV CB. Driving mechanism box for individual poles to be mounted on CB structure for 420/245 kV CB. The common enclosure may be mounted on the structure for 145 kV CB.

8.4. All working parts in the mechanism shall be of corrosion-resistant material. All bearings which require greasing, shall be equipped with pressure grease fittings.

8.5. The design of the operating mechanism shall be such that it shall be practically maintenance-free. The guaranteed years of maintenance-free operation, the number of full load and full rated short circuit current breaking/operation without requiring any maintenance or overhauling shall be clearly stated in the bid. As far as possible the need for lubricating the operating mechanism shall be kept to the minimum and eliminated altogether if possible.

8.6. The operating mechanism shall be non-pumping and trip-free electrically and mechanically under every method of closing. There shall be no rebounds in the mechanism and it shall not require any critical adjustments at site. Operation of the power-operated closing device, when the circuit breaker is already closed, shall not cause damage to the circuit breaker or endanger the operator, provision shall be made for attaching an operation analyzer to facilitate testing of breaker at site.

8.7. A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.

8.8. **Potential free contacts shall be provided in the operation counter for integration of status in SAS if swipe contacts are not provided in CB auxiliary switch.**

8.9. **Four (4) nos spare contacts shall be provided in LR and TNC switch for (2 nos for each operation) for future use.**

8.10. **2 NO + 2 NC spare contacts shall be provided in the spring charge limit switch for future use.**

8.11. **Two (2) nos add-on contacts (2 NC) shall be provided in each DC & AC supply MCB for use in SAS. (For AC & DC supply supervision.)**

8.12. The supplier shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.

8.13. The Breaker shall have spare auxiliary switches for owners use (i.e, for Interlocking, indication, contacts to main and back up relay etc). A minimum of 20 N/O (52a) & 20 N/C (52b) spare auxiliary switch contacts should be provided.

## **9. CONTROL:**

9.1. The close and trip circuits shall be designed to permit use of momentary contact switches using pistol grip type.

9.2. Each breaker pole shall be provided with two (2) independent tripping circuits, pressure switches and coils each connected to a different set of protective relays, fed from separate DC sources.

9.3. The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and non-lockable pistol grip TNC switch shall be provided in the breaker central control cabinet (supplier's scope). Remotely located LR switch and TNC switch and indicating lamps shall be provided in the C/R panel (purchaser's scope).

9.4. The trip coils shall be suitable for trip circuit supervision. The trip circuit supervision relay would be provided in the CR panel. Necessary terminals shall be provided in the central control cabinet of the circuit breaker by the supplier.

9.5. Closing coil shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip shall operate correctly under all operating conditions of the circuit breaker up to the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of the rated voltage. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on outdoor circuit breakers shall be clearly brought out in the additional information schedules. In the absence of adequate details the offer is likely to be rejected.

9.6. The pressure switches used for interlock purposes shall have adequate contact ratings to be directly used in the closing and tripping circuits.

9.7. Spring charge handle shall be easily operated by one man standing on the ground and direction of motion of handle shall be clearly marked.

9.8. The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

9.9. The devices shall provide continuous & automatic monitoring of the state of the gas as follows:

- a. **'SF6 gas density Low' Alarm level – 1:** This contact will be used for remote indication/ to annunciate the need for the gas refilling.
- b. **'SF6 gas density Low' Alarm level – 2:** This contact will be used to annunciate the need for gas refilling under emergency. **Provision for tripping the circuit breaker at this level shall be available in the control circuit for tripping the CB, which may be implemented if required by OPTCL.**

- c. **'Lockout' level:** This is the minimum gas density at which the manufacturer will guarantee the rated fault interrupting capability of the breaker. At this level the breaker block contact shall operate & the tripping & closing circuit shall be blocked.
- 9.10. The density monitor shall be placed suitably inclined in such a way so that the readings are visible from ground level or from platform level. Separate contacts have to be used for each of tripping and closing circuits. Contacts shall be suitably rated.
- 9.11. Density monitors are to be so mounted that the contacts do not change on vibration during operation of circuit Breaker.

#### **10. MOTOR COMPRESSED SPRING CHARGING MECHANISM:**

- 10.1. Spring operated mechanism shall be complete with motor, opening spring, closing spring, limit switches and all other necessary accessories to make the mechanism a complete unit.
- 10.2. Breaker operation shall be independent of motor which shall be used solely for the purpose of charging the closing spring. Motor rating shall be such that it requires only 15 seconds for fully charging the closing spring.
- 10.3. Closing operation shall compress the opening spring and keep ready for tripping.
- 10.4. The mechanism shall be provided with means for charging the spring by hand. This operation shall be carried out with the doors of the cubicle open. During the process no electrical or mechanical operation of the mechanism shall endanger the operator or damage the equipment.
- 10.5. A mechanical indicating device shall be provided to indicate the state of the charge spring and shall be visible with the door of the cubicle closed.
- 10.6. An alarm shall be provided for spring failing to be charged within a pre-set time after circuit breaker closing.
- 10.7. Opening spring and closing spring with limit switches for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.
- 10.8. As long as power is available to the motor, a continuous sequence of the closing and opening operations shall be possible. The motor shall have adequate thermal rating for this duty.
- 10.9. After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.
- 10.10. Closing action of the breaker shall compress the opening spring ready for tripping.
- 10.11. When closing spring are discharged after closing a breaker, closing spring shall automatically get charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.
- 10.12. The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated-making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.
- 10.13. Provision shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition. Mechanical interlocking shall be provided in the operating mechanism to prevent discharging of closing spring when the breaker is already in the closed position.

#### **11. OPERATING/DRIVING MECHANISM HOUSING:**

The operating mechanism housing shall conform to the requirement specified in **clause 21**. This enclosure shall conform to the degree of protection IP - 55 of IS - 2147.

#### **12. INTERLOCKS:**

It is proposed to electrically interlock the circuit breaker with purchaser's associated air break disconnectors in accordance with switchyard safety interlocking scheme. The details of the scheme will be furnished to the supplier. All accessories required on breaker side for satisfactory operation of the scheme shall be deemed to be included in the scope of supply of this specification.

#### **13. SUPPORT STRUCTURE:**

The circuit breakers shall be suitable for mounting on steel galvanized structures. The prices of these support structure shall be included in the price of the equipment and same shall be indicated clearly in the bid proposal sheet.

However, purchaser reserves the right to procure these from the supplier or through separate contract.

The steel support structure shall be designed with factor of safety of 2.5 based on elastic limit of tension members and on crippling load of compression members.

The steel support structure shall be designed with **factor of safety of 2.5** based on elastic limit of tension members and on crippling load of compression members.

The support structure design shall be so that it shall meet the Minimum statutory safety clearances as per clause 24 Technical Requirements, IE rules and relevant IS/IEC.

#### **14. PLATFORM & LADDER:**

14.1. A suitable ladder with the safety cage and a free standing maintenance platform with railing for each pole of the circuit breaker shall be supplied along with the equipment and its support structure. The platform shall be suitable for 2 nos maintenance personnel to stand and carryout the activities along with the tools and plant.

14.2. The ladder cum maintenance platform shall be designed as a free standing structure without taking any support from the main circuit breaker structure. The ladder having height more than 3.0m shall have at least 15 degree slope and is to be provided with safety guard above 2.0m level. The steps in ladder shall start from ground level and shall not be more than 1 feet apart from each other.

14.3. All structural steel for the platform shall be as per IS: 2062. The ladder shall be hot dip galvanized with zinc coating thickness of 86 micron and weight of 610 gram/sqm.

14.4. The ladder should be such that the driving mechanism of all 3 poles are accessible from both front and back sides, if required for CB maintenance.

14.5. The ladder shall be provided with suitable foundation bolts similar to the structure. OPTCL shall make its own concrete foundation for mounting the ladders on the concrete foundations.

14.6. Plan of foundation details with center-center distance of bolts, distance between various concrete plinths including circuit breaker support structure plinth shall be provided by the OEM.

14.7. For 145 kV circuit breakers, ladders are not to be provided by the OEM. OPTCL shall make its own concrete/brick masonry step & platform for accessing the mechanism box. The recommended height of the concrete platform for carrying out maintenance shall be specified in the GA drawing by the OEM.

14.8. The structural details shall be finalized during detail engineering.

**15. FITTINGS AND ACCESSORIES:**

- 15.1. The central control cabinet shall be complete with but not limited to cable glands, LR changeover switch, TNC switch, operation counter, indication lamps, MCBs (fuses not allowed), terminal blocks with 20% spare for OPTCL use, anti-pumping relay, rating plate, internal wiring, external locking arrangement, indication lamps (SF<sub>6</sub> pressure gauges, coils & operating mechanism in case of 145 kV CB). Number and exact locations of these parts shall be indicated in the bid.
- 15.2. All the terminal blocks to be used in the operating mechanism and control cubicle should be of stud type of Melamine material of Elmex/Connectwell make for 2.5 sqmm cable or higher.
- 15.3. Rating and diagram plate in accordance with IEC / IS incorporating year of manufacture.

**16. PAINTING, GALVANISING AND CLIMATE PROOFING:**

- 16.1. Ferrous parts such as support channels, structures, ladders, all sizes of nuts, bolts, foundation bolts shall be hot dip galvanized conforming to latest version of IS 2629. For HDG galvanization thickness shall be 86 micron and weight of zinc coating 610 gram/sqm. Spring washers shall be electro galvanized.
- 16.2. All other parts shall be painted.
- 16.3. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. All steel surfaces shall be cleaned with sand blasting, given a coat of primer and finished with two coats of synthetic enamel paints.
- 16.4. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling. All external paintings shall be as per shade no. 697 of IS:5.
- 16.5. Metal parts not accessible for painting shall be made of corrosion resisting material.
- 16.6. Paint inside the metallic housing shall be of anti-condensation type and the paint on outside surfaces shall be suitable for outdoor installation.

**17. EARTHING:**

The operating mechanism housing, control cabinets, support structure etc. shall be provided with two separate earthing terminals suitable for bolted connection to 50X6 mm<sup>2</sup> mild steel flat to be provided by the purchaser for connection to station earth mat.

**18. NAME AND RATING PLATES:**

Circuit breaker and its operating device shall be provided with rating plates marked with the data as mentioned in Annexure I and as per IS/IEC 62271-100. The rating plate shall be visible in position of normal service and installation. The rating plate shall be made of stainless steel with text engraved on it in black color.

**19. LIMITS OF TEMPERATURE RISE:**

The temperature rise of any part of the circuit breaker at an ambient air temperature not exceeding 40 °C shall not exceed the temperature-rise limits specified in latest editions and amendments of IEC 62271-1 and IEC 62271-100. If the maximum ambient temperature rises from above mentioned value (of 40 °C), permissible values shall be reduced accordingly.

**20. TERMINAL CONNECTORS:**

The terminal connectors shall meet the following requirements:

- 20.1. Terminal connectors design should be type tested and manufactured as per IS: 5561.

- 20.2. Terminal connectors shall be meant for take-off by Twin Moose/Moose/Zebra/IPS aluminum tube. **Both the pad portion and conductor holding portion shall be six (6) bolted type.**
- 20.3. **The nuts and bolts shall be stainless steel type.**
- 20.4. All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- 20.5. No part of a clamp shall be less than 10 mm thick.
- 20.6. All ferrous parts shall be hot dip galvanized.
- 20.7. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminum body.
- 20.8. Flexible connectors shall be made from tinned copper.
- 20.9. All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 20.10. Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561.

## **21. CONTROL CABINETS:**

- 21.1. The common control cabinet enclosure shall be mounted on a separate concrete plinth for 420/245 kV CB. Mechanism box for individual poles to be mounted on CB structure for 420/245 kV CB.
- 21.2. The common enclosure may be mounted on the structure for 145 kV CB.
- 21.3. Control cabinet of the operating mechanism shall be made out of Aluminum alloy sheet (minimum 3 mm thickness)/Stainless steel (minimum 2 mm thickness). The gland plates shall be made of same material as the control cabinet and its sheet thickness shall be 1 mm more than the control cabinet. The operating mechanism shall be strong, rigid & not subject to rebound. Hinged door shall be provided with lock and key arrangement. The door shall have door handle for opening and closing. Sloping rain hood shall be provided to cover all sides. 15 mm thick neoprene or better type of gaskets shall be provided to ensure degree of protection of at least IP55 as per IS: 2147.
- 21.4. The motors used in the supplied circuit breakers shall be the same as the type-tested CB design in extended mechanical endurance test on class M2 circuit-breakers. The motors for the three individual poles shall be taken from 3 separate phases of the 415 V, 3 phase 50 Hz LVAC system.
- 21.5. MCBs shall be group operated units (3 pole for use on 3-phase supply systems and 2 pole for single phase supply systems) quick make quick break type. All MCBs shall be C curve type. No fuses shall be used in the control cabinet, only MCBs shall be used.
- 21.6. No Push buttons shall be used in the cabinet, only pistol grip type switches shall be used. Red, Green and Amber LED indicating lamps shall be flush mounted.
- 21.7. Single phasing preventer relay shall be provided for 3 phase motors to provide positive protection against single phasing.
- 21.8. Purchaser's power cables will be of 1100 volts grade stranded aluminum conductor, XLPE/PVC insulated, PVC sheathed, steel round wire/strip armored and PVC jacketed. Purchasers control cables shall be 1100 volts grade stranded copper conductor, PVC insulated, PVC sheathed, steel wire/strip armored/non armored



and PVC jacketed. Necessary termination arrangement in control cabinet shall be made keep this in view.

- 21.9. All necessary cable terminating accessories such as intra panel/internal cables, inter limb cables, control cubicle to limb cables, glands, crimp type tinned copper lugs etc. for power as well as control cables shall be included in supplier's scope of supply. Suitable brass/stainless steel cable glands shall be provided for cable entry.
- 21.10. All cables for inter-limb wiring and wiring from cubicle to the limbs which are external to the control cubicles shall be armored type.
- 21.11. Wiring for all control circuits shall be carried out with 1100 volts grade PVC insulated tinned copper stranded conductors of sizes not smaller than 2.5 sq. mm.
- 21.12. Wiring for all LV power circuits shall be carried out with 1100 volts grade XLPE insulated tinned copper stranded conductors of appropriate sizes as per IS 3961. At least 20% spare terminal blocks for control wire terminations shall be provided on each panel. The terminal blocks shall be of non-disconnecting stud type. All terminals shall be provided with ferrules indelibly marked or numbered and these identifications shall correspond to the designations on the relevant wiring diagrams. The terminals shall be rated for adequate capacity which shall not be less than 10 Amps.
- 21.13. Separate terminal blocks shall be provided for terminating circuits of AC & DC.
- 21.14. Control cabinet shall be provided with 240 V, 1-phase 50 Hz, 20 W LED light fixture and a suitably rated 240 V, 1-phase, 5 amps, 3 pin socket for hand lamps.
- 21.15. Strip heaters shall be provided inside each cabinet complete with thermostat (preferably differential type) to prevent moisture condensation. Heaters shall be controlled by suitably rated double pole miniature Circuit Breakers.
- 21.16. **Care should be taken in placement of the heaters so that it shall not come into contact the internal wires or external wires which enter into the control cubicle.**
- 21.17. **The terminal blocks shall be so placed that the clearance from bottom of cabinet shall be minimum 100 mm and clearance from side walls and top wall of cabinet shall be 50 mm minimum, for ease of working during maintenance.**
- 21.18. Items inside the cabinet made of material shall be coated with a fungus resistant varnish.

## **22. MOTORS:**

Motors shall be **universal type** suitable for operation in AC & DC supply of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment. The motors used in the supplied design should be same as the type tested CB design.

## 23. Technical Requirements for SF6 Circuit Breaker:

The CB shall be in accordance with requirements specified hereunder.

SI No	Description	400 kV	220 kV	132 kV
<b>1.0</b>	<b>System Particulars</b>			
1.1	Nominal Voltage of System ( $U_n$ )	400 kV	220 kV	132 kV
1.2	Highest System Voltage	420 kV	245 kV	145 kV
1.3	Frequency	50 Hz		
1.4	Number of Phases	3		
1.5	Neutral Earthing	Solid Ground/Effectively Earthed		
1.6	Phase-to-phase spacing in switchyard	7000 mm	4500 mm	2700 mm
1.7	Height of the concrete plinth (to be provided by OPTCL)	Above Switchyard Gravel Level 200 mm Above Finished Ground Level 300 mm		
<b>2.0</b>	<b>Minimum Statutory Safety Clearances</b> (IEC 61936-1/IS 10118-3/ IE Rules)			
2.1	Minimum phase-to-phase clearance	4.2 m	2.1 m	1.3 m
2.2	Minimum phase-to-earth clearance	3.4 m	2.4 m	1.3 m
2.3	Minimum ground clearance of live part	8 m	5.5 m	4.8 m
2.4	Minimum safety working clearance	6.4 m	5 m	4 m
2.5	Minimum height to base of insulator (IE Rules 1956)	2.44 m	2.44 m	2.44 m
<b>3.0</b>	<b>Characteristics of CB</b>			
3.1	Rated Voltage $U_r$	420 kV	245 kV	145 kV
3.2	Type	SF <sub>6</sub> for AIS substation		
3.3	Number of poles	3		
3.4	Class: indoor or outdoor	Outdoor		
3.5	Type of Housing and support insulator	Brown Porcelain		
3.6	Mounting	HDG lattice/pipe steel support structure to be supplied by the CB manufacturer		
3.7	Type of Operation	Individually Operated Single Poles	Individually Operated Single Poles	Gang Operated
3.8	Operating Mechanism	Spring-Spring		
3.9	Mechanism Enclosure/Control Cubicle	Stainless Steel (2 mm thick)/Aluminum Alloy (3 mm thick).		

		Gland Plate same material as cubicle with 1 mm higher thickness.		
3.10	Auto reclosing duty	Single & Three phase		3 phase
3.11	Inter-pole Spacing of CB	As per switchyard phase-to-phase spacing.		As per the type-tested design, with due regard to the minimum statutory phase-to-phase clearance requirement.
3.12	Rated Insulation Level			
3.12.1	1 minute Power Frequency withstand Voltage ( $U_d$ )			
3.12.1.1	phase-earth (Type Test & Routine Test )	520 kV <sub>rms</sub>	460 kV <sub>rms</sub>	275 kV <sub>rms</sub>
3.12.1.2	phase-phase (Type Test & Routine Test )	520 kV <sub>rms</sub>	460 kV <sub>rms</sub>	275 kV <sub>rms</sub>
3.12.1.3	across open breaker contacts	Type Test : 610 kV <sub>rms</sub> Routine Test: 520 kV <sub>rms</sub>	460 kV <sub>rms</sub>	275 kV <sub>rms</sub>
3.12.2	Rated (1.2/50 $\mu$ s) Lightning Impulse Withstand Voltage ( $U_p$ )			
3.12.2.1	phase-earth & phase-phase	1425 kV <sub>p</sub>	1050 kV <sub>p</sub>	650 kV <sub>p</sub>
3.12.2.2	across open breaker contacts	COMBINED VOLTAGE : 1. One Terminal - 1425 kV <sub>p</sub> 2. Opposite Terminal - pf voltage with peak value of 240 kV	1050 kV <sub>p</sub>	650 kV <sub>p</sub>
3.12.3	Rated (250/2500 $\mu$ s) Switching Impulse Withstand Voltage ( $U_s$ )			
3.12.3.1	phase-earth & across open breaker contacts	1050 kV <sub>p</sub>	NA	NA
3.12.3.2	phase-phase	1575 kV <sub>p</sub>	NA	NA
3.13	Rated Frequency	50 Hz		
3.14	Rated Normal (Continuous) Current ( $I_r$ )	3150 A	3150 A	3150 A

3.15	Rated Short Circuit Breaking Current ( $I_{sc}$ )			
3.15.1	Symmetrical AC Component ( $kA_{rms}$ )	63 $kA_{rms}$	50 $kA_{rms}$	40 $kA_{rms}$
3.15.2	DC Component	50 %/As per IEC 62271-100		
3.16	Temperature rise of parts, materials and dielectrics over an ambient temperature of 40 °C	As per IEC 62271-1 and 62271-100		
3.17	Rated Short Time Withstand Current ( $I_k$ )	63 $kA_{rms}$	50 $kA_{rms}$	40 $kA_{rms}$
3.18	Rated duration of short circuit( $t_k$ )	3 sec		
3.19	Rated Peak Withstand Current ( $I_p$ )	157.5 $kA_p$	125 $kA_p$	100 $kA_p$
3.20	Rated Short-circuit making current	157.5 $kA_p$	125 $kA_p$	100 $kA_p$
3.21	Out of phase breaking current capability kA	15.75 $kA_{rms}$	12.5 $kA_{rms}$	10 $kA_{rms}$
3.22	Out of phase making current capability kA	157.5 $kA_p$	125 $kA_p$	100 $kA_p$
3.23	Rated Capacitive Switching Currents	400 $A_{rms}$	250 $A_{rms}$	160 $A_{rms}$
3.24	Small inductive current (A) rms	100 without switching o/v exceeding 2.3 p.u. /(As per IEC 62271-110)		
3.25	Rated first-pole-to-clear factor	1.3	1.3	1.5
3.26	Rated operating sequence/Duty cycle	O - 0.3s – CO – 3 min - CO		
3.27	Type of tripping	Trip Free		
3.28	Rated Break-time (Max)	≤ 40 ms	≤ 60 ms	≤ 60 ms
3.29	Total Closing Time	≤ 100 ms	≤ 100 ms	≤ 100 ms
3.30	Time Discrepancy between poles (@Rated Control Voltage, Rated Operating Duty & SF <sub>6</sub> pressure)			
3.30.1	Pole to Pole Break time discrepancy	≤ 3 ms	≤ 3 ms	≤ 3 ms
3.30.2	Pole to Pole Make time discrepancy	≤ 5 ms	≤ 5 ms	≤ 5 ms
3.31	CB Class			
3.31.1	Mechanical operations class	M2 class		
3.31.2	Restrike performance	C2 class		

3.31.3	Electrical Endurance Class as per IEC 62271-310	E2 Class		
3.32	Rated auxiliary AC supply voltage ( $U_{aAC}$ )	3 $\emptyset$ , 4 wire, 50 Hz, 415 V <sub>rms</sub> neutral grounded AC (Tolerance $\pm 10\%$ )		
3.33	Method of earthing of LVAC system	Effective Earthing/Soild ground		
3.34	Rated DC supply voltage for coils, control, protection & indication/alarm circuits ( $U_{aDC}$ )	220 V, 2 wire, DC (Tolerance -15% + 10%)		
3.35	Type of Spring Change Motor	Universal Type		
3.36	Electromagnetic Compatibility Requirements			
3.36.1	Minimum Corona Extinction Voltage (kV <sub>rms</sub> )	320	156	92
3.36.2	RIV at $1.1 \times \frac{U_m}{\sqrt{3}}$	$\leq 1000 \mu V$	$\leq 1000 \mu V$	$\leq 1000 \mu V$
3.37	Spare Auxiliary Contacts for CB			
3.37.1	NO	20 nos/pole	20 nos/pole	20 nos
3.37.2	NC	20 nos/pole	20 nos/pole	20 nos
3.37.3	Rating of Auxiliary Contacts	20 A	20 A	20 A
3.38	Total Auxiliary Contacts for Pressure Switch			
3.38.1	For SF <sub>6</sub> pressure low Level 1	3 NC/pole	3 NC/pole	3 NC total
3.38.2	For SF <sub>6</sub> pressure low Level 2	4 NC/pole	4 NC/pole	4 NC total
3.38.3	For SF <sub>6</sub> pressure lockout	2 NC/pole	2 NC/pole	2 NC total
3.38.4	Healthy	1 NO/pole	1 NO/pole	1 NO total
3.38.5	Rating of Pressure Switch Auxiliary Contacts	10 A	10 A	10 A
3.39	Spare Contacts (10 A rating) for TNC Switch	4 nos (2 trip + 2 close)	4 nos (2 trip + 2 close)	4 nos (2 trip + 2 close)
3.40	Spare Contacts for LR Switch	4 nos (2 local + 2 remote)	4 nos (2 local + 2 remote)	4 nos (2 local + 2 remote)
3.41	Spare Contacts for Spring Charge Limit Switch (10 A rating)	(2 NO + 2 NC)/pole	(2 NO + 2 NC)/pole	2 NO + 2 NC

3.42	Potential Free Contact for Operation Counter (refer clause 8.9)	2 swipe contacts	2 swipe contacts	2 swipe contacts
3.43	Add-on contacts for AC & DC supply MCB	2 NC	2 NC	2 NC
3.44	Number of Tripping Coils	2/pole	2/pole	2 total
3.45	Number of Closing Coils	1/pole	1/pole	1 total
3.46	Spring Charging Time Through Motor Operation	≤ 15 s	≤ 15 s	≤ 15 s
3.47	Minimum Creepage Distance			
3.48	Specific Creepage Distance mm/kV (Refer clause 3.5)	31	31	31
3.49	Phase to Ground (mm)	13020	7595	4495
3.50	Between CB Terminals (mm)	13020	7595	4495
3.51	Seismic Requirement			
3.51.1	Seismic Qualification Level as per IEC 62271-300	AF3		
3.51.2	Zero Point Acceleration	0.3g		
3.52	Maximum noise level at base and up to 50 m	140 dB		

## Annexure I

### Nameplate Information

SF <sub>6</sub> Circuit Breaker		
Description	UOM	Value
Manufacturer		
Type designation		
Serial number		
Rated voltage (U <sub>r</sub> )	kV	
Rated Power Frequency Withstand Voltage (U <sub>d</sub> )	kV	
Rated lightning impulse withstand Voltage (U <sub>p</sub> )	kV	
Rated switching impulse withstand Voltage (U <sub>s</sub> )	kV	
Rated frequency (f <sub>r</sub> )	Hz	
Rated normal current (I <sub>r</sub> )	A	
Rated duration of short circuit (t <sub>k</sub> )	s	
Rated short-circuit breaking current (I <sub>sc</sub> )	kA	
D.C. time constant of the rated short circuit breaking current (τ)	ms	
D.C. component of the rated short circuit breaking current at contact separation corresponding to the d.c. time constant of the rated short-circuit breaking current (p <sub>cs</sub> )	%	
First pole-to-clear factor(k <sub>pp</sub> )		
Rated out-of-phase breaking current (I <sub>d</sub> )	kA	
Rated line-charging breaking current (I <sub>l</sub> )	A	
Rated cable-charging breaking current (I <sub>c</sub> )	A	
Rated single capacitor bank-breaking Current (I <sub>sb</sub> )	A	
Rated filling pressure for interruption (p <sub>re</sub> )	MPa	
Number of Closing & Tripping Coils	nos	
Breaking Time	ms	
Closing Time	ms	
Mass of CB including SF <sub>6</sub> (M)	kg	
Mass of SF <sub>6</sub> per CB (m)	kg	
Rated operating sequence		
Year of manufacture		
Mechanical Performance Classification		M2
Electrical Endurance Classification (if applicable)		E2
Restriking Performance Classification		C2
Relevant Standard		IEC 62271-100
Operating Device		
Manufacturer		
Type designation		
Serial number		
Rated filling pressure for operation (p <sub>rm</sub> )	MPa	
Rated supply frequency of closing and opening devices (U <sub>op</sub> )	V	

Rated (AC) supply frequency of closing and opening devices	Hz	
Rated (AC) supply voltage of the auxiliary Circuits (U <sub>a</sub> )	V	3 Ø 415 (±10%)
Rated supply frequency of (AC) auxiliary circuits	Hz	50
Rated (DC) supply voltage of the auxiliary Circuits	V	220 (-15% +10%)
Mass	kg	
Relevant Standard		IEC 62271-100



## Annexure II

### Mandatory Spares to be provided with SF<sub>6</sub> CB

SN	Description	Quantity
1	SF <sub>6</sub> Cylinder	20% of total gas requirement of supplied CBs
2	Tripping Coil Assembly	1 nos/CB
3	Closing Coil Assembly	1 nos/CB
4	Motor limit switch	1 nos/CB
5	Spring Charging Motor	1 nos/PO or 1 nos/Turnkey Project
6	Anti-pumping Relay	1 nos/PO or 1 nos/Turnkey Project
7	Auxiliary Switch Assembly (12 NO + 12 NC)	2 nos/PO or 1 nos/Turnkey Project
8	TNC Switch and LR Switch	2 set each /PO or 1 set each/Turnkey Project
9	Operation and maintenance manual	1 nos/CB

## Annexure III

### GUARANTEED TECHNICAL PARTICULARS FORMAT

(To be filled up by bidder/OEM separately for 420 kV, 245 KV & 145 KV SF<sub>6</sub> Circuit Breakers)

SN	Description	Value as per TS/Standard	Guaranteed Value
1.0			
1.1	Maker's name and country of manufacture		
1.2	Manufacturer's type Designation		
2.0	Applicable technical standards		
3.0			
3.1	Rated voltage(kV)		
3.2	Rated frequency(Hz)		
4.0	Number of Poles		
5.0	<b>Class</b>		
6.0	Rated normal current		
6.1	Under site conditions		
6.2	Rated		
7.0			
7.1	Rated short circuit breaking current		
7.1.1	RMS value of AC component of rated short circuit current (KA)		
7.1.2	Percentage DC component		
7.1.3	Asymmetrical Breaking Current at Highest System Voltage		
7.1.4	Certificate or report no		
7.1.5	Oscillogram no.		
7.2	Rated short circuit making current (KA peak)		
7.2.1	At Higher rated Voltage		
7.2.2	At Lower rated Voltage		
7.3	Maximum Breaking capacity Under Phase Opposition(KAP)		
7.3.1	Max Pole discrepancy(ms)		
7.3.2	Max arc duration & Corresponding current under lockout pressure		
8.0	First pole to clear factor		
9.0	Rated transient recovery voltage for terminal faults (kV peak)		
10.0	Rated characteristics for short line faults.		
11.0	Rated operating sequence		
12.0	Rated duration of short circuit(Sec.)		
13.0	Rated out of phase making & breaking current (kA)		
14.0	<b>Operation Times</b>		
14.1	<b>Opening time (ms)</b>		
14.1.1	Maximum Opening time under any condition		
14.1.2	With limiting Voltage & Pressure.		
14.2	<b>Arcing time (ms)</b>		
14.2.1	At 100% rated breaking current (ms)		
14.2.2	At 50% rated breaking current (ms)		
14.2.3	At 25% rated breaking current (ms)		

14.2.4	At 10% rated breaking current (ms)		
14.2.5	Maximum arcing time at lowest fault current (ms).		
<b>14.3</b>	<b>Break Time (ms)</b>		
14.3.1	At 100% rated breaking current (ms)		
14.3.2	At 50% rated breaking current (ms)		
14.3.3	At 25% rated breaking current (ms)		
14.3.4	At 10% rated breaking current (ms)		
14.3.5	Maximum break time at lowest fault current (ms).		
14.3.6	Maximum Total Break Time under any duty condition For any current up to rated breaking current with limiting condition of Voltage & Pressure(ms)		
14.4	Closing time (ms)		
14.5	Minimum dead time for 3 phase reclosing		
14.6	Maximum Close Open Time under any condition With limiting Voltage & Pressure		
14.7	Minimum Time Interval between each make/ Break Operation		
15.0	Rated line charging breaking current (kA)		
16.0	Rated small inductive breaking current (kA)		
17.0			
17.1	Max. rise of temperature over ambient <b>for current rating under sl. 6.</b>		
17.2	Max. rise of temperature for Main contacts over design ambient temperature of <b>50 deg C.</b>		
18.0	Interrupting capacity based on duty cycle <b>as per sl. 11.</b>		
18.1	AC component (kA)		
18.2	Percentage DC component		
19.0	Latching current (kA)		
20.0	No. of breaks in series per pole		
21.0	Length of contact travel (mm)		
22.0	Total length of break per pole (mm)		
23.0	Rate of contact travel:		
23.1	At tripping (metres/sec.)		
23.2	At closing (metres/sec.)		
24.0	Type of devices, if any, used to obtain uniform voltage distribution between breaks.		
25.0	Recovery voltage distribution between breaks in percent of rated voltage.		
25.1	Single line to ground fault		
25.2	Interruption on short lines		
25.3	Switching off an unloaded, transformer		
26.0			
26.1	Type of main contact		
26.2	Number of auxiliary contacts per pole for normal operation (NO & NC)		
26.3	Number of auxiliary contacts per pole provided for Owner's use (NO & NC)		
26.4	Current rating of Auxiliary contacts		
27.0	Type of arcing-contacts and/or arc control device		
28.0	Material of contacts:		
28.1	Main		

28.2	Arcing		
28.3	Whether contacts are silver plated		
28.4	Thickness of silver coating mm		
28.5	Contact pressure, kg/sq. mm		
29.0	Insulation level of the breaker:		
29.1	1 minute power frequency withstand voltage kV rms (Dry & Wet)		
29.1.1	Between live terminals & Ground		
29.1.2	Between terminals with Breaker contacts open		
29.2	Switching surge withstand test Voltage kV (peak)		
29.2.1	To earth		
29.2.2	Across open contacts		
29.3	Lightning impulse withstand test voltage, kV(peak)		
29.3.1	To earth		
29.3.2	Across open contacts		
29.4	Max. dynamic power frequency over voltage withstand kV (peak)		
30.0			
30.1	RIV level (Max)		
30.2	Corona inception voltage (kV rms)		
30.3	Corona extinction voltage (kV rms)		
31.0	Minimum clearances		
31.1	Between phases (live parts) (mm)		
31.2	Between live parts and earth (mm)		
31.3	Total Creepage Distance		
31.3.1	To ground		
31.3.2	Between Terminals		
32.0	Whether the circuit breaker is fixed trip or trip free		
33.0	Method of closing		
33.1	Normal		
33.2	Emergency		
34.0	Type of closing mechanism		
35.0			
35.1	Normal voltage of closing		
35.2	Pick up range (volts DC)		
36.0			
36.1	Power at normal voltage of closing mechanism (watts)		
36.2	Power at 85% of normal voltage of closing mechanism (watts)		
36.3	No of closing coils in operation		
37.0	Type of tripping mechanism Number of Tripping Coil		
38.0			
38.1	Normal voltage of tripping coils(volts)		
38.1.1	Power at normal voltage for Tripping coils (watts)		
38.1.2	Power at 70% normal voltage for Tripping coils (watts)		
38.1.3	No. of tripping coils in operation		
38.1.4	Pick up range (V DC)		
38.2	Number of close open operation		
38.2.1	possible after failure of AC supply to motor		

38.2.2	Time required for motor to charge the closing spring(Sec)		
38.2.3	Whether indication of spring charged condition will be provided in control cabinet		
39.0	Arc duration at 100% (ms)		
40.0	Interruption capacity:		
40.1	Opening		
40.1.1	Arcing time no. of loops and time including resistor current duration (cycle)		
40.1.2	Resistor current duration (cycle)		
40.1.3	Total length of the arc (mm)		
40.1.4	Max. length of the arc (mm)		
40.1.5	Total interrupting time measured from instant of trip coil energization to arc extinction of resistor current (cycles)		
40.2	Closing time measured from instant of application of power to closing device upto arcing contacts touchings (cycles)		
41.0	Critical current (current giving the longest arc when a break takes place) (kA)		
41.1	Recovery voltage when circuit breaker tested at 100% rated breaking capacity (kV inst.)		
41.2	Rate of rise of restriking voltage at breaking		
41.2.1	for 30% breaking capacity (kV/microsecs.)		
41.2.2	for 100% breaking capacity (kV/microsecs.)		
41.3	Maximum over-voltage factor of the circuit breaker when switching off.		
41.3.1	Unloaded transformers		
41.3.2	Loaded transformer		
41.3.3	Open circuited lines		
42.0	When switching of synchronous systems:		
42.1	Max. current (kA)		
42.2	Max. contacts of 1 pole (kV)		
43.0	No. of openings the circuit breaker is capable of performing without inspection, replacement of contacts or other main parts.		
43.1	at 50% rated current		
43.2	at 100% rated current		
43.3	at current corresponding to 50% rated breaking capacity.		
43.4	at current corresponding to 100% rated breaking capacity.		
44.0			
44.1			
44.1.1	Weight of complete circuit breaker (Kg)		
44.1.2	Impact loading for foundation design, to include dead load plus impact value on opening at maximum interrupting ratings, in terms of equivalent static load (Kg.)		
44.1.3	Overall dimensions:		
44.1.3.1	Height (mm)		
44.1.3.2	Width (mm)		
44.1.3.3	Length (mm)		

44.2	Type & Material of Gasket used to ensure gas tight joints		
44.2.1	Metal to Metal Joint		
44.2.2	Metal to Porcelain Joints		
44.3	Type & make of		
44.3.1	Density Monitor		
44.3.2	Pressure Gauge		
44.4	Density Monitor Setting		
44.4.1	Lock Out		
44.4.2	Alarm		
45.0	Porcelain:		
45.1	Make		
45.2	Type		
45.3	Descriptive pamphlet no.		
45.4	Weight (kg.)		
45.5	Transport dimensions (mm)		
45.6	Height above floor, required to remove porcelain (mm).		
45.7	Insulation class		
45.8	One minute power frequency withstand, kV (rms) (dry & wet)		
45.9	Flash over voltage (kV)		
45.10	Lightning impulse withstand voltage kV (peak) (dry & wet)		
45.11	Switching surge withstand voltage kV (peak) (wet)		
45.12	Corona discharge voltage (kV rms)		
45.13	Creepage distance, total protected (mm)		
45.14	Permissible safe cantilever loading on installed porcelain (Kg.m)		
46.0			
46.1	Rated pressure of SF6 gas in the circuit breaker (Kg/sq.cm )		
46.2	Rated Pressure of SF6 in operating Chamber(kg/cm <sup>2</sup> ) at 20deg C		
46.3	Limits of Pressure of extinguishing medium		
47.0	Rated pressure of SF6 gas in the gas cylinders (Kg/sq.cm )		
48.0			
48.1	Quantity of SF6 gas required per single pole unit (Kg.) at rated Pressure & at 20 deg C		
48.2	Guaranteed Maximum Leakage rate per Year.		
49.0	Quantity of SF6 gas per cylinder (Kg.) & Standard to which SF6 Gas Complies.		
49.1	Weight of empty cylinder (Kg.)		
49.2	Whether Breakers are dispatched filled with SF6 Gas or filled at site.		
49.3	Quantity of absorbent required per pole (Kg.)		
49.4	Recommended interval for renewal of absorbent in case of outdoor circuit breakers operating in tropical conditions.		
49.5	Chemical composition of absorbent		
49.6	Quantity of absorbent covered in the scope of supply (including spare quantities)		

49.7	Limits of gas pressure for pressure operation of circuit breaker – (Kg/sq.cm )		
49.8	Pressure and temperature at which the temperature compensated gas pressure switch will		
49.8.1	give alarm (Kg/sq.cm., deg. C)		
49.8.2	cut off (Kg/sq.cm. deg. C)		
49.9	Name of SF6 supplier and country of origin.		
49.10	Quantity of SF6 gas supplied for		
49.10.1	Actual use in breakers (Kg.)		
49.10.2	As spare (Kg.)		
49.11	Chemical composition of gas:		
49.11.1	Qty. of air by weight (ppm)		
49.11.2	Qty. of H <sub>2</sub> O by weight (ppm)		
49.11.3	Qty. of CF <sub>4</sub> by weight (ppm)		
49.11.4	Qty. of free acid by weight (ppm)		
49.11.5	Density		
49.11.6	Oil Content		
49.11.7	Resistivity		
49.12	Motor For Circuit Breaker		
49.12.1	Manufacture's name & address		
49.12.2	Equipment driven by motor or not.		
49.12.3	Motor Type		
49.12.4	Country of Origin		
49.12.5	Type of Duty		
49.12.6	Type of Enclosure & Method of Cooling		
49.12.7	Applicable Standard to which motor confirms		
49.12.8	Type of mounting		
49.12.9	Direction of rotations as viewed from non-driving end.		
49.12.10	Standard Continuous rating at 50deg C		
49.12.11	Rated Voltage		
49.12.12	Rated Speed at rated Voltage & Frequency (rpm).		
49.12.13	Full Load current at rated voltage & frequency.		
49.12.14	Power Factor at rated load.		
49.12.15	Rating of the Motor.		
49.12.16	Time for fully charging the closing spring		
49.13	Control Cabinet		
49.13.1	Material of enclosure		
49.13.2	Thickness of sheet steel		
49.13.3	Painting for control cubicle		
49.13.4	Paint shade		
49.13.5	Degree of protection		
49.13.6	Dimension		
49.13.7	Material of gasket		
49.13.8	Material of O ring		
49.13.8.1	Manufacturer		
49.13.8.2	Material		
49.13.8.3	Compression set		
50.0	The guaranteed years of maintenance free operation		

51.0	Number of full load and full rated short circuit current breaking/operation without requiring any maintenance or overhauling		

**Name of the firm .....**

**Signature of Bidder .....**

**Designation & Seal .....**

**Date .....**



### **SECTION 3:**

#### **36 KV RATED VACCUM CIRCUIT BREAKERS (OUT DOOR TYPE): TECHNICAL DETAILS**

##### **1. TYPE AND RATING:**

The circuit breakers shall be vacuum type suitable for outdoor operation under the climatic conditions specified without any protection from sun and rain.

The circuit breaker shall have the following ratings:

- 1.1. Number of poles : 3 (One unit with three phase making and breaking).
- 1.2. Frequency. : 50 Hz
- 1.3. Nominal system voltage : 33 KV rms.
- 1.4. Highest system voltage : 36 KV rms.
- 1.5. Basic insulation level :
  - 1.5.1. Rated Lightning Impulse Withstand Voltage : 170 KVP
  - 1.5.2. Rated 1 min Power frequency withstand Voltage : 70 KV (rms.)
- 1.6. Nominal Current/ Continuous current rating : 1600 Amps rms.
- 1.7. First pole to clear factor : 1.5
- 1.8. Breaking capacity
  - 1.8.1. Symmetrical. : 31.5 KA<sub>rms</sub>
  - 1.8.2. Asymmetrical. : As per IEC
- 1.9. Making capacity : 78.75 KA Peak.
- 1.10. Operating Duty. : O-0.3 Sec-CO-3 Min-CO.
- 1.11.
  - 1.11.1. Break time : 3 Cycle
  - 1.11.2. Make time : 5 Cycle
- 1.12. Insulator or bushing
  - 1.12.1. Dry one minute power Frequency voltage : 70 KV
  - 1.12.2. Wet one minute power Frequency withstand Voltage.: 70 KV
  - 1.12.3. Creepage distance : 900 mm (Minimum)
- 1.13. Short time current withstand rating for 3 seconds. : 31.5 KA for 3 seconds.
- 1.14. Control circuit voltage : 220 V D.C
- 1.15. Type of Operating Mechanism : Spring-Spring
- 1.16. **Actual** ground clearance of bottom live part : 3800 ± 100 mm
- 1.17. Class of VCB : M2-E2-C2
- 1.18. No of Coils: 2 Trip + 1 Close
- 1.19. Auto-reclosing : 3 phase
- 1.20. Seismic Qualification Level as per IEC 62271-300 : AF3

##### **2. GENERAL:**

The circuit breakers shall be of vacuum type. The breakers shall be furnished as a complete unit with all accessories and equipment in place and all internal wiring installed and terminated in the mechanism. The circuit breakers shall consist of three identical single-phase units with a common operating mechanism.

The circuit breakers shall provide rapid and smooth interruption of current under all conditions, completely suppressing all undesirable phenomena even under the most severe and persistent short circuit conditions or when interrupting small currents of leading or lagging reactive current. The details of any device incorporated to limit or control the rate of rise of restricting voltages across the circuit breaker contacts shall be stated. The over voltages caused by the circuit breaker switching on inductive or capacitive load shall not exceed, 2.5 times the normal phase to neutral voltage. The total

break time for the circuit breakers throughout the range of their operating duty shall be stated in the tender and guaranteed.

The vacuum interrupter, consisting of fixed contact and moving contact, shall be interchangeable among the same type interrupter.

**3. CONSTRUCTIONAL FEATURES:**

Each circuit breaker shall comprise 3 identical poles complete with a gang operated mechanism for specified duty. All these poles of the C.B. shall be linked together Electrically, mechanically for specified duty.

The breaker shall be capable of interruptions of low reactive current (lagging/leading) without undue over voltage and restrike.

**4. CONTROL CUBICLE:**

A common control cubicle shall be furnished to house electrical controls, monitoring devices and all other accessories. The cubicle shall be of gasketed weather proof construction, fabricated from sheet Aluminum alloy (minimum 3 mm thick) / Stainless Steel sheet (minimum 2 mm thick). The operating mechanism shall be strong, rigid and not subject to rebound.

The cubicle shall have front access door with lock and keys and removable gland plate at the bottom for owner's cable entry. Thermostat controlled space heater, internal illumination lamp, 5 A 3 pin socket with individual on off switches shall be provided in the cubicle.

**5. MOUNTING SUPPORT STRUCTURE:**

The circuit breakers shall be suitable for mounting on steel galvanized structures. The prices of these support structure shall be included in the price of the equipment and same shall be indicated clearly in the bid proposal sheet.

However, purchaser reserves the right to procure these from the supplier or through separate contract.

The steel support structure shall be designed with **factor of safety of 2.5** based on elastic limit of tension members and on crippling load of compression members.

The support structure design shall be so that it shall meet the Minimum statutory safety clearances as per IE rules and relevant IS/IEC.

The circuit breaker shall be supplied complete with the necessary lifting tools, foundation bolts and other accessories.

**For 36 kV circuit breakers, ladders are not to be provided by the OEM. OPTCL shall make its own concrete/brick masonry step & platform for accessing the mechanism box. The recommended height of the concrete platform for carrying out maintenance shall be specified in the GA drawing by the OEM.**

**6. TEMPERATURE RISE:**

The temperature rise of any part of the circuit breaker at an ambient air temperature not exceeding 40 °C shall not exceed the temperature-rise limits specified in latest editions and amendments of IEC 62271-1 and IEC 62271-100. If the maximum ambient temperature rises from above mentioned value (of 40 °C), permissible values shall be reduced accordingly.

**7. INSULATION OF THE CIRCUIT BREAKERS:**

The insulation to ground, the insulation between open contacts, the insulation between phases of the completely assembled circuit breakers, should be capable of withstanding satisfactorily die-electric test voltages corresponding to basic insulation level specified in **clause-1.5.**

The minimum statutory clearance in open air shall be maintained as per IEC 61936-1, IS 10118-3 and Indian Electricity Rules. However, higher clearances as per type test design is acceptable.

7.1.Phase to phase	:	320 mm
7.2.Phase to earth	:	320 mm
7.3.Minimum ground clearance to live part	:	3700 mm
7.4.Safety Working Clearance	:	2800 mm
7.5.Height of lowest point on the insulator (where it meets the earthed metal):		2440 mm
7.6.Actual ground clearance to bottom live part	:	Refer clause 1.16

#### **8. PORCELAIN HOUSING:**

- 8.1.The porcelains used shall be homogenous and free from cavities and other flaws. They shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above.
- 8.2.The porcelain housing shall be of single-piece construction without any joint or coupling. It shall be made of homogeneous, vitreous porcelain of high mechanical and dielectric strength. Glazing of porcelain shall be uniform brown or dark brown color with a smooth surface arranged to shed away rainwater or condensed water particles (fog). The type and profile of the porcelain insulator sheds shall be in accordance with IEC 60815 & IEC 62155.
- 8.3.The breaker porcelain shall be capable of withstanding all pressure resulting from any specified performance of the breaker.
- 8.4.The puncture strength of the bushings shall be greater than the flashover value.
- 8.5.The mechanical characteristics of insulators shall match with the requirements specified in this specification.
- 8.6.**The specific creepage distance of insulators shall be 25 mm/kV in general unless specifically called for 31mm/kV in the tender.**

#### **9. OPERATION MECHANISM:**

- 9.1.The operating mechanism shall be spring-operated type. Spring charging shall be motor operated having provision of hand-operated spring charging. Provision of local/remote electric control under normal operation shall be there. The mechanism shall be able to close/trip electrically as well as mechanically. All working parts in the mechanisms shall be corrosion resistant material and all bearings which require greasing shall be equipped with pressure grease fittings. The mechanism shall be strong, positive, quick in action and shall be removable without disturbing the other parts of the circuit breakers. The mechanisms of breaker shall be such that the failure of any spring will not prevent tripping.
- 9.2.The circuit breakers shall have motor wound spring charged trip free mechanism with anti-pumping feature. In addition, facility for manual charging of spring, shall be provided.
- 9.3.The operating mechanism along with its accessories shall be mounted in a weather proof cabinet with hinged, gasketed doors located near the breakers, on the VCB support structure. A local pistol grip TNC control switch and the breaker position indicator shall be provided in the cabinet. The circuit breakers shall also be provided with means for manual operation for maintenance purposes. The cabinet shall be IP 55 rated.
- 9.4.Each breaker shall be provided with manual close & open facility, mechanical ON-OFF indication, an operation counter and mechanism charge/discharge indication.
- 9.5.Spring charging shall take place automatically after each breaker closing operation. One open-close-open operation of the circuit breaker shall be possible after failure

of power supply to the motor. A visual mechanical indicating device will also be provided to show the position of the spring.

- 9.6. The control circuits shall be designed to operate on 220V DC. The closing and tripping coils shall be designed to operate satisfactorily at any control voltage from 70% to 110% of the normal rated voltage. A heater shall be provided in the cabinet to prevent moisture condensation.
- 9.7. Necessary cable glands (bronze/stainless steel) for the cables of the operating mechanism shall be provided.
- 9.8. All the terminal blocks to be used in the operating mechanism should be of stud type of Melamine material of Elmex/Connectwell for 2.5 sqmm cable or higher.
- 9.9. The Motor to be used for spring charging shall be of Universal type and suitable for AC and DC supply (220 V DC).
- 9.10. Wiring for all control circuits shall be carried out with 1100 volts grade PVC insulated tinned copper stranded conductors of sizes not smaller than 2.5 sq. mm.
- 9.11. **Potential free contacts shall be provided in the operation counter for integration of status in SAS if swipe contacts are not provided in CB auxiliary switch.**
- 9.12. **Four (4) nos spare contacts shall be provided in LR and TNC switch for (2 nos for each operation) for future use.**
- 9.13. **2 NO + 2 NC spare contacts shall be provided in the spring charge limit switch for future use.**
- 9.14. **Two (2) nos add-on contacts (2 NC) shall be provided in each DC & AC supply MCB for use in SAS. (For AC & DC supply supervision.)**

#### **10. TERMINAL CONNECTORS:**

The terminal connectors shall meet the following requirements:

- 10.1. Terminal connectors design should be type tested and manufactured as per IS: 5561.
- 10.2. Terminal connectors shall be meant for take-off by Moose/Zebra. **Both the pad portion and conductor holding portion shall be six (6) bolted type.**
- 10.3. **The nuts and bolts shall be stainless steel type.**
- 10.4. All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- 10.5. No part of a clamp shall be less than 10 mm thick.
- 10.6. All ferrous parts shall be hot dip galvanized.
- 10.7. For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminum body.
- 10.8. Flexible connectors shall be made from tinned copper.
- 10.9. All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 10.10. Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561.

#### **11. AUXILIARY SWITCHES:**

Spare 15 Nos N/O (normally open) & 15 Nos N/C (normally closed) of auxiliary switches (contacts) shall be provided on each circuit breaker for use in the remote indication and control scheme of the circuit breaker and for providing safety interlocking with disconnecter etc. Special contact for use with trip coil and single short reclosing operation which permits relative adjustment with respect to the travel of the moving contact of the circuit breaker shall also be provided. There shall be provision to add more auxiliary switches at the later date if required.

**24. INTERLOCKS:**

It is proposed to electrically interlock the circuit breaker with purchaser's associated air break disconnectors in accordance with switchyard safety interlocking scheme. The details of the scheme will be furnished to the supplier. All accessories required on breaker side for satisfactory operation of the scheme shall be deemed to be included in the scope of supply of this specification.

**25. PAINTING, GALVANISING AND CLIMATE PROOFING:**

25.1. Ferrous parts such as support channels, structures, ladders, all sizes of nuts, bolts, foundation bolts shall be hot dip galvanized conforming to latest version of IS 2629. For HDG galvanization thickness shall be 86 micron and weight of zinc coating 610 gram/sqm. Spring washers shall be electro galvanized.

25.2. All other parts shall be painted.

25.3. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. All steel surfaces shall be cleaned with sand blasting, given a coat of primer and finished with two coats of synthetic enamel paints.

25.4. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling. All external paintings shall be as per shade no. 697 of IS:5.

25.5. Metal parts not accessible for painting shall be made of corrosion resisting material.

25.6. Paint inside the metallic housing shall be of anti-condensation type and the paint on outside surfaces shall be suitable for outdoor installation.

**26. EARTHING:**

The operating mechanism housing, control cabinets, support structure etc. shall be provided with two separate earthing terminals suitable for bolted connection to 50X6 mm<sup>2</sup> mild steel flat to be provided by the purchaser for connection to station earth mat.

**27. NAME AND RATING PLATES:**

Circuit breaker and its operating device shall be provided with rating plates marked with the data as per IS/IEC 62271-100. The rating plate shall be visible in position of normal service and installation. The rating plate shall be made of stainless steel with text engraved on it in black color.

**Annexure IV**  
**Mandatory Spares to be provided with VCB**

<b>SN</b>	<b>Description</b>	<b>Quantity</b>
1	Tripping Coil Assembly	1 nos/CB
2	Closing Coil Assembly	1 nos/CB
3	Motor limit switch	1 nos/CB
4	Spring Charging Motor	1 nos/PO or 1 nos/Turnkey Project
5	Anti-pumping Relay	1 nos/PO or 1 nos/Turnkey Project
6	Auxiliary Switch Assembly (12 NO + 12 NC)	2 nos/PO or 1 nos/Turnkey Project
7	TNC Switch and LR Switch	2 set each /PO or 1 set each/Turnkey Project
8	Operation and maintenance manual	1 nos/CB
9	Complete Pole Assembly	1 nos/PO or 1 nos/Turnkey Project
10	Insulating Rod	2 nos/PO or 1 nos/Turnkey Project
11	Vacuum Interrupter	2 nos/PO or 1 nos/Turnkey Project

## Annexure V

### GUARANTEED TECHNICAL PARTICULARS FORMAT

(To be filled up by bidder/OEM for 36 KV Vacuum Circuit Breakers)

SN	Description	Value as per TS/Standard	Guaranteed Value
1.0	Name of Manufacturer.		
2.0	Manufacturer's type designation.		
3.0	Rated Voltage. KV		
4.0	Maximum (continuous) service rated Voltage KV		
5.0	Normal current rating.		
5.1	Under normal conditions.		
5.2	Under site conditions.		
6.0	Short time current rating for seconds (rms)		
7.0	Maximum temperature rise over ambient. °C		
8.0	Breaking capacity.		
8.1	Symmetrical. <b>KVA</b>		
8.2	Asymmetrical. <b>MVA</b>		
9.0	Making capacity. KA		
10.0	Total break time in ms.		
10.1	at 10% rated interrupting capacity ms		
10.2	at rated interrupting capacity ms		
11.0	Arcing time. ms		
12.0	Make time. ms		
13.0	Minimum reclosing time at full rated Interrupting MVA from the instant of Trip coil energisation. ms		
14.0	Minimum dead time for 3 phase reclosing. ms		
15.0	Whether restricting free. Yes/No		
16.0	One minute dry power frequency Withstanding test voltage (KV rms)		
16.1	Between line terminal and ground objects. - KV rms.		
16.2	Between terminal with breaker contacts open. - KV rms.		
17.0	1.2/50 micro s full wave impulse withstand test voltage for the two cases above.		
17.1	Between line terminal & grounded objects. - KV(Peak)		
17.2	Between terminal with breaker Contacts open.		
18.0	Busing or Insulators:		
18.1	Type of bushing.		
18.2	Dry 1 minute power frequency withstand test voltage. KV rms		
18.3	Dry flashover value. KV rms.		
18.4	Wet flashover value. KV rms.		
18.5	1.2/50 impulse withstand KV(Peak)		
18.6	Creepage distance. mm		
18.7	Puncture value of bushing. KV		
18.8	Weight of bushing. Kg.		
19.0	Minimum clearance in air.		

19.1	Between phases.        mm		
19.2	Live parts to earth.       mm		
19.3	Live parts to ground level       mm		
19.4	Between live parts & grounded object.   mm		
20.0	Number of poles of circuit breaker.		
21.0	Number of breaks per phase.		
22.0	Total length of break per phase.		
23.0	Type of main contacts.		
24.0	Type of Aux. Contacts.		
25.0	Materials of auxiliary contacts.		
26.0	Contacts silver plated or not.		
27.0	Thickness of silver plating.		
28.0	Contact pressure.		
29.0	Voltage distribution between breaker.		
30.0	Type of device if any, used to limit the rate of rise or restricting voltage.		
31.0	Voltage grading device if any used.		
32.0	Number of auxiliary contacts provided.		
32.1	Those closed when breaker is closed.		
32.2	These open when breaker is closed.		
32.3	Those adjustable with respect to the position of main contacts.		
33.0	Type of operating mechanism.		
33.1	Opening		
33.2	Closing		
34.0	Control circuit voltage.		
35.0	Power required for trip coil at 220V D.C. Watts		
36.0	Power required for close coil at 220V D.C. Watts		
37.0	Frequency at which contacts are To be replaced.		
38.0	Nos. of terminal connector.		
39.0	Steel support structure galvanized With foundation Nuts & Bolts to be provided - Whether yes or no		
40.0	Type test certificate Furnished    Yes/No		
41.0	Circuit Breaker weight.        -        Kg.		
42.0	Quantity.        Nos.		

**Name of the firm .....**

**Signature of Bidder .....**

**Designation & Seal .....**

**Date .....**



**SECTION 4:**  
**420/245/145 KV SF6 CB & 36 KV VCB:**  
**TESTS, INSPECTION, QAP, DOCUMENTATION, PACKING AND**  
**FORWARDING, SUPERVISION OF ERECTION, TESTING AND**  
**COMMISSIONING (ET&C), QUANTITY AND DELIVERY REQUIREMENTS**

**1. TESTS:**

**1.1. Type Tests:**

- 1.1.1. All the equipment offered shall be fully type tested as per the relevant standards (IEC 62271-1 & IEC 62271-100 with latest amendments) & tests as indicated below. The bids offering equipment not type tested will be rejected. In case, the equipment of the type & design offered has already been type tested, the bidder/ EPC agency shall furnish four sets of the type test reports along with the offer. The test must have been conducted not later than ten years from the date of opening of the bids.
- 1.1.2. The purchaser reserves the right to demand repetition of some or all the type & additional type tests in the presence of its representative. For this purpose, the bidder/ EPC agency may quote unit rates for carrying out such type tests.
- 1.1.3. For any change in the design/type of already type tested CB offered against this specification, the purchaser reserves the right to demand repetition of tests without any extra cost or reject the bid without any intimation.
- 1.1.4. All type test reports should have been conducted in independent third-party NABL laboratories. The tests for which testing facility is not available in India, should have been conducted in a laboratory of foreign Country accredited by National Accreditation Body of that Country.
- 1.1.5. The type tests conducted in-house by manufacturers shall also be acceptable provided the lab is accredited by National Accreditation Body of the Country and the tests have been witnessed by a representative of NABL accredited laboratory/Government Power Utility.
- 1.1.6. **List of Type Tests as per IS/IEC:**
  - a. Dielectric tests
  - b. Measurement of the resistance of the main circuit
  - c. Temperature-rise tests
  - d. Short-time withstand current and peak withstand current tests
  - e. Additional tests on auxiliary and control circuits
  - f. Mechanical operation test at ambient temperature (class M1)
  - g. Short-circuit current making and breaking tests
  - h. Radio interference voltage tests for  $U_r$  145 kV, 245 kV & 420 kV
  - i. Verification of the degree of protection
  - j. Tightness test
  - k. Extended mechanical endurance tests on circuit-breakers for special service conditions (class M2)
  - l. High temperature tests for an ambient temperature ( $T_H$ ) of 50 °C
  - m. EMC tests
  - n. Capacitive current switching tests:
    - i. line-charging current breaking tests

- ii. cable-charging current breaking tests
  - o. Single-phase fault test
  - p. Critical current tests
  - q. Short line fault tests
  - r. Out-of-phase making and breaking tests
  - s. X-ray radiation test (for VCB)
- 1.1.7. Additional Type Tests as per Annexure VI:**
- a. Corona extinction voltage test for Ur 145kV, 245 kV & 420 kV
  - b. Seismic withstand voltage test as per IEC/TR 62271-300
- 1.2. Acceptance/Routine Tests:**
- 1.2.1. All acceptance/routine tests as stipulated in IEC-62271-100 and its latest amendments & routine tests as indicated below shall be carried out by the supplier in the presence of purchaser's representative.
- 1.2.2. No sampling is allowed for factory acceptance tests. FAT of 100% of the offered quantity shall be witnessed by OPTCL representative.**
- 1.2.3. List of Acceptance/Routine Tests:**
- a. Dielectric test on the main circuit
  - b. Partial discharge measurement for Ur 145kV, 245 kV & 420 kV
  - c. Tests on auxiliary and control circuits
    - i. Inspection of auxiliary and control circuits, and verification of conformity to the circuit diagrams and wiring diagrams
    - ii. Functional tests
    - iii. Verification of protection against electrical shock
    - iv. Dielectric tests
  - d. Measurement of the resistance of the main circuit
  - e. Tightness test
  - f. Design and visual checks
  - g. Mechanical operating tests
- 1.2.4. In addition to the mechanical and electrical tests specified by IEC as above, the following shall also be performed.
- a. Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break/make operation etc.
  - b. Measurement of coil current & resistance.
  - c. Verification of Closing time, Opening time and CO time as per guaranteed values in the approved GTP.
  - d. Any additional tests required by the inspecting officer.
- 1.3. ADDITIONAL TESTS:**
- The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier/laboratory or at any other recognized laboratory/research institute in addition to the above mentioned type, acceptance

and routine tests at the cost of the purchaser to satisfy that the material complies with the intent of this specification.

## **2. INSPECTION:**

- 2.1. The inspection may be carried out by the purchaser at any stage of manufacture. The supplier shall grant free access to purchaser's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the purchaser shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.
- 2.2. Before offering for inspection, the supplier shall furnish shop routine test certificates and calibration reports of the equipment/instruments to be used during testing. After acceptance of these calibration reports and shop routine test certificate, inspecting officer will be deputed for witnessing such inspections.
- 2.3. The purchaser reserves the right to insist for witnessing the acceptance/routine testing of the bought out items.
- 2.4. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested or unless the same is waived by the purchaser in writing.

## **3. QUALITY ASSURANCE PLAN:**

- 3.1. The Successful Bidder/ EPC agency shall submit Quality Assurance Plan for manufacturing process for approval (or may comply to the Standard Manufacturing Quality Plan of OPTCL as available with the Technical specification).
- 3.2. The Successful Bidder/ EPC agency shall submit process flow chart for the manufacturing process along with the drawings/GTP.
- 3.3. The QAP shall contain the followings:
  - 3.3.1. RAW Materials/Bought out items:
    - a. Incoming raw materials/bought out items from sub vendors,
    - b. Name of the sub vendors,
    - c. List of standards to which the raw materials/bought out items adhere/according to which the raw materials are manufactured,
    - d. List of tests carried out by the OEM on the raw materials/bought out items to verify the quality of the incoming raw materials with sampling rate of the tests,
    - e. Acceptance norms,
    - f. The record of these test results shall be kept for verification by OPTCL.
  - 3.3.2. In process inspection by OEM:
    - a. List of tests carried out by OEM to ensure quality at various stages of manufacture.
    - b. Sampling rate of the tests
    - c. Reference standards for tests and acceptance norms,
    - d. The record of these test results shall be kept for verification by OPTCL.
    - e. **OPTCL preserves the right to witness all/some of these tests at the factory premises of OEM.**
  - 3.3.3. Factory acceptance tests:
    - a. All tests as per IEC 62271-1/62271-100 as applicable on circuit breakers.
    - b. Quantum of check/Sampling rate = 100%.
    - c. Reference standards for tests and acceptance norms,

- d. Tests shall be carried out by manufacturer and witnessed by OPTCL representative.
- 3.3.4. Type test reports:
  - a. The QAP shall also contain list of type test conducted on the design,
  - b. Reference standard,
  - c. Acceptance norms.
- 3.3.5. List of testing equipment available with the OEM for final testing of breakers vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards.
- 3.3.6. Packing and Dispatch:
  - a. List of checks to ensure the completeness of equipment and accessories as per PO,
  - b. List of checks to ensure proper packing of CB and spares,
  - c. Supply of O&M Manual and test reports.
- 3.4. Subsequent to/(During) approval of drawings/GTP & before offering inspection, the supplier shall, submit following information to the purchaser:
  - 3.4.1. List of raw materials as well bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
  - 3.4.2. Type test certificates of the raw material and bought out accessories. **(Vacuum bottle, Terminal Clamps & Hollow Insulators)**
  - 3.4.3. Quality assurance plan (QAP) with hold points for purchaser's inspection (if purchaser so desires).
- 3.5. The supplier shall submit the raw material/ bought out item test certificates and routine test reports, before/at the time of offering inspection call.
- 4. DOCUMENTATION:**
  - 4.1. All dimensions in submitted drawings shall be in SI units.
  - 4.2. All submitted drawings, GTP, MQP, and other documentations shall confirm to IS/IEC and this TS.
  - 4.3. List of drawings & documents:
 

The Bidder/ EPC agency shall furnish four sets of the following drawings/documents along with the offer.

    - a. General outline drawings showing dimensions and shipping weights, quantity of insulating media etc.,
    - b. Guaranteed technical Particulars,
    - c. Isometric view,
    - d. Porcelain Insulator details,
    - e. Control cabinet details,
    - f. Terminal clamp with isometric view,
    - g. Sectional views showing the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts with lifting dimensions for maintenance,
    - h. Schematic diagrams of breaker offered for control supervision and reclosing,
    - i. Structural drawing, design calculations and loading data for support structures and ladders,
    - j. Schematic drawing of control circuit,

- k. Bill of materials,
  - l. Legends and abbreviations,
  - m. Foundation drilling plan and loading data for foundation design,
  - n. Detail sketch of component wise details of operating mechanism of CB,
  - o. Digital Animation of operating mechanism, internal working and arc quenching of circuit breaker – in digital shape,
  - p. Type test reports.
- 4.4. After placement of order the supplier shall submit four sets of final version of all the above drawings/GTP for purchaser's approval. The purchaser shall communicate his comments/approval on the drawings to the supplier within reasonable period. The supplier shall, if necessary, modify the drawings and resubmit four copies of the modified drawings for purchaser's approval. After receipt of purchaser's approval, the supplier shall, submit 15 prints of the approved drawings for purchaser's use.
- 4.5. The supplier shall also furnish fifteen (15) copies of manuals covering erection, commissioning, operation and maintenance instructions and all relevant information and approved drawings pertaining to the main equipment as well as auxiliary devices. Marked erection drawings shall identify the component parts of the equipment as shipped to enable purchaser to carry out erection with his own personnel. Each manual shall also contain one set of all the approved drawings, type test reports as well as acceptance reports of the corresponding consignment dispatched. The instruction manuals shall contain storage, handling, erection, commissioning, troubleshooting, servicing and overhauling instructions.
- 4.6. The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the supplier's risk.
- 4.7. Approval of drawings/work by purchaser shall not relieve the supplier of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirement of the latest revision of applicable standards, rules and codes of practices. The equipment shall conform in all respects to high standards of engineering design workmanship & latest revisions of relevant standards at the time of ordering & purchaser shall have the power to reject any work or materials which in his judgment is not in full accordance therewith.
- 4.8. TEST REPORTS:**
- 4.8.1. Four copies of acceptance test reports shall be furnished to the purchaser as per the inspection of testing. One copy will be returned, duly certified by the purchaser and only there afterwards shall the material be dispatched.
  - 4.8.2. All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.
  - 4.8.3. All test reports of tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

**5. PACKING AND FORWARDING:**

- 5.1. The equipment shall be packed in suitable crates so as to withstand handling during transit. The supplier shall be responsible for any damage to the equipment during

transit, due to improper and inadequate packing and handling. The easily damageable materials shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost.

5.2. Each consignment shall be accompanied by a detailed packing list containing the following information:

- a. Name of the consignee.
- b. Details of consignment.
- c. Destination.
- d. Total weight of consignment.
- e. Sign showing upper / lower side of the crate.
- f. Handling and unpacking instructions.
- g. Bill of material indicating contents of each package and spare material.
- h. Manuals containing approved drawings & test reports

5.3. The supplier shall ensure that the packing list and bill of material are to be supplied in advance to the purchaser & to the consignees before dispatch.

**6. SUPERVISION OF ERECTION, TESTING AND COMMISSIONING (ET&C):**

The erection, testing and commissioning of the breakers shall be supervised, by trained personnel (Engineer) of the supplier/OEM who shall direct the sequence of ET&C and make the necessary adjustments to the apparatus and correct in the field any errors or omissions in order to make the equipment and material properly perform in accordance with the intent of this specification. The Engineer shall also instruct fully (up to the satisfaction) to the plant operators, in the operation and maintenance of equipment furnished. The supplier shall be responsible for any damage to the equipment, on commissioning the same, if such damage results from faulty or improper ET&C procedure. Purchaser shall provide adequate number of skilled/semi-skilled workers as well as all ordinary tools and equipment and cranes required for breaker erection, at his own expense. Apart from the above, the purchaser shall not be responsible for any other expenses incurred by the supplier and against personal injuries to the Engineer etc., shall be to supplier's account. Special tools, if required for erection and commissioning shall be arranged by the supplier at his cost and on commissioning these shall be supplied to the purchaser, free of cost, for future use.

**7. QUANTITY AND DELIVERY REQUIREMENTS:**

The scope of supply shall include a supply of 25% extra-quantity of bolts, nuts, washers, split pins, cotter pins and such other small loose items free of cost.

**8. AFTER SALES SERVICE:**

The guarantee period shall be as per tender condition/PO/WO. The supplier also should guarantee after sales service beyond the free service period. Supplier also should provide after sales service within 15 days of receipt of intimation from the field Engineer-in-charge of the equipment or the purchaser.

## **12. COMPLETENESS OF EQUIPMENT:**

Any fittings, accessories or apparatus which may not have been specifically mentioned in the specification but which are usual or necessary in the equipment of similar plant shall be deemed to be included in the contract and shall be supplied by the supplier without extra charges. All plant and equipment shall be complete in all details whether such details are mentioned in the specification or not. The detail bill of materials list to be furnished along with the tender.

## ANNEXURE VI

### CORONA, RIV AND SEISMIC TEST PROCEDURES

#### Corona and Radio Interference Voltage (RIV) test

1. **General:** Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV).
2. **Test Levels:** The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.
3. **Test Methods for RIV: (For  $U_r \geq 145$  kV)** As per IEC 62271-100.
4. **Test Methods for Visible Corona: (For  $U_r \geq 145$  kV)**
  - 4.1. The purpose of this test is to determine the corona extinction voltage of apparatus and connectors, the test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset of extinction voltages, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained there for five minutes. The voltage will then be decreased slowly until all visible corona disappears. The voltage will then be raised slowly again to the same maximum voltage. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e., 85%, 100%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. At least two photographs shall be taken in each case.
  - 4.2. The “test to determine the visible corona extinction voltage” need not be carried out simultaneously with “test to determine RIV levels”. However, both tests shall be carried out with the same test set up and as little time duration between tests as possible. No modifications or treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of owner’s inspector if, the same, in his opinion, will not prejudice other tests.

#### Seismic Withstand Test

The seismic withstand test on the complete equipment shall be carried out along with the supporting structures etc. The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the terminal pad of the equipment and any other point as agreed by the purchaser. The seismic test shall be carried out in all possible combinations of the equipment. IEC/TR 62271-300 Seismic qualification of alternating current circuit-breakers shall be followed.