



ODISHA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

FOR

**420, 245, 145, & 36 KV
CIRCUIT BREAKERS**

- i. 420 KV SF6 CIRCUIT BREAKER
- ii. 245KV SF6 CIRCUIT BREAKER
- iii. 145 KV SF6 CIRCUIT BREAKER
- iv. 36 KV VCB

420/245/145 KV CIRCUIT BREAKERS

1.0 **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 SF6 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 judgement, is not in full accordance therewith.

2.0 **STANDARDS**

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

SL. NO.	STANDARD	TITLE
1.	IEC-62271-100	High Voltage Alternating Current Circuit-Breaker
2.	IS-12729:2004/IEC-60694	Common Specification for High Voltage Control gear & Switchgear standard
3.	IS-14658/IEC-1633	H.V Alternating Current Ckt Breaker-Guide for Short Ckt & Switching Test Procedures for metal enclosed & dead tank Circuit Breaker
4.	IS-14674:1999/IEC-1166:1993	H.V Alternating Current Ckt Breaker-Guide for Seismic qualification of HV A.C Circuit Breaker
5.	IEC-56 / IS-13118	Specification for alternating current circuit breakers
6.	IS-325	Specification for three phase induction motors
7.	IS-375	Marking and arrangement for switchgear bus-bar, main

		connections and auxiliary wirings.
9.	IS-802 (Part-1)	Code of practice for use of structural steel in overhead trans. Line towers.
10.	IS-2099	High voltage porcelain bushings.
11.	IS-2147	Degree of protection provided for enclosures for low voltage switchgear and control gear.
12.	IS-2629	Recommended practice for hot dip galvanizing of iron and steel.
13.	IS-4379	Identification of the contents of Industrial Gas Cylinders.
14.	IS-7311	Seamless high carbon steel cylinders for permanent and high pressure liquefied gases.

2.2 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 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.

2.3 The standards mentioned above are available from:

Reference/Abbreviation	Name and address from which the standards are available
IS	Bureau of Indian Standards, Nanak Bhawan, 9-Bahadur Shah Zafar Marg, New Delhi-110 001 INDIA
IEC	International Electrotechnical Commission Bureau Central De la Commission Electro Technique International 1,Rue De Verembe Geneva, Switzerland

3.0 AUXILIARY POWER SUPPLY

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

(a)	Power Devices like drive Motors of rating 1 KW and above.	415 V, 3 phase 4 wire 50Hz, neutral grounded AC supply.
(b)	Lighting, space heaters and Fractional KW motors.	240 V, single phase, 50 Hz neutral grounded AC supply.
(c)	Alarm, control and Protective devices.	220 V DC, 2 wire

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, terminal boxes etc. The above supply voltage may vary as below and all devices shall be suitable for continuous operation over entire range of voltages.

i) AC supply : voltage $\pm 10\%$ frequency $\pm 5\%$

i) DC supply : - 15% to + 10%

4.0 PRINCIPAL PARAMETERS

The breakers shall conform to the specific technical requirements specified hereunder:

Sl. No.	Item	Requirements	
		145 KV	245KV/420KV
1.	Rated voltage (KV rms) frequency (Hz)	145 50HZ	245/420 KV 50HZ
2.	Continuous current rating (A) rms	3150	3150/3150

3.	Type	Outdoor SF6	
4.	Mounting	Hot dip galvanized lattice steel support structure to be supplied by the Bidder	
5.	Number of Poles	3	
6.	Type of Operation	Gang Operated	Individually Operated Single poles.
7.	Phase to phase spacing in the switchyard i.e. interpole spacing for breaker (mm)	2150	4500/7000
8.	Required ground clearance from the lowest live terminal (mm):		
	i.	If both the terminals are not in the same horizontal plane	- 4800/7000
	ii.	If both the terminals are in the same horizontal plane	4600 6500/7000
9.	Height of concrete plinth (to be provided by the Owner) mm.	300	300
10.	Minimum height of the lowest part of the support insulator from ground level (mm)	2550	2550/3500
11.	Operating Mechanism	spring charged(Spring-Spring) FOR 420 KV /SPRING-SPRING/	
12.	Autoreclosing duty	Single Phase	
13.	Rated operating duty cycle	0-0.3 sec-co-3 min-co	
14.	First pole to clear factor	1.3(As per IEC-62271-100)	
15.	Type of tripping	Trip free	
16.	Max. closing time(ms)	60	

17.	Max. BREAK TIME (ms)		30 ± 4	50/40
18.	1.2/50 microsecond impulse withstand voltage: (dry)			
	i.	To earth(kvp)	650	1050/1550
	ii.	Across the open contacts with impulse on one terminal and power frequency voltage on opposite terminal (kvp/kv rms)	650	1050/1550
19.	1 minute power frequency withstand voltage (kv rms) (wet)		275	460/610
20.	Max. radio interference voltage (micro volts) at 1.1 times maximum phase voltage		500	500/1000
21.	Min. corona extinction voltage (kv rms)		105	176/320
22.	Rated breaking current capacity:			
	i.	Line charging at rated voltage at 90 deg. Leading power factor (A) rms	50	125/600
	ii.	Small inductive current (A) rms	-----0.5 to 10----- without switching o/v exceeding 2.3 p.u.	
	iii.	Short circuit current		
		a) AC component (kA)	40	40 or 50/ 63
		b) % DC component	25%	40%/as per IEC62271-100
23.	Rated short circuit making current capacity (kA)		79	100/125/ 158
24.	Permissible limit of temperature rise		As per Clause 5.29	

25.	Max. acceptable difference in the instant of closing/opening of contacts			
	i)	Within a pole (ms)	5	5/2.5
	ii)	Between poles (ms)	10	10/3.3 for opening & 5 for closing
26.	Min. creepage distance of support insulator(mm)		3,625	6,125/10500
27.	Short time current carrying capability for three second (kA)		40	40/50/63
28.	Rating of auxiliary contacts		----10A at 220 V D.C.----	
29.	Breaking capacity of auxiliary contact		2 A DC with the circuit time constant not less than 20 ms	
30.	Noise level at base and upto 50 metres		-----140 dB (max.)-----	
31.	Seismic acceleration		-----0.3 g -----	

Note:-Purchaser may accept the phase to phase, or phase to earth spacing of the breakers & structure heights basing on the firm's type test reports or he may ask the firm to manufacture the breakers as per the dimensions indicated in this specification. .

5.0 GENERAL TECHNICAL REQUIREMENTS

5.1 Circuit breaker offered shall be sulphur hexaflouride (SF6) type only.

5.2 Any part of the breaker, especially the removable ones, shall be freely interchangeable without the necessity of any modification at site.

5.3 Circuit breaker shall comprise of three identical single pole units. If the circuit breaker 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:

5.3.1 Breaker assemblies with bases, support structure for circuit breaker as well as for control cabinet, Ladder, central control cabinet and foundation bolts for main structure as well as control cabinet and central control cabinet (except concrete foundations), terminals and operating mechanisms.

5.3.2 Compressed SF6 gas, spring operated systems complete including piping, fittings, valves and controls and etc.

5.3.3 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.

5.3.4 Instruments, pressure gauges and other devices like gas density monitor, temp. monitor & etc. for SF6 gas pressure supervision.

5.3.5 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.

5.4 The circuit breaker shall be designed for high speed single and three pole reclosing with and operating sequence and timing as specified in clause 4.0 "Principal Parameters".

5.5 The support structure of circuit breaker as well as that of control cabinet shall be hot dip galvanized. The minimum weight of zinc coating shall be 610 gm/sq.m and minimum thickness of coating shall be 86 microns for all items thicker than 5 mm.

5.6 Circuit breaker shall be suitable for hot line washing.

5.7 All breakers shall be supplied with terminal connectors. The exact requirement of terminal connectors would be intimated to the supplier during the course of detailed engineering(during drawing approval).

5.8 Terminal pads shall have silver plating of atleast 50 microns thickness.

5.9 CONTACTS

5.9.1 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.

5.9.2 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 silver plated or made of superior material like graphite.

5.9.3 Any device provided for voltage grading to damp oscillations or to prevent restriking 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.

5.9.4 Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life or the material used. The temperature shall not exceed that indicated in IEC-56 under specified ambient conditions.

5.9.5 Contacts shall be kept permanently under pressure of SF₆ 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 SF₆ gas due to its leakage.

5.9.6 If multibreak 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 along with the bid. The thermal and voltage withstands of the grading elements shall be adequate for the service conditions and duty specified.

5.10 PORCELAIN HOUSING

5.10.1 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 colour with a smooth surface arranged to shed away rain water or condensed water particles (fog). The type and profile of the porcelain insulator sheds shall be in accordance with IEC-815 joints as per IEC-233.

5.11 ADDITIONAL REQUIREMENTS :

a) 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 SF₆ gas on the internal insulating surface of the circuit breaker.

b) All gasketed 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 (SF₆ 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.

c) In the interrupter assembly there shall be an absorbing product box to eliminate SF₆ decomposition products and moisture. The material used in the construction of the circuit breakers shall be fully compatible with SF₆ gas.

d) Each pole shall form an enclosure filled with SF₆ gas independent of two other poles. The SF₆ density of each pole shall be monitored and regulated by individual pressure switches.

e) The SF₆ gas density monitor shall be adequately temp. compensated. The density monitor shall meet the following requirements:

i) It shall be possible to dismantle the density monitor for checking/replacement without draining the SF₆ gas by using suitable interlocked non-return couplings.

ii) 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.

iii) A pressure indicator (pressure gauge) shall also be supplied.

f) Means for pressure relief shall be provided in the gas chamber of circuit breaker to avoid the damages or distortion during occurrence of abnormal pressure increase or shock waves generated by internal electric fault occurs. The position of vents, diaphragms and pressure relief devices shall be so arranged as to minimize danger to the operators in the event of gas or vapour escaping under pressure.

g) 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.

h) Sufficient SF₆ gas shall be provided to fill all the circuit breakers installed. **In addition to this 20% of the total gas requirement shall be supplied in separate cylinders as spare requirement.**

i) Provisions shall be made for attaching an operation analyzer after installation at site to record contact travel, speed and making measurement of operation timings, pre insertion timing of closing resistor, synchronization of contacts in one pole.

5.12 SULPHUR HEXAFLUORIDE GAS (SF₆ GAS) :

- a) The SF6 gas shall comply with IEC-376, 376A and 376B and be suitable in all respects for use in the switchgear under the worst operating conditions.
- b) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the following standards and regulations:

IS:4379 Identification of the contents of industrial gas cylinders.

IS: 7311 Seamless high carbon steel cylinders for permanent and high pressure liquifiable gases.

The cylinders shall also meet Indian Boiler regulations.

- c) Test: SF6 gas shall be tested for purity, dew point, break down voltage, water contents as per IEC-376, 376A and 376B and test certificates shall be furnished to owner indicating all the tests as per IEC-376 for each lot of SF6 gas.

5.13 PREINSERTION RESISTOR (PIR)

DELETED

5.14 DUTY REQUIREMENTS

5.14.1 The circuit breaker shall be totally restrike free under all duty conditions. Opening resistors shall not be used.

5.14.2 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. It shall withstand the maximum expected dynamic loads (including the seismic) to which the circuit breaker may be subjected during its 45 years service life.

5.14.3 The circuit breaker shall be capable of:

- i) Interrupting the steady and transient magnetizing current corresponding to 420 kv/245 KV and 145 KV class transformers of 100 MVA & 160 MVA ratings respectively.
- ii) Interrupting line charging current as given in clause 4.0, "Principal Parameters" of this specification with a temporary overvoltage as high as 1.5 p.u. without restrikes.
- iii) Clearing short line faults (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
- iv) Breaking inductive currents of 0.5 to 10 A without switching overvoltage exceeding 2.3 p.u.
- v) Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.

5.14.4 The critical current, which gives the longest arc duration at lockout pressure of extinguishing medium and the arc duration shall be indicated.

5.14.5 The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energization of lines with trapped charges. The breaker shall ALSO WITHSTAND THE VOLTAGE SPECIFIED IN CLAUSE 4.0 “principal Parameters” of this specification.

5.15 TOTAL BREAK TIME

5.15.1 The “Total Break Time” as specified in clause 4.0, “Principal Parameters” of this section shall not be exceeded under any of the following duties:

i) Test duties 1,2,3,4,5 (with TRV as per IEC-62271-100)/as per related IS.

ii) Short line fault L90, L75 (with TRV as per IEC-62271-100) /as per related IS.

5.15.2 The Bidder 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 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.

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

5.16 OPERATING MECHANISM AND ASSOCIATED EQUIPMENTS

5.16.1 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).

5.16.2 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 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, with **Aluminium alloy enclosure(minimum 3mm thickness)**. This enclosure shall conform to the degree of protection IP-55 of IS- 2147. The enclosure shall be invariably mounted on a separate concrete plinth.

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

5.16.4 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.

5.16.5 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.

5.16.6 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.

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

5.16.8 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.

5.17 CONTROL

5.17.1 The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.

5.17.2 Each breaker pole shall be provided with two (2) independent tripping circuits, valves and coils each connected to a different set of protective relays.

5.17.3 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 close and trip push buttons shall be provided in the breaker central control cabinet. Remote located push buttons and indicating lamps shall be provided by purchaser.

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

5.17.5 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 upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. However, even at 50% of rated voltage, the breaker shall be able to perform all its duties. 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.

5.17.6 Suitable relay for monitoring of DC supply voltage to the control cabinet shall be provided. The pressure switches used for interlock purposes shall have adequate contact ratings to be directly used in the closing and tripping circuits. In case the contacts are not adequately rated and multiplying relays are used then the interlock for closing/opening operation of breaker shall be with No logic of the relay i.e. if the DC supply to the interlock circuit fails then operation lockout shall take place.

5.17.7 For all types of operating mechanism a local manual closing device which can be easily operated by one man standing on the ground shall also be provided for maintenance purposes and direction of motion of handle shall be clearly marked.

5.17.8 The auxiliary switch of the breaker shall be preferably positively driven by the breaker operating rod and where due to construction features, same is not possible a plug in device shall be provided to simulate the opening and closing operations of circuit breaker for the purpose of testing control circuits.

5.18 MOTOR COMPRESSED SPRING CHARGING MECHANISM

Spring operated mechanism shall be complete with motor, **opening spring, closing spring** and all other necessary accessories to make the mechanism a complete unit. 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. Closing operation shall compress the opening spring and keep ready for tripping. 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. 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. An alarm shall be provided for spring failing to be charged within a pre-set time after circuit breaker closing. The spring mechanism shall be fitted with a local manual release, preferably by a push button to avoid inadvertent operation. Means shall be provided for discharging the spring when the circuit breaker is in the open position without circuit breaker attempting to close.

Opening spring and closing spring with limit switches for automotive charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.

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.

After failure of power supply to the motor one close open operation shall be possible with the energy contained in the operating mechanism.

Breaker operations shall be independent of the motor which shall be used solely for compressing the closing spring. Facility for manual charging of the closing spring shall also be provided. The motor rating shall be such that it requires not more than 15 seconds for full charging of the closing spring.

Closing action of the breaker shall compress the opening spring ready for tripping.

When closing spring are discharged after closing a breaker, closing spring shall automatically be charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.

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 also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

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.

5.18.1 OPERATED MECHANISM FOR 400 KV BREAKERS.

The operating mechanism for 420 KV circuit breakers shall also be spring operated mechanism.(Closing spring and opening also spring).

5.19 OPERATING MECHANISM HOUSING

The operating mechanism housing/control cabinet shall conform to the requirement specified in clause 5.29. The entire operating mechanism and control mechanism control circuitry & etc as required, shall be housed in an outdoor type, made out of **Aluminium alloy sheet of 3mm thickness** enclosure. This enclosure shall conform to the degree of protection IP-55 of IS-2147.

5.20 INTERLOCKS

It is proposed to electrically interlock the circuit breaker with purchaser's associated air break isolating switches in accordance with switch yard 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.

5.21 SUPPORT STRUCTURE

The supplier shall indicate the price of support structure along with the foundation bolts required separately in the bid proposal sheets and these shall be considered in evaluation. Purchaser reserves the right to procure these from the supplier or through separate contract. However, in case the equipment offered have integral support structure or the specialties of the breaker are such that support structures have to be provided by the supplier, 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. The support structure shall meet the following requirements:

- 1) The minimum vertical clearance from any energized metal part to the bottom of the circuit breaker (structure) base, where it rests on the foundation pad, shall be minimum 8 mtrs for 400 KV, 5.5 mtrs for 245KV & 4.6 mtrs for 145 KV.
- 2) The minimum vertical distance from the bottom of the lowest porcelain part of the bushings, porcelain enclosures or supporting insulators to the bottom of the circuit breaker base, where it rests on the foundation pad shall be 2.55 mtrs. for all voltages.
- 3) The minimum clearance between the live parts and earth shall be 3.5 mtrs for 400 KV, 2.4 mtrs for 245 KV and 1.5 meters for 145 KV.

5.22 FITTINGS AND ACCESSORIES

5.22.1 Following is a partial list of some of the major fittings and accessories to be furnished by supplier in the central control cabinet. Number and exact locations of these parts shall be indicated in the bid.

- a) Central control cabinet in accordance with clause no. 5.29 complete with
 - i) Cable glands.
 - ii) Local/remote changeover switch.
 - iii) Operation counter.
 - iv) SF6 pressure gauges.
 - v) Control switches to cut off control power supply.
 - vi) Fuses as required.
 - vii) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for owner's use.

All the terminal blocks to be used in the operating mechanism and control cubicle should be of stud type of Poly-amide/Melamine material of make like Elmex (OAT-6 for non-disconnecting type and OAT 6T for disconnecting type) / Connectwell (Equivalent).

- b) Anti-pumping relay.

c) Rating and diagram plate in accordance with IEC / IS incorporating year of manufacture.

5.23 PAINING, GALVANISING AND CLIMATE PROOFING

5.23.1 All interiors and exteriors of tanks and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter and the surfaces treated by phosphating (e.g. seven tank phosphating sequence). All steel surfaces in contact with insulating oil, as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paint.

5.23.2 All metal surfaces exposed to atmosphere shall be given, in addition to the treatment described in clause 5.23 two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped or otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling. All external paintings shall be as per shade no. 697 of IS:5.

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

5.23.4 All components shall be given adequate treatment of climate proofing as per IS:3202 so as to withstand corrosive and serve service conditions.

5.24 GALVANISING

All ferrous parts including all sizes of nuts, bolts, support channels, structures, etc. as also the mechanism housing shall be hot dip galvanized conforming to latest version of IS:2629. Spring washers shall be electro galvanized.

5.25 EARTHING

The operating mechanism housing, control cabinets, dead tanks, support structure etc. shall be provided with two separate earthing terminals suitable for bolted connection to 50X8 mm mild steel flat to be provided by the Purchaser for connection to station earth mat.

5.26 NAME AND RATING PLATES:

Circuit breaker and its operating device shall be provided with a rating plate or plates marked with but not limited to following data:

- a) Manufacturer's name or trade mark.
- b) Serial Number or type designation making it possible to get all the relevant information from the manufacturer.
- c) Year of manufacture.

- d) Rated voltage.
- e) Rated insulation level.
- f) Rated frequency.
- g) Rated normal current.
- h) Rated short circuit breaking current.
- i) First pole to clear factor.
- j) Rated duration of short circuit.
- k) Rated auxiliary D.C. supply voltage of closing and opening devices.
- l) Rated pressure of compressed air gas for operation and interruption.
- m) Rated out of phase breaking current.
- n) Rated supply voltage of auxiliary circuits.
- o) Rated supply frequency of auxiliary circuits.
- p) Number of closing & Tripping coils
- q) Opening time & closing time

Other information are as per IS 12729/IEC 60694.

The coils of operating devices shall have a reference mark permitting the data to be obtained from the manufacturer.

The rating plate shall be visible in position of normal service and installation. The rating plate shall be weather proof and corrosion proof.

5.27 LIMITS OF TEMPERATURE RISE

The temperature rise on any part of equipment shall not exceed the maximum temperature rise specified below under the conditions specified in test clauses. The permissible temperature rise indicated is for a maximum ambient temperature of 50 deg. C. If the maximum ambient temperature rises, permissible values shall be reduced accordingly.

Sl. No.	Nature of the part or of the liquid	Maximum Value of	
		Temp.	Temp. rise at a max. ambient air temp. not exceeding 50 deg. C.
1.	Contacts in air, silver-faced copper, copper alloy or aluminium alloy [see notes (i) and (ii)]	105	55

	Bare copper or tinned aluminium alloy.	75	25
2.	Contacts in oil: Silver-faced copper, copper alloy or aluminium alloy (see note ii) Bare copper or tinned aluminium alloy	90 80	40 30
3.	Terminals to be connected to external conductors by screws or bolts silver faced (see note iii)	105	55
4.	Metal parts acting as springs	See Note iv	See note iv
5.	Metal parts in contact with insulation of the following classes: Class Y: (for non-impregnated materials) Class A: (for materials immersed in oil or impregnated) Class E: in air in oil Class B: in air in oil Class F: in air in oil Enamel: Oil base Synthetic, in air Synthetic, in oil	90 100 120 100 130 100 155 100 100 120 100	40 50 70 50 80 50 105 50 50 70 50
6.	Any part of metal or of insulating material in contact with oil, except contacts	100	50

7.	Oil	90	40
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Notes:(i)When applying the temperature rise of 55 deg. C, care should be taken to ensure that no damage is caused to the surrounding insulating materials.

(ii) The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test. Otherwise, the contacts shall be regarded as “bare”.

(iii) The values of temperature and temperature rise are valid whether or not the conductor connected to the terminals is silver-faced.

(iv) The temperature shall not reach a value whether the elasticity of the material is impaired. For pure copper, this implies a temperature limit of 80 deg. C.

5.28 TERMINAL CONNECTORS

5.28.1 The terminal connectors shall meet the following requirements:

- a) Terminal connectors shall be manufactured and tested as per IS: 5561.
- b) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- c) No part of a clamp shall be less than 10 mm thick.
- d) All ferrous parts shall be hot dip galvanized conforming to IS: 2633.
- e) For bimetallic connectors, copper alloy liner of minimum thickness of 2 mm shall be cast integral with aluminium body.
- f) Flexible connectors shall be made from tinned copper.
- g) All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- h) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS: 5561.

5.29 SPECIFICATION FOR CONTROL CABINETS:

1. Control cabinets shall be of the free standing floor mounting type.
2. Control cabinet of the operating mechanism shall be made out of **Aluminium alloy sheet (minimum 3 mm thickness). The operating mechanism shall be strong,rigid & not subject to rebound.** Hinged door shall be provided with padlocking arrangement. 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.

3. Bus bars shall be of tinned copper of adequate cross-section to carry the normal current, without exceeding the permissible temperature rise over an ambient temperature of 50 deg. C outside the cubicle. The buses shall be braced to withstand forces corresponding to short circuit current of 25 KA.
4. Motors rated 1 kw and above being controlled from the control cabinet would be suitable for operation on a 415 V, 3 phase 50 Hz system. Fractional KW motors would be suitable for operation on a 240 V, 1-phase, 50 Hz supply system.
5. Isolating switches (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, capable of breaking safely and without deterioration, the rated current of the associated circuit. Switch handle shall have provision for locking in both fully open and fully closed positions.
6. Push buttons shall be rated for not less than 6 Amps, 415 V A.C. or 2 Amps, 220 V D.C. and shall be flush mounted on the cabinet door and provided with appropriate name plates. Red, Green and Amber indicating lamps shall be flush mounted.
7. For motors up to 5 KW, contactors shall be direct-on-line, air break, single throw type and shall be suitable for making and breaking the stalled current of the associated motor which shall be assumed equal to 6.5 times the full load current of the motor at 0.2 p.f. For motors above 5 KW, automatic star delta type starters shall be provided. 3 pole contactors shall be furnished for 3 phase motors and 2-pole contactors for single phase motors. Reversing contactors shall be provided with electrical interlocks between forward and reverse contactors. If possible, mechanical interlocks shall also be provided. Contactors shall be suitable for uninterrupted duty and shall be of duty category class AC4 as defined in IS: 2959. The main contacts of the contactors shall be silver plated and the insulation class for the coils shall be class E or better. The dropout voltage of the contactors shall not exceed 70% of the rated voltage.
8. Contactors shall be provided with a three element, positive acting, ambient temperature compensated, time lagged, hand reset type thermal overload relay with adjustable setting, hand reset button shall be flush with the front door of the cabinet and suitable for resetting with starter compartment door closed.
9. Single phasing preventer relay shall be provided for 3 phase motors to provide positive protection against single phasing.
10. Mini starters shall be provided with no volt coils whenever required.
11. Purchaser's power cables will be of 1100 volts grade stranded aluminium conductor. PVC insulated, PVC sheathed single steel wire armoured and PVC jacketed. All necessary

cable terminating accessories such as 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 cable glands shall be provided for cable entry.

12. 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. Atleast 10% 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.

13. Separate terminal blocks shall be provided for terminating circuits of various voltage classes. CT loads shall be terminated on a separate block and shall have provision for short circuiting the CT secondary terminals.

14. Control cabinet shall be provided with 240 V, 1-phase 50 Hz, 20 W CFL TUBE light fixture and a suitably rated 240 V, 1-phase, 5 amps, 3 pin socket for hand lamps.

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.

16. Signal lamps provided shall be of neon screw type with series resistors, enclosed in bakelite body. Each signal lamp shall be provided with a fuse integrally mounted in the lamp body.

17. Electric measuring instruments shall be of moving iron type. Ammeters for measuring current upto 30 Amps shall be directly connected while those for measuring above 30 Amps shall be connected through suitable CBs. Ammeters shall be provided with selector switches.

18. Items inside the cabinet made of material shall be coated with a fungus resistant varnish.

5.30 MOTORS :(UNIVERSAL MOTOR)

Motors shall be universal type suitable for operation in AC & DC supply, as per IS:325 of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment.

6.1.1 TESTS

Type Tests

All the equipments offered shall be fully type tested as per the relevant standards(**IEC-62271-100**,IEC-60694/IS-12729 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 shall furnish four sets of the type test reports along with the offer. **The test must have been conducted not later than five years from the date of opening of the bids.** The purchaser reserves the right to demand repetition of some or all the type & additional type tests in the presence of his representative. For this purpose, the bidder may quote unit rates for carrying out such type tests. For any change in the design/type already type tested the design/type 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.

Type Tests:--(As per IEC-62271-100 with latest amendments)

- 1) Dielectric Test(LI Voltage,PF Voltage Withstand(Dry&Wet)& etc)
- 2) RIV Test
- 3) Measurement of resistance of the main circuit
- 4) Temperature rise Test
- 5)Short Time withstand current & Peak withstand current Test
- 6) Tightness Test
- 7) Mechanical Operation Test, Mechanical endurance test
- 8)Short Circuit making & Breaking Test
- 9) Capacitive Current, Switching Test , Line charging current breaking Test
- 10)Test to verify degree of protection
- 11)EMC Test

Routine Tests:-

- 1) Dielectric Tests on the main Circuit ,auxiliary & control circuits
- 2) Measurement of resistance of the main circuit.
- 3) Tightness Test

4) Design & Visual Checks

5) Mechanical operation Test

6) Operating time of the device, motor Characteristics, measurement of coil current & resistance , Sf6 gas pressure monitoring , control Circuit , anti-pumping, dimensions, nameplate details , contact travel & timing checks & contact speed in m/sec.

The following additional type tests are proposed to be conducted. The type test charges for these tests shall be quoted along with other type tests(AS indicated above) as per IEC/ IS in the relevant schedule & the same shall be indicated in the total bid price.

1) Corona extinction voltage test (As per Annexure-I)

2) Out of phase closing tests per IEC

3) Line charging breaking current test

4) Seismic Withstand test in unpressurised condition (as per Annexure-I)

6.1.2 The prices quoted by the bidder towards conductance of type tests & additional type tests shall be taken in to consideration for bid evaluation.

6.2 TYPE, ACCEPTANCE AND ROUTINE TESTS

6.2.1 All acceptance and routine tests as stipulated in IEC-62271-100,IEC-60694/IS-12729, IS 13118 with its latest amendments & routine tests as indicated above shall be carried out by the supplier in the presence of purchaser's representative. Also type test on one unit may be carried out by the supplier in the presence of purchaser's representative if purchaser decides & if such facility will be available either in the manufacturer's laboratory or in the CPRI. Rates for these tests must be indicated in the Annexure-IV, V, of Section-III of this tender specification. If the manufacturer wants to do the above tests in free of cost, then he may indicate the rates as 'NIL'. Purchaser reserves the right to conduct type test or may not insist for this test.

6.2.2 In addition to the mechanical and electrical tests specified by IEC, the following shall also be performed.

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. This test shall also be performed at site for which the necessary operation analyzer along with necessary transducers, cables, console, etc. shall be furnished as mandatory maintenance equipment.

6.2.3 Immediately after finalization of the program of type/acceptance/routine testing, the supplier shall give sufficient advance intimation (20 days) to the purchaser to enable him to depute his representative for witnessing the tests.

6.3 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.

7.0 INSPECTION

7.1 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.

The supplier shall keep the purchaser informed in advance, about the manufacturing program so that arrangement can be made for inspection. 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 of the purchaser will be deputed for witnessing such inspections.

7.2 The purchaser reserves the right to insist for witnessing the acceptance/routine testing of the bought out items.

7.3 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.

8.0 QUALITY ASSURANCE PLAN:

The bidder shall invariably furnish following information along with his offer, failing which his offer, shall be liable for rejection.

i)Statement giving list of important raw materials including but not limited to:

- (a) Contact Material
- (b) Insulation
- (c) Porcelain

- (d) Oil
- (e) Sealing material
- (f) Contactor, limit switches, etc. in control cabinet.

Names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested, list of test normally carried out on raw materials in presence of Bidder's representative, copies of test certificates.

ii) Information and copies of test certificates as in (i) above in respect of bought out accessories.

lii) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

iv) Special features provided in the equipment to make it maintenance free.

vi) List of testing equipment available with the Bidder for final testing of breakers vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the relevant schedule i.e. schedule of deviations from specified test requirements.

vii) The supplier shall, within 30 days of placement of order, submit following information to the purchaser.

1) List of raw materials as well bought out accessories and the names of sub-suppliers selected from those furnished along with offer.

2) Type test certificates of the raw material and bought out accessories.

3) Quality assurance plan (QAP) with hold points for purchaser's inspection (if purchaser will desires).

The supplier shall submit the routine test certificates of bought out items and raw material, at the time of routine testing of the fully assembling breaker

9.0 DOCUMENTATION

9.1 All drawings shall conform to relevant International Standards Organization (ISO) Specification/ISS. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

9.2 List of Drawings and Documents:

The Bidder shall furnish four sets of relevant descriptive and illustrative published literature pamphlets and the following drawings/documents for preliminary study along with the offer.

- a) General outline drawings showing dimensions and shipping weights, quantity of insulating media, air receiver capacity etc.
- b) Sectional views showing the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts with lifting dimensions for maintenance.
- c) Schematic diagrams of breaker offered for control supervision and reclosing.
- d) Structural drawing, design calculations and loading data for support structures.
- e) Foundation drilling plan and loading data for foundation design.
- f) Type test reports .

9.3 The supplier shall, within 2 weeks of placement of order submit four sets of final version of all the above drawings 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 within two weeks from the date of comments. After receipt of purchaser's approval, the supplier shall, within three weeks, submit 15 prints and one good quality reproducibles of the approved drawings for purchaser's use.

9.4 The supplier shall also furnish fifteen 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.

9.5 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 risk.

9.6 TEST REPORTS

i) Four copies of acceptance test reports and type 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.

ii) All records of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.

iii) 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.

10 PACKING AND FORWARDING

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.

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

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.

11.0 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 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.

12.0 QUANTITY AND DELIVERY RERQUIREMENTS

i)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.

SCHEDULE- A

TECHNICAL PARTICULARS AND GUARANTEES

1. Topographical and Meteorological site conditions

Location		State of ODISHA
Altitude	m	1000
Air Temperatures		
Minimum	□C	0
Maximum	□C	55
maximum daily average	□C	32
Humidity variation	per cent	100
Pollution level to IEC 815		Heavy
Airborne contamination, if any		Highly polluted
Isoceraunic level	day/annum	70
Seismic withstand factor (all equipment)	g	0.3
Maximum wind pressure	kg/sq. m	80.84
Wind velocity - (Wind Zone to IS 875)	m/sec	50
Average annual rain fall	cm	150

1	SYSTEM DETAILS	kV	400	220	132
1.1	Rated system voltage	kV	420	245	145
1.2	Earthing of system neutral		solid	solid	solid
1.3	System frequency	Hz	50	50	50
2	INSULATION LEVEL (at site altitude)				
2.1	Lightning impulse voltage withstand level, positive and negative polarity	kVp	1425	1050	650
2.2	Switching impulse voltage withstand level of insulation to ground, positive and negative polarity dry wet	kVp kVp	1050 1050	- -	- -
2.3	Power frequency withstand voltage dry wet	kV kV	520 520	460 460	275 275
2.4	Voltage below which corona shall not be visible	kV	320	176	105
2.5	Maximum radio interference voltage level measured at 1.1 times $U_s/\sqrt{3}$ at 1 MHz	μ V	<1000	<500	<500
2.6	Minimum creepage to earth over insulation on rated service voltage (to IEC 815)	mm/kV	25	25	25

Us is rated system voltage

Creepage distance across interrupter chambers shall be at least 10 percent greater than the creepage distance to earth and shall comply with the pollution conditions of IEC 815.

2. - SWITCHGEAR DETAILS

Item No	Description	Particulars			
		kV	420	245	145
1	TYPE OF SWITCHGEAR				
1.1	Type of switchgear GIS or Open terminal			Open terminal	
1.2	Installation Outdoor		Outdoor	Outdoor	Outdoor
2	SHORT TIME CURRENT CAPACITY				
2.1	All equipment 3 seconds	kA	50	40	40
2.2	Maintenance earthing devices, 3 seconds	kA	50	40	40
3	CIRCUIT BREAKER				
3.1	Normal current rating	A	3150	3150	3150
3.2	Fault rating				
'3.2.1	Making current	kAp	125	100	100
'3.2.2	Breaking current (symmetrical)	kA	50	40	40
'3.2.3	Breaking current (asymmetrical)	% DC/kAp	IEC 56 <50%	IEC 56 <50%	IEC 56 <50%
'3.2.4	Breaking current under out of phase conditions	kA	10	10	10
'3.2.5	Rated line charging current	A	600	125	50

					as per IEC	as per IEC
'3.2.6	Rated cable charging current	A	600	250	as per IEC	160 as per IEC
'3.2.7	Rated inductive current	A	1 to 10 - 50 - 100 - 200			
'3.2.8	Maximum overvoltage factor on any switching duty	pu	<2.0	<2.0	<2.0	
3.3	Operating sequence					
'3.3.1	Normal		0-0.3 s - CO-3 min - CO			
'3.3.2	Auto reclosing		0-0.3 s - CO-3 min - CO			
'3.3.3	Delayed three phase auto reclose cycle adjustable dead time range	s	2-30	2-30	2-30	
		kV	420	245	145	
'3.3.4	High speed single phase auto reclose cycle adjustable dead time	s	0.3-20	0.3-20	-	
'3.3.5	Number of closing operations under out of synchronous conditions	(2.0 pu)	2	2	2	
3.4	Transient recovery voltage					
'3.4.1	First phase to clear factor		1.3	1.3	1.5	
'3.4.2	Recovery voltage parameter for 3 phase unearthed terminal fault		IEC 56	IEC 56	IEC 56	
'3.4.3	Short line fault parameter		IEC 56	IEC 56	IEC 56	
'3.4.4	Surge impedance for short line fault test	ohms	450	450	450	
'3.4.5	Minimum voltage to earth when switching capacitive currents, (1.4 times rated phase to earth voltage)	kV	340	198	117	

'3.4.6	Voltage across circuit breaker under out of phase switching conditions	pu	2	2	2
3.5	Electro mechanical performance				
'3.5.1	Maximum total break time throughout complete rating, ie trip coil initiation to final arc extinction	ms	40	50	50
'3.5.2	Maximum time interval between closure of first and last phase of three phase circuit breakers	ms	2	1	1
'3.5.3	Maximum time interval between closure of interrupters of one phase of the circuit breaker	ms	1	-	-
'3.5.4	Maximum time interval between opening of first and last phase of three phase circuit breaker	ms	3.3	3.3	3.3
'3.5.5	Maximum time interval between opening of interrupters of one phase of the circuit breaker	ms	1	-	-
		kV	420	245	145
4	Insulation level (IEC 694)				
41*	Lightning impulse withstand (1.2/50 wave) - positive and negative				
	a. To earth, closed contacts	kVp	1425	1050	650
	b. Across, open contacts	kVp	-	1050	650
		kVp + kVACp	1425 +(240)	-	-
4.2*+	Switching impulse withstand				

* Biased tests (Impulse + ACp), required on switchgear for 300 kV and above.

+ Wet tests are required on outdoor open-terminal switchgear.

	(250/ 2500 wave) - positive and negative				
	c. To earth, closed contacts	kVp	1050	-	-
	d. Across, open contacts	kVp	1050	-	-
		kVp + kVACp	900 +(345)	-	-
4.3	Power frequency withstand	Dry/wet			
	e. To earth, closed contacts - 1 minute	kV	520	460	275
	f. Across, open contacts - 1 minute	kV	610	530	315
4.4	Ancillary equipment				
4.5	Number of trip coils required		2	2	2
4.6	Number of closing coils required		1	1	1
4.7	Degree of protection		IP 55	IP 55	IP 55

TABLE 1. - 420KV CIRCUIT BREAKERS**(A) TERMINAL FAULT REQUIREMENTS - FOUR PARAMETER TRV**

Fault duty	Current kA (rms)	First test voltage U₁ (kV)	Time co-ord t₁ (μs)	TRV peak value U_c (kV)	Time co-ord₂ (μs)	Time delay t_d (μs)	Volt co- ord u' (kV)	Time co-ord t' (μs)	Rate of rise U'/t kV (kV/μs)
10% symmetrical	5	-	-	787	88	11	262	4	8.9
30% symmetrical	15	446	89	669	668	5(22)	223	50(67)	5.0
60% symmetrical	30	446	149	669	671	2(37)	223	76(111)	3.0
100% symmetrical	50	446	223	624	669	2	223	113	2.0
100% Asym.	**	446	223	624	669	2	223	113	2.0
Asynchronous	12.5	686	446	857	1338	-	-	-	-
100% closing	125	-	-	-	-	-	-	-	-

** Dependent on circuit breaker opening time

*** 100% Sym and Assym duties shall either include ITRVs of Table III of IEC 56 or the SLF duties have been performed with $t_{dL} = 0$

(B) SHORT LINE FAULT REQUIREMENTS

Source side	50	343	171	480	513	2	171	88	2.0
				U_L	t_L	t_{dL}			U_L/t_L
Line side L90	45	-	-	54.9	6.1	0.5	-	-	9
Line side L75	37.5	-	-	137.3	18.4	0.5	-	-	7.46
Line side L 60	30	-	-	219	36.5	0.5	-	-	6

TABLE 2 - 245 kV CIRCUIT BREAKERS

(A) TERMINAL FAULT REQUIREMENTS - FOUR PARAMETER TRV

Fault duty	Current kA (rms)	First test voltage U1 (kV)	Time co-ord t1 (μs)	TRV peak value Uc (Kv)	Time co-ordt2 (μs)	Time delay td (μs)	Volt co-ord u' (kV)	Time co-ord t' (μs)	Rate of rise U'/t kV (kV/μs)
10% symmetrical	5	-	-	459	66	8	153	30	7.0
30% symmetrical	15	300	60	450	450	5(15)	150	35(45)	5.0
60% symmetrical	30	260	87	390	392	2(22)	130	45(65)	3.0
100% symmetrical	50	260	130	364	390	2	130	67	2.0
100%	**	260	130	364	390	2	130	67	2.0

asymmetrical									
Asynchronous	12.5	400	260	500	780	-	-	-	1.54
100% closing	125	-	-	-	-	-	-	-	-

** Dependent on circuit breaker opening time

*** 100% Sym and Assym duties shall either include ITRVs of Table III of IEC 56 or the SLF duties have been performed with $t_{dL} = 0$

(B) SHORT LINE FAULT REQUIREMENTS

Source side	50	200	100	280	300	2	100	52	2.0
				U_L	t_L	t_{dL}			U_L/t_L
Line side L 90	45			32	3.6	0.5	-	-	8.9
Line side L 75	37.5			80	10.6	0.5	-	-	7.55
Line side L 60	30			128	21.3	0.5	-	-	6

TABLE 3 - 145 kV CIRCUIT BREAKERS**(A) TERMINAL FAULT REQUIREMENTS - FOUR PARAMETER TRV**

Fault duty	Current kA (rms)	First test voltage U1 (kV)	Time co-ord t1 (μs)	TRV peak value Uc (kV)	Time co-ordt2 (μs)	Time delay td (μs)	Volt co- ord u' (kV)	Time co-ord t' (μs)	Rate of rise U'/t kV (kV/μs)
10% symmetrical	4	-	-	272	45	6	91	21	6.0
30% symmetrical	12	178	36	266	270	5(9)	89	23(27)	5.0
60% symmetrical	24	178	59	266	266	2(15)	89	32(44)	3.0
100% symmetrical	40	178	89	249	267	2	89	46	2.0
100% asymmetrical	**	178	89	249	267	2	89	46	2.0
Asynchronous	10	296	178	370	534	-	-	-	1.67
100% closing	100	-	-	-	-	-	-	-	-

** Dependent on circuit breaker opening time

*** 100% Sym and Assym duties shall either include ITRVs of Table III of IEC 56 or the SLF duties have been performed with $t_{dL} = 0$

(B) SHORT LINE FAULT REQUIREMENTS

Source side	40	118	59	166	177	2	59	32	2.0
				U_L	t_L	t_{dL}			U_L/t_L
Line side L90	36	-	-	18.9	2.6	0.2	-	-	7.3
Line side L75	30	-	-	47.4	7.9	0.2	-	-	6.0
Line side L60	24	-	-	75.9	15.8	0.2	-	-	4.8

Item No	Description	Particulars			
		kV	420	245	145
1	MINIMUM FACTORS OF SAFETY FOR SWITCHGEAR				
1.1	Complete insulators based on electro-mechanical test		2.5	2.5	2.5
1.2	Insulator metal fittings based on elastic limit		2.5	2.5	2.5

1.3	Steel structures based on elastic limit of tension members and on crippling loads of compression members		2.5	2.5	2.5
1.4	Foundations for structures against overturning or uprooting under maximum simultaneous working loadings		2.5	2.5	2.5

8. CLEARANCES*

8.1 Clearances for busbars and connections

RATED SYSTEM VOLTAGE kV					
		36	145	245	420
BIL	kVpK	170	650	1050	1425
SIL	kVpK	-	-	-	1050
Minimum Clearance between Live metal and Earth	m	0.32	1.3	2.0	3.4
Minimum Clearance between Live metal of Different Phases	m	0.43	1.5	2.4	3.9
Safety Working Clearance Horizontal	m	2.3	3.2	3.3	5.4
Safety Working Clearance Vertical	m	2.9	3.7	4.5	6.4
Minimum height to base of insulation	m	2.4	2.4	2.6	2.7

* Based on BS 7354: 1990

Clearances apply only to equipment not subject to impulse voltage type tests.

They apply to conditions of maximum conductor swing and sag.

Item	Description		Particulars		
9	FINISH OF EQUIPMENT				
9.1	Outdoor equipment		Outdoor	Outdoor	Outdoor
9.1.1	Porcelains		Brown	Brown	Brown
9.1.2	Structures		Hot dip galvanized		
9.1.3	Cubicles and enclosures		As	specified	
10	LVAC EQUIPMENT				
10.1	Rated system voltage	V	415V-30 240V-10	415V-30 240V-10	415V-30 240V-10
10.2	Rated frequency	Hz	50	50	50
10.3	Method of earthing system neutral		Solidly earthed		
10.4	Type of equipment required (switchfuses, MCCBs, air circuit breakers etc)		Air circuit breaker MCCBs		
10.5	Voltage limits for correct operation of circuit breakers	%V %□	□10 □5	□10 □5	□10 □5
11	DC AUXILIARY SUPPLIES				
11.1	Nominal voltage of system	V	220	220	220
11.2	Voltage limits for correct operation of equipment	%	□10 □5	□10 □5	□10 □5
12	NOMINAL VOLTAGE OF AUXILIARY SUPPLIES				
12.1	Supply for electrical operation of circuit				

	breakers				
12.1 .1	Closing initiation	V dc	220	220	220
12.1 .2	Tripping	V dc	220	220	220
12.2	Power supply for compressor equipment		415	415	415
12.3	Power supply for spring and hydraulic charging motors	V ac	240	240	240
12.4	Supply for indication and alarm circuits	V dc	220	220	220

ANNEXURE – I

(CIRCUIT BREAKERS)

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

3.1 RIV tests shall be made according to measuring circuit as per International Sub-Committee on Radio Interference Publication 1- 1972 second edition. The measuring circuit shall preferably be tuned to frequency of 0.5 MHz but other frequencies in the range of 0.5 MHz to 2 MHz may be used. The measuring frequency shall be recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be conducted in accordance with NEMA standard publication No. 107-1964 except as otherwise noted herein.

3.3 In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 metres of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurement. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipments unless otherwise specified.

3.5 The metering instruments shall be as per CISPR recommendation or equipment device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a properly tuned noise meter.

4.0 Test Methods for Visible Corona:

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.

B. 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. The detailed seismic test procedure shall be furnished for approval to the purchaser ,before offer for inspection.

TECHNICAL SPECIFICATION

FOR 36 KV VACCUM CIRCUIT BREAKERS (OUT DOOR TYPE)

TECHNICAL SPECIFICATION FOR 36 K.V. VACCUM CIRCUIT BREAKERS (OUTDOOR TYPE)

1.1 SCOPE:

36 K.V. 1430 MVA Circuit Breakers are intended to be purchased for installation at different Sub-stations. Some of the Sub-stations for which equipment are tendered are situated in coastal areas where saline climate prevails. The base structure of the circuit breakers must be galvanized.

1.2 POWER SUPPLY TO AUXILIARIES :

A.C. supply to auxiliaries will be 3 phase, 3 wire, 430 volt or single phase 250 volts at 50 C/s. The voltage variation will be within 10% and the frequency variation $\pm 5\%$.

1.03 33 K.V. CIRCUIT BREAKERS 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. | Number of poles | : | 3 (One unit with three phase making and breaking). |
| 2. | Frequency. | : | 50 C/s. |
| 3. | Nominal system voltage | : | 33 KV rms. |
| 4. | Highest system voltage | : | 36.0 KV rms. |
| 5. | Basic insulation level | : | 170 KVP |
| 6. | Power frequency test Voltage (wet). | : | 75 KV (rms.) |
| 7. | <u>Nominal Current.</u> | : | 1250 Amps rms. |
| 7a. | First pole to clear factor | : | 1.5 |
| 8. | Breaking capacity. | : | |
| | (a) Symmetrical. | : | 25 KA/1430 MVA. |
| | (b)A symmetrical. | : | 33 KA Peak. |
| 9. | Making capacity. | : | 62.5 KA Peak. |
| 10. | Continuous current rating. | : | 1600 Amps (RMS) |

- | | | |
|---|---|-------------------------|
| 11. Operating Duty. | : | 0-0.3 Sec-CO-3 Min-CO. |
| 12.(a) Break time | : | 3 Cycles |
| (b)Make time | : | 5 Cycles. |
| (c)Minimum reclosing time | : | 15 Cycle. |
| (d)Minimum dead time for reclosing | : | 15 Cycle |
| 13. Dry one minute power frequency withstand test voltage | | |
| a) Between line terminal | : | 75 KV rms. |
| b)Between line and body | : | 75 KV rms. |
| 14. Impulse withstand test voltage ; | | |
| a)Between terminal
with C.B. open. | : | 170 KV (Peak) |
| b)Between body & terminal | : | 170 KV (Peak) |
| 15. Insulator or bushing | | |
| a)Dry one minute power
Frequency voltage, | : | 75 KV |
| b)Wet one minute power
Frequency withstand Voltage. | : | 75 KV |
| c) Creepage distance | : | 580 mm (Minimum) |
| 16.Short time current
rating for 3 seconds. | : | Not less than 25 KA for |
| 17.Control circuit voltage | : | 220 V D.C |

1.04 **STANDARDS :**

The circuit breakers shall comply with the requirements of latest issue of IEC-62271-100,IEC-60694/IS12729:2004,IS-13118:1991, except wherein specified otherwise. Where the equipment offered confirm to any other standard the silent points of difference between the standard adopted and the IS or IEC recommendations shall be brought out in the tender. Equipment meeting any other authoritative standard which ensures an equal or better quality than the standard mentioned above is also acceptable.

CLIMATIC CONDITIONS :

The climatic conditions at site under which the equipment shall be operated satisfactorily are as follows :

- | | | |
|--|---|-------|
| Peak ambient air temperature | : | 50° C |
| Maximum temperature attainable by
an object exposed to sun. | : | 60°C |
| Minimum temperature of the air
in shade. | : | 0°C |
| Maximum yearly weighted average | : | 32° C |

ambient Temp.

Maximum daily average ambient temp	:	35deg C
Maximum humidity.	:	100%
Average number of thunder storm	:	70 Days per annum.
Average number of rainy days per Annum.	:	120
Average annual rainfall	:	1500 mm
Number of months of tropical Monsoon conditions per annum	:	4
Maximum wind pressure	:	260 kg/Sq.m.
Altitudes not exceeding.	:	1000 M

For the purpose of the specification, the limit of ambient temperature shall be 50° C peak and 45° C average over a 24 hours period.

Some of the breakers to be purchased against this specification are intended to be installed on the sea coast having extremely saline climate. Necessary anti corrosive provisions need be incorporated.

1.5 **GENERAL :**

1.6 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.

1.7 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.

1.8 **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.

1.9 **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 / Galvanizing iron sheet having minimum 3 mm thick. The operating mechanism shall be strong, rigid and not subject to rebound.**

1.10 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.

1.11 MOUNTING :

The circuit breakers shall be suitable for mounting on steel galvanized structures. The prices of necessary frames for mounting the circuit breaker shall be included with the offer. A ladder should be provided in the structure for easy access to the operating mechanism house. The ladder shall be of M.S with hot dip galvanised.

1.12 The circuit breakers shall consist of three identical single phase units with a common operating mechanism. All joints shall be welded so as to have adequate mechanical strength. The breaker porcelain shall be capable of withstanding all pressure resulting from any specified performance of the breaker.

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

1.13 TEMPERATURE RISE :

The maximum temperature attained by any part of the equipment when in-service at site under continuous full load conditions and exposed to direct rays of sun shall not exceed the permissible limits fixed by approved specifications. When the standards specifies the limits of temperature rise these shall not exceed when corrected for the difference between ambient temperature at site and the ambient temperature specified in the approved specification. The corrections proposed shall be stated in the tender and shall be subject to approval of the purchaser.

1.14 INSULATION OF THE CIRCUIT BREAKERS :

1.15 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-1.03.

1.16 The clearance in open air shall be as follows, unless the apparatus is impulse tested after complete assembly.

- i) Minimum clearance between phase : 505 mm
- ii) Phase to Earth. : 305 mm
- iii) Minimum clearance between live : 1400 mm
Parts and grounded objects.
- iv) Minimum ground clearance to live: 3700 mm

part.

1.17 BUSHING AND INSULATIONS :

The basic insulation level of the insulating porcelains shall be as specified and shall be suitable for installation in contaminated atmospheres. 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. The puncture strength of the bushings shall be greater than the flashover value. The bushings shall be entirely free from radio disturbance when operating at a voltage 10% above rated voltage and also be free from external corona.

Adequate means shall be provided to accommodate conductor expansion and there should not be any undue stressing of any part due to temperature change.

1.12 OPERATION MECHANISM :

1.12.1 The operating mechanism shall be spring operated type. In case of spring operating mechanism it shall be of motor operated having provision of hand operated spring charging type or by local/remote electric control under normal operation. The mechanism shall be trip from electrically and 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.

1.12.2 The operating mechanism along with its accessories shall be mounted in a weather proof cabinet with hinged doors located near the breakers. A local 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.

1.12.3 The control circuits shall be designed to operate on 220V. d.c. It shall be possible to adopt to work on other voltages by simply changing the operating coils. The closing and operating coils shall be designed to operate satisfactorily at any control voltage from 70% to 115% of the normal rated voltage. A heater shall be provided in the cabinet to prevent moisture condensation.

1.12.4 Necessary cable glands for the cables of the operating mechanism shall be provided.

1.12.5 All the terminal blocks to be used in the operating mechanism should be of stud type of Poly-amide/Melamine material of make like Elmex (OAT-6 for non-disconnecting type and OAT 6T for disconnecting type) / Connectwell (Equivalent).

1.12.6 The Motor to be used for spring charging shall be of Universal type and suitable for AC and DC supply(220 V DC).

1.13 TERMINAL CONNECTORS :

Technical connectors suitable for all ACSR Moose/ACSR Zebra Conductor (as per the provision laid down) shall be provided, Suitable terminal earth connector for earthing connections shall also be supplied.

1.14 AUXILIARY SWITCHES :

Spare 10 Nos N/O (normally open) & 10 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 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.

1.15 COMPLETENESS OF EQUIPMENT :

Any fittings, accessories or apparatus which may not have been specifically mentioned in those 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 contractor 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.

1.16 AFTER SALES SERVICE :

1.16.1 The supplier should guarantee for after sales service for a minimum period of one and half years from the date of receipt of the equipment or one year from the date of commissioning of the equipment whichever is earlier.

1.16.2 The supplier also should guarantee after sales service beyond the free service period.

1.16.3 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.

1.16.4 COMMISSIONING :

The manufacturers shall render all help for commissioning of the breakers. Supervision of erection , testing & Commissioning charges per breaker to be quoted in the schedule of prices (Annexure-v) for evaluation of the Price bid or else it will be presumed that the charges towards Supervision of erection , testing & Commissioning per Breaker are included in the unit price offered.

1.17 EXPERIENCE :

The list of supplies already made by the supplier/manufacturers are to be enclosed along with the tenders.

1.18 RECOMMENDED SPARES AND TOOLS :

For 5 (five) years operation, price are to be enclosed along with the tenders for each item of spares and special tools.

2.0 TEST :

2.1 Type test : - All the equipment offered shall be fully type tested as per the relevant standards. In case the equipment of the type and design offered, has already been type tested in an Govt. Approved test Laboratory, the bidder shall furnish four sets of type test reports along with the offer. These tests **must not have been conducted earlier than five years from the date of opening of bids**. The purchaser reserves the right to demand repetition of some or all the type tests in the presence of owner's representative. For this purpose the bidder may quote unit rates for carrying out each type test. These prices shall be taken into consideration for bid evaluation. For any change in the design/type offered against this specification, if accepted by the purchaser, the purchaser reserves the right to demand repetition of tests without any extra cost. Reports of Type tests as stipulated in relevant IS along with Impulse and short circuit test documents conducted shall be supplied along with the tender. All the test reports should be submitted and shall be approved by the purchaser before dispatch of the material.

Note :- Tender not accompanying with the type test reports along with Impulse and short circuit tests are liable for rejection.

Type Tests:--(As per IEC-62271-100)

- 1) Dielectric Test(LI Voltage,PF Voltage Withstand(Dry&Wet)& etc)
- 2) RIV Test
- 3) Measurement of resistance of the main circuit
- 4) Temperature rise Test
- 5)Basic short circuit duty test ,Short Time withstand current & Peak withstand current Test
- 6) Mechanical Operation Test, Mechanical endurance test
- 7)Out of phase / Short Circuit making & Breaking Test
- 8) Capacitive Current, Switching Test ,a) cable charging current Test b)Single capacitor Bank current switching test
- 9)Test to verify degree of protection

Routine Tests:-

- 1)Dielectric Tests on the main Circuit ,auxiliary & control circuits
- 2)Measurement of resistance of the main circuit.
- 3) Design & Visual Checks(Dimensions,clearances&etc)
- 4) Mechanical operation Test

5) Operating time of the device, motor Characteristics, measurement of coil current & resistance , Sf6 gas pressure monitoring ,electrical scheme,control Circuit,anti-pumping, vaccum interrupter(type,make&etc),dimensions, name plate details , contact travel & timing checks .

Acceptance and Routine Tests.

2.1.1 All acceptance and routine tests as stipulated in the relevant standards & above shall be carried out by the supplier in presence of owner's representative.

2.1.2 Immediately after finalization of the programme of type/acceptance/routine testing, the supplier shall give twenty days advance intimation to the purchaser, along with the shop routine test certificate and valid calibration certificates of the equipments/instruments calibrated in a govt. approved test house ,to be used during testing for scrutiny,to enable him to depute his representative for witnessing the tests.

3.0 **INSPECTION** :The inspection may be carried out by the purchaser at any stage of manufacture. The successful tendered shall grant free access to the purchaser's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipments under this specification by the purchaser, shall not relieve the supplier in his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

The supplier shall keep the purchaser informed in advance, about the manufacturing programme so that arrangement can be made for inspection.

The purchaser reserves the right to insist for witnessing the acceptance/routine testing of the bought out items.

4.0 **QUALITY ASSURANCE PLAN** :

4.1 The tenderer shall invariably furnish following information along with his offer, failing which his offer shall be liable for rejection. Information shall be separately given for individual type of equipment offered.

(i) Statement giving list of important raw materials names of sub-suppliers for the raw materials, list of standards according to which the raw materials are tested. List of tests normally carried out on raw materials in presence of tenderer's representative, copies of test certificates.

(ii) Information and copies of test certificates as in (i) above in respect of bought out accessories.

(iii) List of manufacturing facilities available.

(iv) Level of automation achieved and list of areas where manual processing exists.

(v) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.

(vi) Special features provided in the equipment to make it maintenance free.

(vii) List of testing equipments available with the tenderer for final testing of equipment specified and test plant limitation. If any, vis-avis the type, special acceptance and routine tests specified in the relevant standard. These limitations shall be very clearly brought out in schedule of deviations from specified test requirements.

4.2 The successful tendered shall within 30 days of placement of order, submit following information to the purchaser.

(i) List of raw materials as well as bought out accessories and the names of sub suppliers selected from those furnished along with offer.

(ii) Type test certificates of the raw material and bought out accessories.

(iii) Quality assurance plan (QAP) with hold points for purchaser's inspection. The quality assurance plan and purchasers hold points shall be discussed between the purchaser and supplier before the QAP is finalized.

4.3 The successful bidder shall submit the routine test certificates of bought out accessories and central excise passes for raw material viz. oil, copper, aluminum, conductors, insulating materials, core material at the time of routine testing of the fully assembled equipment.

4 .4 DOCUMENTATION :

5.1 All drawing shall conform to International Standards organization (ISO). A series of drawing sheet/Indian standards specification IS.656. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. Units.

4.1 List of drawings and documents.

The bidder shall furnish four sets of following drawings along with his offer.

a) General outline and assembly drawings of the equipment.

b) Graphs showing the performance of equipment

c) Sectional views showing :-

i) General Constructional features.

ii) The materials/gaskets/sealing used.

iii) method of connections.

iv) Porcelain used and its dimensions along with the mechanical and electrical characteristics.

d) Arrangement of terminal's and details of connection studs provided.

e) Name Plate.

f) Schematic drawing :-

g) Type test reports in case the equipment has already been type tested.

h) Test reports, literature, pamphlets of the bought out items, and raw material.

4.2 The successful tender shall, within 2 weeks of placement of order, submit four sets of final version of all above said drawings for purchaser's approval. The purchaser shall communicate his comments/ approval on the drawings to the supplier within four weeks. The supplier shall, if necessary modify the drawings and resubmit three copies of the modified drawings for owner's approval within two weeks from the date of owner's comments. After receipt of owner's approval, the supplier shall within two weeks, submit. 15 prints and two good quality reproducible of the approved drawings for purchaser's use.

4.3 Six sets of the type test reports, duly approved by the purchaser, shall be submitted by the supplier for distribution before commencement of supply. Adequate copies of acceptance and routine test certificates, duly approved by the purchaser, shall accompany the dispatched consignment.

4.4 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.

4.5 15 sets of nicely printed and bound volumes of operation, maintenance and erection manuals in English language for each type and rating of equipment supplied shall be submitted by the supplier for distribution, prior to the dispatch of the equipment. The manual shall contain all the drawings and information required for erection, operation and maintenance of the equipment. The manual shall also contain a set of all the approved drawings, type test reports etc.

4.6 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.

5 PACKING AND FORWARDING

5.1 The equipment shall be packed in crates suitable for vertical/horizontal transport as the case may be, and suitable to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbol. Wherever necessary, proper arrangement for lifting, such as lifting books etc. shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

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

a) Name of the consignee.

Details of consignment.

Destination

Total weight of consignment.

Sign showing upper/lower side of the crate.

Handling and unpacking instructions.

Bill of material indicating contents of each package.

The supplier shall ensure that the packing list and bill of material are approved by the purchaser before dispatch.

TOPOGRAPHICAL AND METEOROLOGICAL SITE CONDITIONS

Location of installations	State of ODISHA
Altitude	1000 m
Maximum Temperature	60°C
Minimum Temperature	0°C
Maximum daily average temperature	35°C
Maximum humidity 100%	
Pollution level	Heavy
Airborne contamination, if any	Highly Polluted
Seismic withstand factor	0.3 g
Maximum wind pressure	260 kg/m ²
Wind velocity	50m/sec
Maximum rainfall per annum	2000 mm
Average rainfall per annum	1500 mm
Average no. of thunder-storm days/annum	70
Average no. of dust storm days per annum	20

GUARANTEED TECHNICAL PARTICULARS FOR CIRCUIT BREAKERS

(To be filled in & furnished by the Bidder , separately for 420 Kv, 245 KV & 145 KV SF6 Circuit Breakers)

(a)Maker's name and country of manufacture

(b) Manufacturer's type Designation

2. Applicable technical standards

3. (a)Rated voltage(kV)

(b)Rated frequency(Hz)

4. Number of Poles

5. Class

6. Rated normal current

(a) Under site conditions(Amps)

(b) Rated (Amps)

7. (a) Rated short circuit breaking current

(i) Rms value of AC component of rated short circuit current (KA)

(ii)Percentage DC component

(iii)Assymetrical Breaking Current at Highest System Voltage

(iv)Certificate or report no

(v)Oscillogram no.

(b)Rated short circuit making current (KA peak)

(i)At Higher rated Voltage

(ii)At Lower rated Voltage

(c) Maximum Breaking capacity Under Phase Opposition(KAP)

(i)Max Pole discrepancy(ms)

(ii)Max arc duration & Corresponding current under lockout pressure

8. First pole to clear factor
 9. Rated transient recovery voltage for terminal faults
(kV peak)
 10. Rated characteristics for short line faults.
 11. Rated operating sequence
 12. Rated duration of short circuit(Sec.)
 13. Rated out of phase making & breaking current (kA)
 14. (a) Opening time (ms)
 - (i) Maximum Opening time under any condition
 - (ii) With limiting Voltage & Pressure.
 - (b) Arcing time (ms)
 - (i) At 100% rated breaking current (ms)
 - (ii) At 50% rated breaking current (ms)
 - (iii) At 25% rated breaking current (ms)
 - (iv) At 10% rated breaking current (ms)
 - (v) Maximum arcing time at lowest
fault current (ms).
 - (c) Break Time (ms)
 - (i) At 100% rated breaking current (ms)
 - (ii) At 50% rated breaking current (ms)
 - (iii) At 25% rated breaking current (ms)
 - (iv) At 10% rated breaking current (ms)
 - (v) Maximum break time at lowest fault current (ms).
 - (i) Maximum Total Break Time under any duty condition
- For any current up to rated breaking current with limiting condition of Voltage & Pressure(ms)
- (d) Closing time (ms)

- (e) Minimum dead time for 3 phase reclosing
- (f) Maximum Close Open Time under any condition
 - With limiting Voltage & Pressure.
- (g) Minimum Time Interval between each make/ Break Operation.
- 15. Rated line charging breaking current (kA)
- 16. Rated small inductive breaking current (kA)
- 17. (i)Max. rise of temperature over ambient for
current rating under sl. 6.
(ii)Max. rise of temperature for
Main contacts over design ambient temperature of 50deg C.
- 18. Interrupting capacity based on duty cycle as per sl. 11.
 - (a) AC ;component (kA)
 - (b) Percentage DC component.
- 19. Latching current (kA)
- 20. No. of breaks in series per pole.
- 21. Length of contact travel (mm)
- 22. Total length of break per pole (mm)
- 23. Rate of contact travel:
 - (a) At tripping (metres/sec.)
 - (b) At closing (metres/sec.)
- 24. Type of devices, if any, used to obtain
uniform voltage distribution between breaks.
- 25. Recovery voltage distribution between
breaks in percent of rated voltage.
 - (a) Single line to ground fault
 - (b) Interruption on short lines.

- (c) Switching off an unloaded, transformer
- 26. (i) Type of main contact.
 - (i) Number of auxiliary contacts per pole for normal operation(NO & NC)
 - (ii) Number of auxiliary contacts per pole provided for Owner's use(NO & NC)
 - (iii) Current rating of Auxiliary contacts
- 27. Type of arcing-contacts and/or arc control device
- 28. Material of contacts:
 - i. Main
 - ii. Arcing
 - iii. Whether contacts are silver plated
- iv. Thickness of silver coating mm
- v. Contact pressure, kg/sq. mm.
- 29. Insulation level of the breaker:
 - (a) 1 minute power frequency withstand voltage kV rms(Dry & Wet)
 - (i) Between live terminals & Ground
 - (ii) Between terminals with Breaker contacts open
 - (a) Switching surge withstand test Voltage kV (peak)
 - To earth
 - Across open contacts
 - (c) Lightning impulse withstand test voltage, kV(peak)
 - To earth
 - Across open contacts
 - (d) Max. dynamic power frequency over voltage withstand kV (peak)

30. i) RIV level (Max)
- (viii) Corona inception voltage (kV rms)
- (ix) Corona extinction voltage (kV rms)
31. Minimum clearances
- (a) Between phases (live parts)(mm)
- (b) Between live parts and earth (mm)
- (c) Total Creepage Distance
- (i) To ground (ii) Between Terminals
32. Whether the circuit breaker is fixed trip or trip free
33. Method of closing
- (a) Normal
- (b) Emergency
34. Type of closing mechanism
35. (a) Normal voltage of closing
- (b) Pick up range (volts DC)
36. (a) Power at normal voltage of closing mechanism (watts)
- (b) Power at 85% of normal voltage of closing mechanism(watts)
- (c) No of closing coils in operation
37. Type of tripping mechanism
- Number of Tripping Coil
38. (A) Normal voltage of tripping coils(volts)
- (a) Power at normal voltage for Tripping coils (watts)
- (b) Power at 70% normal voltage for Tripping coils (watts).
- (c) No. of tripping coils in operation
- (d) Pick up range (V DC)

(B) Number of close open operation

(i) possible after failure of AC supply to motor

(ii) Time required for motor to charge the closing spring(Sec)

(iii) Whether indication of spring charged condition will be provided in control cabinet.

39. Arc duration at 100% (ms)

40. Interruption capacity:

2 Opening

Arcing time no. of loops and time including resistor current duration (cycle)

Resistor current duration (cycle)

Total length of the arc (mm)

Max. length of the arc (mm)

Total interrupting time measured from instant of trip coil energization to arc extinction of resistor current (cycles)

3 Closing time measured from instant of application of power to closing device upto arcing contacts touchings (cycles)

41. Critical current (current giving the longest arc when a break takes place) (kA)

a) Recovery voltage when circuit breaker tested at 100% rated breaking capacity (kV inst.)

b) Rate of rise of restriking voltage at breaking

i) for 30% breaking capacity (kV/microsecs.)

ii) for 100% breaking capacity (kV/microsecs.)

c) Maximum over-voltage factor of the circuit breaker when switching off.

i) Unloaded transformers

ii) Loaded transformer

iii) Open circuited lines

42. When switching of synchronous systems:

- (a) Max. current (kA)
- (b) Max. contacts of 1 pole (kV)

43. No. of openings the circuit breaker is capable of performing without inspection, replacement of contacts or other main parts.

- (a) at 50% rated current
- (b) at 100% rated current
 - (c) at current corresponding to 50% rated breaking capacity.
 - (d) at current corresponding to 100% rated breaking capacity.

44. (A)a) Weight of complete circuit breaker (Kg).

b) 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.)

c) Overall dimensions:

Height (mm)

Width (mm)

Length (mm)

(B)- Type & Material of Gasket used to ensure gas tight joints for

(i) Metal to Metal Joint

(ii) Metal to Porcelain Joints

(C) Type & Make of

a) Density Monitor

b) Pressure Gauge

(D) Density Monitor Setting

a) Lock Out

b) Alarm

45. Porcelain:

i) Make

j) Type

k) Descriptive pamphlet no.

l) Weight (kg.)

m) Transport dimensions (mm)

n) Height above floor, required to remove porcelain (mm).

o) Insulation class

p) One minute power frequency withstand, kV (rms) (dry & wet)

q) Flash over voltage (kV)

r) Lightning impulse withstand voltage kV (peak) (dry & wet)

s) Switching surge withstand voltage kV (peak) (wet)

t) Corona discharge voltage (kV rms)

u) Creepage distance, total protected (mm)

v) Permissible safe cantilever loading on installed porcelain (Kg.m)

46. (i) Rated pressure of SF₆ gas in the circuit breaker (Kg/sq.cm)

(ii) Rated Pressure of SF₆ in operating Chamber(kg/cm²) at 20deg C

(iii) Limits of Pressure of extinguishing medium

47. Rated pressure of SF₆ gas in the gas cylinders (Kg/sq.cm)

48. (i) Quantity of SF₆ gas required per single pole unit (Kg.) at rated Pressure & at 20 deg C

(ii) Guaranteed Maximum Leakage rate per Year.

49. Quantity of SF₆ gas per cylinder (Kg.)

Standard to which SF₆ Gas Complies.

(i) Weight of empty cylinder (Kg.)

(ii) Whether Breakers are dispatched filled with SF₆ Gas or filled at site.

Quantity of absorbent required per pole (Kg.)⁵².

Recommended interval for renewal of absorbent in case of outdoor circuit breakers operating in tropical conditions.

- iv) Chemical composition of absorbent
- v) Quantity of absorbent covered in the scope of supply
(Including spare quantities)
- vi) Limits of gas pressure for pressure operation of circuit breaker – (Kg/sq.cm)
- vii) Pressure and temperature at which the temperature compensated gas pressure switch will
 - a) give alarm (Kg/sq.cm., deg. C)
 - b) cut off (Kg/sq.cm. deg. C)
- viii) Name of SF₆ supplier and country of origin.
- ix) Quantity of SF₆ gas supplied for
 - a) Actual use in breakers (Kg.)
 - b) As spare (Kg.)
- x) Chemical composition of gas:
 - a) Qty. of air by weight (ppm)
 - b) Qty. of H₂O by weight (ppm)
 - c) Qty. of CF₄ by weight (ppm)
 - d) Qty. of free acid by weight (ppm)
 - e) Density
 - f) Oil Content
 - g) Resistivity
- xi) Motor For Circuit Breaker
 - (a) Manufacture's name & address
 - (b) Equipment driven by motor or not.
 - (c) Motor Type
 - (d) Country of Origin
 - (e) Type of Duty

- (f) Type of Enclosure & Method of Cooling
 - (g) Applicable Standard to which motor confirms
 - (h) Type of mounting
 - (i) Direction of rotations as viewed from non driving end.
 - (j) Standard Continuous rating at 50deg C
 - (k) Rated Voltage
 - (l) Rated Speed at rated Voltage & Frequency(rpm).
 - (m) Full Load current at rated voltage & frequency.
 - (n) Power Factor at rated load.
 - (o) Rating of the Motor.
 - (p) Time for fully charging the closing spring
- xii) Control Cabinet
- i. Material of enclosure
 - ii. Thickness of sheet steel
 - iii. Painting for control cubicle
 - iv. Paint shade
 - v. Degree of protection
 - vi. Dimension
 - vii. Material of gasket

Name of the firm..... Signature of Bidder.....

Designation & Seal Date

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 36 KV

CIRCUIT BREAKERS

1. Name of Manufacturer.
2. Manufacturer's type designation.
3. Rated Voltage. - KV
4. Maximum (continuous) service rated Voltage - KV
5. Normal current rating.
 - a) Under normal conditions.
 - b) Under site conditions.
6. Short time current rating for seconds (rms)
7. Maximum temperature rise over ambient. -°C
8. Breaking capacity.
 - a) Symmetrical. KVA
 - b) Assymmetrical. MVA
9. Making capacity. KA
10. Total break time in ms.
 - a) at 10% rated interrupting capacity - MS
 - b) at rated interrupting capacity - MS
11. Arcing time. - M.S.
12. Make time. - M.S.
13. Minimum reclosing time at full rated - M.S.

Interrupting MVA from the instant of Trip coil energization.
14. Minimum dead time for 3 phase reclosing.- M.S.
15. Whether restricting free. - Yes/No
16. One minute dry power frequency

Withstanding test voltage (KV rms)

Between line terminal and ground objects. - KV rms.

Between terminal with breaker contacts open. -KV rms.

17. 1.2/50micros full wave impulse withstand test voltage for the two cases above.

i) Between line terminal & grounded objects. -KV(Peak)

ii) Between terminal with breaker Contacts open. -

18. **Busing or Insulators :**

i) Type of bushing. -

ii) Dry 1 minute power frequency - KV rms

withstand test voltage.

iii) Dry flashover value. - KV rms.

iv) Wet flashover value. - KV rms.

v) 1.2/50 impulse withstand - KV(Peak)

vi) Creepage distance. - mm

vii) Puncture value of bushing. - KV

viii) Weight of bushing. - Kg.

19. Minimum clearance in air.

i) Between phases. - mm

ii) Live parts to earth. - mm

iii) Live parts to ground level - mm

iv) Between live parts & grounded object. - mm

20. Number of poles of circuit breaker.
21. Number of breaks per phase.
22. Total length of break per phase.
23. Type of main contacts.
24. Type of Aux. Contacts.
25. Materials of auxiliary contacts.
26. Contacts silver plated or not.
27. Thickness of silver plating.
28. Contact pressure.
29. Voltage distribution between breaker.
30. Type of device if any, used to limit
the rate of rise or restricting voltage.
31. Voltage grading device if any used.
32. Number of auxiliary contacts provided.
 - i) Those closed when breaker is closed.
 - ii) These open when breaker is closed.
 - iii) Those adjustable with respect to
the position of main contacts.
33. Type of operating mechanism.
 - i) Opening
 - ii) Closing.
34. Control circuit voltage.
35. Power required for trip coil - Watts

at 220V D.C.

- 36. Power required for close coil
At 220V D.C. - Watts
- 37. Frequency at which contacts are
To be replaced.
- 38. Nos. of terminal connector.
- 39. Steel support structure galvanized - Whether
With foundation – Nuts & Bolts to be provided yes or no
- 40. Type test certificate Furnished - Yes/No
- 41. Circuit Breaker weight. - Kg.
- 42. Quantity. - Nos.

Name of the Firm:-

Signature of the bidder:-

Designation & seal:-

Date:-