



SUPPLY CHAIN MANAGEMENT THIRUVANANTHAPURAM

SPECIFICATION

220kV, 110kV & 66kV SF6 CIRCUIT BREAKERS

APPLICABLE TO KSEBL

Rev#0

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Technical Specification and Evaluation Committee for Transmission Material



SUPPLY CHAIN MANAGEMENT

Thiruvananthapuram

TECHNICAL SPECIFICATION

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(i) Document Approval & Control Status

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Date	23/04/2021	23/04/2021	03/05/2021
Signature	Sd/-	Sd/-	Sd/-

(ii) Amendments and History

Sec. #	Rev. #	Date	History of Change



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1. Purpose:

Purpose of this document is to document updates & history, upkeep and publish the specifications related to **220kV,110kV & 66kV SF6 Circuit Breakers** in a professional manner

2. Scope:

The Scope of this document is to inform and alert all relevant stakeholders including KSEBL, Public, KSERC etc regarding the current specifications and historical changes adopted in specifications of **220kV, 110kV & 66kV SF6 Circuit Breakers** used in field by KSEBL

3. Responsibility:

The Executive Engineer (T), Office of Chief Engineer, Supply Chain Management shall compile and take necessary steps to publish the specification in KSEBL website and shall inform relevant stakeholders regarding updates and revisions

4. Procedure for Revision:

Modifications if any, in the technical specification will be incorporated as **Revisions**. Any changes in values, minor corrections in pages, incorporation of small details etc. will be considered as Minor Modification. **The Revisions due to minor modifications will be assigned as Rev. No.0.1, 0.2 etc.**

A complete updation of the technical specification will be considered as Major modification. **The Revisions due to major modifications will be assigned as Rev. No.1.0, 2.0 etc.**

All the details of regarding the revisions (both minor and major) will be incorporated in **“(ii)-Amendments and history”** above.

The concerned officers, in consultation with the Technical Committee will review and suggest changes required and the revision suggestion will be approved by **Chief Engineer (SCM)**. Those who notice any discrepancy or have any suggestion regarding revision, may bring the matter to the attention of Chief Engineer (SCM) in writing or through e-mail id:**cescm@kseb.in**



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TECHNICAL SPECIFICATION FOR 220KV,110kV & 66kV SF6 CIRCUIT BREAKERS

1) SCOPE:-

This specification covers the design, manufacture, assembly, inspection and testing at manufacturers works, delivery and commissioning of 220, 110kV and 66kV circuit breakers complete with Structures, SF6 gas cylinders and accessories required for its satisfactory operation and satisfactory commissioning in various sites. Scope of supply includes a suitable adaptor with Gas filling kit assembly shall be provided along with breakers for filling the SF6 gas. 220kV – 2Nos., 110kV -10 Nos. & 66kV – 1 No.

2) TYPE AND RATING:-

The circuit breakers shall be of the SF6 gas type suitable for outdoor operation under the climatic conditions specified without any protection from sun and rain.

3) STANDARDS:-

The circuit breaker shall comply with the latest issue of Indian Standards(IS13118/1991(latest revisions)) or IEC 62271-100 & 60060 (latest revisions), IEC: 60694 for gas Circuit breakers. Breakers meeting any other authoritative standards which ensures an equal or better quality than the standards mentioned are also acceptable.

Sl.No.	Standard	Title No.
1)	IEC-62271-100	Specification for alternating current circuit breaker
2)	IEC-62271-203	Gas Insulated metal-enclosed switch gear for rated voltage above 52 kV
3)	IEC-62271-1	Common clauses for high voltage Switch gear and control-gear standards
4)	IEC-62271-102	Alternating current earthing switches Induced current switching
5)	IEC-60137	Bushing for alternating voltages above 1000V
6)	IEC-62271-209	Cable connections for gas-insulated switch gear



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7)	IEC-60480	Guide to checking of sulphur hexafluoride taken from electrical equipment
8)	IEC-376	Specification and acceptance of new supply of sulfur hexafluoride
9)	IEC-60947	Degree of protection provided for enclosures for low voltage switchgear and control gear.
10)	IS-325	Specification for three phase induction motors
11)	IS-2516	Specification for high voltage alternating current circuit breaker
12)	IS-2629	Recommended practice for hot dip galvanizing of iron and steel
13)	IS-2099	High Voltage Porcelain Bushing
14)	IS-2486	Specifications for Clamp connectors
15)	IS-2062	Hot Rolled Medium and High Tensile Structural Steel

The circuit breaker shall have the following technical particulars.

	220kV CB	110kV CB	66kV CB
Nominal system voltage	220kV	110kV	66kV
No. of poles	3	3	3
Highest System Voltage	245kV	145kV	72.5kV
Rated frequency	50 Cycles	50 Cycles	50 Cycles
Rated continuous current (Minimum)	3150A	3150A	2500A
Short time withstand current rating	50kA, 3 Sec.	40kA, 3 Sec.	31.5kA 3 Sec.

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Rated short circuit breaking current	50 kA	40 kA	31.5kA
Automatic rapid reclosing	1 phase & 3 phase	3 phase only	3 phase only
Basic insulation level	1050kVp	550kVp	325kVp
Total break time	2 Cycles	3 Cycles	3 Cycles
Rated operating sequence	O-0.3sec-CO-3Min-CO	O-0.3sec-CO-3Min-CO	O-0.3sec-CO-3Min-CO
Rated line charging breaking current	120A	50A	10A
Short circuit making current	125 kAp	100 kAp	100kAp
Duration of short circuit	3 sec	1 sec	1 sec
Rated break time as per IEC (ms)	≤ 60	≤ 60	≤ 60
Total closing time (ms)	Not more than 150	Not more than 150	Not more than 150
Trip coil and closing coil voltage	110V DC one closing coil and two tripping coils. Both trip circuits shall be independent	110V DC one closing coil and two tripping coils. Both trip circuits shall be independent	110V DC in duplicate, independent trip coils
Spare Auxiliary breaker contacts	10 NO + 10 NC	10 NO + 10 NC	10 NO + 10 NC
Rated Power frequency withstand voltage	460 kV	230 kV	230 kV

4) CLIMATIC CONDITIONS:-

The climatic conditions at site under which the equipment shall operate satisfactorily, are as follows:



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Maximum temperature of the air in shade	40 ° C
Minimum temperature of the air in shade	17 ° C
Maximum humidity	100%
Average number of thunderstorm days per annum	50
Average number of dust-storm days per annum	5
Average number of rainy days/annum	90
Average annual rainfall	3000 mm
Number of months of tropical monsoon Condition per annum	5
Maximum wind pressure	100 Kg/sq.metres
Max. altitude not exceeding	1000 m.

5) GENERAL:-

The SF6 gas Circuit breaker shall comprise three identical single pole units complete in all respects with all piping, fittings etc.suitable for gang operation.The breakers shall be of spring-spring type. All pipes and fittings shall have adequate mechanical strength and shall remain pressure tight. Safety valves shall be provided where necessary to prevent damage due to excessive pressure. Suitable coolers and strainers shall be provided for successful operation of the breaker under the severest operating conditions. Standard structure for mounting the breakers shall also be included.The Circuit Breaker shall be complete with terminal connectors, operating mechanism, control cabinets, piping, cable accessories like glands, terminal blocks, marking ferrules, lugs, density monitors (with graduated scale), galvanized support structure for CB, their foundation bolts and all other circuit breaker accessories required for carrying out all the functions the CB is required to perform. All necessary parts to provide a complete and operable Circuit Breaker installation such as main equipment, terminals, control parts, connectors other devices whether specifically called for herein or not shall be provided.

The circuit breaker shall meet the duty requirements for any type of fault or fault location also for line switching when used on a effectively grounded system, and perform make and break operations as per the stipulated duty cycles satisfactorily.

Local operation of the breaker shall be possible from a ground level mounted central control Cabinet, fixed nearer to and in front of the CB unit. The breaker operating mechanism accommodating cubicle on each pole shall be provided with suitably sized platform with steps for facilitating inspection of cubicle, routine maintenance of operating mechanisms, replacement of trip/ close coils, verification of Gas level/ Gas leakage of the Gas monitor etc.

The breaker shall be capable of interrupting the steady state and transient magnetizing current corresponding of power transformers.

The circuit breaker shall also be capable of:

- i) Interrupting line/cable charging current as per IEC without any restrikes.
- ii) Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
- iii) Breaker shall be suitable for switching (breaking and making) capacitor banks
- iv) Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition. The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges. The breaker shall also withstand the voltages specified in this Section

The SF6 Circuit Breaker shall meet the following additional requirements :

- a) The circuit breaker shall be single pressure type. The design and construction of the circuit breaker shall be such that there is a minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6 gas on the internal insulating surfaces of the circuit breaker.
- b) All gasketed surfaces shall be smooth, straight and reinforced, if necessary, to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF6 media) shall have adequate seals. The SF6 gas leakage should not exceed 1 % per year. In case the leakage under the specified conditions is found to be greater than 1% after one year of commissioning of circuit breaker, the manufacturer will have to supply free of cost, the total gas

requirement for subsequent ten (10) years, based on actual leakage observed during first year of operation after commissioning.

- c) In the interrupter assembly there shall be an absorbing product box to minimize the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be such as fully compatible with SF6 gas decomposition products.
- d) All three poles shall be properly interconnected using proper copper tubes to make the breaker a common SF6 gas pressure system. The copper tubes shall be properly connected to each pole through detachable type non return valves. One common temperature compensated SF6 density monitor with suitable gas filling arrangement shall be provided. It shall be possible to fill/ drain/ vaccuming each pole separately without affecting the gas pressure of other poles. **A suitable adaptor with Gas filling kit assembly shall be provided along with breakers for filling the SF6 gas. 220KV – 2Nos., 110kV -10 Nos. & 66kV – 1 No.**

Each pole shall form an enclosure filled with SF6 gas independent of two other poles, the SF6 density of each pole shall be monitored independently for 220kV Circuit Breakers.

- e) The dial type SF6 density monitor shall be adequately temperature compensated to model the pressure changes due to variation in ambient temperature within the body of circuit breaker as a whole. The density monitor shall have graduated scale and shall meet the following requirements.
- f) It shall be possible to dismantle the density monitor for checking / replacing without draining the SF6 gas by providing suitable interlocked non return valve coupling.
- g) Each Circuit Breaker shall be capable of withstanding a vacuum of minimum 8 millibars without distortion or failure of any part.
- h) Sufficient SF6 gas including that will be required for gas analysis during filling shall be provided to fill all the circuit breakers installed. In addition spare gas of 10 % of total gas requirement shall be supplied in separate unused cylinders.

Provisions shall be made for attaching an operational analyser after installation of circuit breakers at site to record contact travel, speed and making measurement of operating timings, preinsertion timings of closing resistors if used, synchronisation of contacts in one pole. In case operation analyzer is already available at a particular site, the supplier shall have to supply a suitable adopter so that the offered Circuit Breaker can be used with the operational analyzer.



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The operation analyser available with the KSEBL testing team is Megger make TM-1800 breaker analyzer.

6) RECOVERY VOLTAGE AND POWER FACTOR:-

- 6.1) The circuit breaker shall be capable of interrupting rated power with recovery voltage equal to the rated maximum line to line service voltage at rated frequency and at a power factor not exceeding 0.15.
- 6.2) The breaker shall be capable of satisfactory operation even under conditions of phase opposition that may arise due to faulty synchronising. The maximum power, which the breaker can satisfactorily interrupt under phase opposition, shall be stated.

7) RESTRIKING VOLTAGE:-

- 7.1) The circuit breaker shall be restrike free as per IEC under all duty conditions and shall be capable of performing their duties. The breaker shall be capable of interrupting the rated power when the restriking voltage has frequency of not less than 400 cycles per second and with a restriking voltage having a frequency of 2000 cycles per second. The circuit breaker shall be capable of interrupting at least 50% of nominal breaking capacity. The complete data for the frequency, amplitude factor etc. for the rate of rise of restriking shall be furnished.
- 7.2) The measures adopted for ensuring proper operation of high rate of rise of restriking voltage and for limiting the actual voltage values across the breakers shall be furnished. The type, characteristics and rating of the resistor used, if any, to shunt the breaker contacts the resistor used, if any, to shunt the breaker contacts, and the auxiliary switching devices used for interrupting the resistor current shall be clearly stated.

8) LINE CHARGING CURRENT INTERRUPTING CAPACITY:-

- 8.1) The circuit breaker shall be designed so as to be capable of interrupting line charging currents without undue rise in the voltage on the supply side and without any restrike and without showing signs of undue strains. The guaranteed over voltages which will not be exceeded while interrupting rated line charging breaking currents shall be stated.
- 8.2) The results of the tests along with copies of the oscillographs conducted to prove the ability of the breaker to interrupt these and lower line charging current values shall be furnished.

8.3) Total Break Time:-

- 8.3.1) The total break time as specified under this section shall not be exceeded under any of the following duties :

Test duties 1,2,3,4,5	(TRV as per IEC : 62271-100)
Short line fault L75, L90	(TRV as per IEC : 62271-100)

8.3.2) The Bidder may please note total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, (70-110%) and arc extinguishing medium pressure etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidders 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.

8.3.3) The values guaranteed shall be supported with the type test reports

9) TRANSFORMER CHARGING CURRENT BREAKING CAPACITY:-

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

10) SHUNT CAPACITOR SWITCHING CAPACITY:-

The maximum rating of single bank of shunt capacitors which can be switched by the circuit breakers without restriking shall be stated along with over – voltage occurring during such switching.

11) BREAKING CAPACITY FOR KILOMETRIC FAULT:-

The interrupting capacity of the breaker for kilometric faults (short line faults) shall be the same as the rated capacity. The details of tests conducted for proving the capabilities of the breaker under kilometric fault conditions shall also be stated.

12) AUTOMATIC RAPID RECLOSING:-

The Circuit Breakers shall be suitable for 1 phase & 3 phase auto reclosing for 220kV and for 3phase for 110kV CB. The perating duty of the Circuit Breaker is O-Q-CO in which the Q represents the dead time of the circuit breaker. If the dead time of the circuit breaker is adjustable the limits of adjustment shall be stated. The maximum dead time shall be 300ms.

All the duty requirements shall be proved with the support of adequate test reports to be furnished as per latest revision of IS/IEC 62271-100.

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 the direct rays of sun shall not exceed the permissible limits fixed in latest issue of relevant standards. When the standards specify the limits of temperature rise these shall not be exceeded when corrected for the difference between ambient temperature at site and the ambient temperature specified in the approved specifications. The correction proposed shall be stated and shall be subject to approval of the purchaser.

14) CONTACTS:-

- 14.1) All making and breaking contacts shall be sealed and free from atmospheric effects. The contacts shall be permanently under pressure of SF6 gas. The gap between open contacts shall be such that it can withstand the rated dielectric stresses at zero guage pressure of SF6 gas due to its leakage.
- 14.2) Main contacts shall be the first to open and the last to close so that there will be little contact burning and wear.
- 14.3) Arcing contacts shall be the first to close and the last to open and shall be easily accessible for inspection and replacement. If there are no separately mounted arcing contacts, the main contacts shall be accessible for inspection and replacement.
- 14.4) Main contacts shall have ample area and contact pressure for carrying the rated current and the short time rated current of the breaker without excessive temperature rise, which may cause pitting or welding.
- 14.5) Contacts shall be adjustable to allow for wear, easily replaceable and shall have a minimum of movable parts and adjustments to accomplish these results.
- 14.6) Tips of arcing and main contacts shall be silver-plated or have a tungsten alloy tipping.
- 14.7) Diagrams showing contacts in the following positions shall be furnished.
 - 1) Close position
 - 2) Arc initiation position
 - 3) Full arcing position
 - 4) Arc extinction position
 - 5) Open position



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15) INSULATION OF CIRCUIT BREAKER:-

- 15.1) The insulation to ground, the insulation between open contacts and the insulation between phases of the completely assembled circuit breaker shall be capable of withstanding satisfactorily dielectric test voltages corresponding to the basic insulation levels of each rating of CBS.
- 15.2) The medium utilised for insulating purposes across open contacts and the insulation strength of the breaker at the lowest permissible gas pressure shall be stated.
- 15.3) The clearances in open air shall be as follows:

Minimum Ground Clearances	} As per IS
As per IS	
Minimum clearance between live parts and earth	
Minimum clearance between phases	
Minimum clearance of live terminal to ground	

15.4) INSULATORS:-

- i) The porcelain of the insulators shall conform to the requirements stipulated in this specification.
- ii) The mechanical characteristics of insulators shall match with the requirements specified.
- iii) All insulators shall conform to IEC-61264 (for pressurised hollow column insulators) and IEC-233 (for other). All routine and sample tests shall be conducted on the hollow column insulators as per these standards with requirements and procedures modified as under:
 - a) Pressure test as a routine test.
 - b) Bending load test as a routine test
 - c) Bending load test as sample test on each lot
 - d) Burst pressure test as a sample test on each lot
 - e) In addition to above, ultrasonic test shall be carried out as additional routine test.

- iv) Hollow Porcelain for pressurised columns/ chambers should be in one integral piece. The colour shade of porcelain shall be brown.

16) **INSULATING SUPPORTS:-**

The basic insulation level of the external insulator supports shall be 1050kVp for 220kV Circuit breaker and 550 kVp for 110kV Circuit Breaker and shall be suitable for installation in contaminated atmospheres. The high pressure hollow insulator shall be protected by a suitable insulating tube which shall withstand a static air Pressure equal to thrice the normal working pressure used shall be homogeneous, and free from cavities or other flaws. They shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above. All bushings of identical ratings shall be interchangeable. The puncture Strength of the bushings shall be greater than the flash over value.

The bushing shall be entirely free from radio disturbance when operating at a voltage up to 10% above rated voltage and shall also be free from external and internal corona. The creepage distance shall not be less than 25mm/kV.

17) **OPERATING MECHANISM AND CONTROL:-**

- 17.1) The circuit breaker shall be designed for remote control from the control room and in addition there shall be provision for manual operation of circuit breakers during maintenance and for local tripping and closing by normal means.
- 17.1.1) The operating mechanism shall be of spring and shall be trip free. The mechanism shall perform satisfactorily the reclosing duty cycles indicated in the GTP.
- 17.1.2) The operating mechanism along with its accessories shall be mounted in a weather and vermin proof cabinet with hinged doors located near the breaker. The local control switch and the breaker position indicator shall be provided in this cabinet. The control circuits shall be designed to operate on 110 Volts D.C for Circuit Breaker. The closing and opening coils shall be designed to operate satisfactorily at any control voltage from 70% to 110% from the normal voltage.
- 17.1.3) A space heater with thermostat control shall be provided in the cabinet to prevent moisture condensation. The space heater shall be fixed on bottom side of the cabinet and shall be not very near to the wirings to avoid heating up of wirings.
- 17.1.4) The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing.



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- 17.1.5) The mechanism shall be such that the failure of any auxiliary spring will not prevent tripping and will not cause trip or closing operation of the power operating devices.
- 17.1.6) A mechanical indicator shall be provided to show open and close position of the breaker in addition to facilities for remote indication. 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.
- 17.1.7) Working parts of the mechanism shall be corrosion resisting material, bearings which require grease shall be equipped with pressure type grease fittings. Bearing pin, bolts nuts and other parts shall be adequately pinned or locked to prevent loosening or changing adjustment with repeated operation of the breaker. An operation counter shall be provided in the operation cabinet of each pole.
- 17.1.8) The bidder shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker. The instruction manual shall contain exploded diagrams with complete storage, handling, erection, commissioning, troubleshooting, servicing and overhauling instruction.
- 17.2) **CONTROL:-**
- 17.2.1) The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.
- 17.2.2) The 220kV Circuit breaker shall be provided with 2 trip coils per phase and 110KV and 66kV shall be gang operated and should provide 2 trip coil per Circuit Breaker. Provision shall be made for supervision of each trip circuit completely to the maximum end possible both in post close and pre close condition of the breaker by wiring necessary NC/NO contacts in series with trip coils. Each trip coil shall be designed to get DC supply from two independent DC branches.
- 17.2.3) Closing coil shall be connected to one of the above two DC branches.
- 17.2.4) The circuit breakers when specified to have duplicated tripping circuit shall have each tripping circuit and coil galvanically separated. It shall be designed such that one of the tripping circuits would be on the same circuit of the closing mechanism of the breakers and is independent of the other tripping circuit.
- 17.2.5) 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 control switch /

push buttons shall be provided in the Breaker central control cabinet. The control shall be such that (1) when the Local/Remote selector switch is in Local mode both closing and tripping (electrically) shall be possible from local only and (2) when the Local/Remote selector switch is in Remote mode both closing and tripping (electrically) shall be possible from remote only. Protection tripping shall be irrespective of the position of the Local/Remote selector switch. Provision shall be given for closing and opening the breaker mechanically (without using the auxiliary electric supply).

- 17.2.6) Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coil and associated circuits 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 operate. 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. The DC supply shall be of 110V DC and hence the relays/auxiliary relays connected shall comply the same.
- 17.2.7) Density Monitor contacts and pressure switch contact shall be suitable for direct use as permissive in closing and tripping circuits. Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic / schemes are to be employed. DC supplies for all auxiliary circuits shall be monitored and provision shall be made for remote annunciation's and operation lockout in case of D.C. failures. Density monitors are to be so mounted that the contacts do not change on vibration during operation of circuit breaker. Density monitors shall be of such a size & type and its fitting is such that its readings can be taken from ground level regularly.
- 17.2.8) Local operation of the breaker shall be possible from a ground level mounted central control Cabinet, fixed nearer to and in front of the CB unit. This cabinet shall accommodate local/remote switch and TNC/ Close open switches for the operation of the breaker and important indications like close, open and operation counter etc.
- 17.2.9) The auxiliary switch of the breaker shall be positively driven by the breaker-operating rod.
- 17.3) **SPRING OPERATED MECHANISM:-**
- 17.3.1) Spring operated mechanism shall be complete with motor . Opening spring and closing spring with limit switch for automatic charging and other necessary accessories to make the mechanism a complete operating unit shall also be provided.



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- 17.3.2) 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.
- 17.3.3) After failure of power supply to the motor the close open operation as per duty cycle shall be possible with the energy contained in the operating mechanism.
- 17.3.4) Breaker operation 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 30 seconds for full charging of the closing spring. The cranking for manual spring charging shall be at suitable height for easy manual charging of the closing spring. Suitable platform, if required, shall be provided with each circuit breaker.
- 17.3.5) Closing action of circuit breakers shall compress the opening spring ready for tripping.
- 17.3.6) When closing springs are discharged after closing a breaker, closing springs shall be automatically charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.
- 17.3.7) Provisions shall be made to prevent a closing operation of the breaker when the spring is in the partial charged condition. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position.
- 17.3.8) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide the required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism.

18) **AUXILIARY SWITCHES:-**

Sufficient number of spare of auxiliary switches contacts), as indicated in the GTP, both of the 'Normally Open' and "Normally Closed" types shall be provided on each pole for **use in the remote indication for control of the circuit breaker and for safety interlocking**. Special contacts for use with trip coils and single shot reclosing operation which permit of relative adjustment with respect to the travel of the circuit breaker shall also be provided. There shall be provision to add more auxiliary contacts at a later date, if required.

19) TERMINAL CONNECTORS:-

- 19.1) Terminal connectors suitable for ACSR Double Moose for 220kV Circuit Breaker and ACSR 'KUNDAH' shall be provided for 110 kV and 66kV Circuit Breaker and suitable terminal earth connector shall also be provided.
- 19.2) **Terminal Connector Pad:-**The Circuit Breaker terminal pads shall be made up of high quality electrolytic copper or aluminium.

20) SUPPORTING STRUCTURES:-

The circuit breaker shall be suitable for mounting on hot dip galvanized steel structures. The minimum height of such supporting structures shall be sufficient to maintain the ground clearance of 5.5m for 220kV and 4.6m for 110kV and 4m for 66kV vide clause 15.3 above. The hot dip galvanized steel supporting structures shall in general conform to the latest edition of IS : 2629.

The structure design shall be such that during operation of circuit breaker vibrations are reduced to minimum.

The Supplier shall provide suitable platform with steps on both sides of the circuit breaker for easy accessibility of the structure mounted operating mechanism box for monitoring the density / pressure of gas local operations ,manual spring charging and other maintenance works.

21) INTERLOCKS:-

Necessary interlocks to prevent the closing or opening of the breaker under low pressure and devices for initiating alarm shall be provided. Provision shall also be made to enable electrical interlocking with the isolator associated with the breaker to prevent the operation, opening or closing of the isolator when the breaker is closed, etc.

Following general breaker interlocks shall be provided.

- i) It shall not be possible to close the breaker (closing signal shall not reach the closing coil), when the closing spring is not fully charged.
- ii) Once closed, it shall not be possible to close the breaker again till the hand on the TNC switch is released (Anti-pumping feature).

- iii) It shall not be possible to close the breaker, when there is no sufficient SF6 gas pressure in the breaker (lock-out condition).
- iv) Local operation (both closing and opening) shall be possible only if the 'Local/ Remote' switch is in Local mode and vice versa.
- v) It shall not be possible to open the circuit breaker, through any trip coil, when there is no sufficient SF6 gas pressure in the breaker (lock out condition).

22) **SULPHUR HEXAFLUORIDE (SF6) GAS CIRCUIT BREAKER:-**

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.

- 22.1) Circuit breakers shall be single pressure type. The service pressure of SF6 gas may be specified and also whether interrupting capacity can be increased at a later date by increasing the working pressure of gas. The protective measures adopted to prevent operation of the breaker in the event of drop in SF6 gas pressure may also be described.
- 22.2) Design and construction of the circuit breaker shall be such that there is minimum possibility of gas leakage and ingress of moisture. There should not be any condensation of SF6 gas on internal insulating surfaces of the circuit breaker. The type of gas leakage detector used may be described.
- 22.3) The design of the breaker shall be such that, upon loss of pressure, the gap between open contacts shall be suitable to withstand at least the rated voltage at zero gauge pressure of the gas.
- 22.4) In the interrupter assembly there shall be an absorbing product box to eliminate SF6 decomposition products and moisture. The details and operating experience with such filters shall be brought out in additional information schedule.
- 22.5) Suitable pressure switches shall be provided which upon loss of gas shall permit sequential opening of isolator or security clearance of the defective breakers.
- 22.6) Facilities shall be provided to reduce the gas pressure within the circuit breaker to a value not exceeding 8 millibars with 4 hours or less. Each circuit breaker shall be capable of withstanding this degree of vacuum without distortion or failure of any part.
- 22.7) Material used in the construction of circuit breakers shall be such as fully compatible with SF6.

- 22.8) The position of vents, diaphragms and pressure relief devices shall be so arranged to minimise danger to the operators in the event of gas or, vapour escaping under pressure.
- 22.9) The quantity of gas required per breaker shall be indicated. Sufficient SF6 gas shall be provided to fill all the circuit breakers installed plus an additional 20% of the quantity to compensate for losses. Arrangements for replenishing the gas compensate for losses may also be stated.
- 22.10) Sulphur Hexafluoride Gas (SF 6 Gas):- SF6 gas shall comply with IEC – 4376 and suitable in all respects for use in the switchgear under the operating conditions. It shall meet the following requirements.
- 1) Physical Properties :Colourless, Odourless, non-toxic and non flammable
 - 2) Density at 20^o C and one bar : 6.08g/lit.
 - 3) Electric Strength : 2½ times that of nitrogen.
 - 4) Compatibility: Up to temperature of about 180^o C – its compatibility with materials used in electrical construction is similar to that of nitrogen.
 - 5) Toxic Impurities:The SF6 Gas shall comply with the test as per clause (22) as per IEC – 376 – 1971.
 - 6) Impurities: It shall not contain more than the maximum allowable quantities of impurities given below:

Impurity / Group of Impurities		Max. permitted concentration by mass
i.	CF4	0.05%
ii.	Oxygen + Nitrogen (Air)	0.05%
iii.	Water	15 ppm
iv.	Acidity expressed as HF	0.3 ppm
v.	Hydrolysable flourides expressed as HF	1000 ppm
vi.	Oil content	Substantially free from oil

7. Standard Size of Cylinders with SF6 gas: To be supplied along with each breakers –10 litres(gas)

22.11) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with the following standards and regulations.

- i) IS 4379 (Identification of the contents of Industrial Gas Cylinders)
- ii) IS 7311 (Seamless High Carbon Steel – Cylinders for permanent and high pressure liquifiable gases).
- iii) Indian Boiler regulations.

22.12) Permanent means shall be provided for treating the SF6 gas by the use of dessicants, driers, filters etc. to remove impurities in the gas.

22.13) Tests on SF6 Gas

The SF6 gas shall comply with the following tests:

i	Toxicity test	Clause 22 of IE C – 376/76
ii	Water content & condensation temperature	Clause 23,24,25 & 26 of IEC- 376 B of 1974
iii	Carbon tetrafluoride, Oxygen & Nitrogen	Clause – 27, 28, 29, 30, & 31 of IEC- 376 B of 1974
iv	Hydrolysable flourides	Clause 32,32,34,35,36 & 37 of IEC- 376 B of 1974
v	Acidity	Clause 38,39,40,41 & 42 of IEC- 376 B of 1974
vi	Oil content	Section 13 of IEC – 376 A of 1973

23) INTERPOLE CABLING:-

- a) All cables to be used by supplier shall be armoured and shall be as per IS:1554 (1100 Volts Grade). All cables between circuit breaker central control cabinet and between each pole operation cubicle shall be supplied by the Circuit Breaker manufacturer.

- b) Only Stranded conductor shall be used. Minimum size of the conductor shall be 2.5mm (Copper).
- c) The cables shall be with oxygen index Min-29 and temp. index as 250 degree Celsius as per relevant standards.
- d) The inter pole cable/ wiring shall be properly ferruled at either end so that identification shall be easy.

24) **FITTINGS AND ACCESSORIES:-**

Following is a partial list of some of the major fittings and accessories to be furnished by Contractor in the Central Control cabinet. Number and exact location of these parts shall be indicated in the bid. Any other material found necessary for the satisfactory operation of the breaker shall be included.

- i. Cable glands (Double compression type), Lugs, Ferrules etc.
- ii. Local/remote changeover switch.
- iii. Local mechanical OPEN/ CLOSE Lever
- iv. Operation counter.
- v. Control switches to cut off **both AC & DC** control power supplies and other branch circuits.
- 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 future use.
- viii. Antipumping relay.
- ix. Pole discrepancy relay with variable settings range 25ms – 2500 ms)
- x. D.C Supervision relays.
- xi. Rating and diagram plate in accordance with IEC incorporating year of manufacture.
- xii. Temperature compensated gas monitors on each pole

25) **SURFACE FINISH:-**

All interiors and exteriors of tanks and other metal parts shall be thoroughly cleaned to remove rust, scales, corrosion, greases or other adhering foreign matter. 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.



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All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material all machine finished or bright surface 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 extremities of weather within 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.631 of IS:5.

All ferrous hardware exposed to atmosphere shall be hot dipped galvanized. All ferrous parts including all sizes of nuts, bolts, plates and spring washers, support channels, structures etc. shall be hot dipped galvanized to conform to latest version of IS:2629 or any other equivalent authoritative standard.

26) RATING PLATE:-

Weather proof and corrosion proof rating plates showing year of manufacture and other values as per IS shall be provided on all circuit breakers and its operating devices.

27) TERMINAL BLOCKS:-

Terminal blocks shall be of 1100 V grade and of current carrying capacity of 10Amps with insulated barrels stud type terminals suitable for 4 wires upto 2.5sq.mm spring washers, nut and lock nuts and identification strips. All wiring terminations shall be with suitable tinned copper crimped lugs. All wiring shall be carried out with tinned or annealed P.V.C. insulated copper conductor.

28) TESTS:-

28.1) **Type Tests:-**The bidder shall furnish Type test reports of Circuit Breakers of the type and design offered along with the offer. The offer without the type test reports shall be treated as non-responsive. Attested copy of type test report shall be furnished.

Circuit Breaker - Type Tests: -

- i. Temperature rise test for the main circuits
- ii. Measurement of resistance of the main circuit.
- iii. Operation tests.
- iv. Mechanical endurance tests
- v. Impulse voltage tests.

- vi. One minute power frequency voltage dry withstand tests
- vii. One minute power frequency voltage wet withstand tests
- viii. Tests for short circuit conditions
- ix. Tests for short time current.

28.2) The test reports of the type tests and the following additional type tests as per relevant IEC/IS shall also be submitted for Purchaser's review along with the tender.

- i) Corona extinction voltage test.
- ii) Out of phase closing test.
- iii) Line charging breaking current for proving the specified parameters.
- iv) Test to demonstrate the Power Frequency withstand capability of breaker in open condition at zero Gauge pressure and at lockout pressure.
- v) Seismic withstand test in unpressurized condition.
- vi) Verification of the degree of protection.

28.3) Acceptance and Routine Tests.

28.3.1) All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier in presence of purchaser's representative.

28.3.2) **Circuit Breaker - Routine tests:-** All Routine tests as per IEC: 62271-100 and DCRM tests shall be performed on all (100%) circuit breakers. No sample selection is allowed for 220kV Circuit Breaker.

Some tests are given below:

- 1) Measurement of resistance of the main circuits.
- 2) Operation tests.
- 3) One minute power frequency voltage dry withstand tests on the circuit breakers.
- 4) One-minute power frequency voltage dry withstand tests on auxiliary circuits.
- 5) DCRM Test

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

- 1) Speed curves for each breaker shall be obtained with the help of a suitable operation analyser 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, 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 with the supplier's test kit . In case of Sub-Station where operational analyzer is existing the bidder shall utilize the same.
- 2) Measurement of Dynamic Contact resistance measurement for arcing & main contacts. These Dynamic contact resistance measurements shall be taken as reference for comparing the same during operation and maintenance in order to ascertain the healthiness of contacts. The tests shall be carried out from both trip coils.

28.4) **Site Tests:-** All routine tests except power frequency voltage dry withstand test on all circuit breakers shall be repeated on the completely assembled breaker at site. Measurement of Dynamic Contact resistance measurement need not be repeated for 110kV Circuit Breakers at site.

29) **INSPECTION:-**

All routine tests and inspection shall be made at the place of manufacturer unless otherwise especially agreed upon by the manufacturer and purchaser at the time of purchase.

Inspection may be carried out by the purchaser at any stage of manufacture. The supplier shall grant free access to the purchaser's representative at a reasonable time when the work is in progress. Inspection and acceptance of any material under this specification by the purchaser shall not relieve the supplier of his obligation of furnishing materials in accordance with the specification and shall not prevent subsequent rejection, if the material 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 advance intimation. The supplier shall give 20 days enable the purchaser to depute his representative for witnessing the acceptance and routine tests.

The purchaser has the right to have the tests carried out at the supplier's cost by an independent agency wherever there is a dispute regarding the quality of supply.

30) TESTING AND COMMISSIONING:-

30.1) An indicative list of tests is given below. Supplier shall perform any additional test based on specialties of the items as per the field Q.P /Instructions of the equipment Supplier or Employer without any extra cost to the Employer.

- 1) Insulation resistance of each pole .
- 2) Check adjustments, if any suggested by manufacturer
- 3) Breaker closing and opening time.
- 4) Slow and Power closing operation and opening.
- 5) Trip free and anti pumping operation
- 6) Minimum pick up voltage of coils
- 7) Dynamic contact resistance measurement
- 8) Functional checking of control circuits interlocks, tripping through protective relays.
- 9) Insulation resistance of control circuits, motor etc.
- 10) Resistance of closing and tripping coils
- 11) SF6 gas leakage check
- 12) Dew Point Measurement
- 13) Calibration of pressure switches and gas density monitor
- 14) Checking of mechanical 'CLOSE' interlock, wherever applicable.

For the erection and commissioning of circuit breakers, a service engineer has to be deputed by the supplier.

31) Documentation:-

31.1) All drawings shall conform to International Standards Organisation (ISO) ' A' series of drawing sheet / Indian Standards Specification IS:656. All dimensions and data shall be in S.I units.

31.2) **List of Drawings and Documents:-** The bidder shall furnish the following drawings / documents along with the offer.

- a. General outline and assembly drawing of the equipment.
- b. Name Plate.
- c. Schematic drawing, including control wiring.
- d. Supporting structure and foundation drawings.
- e. Terminal connector



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f. Wiring Scheduled

g. Bill of Materials

The supplier shall, within 2 weeks of placement of order, submit four sets of final versions of all the above said drawings for purchaser's approval. The purchaser shall communicate his comments / approval on the drawings to the supplier. The supplier shall, if necessary, modify the drawings and resubmit four copies of the modified drawings for approval.

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 despatch consignment.

The manufacturing of the equipments 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.

Copies 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 despatch of the equipment. The manual shall contain all the drawings and information required for erection, operation and maintenance of the circuit breaker. The manual shall also contain a set of all the approved drawings, type test reports etc.

Routine tests as per latest revision of IS 13118/1991 or IEC 62271-100 and 60060 shall be carried out on each breaker in the presence of purchaser's representative if so desired by the purchaser. All test reports shall be submitted and shall be got approved by the purchaser before despatch of the equipment.

The manual shall contain all the drawings and information required for erection, operation and maintenance of the circuit breaker. The manual shall also contain a set of all the approved drawings, type test reports etc.

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 requirements of the latest revision of application standards, rules and codes of practices. The equipment shall conform in all respects to high standards of engineering, design, workmanship and latest revisions of relevant standards at the time of ordering and purchaser



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shall have the power to reject any work or materials which, in his judgement is not in full accordance therewith.

Sd/-

Chief Engineer (SCM)



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SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 220kV SF6 CIRCUIT BREAKERS

Sl. No.	Description	Board's requirement	220kV
1	Maker's Name and country of manufacture		
2	Manufacturer's type and designation		
3	Application standards	IEC 62271 - 100	
4	Rated voltage and frequency	245 kV and 50 Hz	
5	Number of poles	3	
6	Class: Indoor or outdoor	Outdoor	
7	Rated insulation level	As per IS	
8	Normal current rating:		
a)	Under normal conditions	3150 A	

	b) Under site conditions	3150 A	
9	Maximum ambient temperature assumed for design.	50 Degree Celsius	
10	Maximum rise of temperature over ambient for continuous rated current	Within limits as specified in IEC 62271 - 100	
11	Short time current rating:		
	a) 1 Sec.	50 kA	
	b) 3 Sec.	50 kA	
12	Rated line charging breaking current with the over voltage not exceeding 2.5 p.u.	120 A as per Specification	
13	Rated line charging breaking current and corresponding over voltage recorded in test.		
	a) Supply side	120 A, 1.4 p.u	
	b) Line side	120 A, 1.4 p.u	

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14	Rated cable charging breaking current and corresponding over voltage recorded in tests.		
	a) Supply side	260 A, 1.4 p.u	
	b) Line side	260 A, 1.4 p.u	
15	Rated (Single) Capacitor breaking current.	400 A	
16	Rated small inductive breaking current	0.5-20 A	
17	Rated short circuit breaking current:		
	a) r.m.s. value of a.c. current	50 kA	
	b) Percentage of d.c. current	39%	
	c) Symmetrical breaking current (including d.c. component)	57.1 kA	
18	First-pole-to-clear factor	1.3 as per IEC 62271 - 100	
19	Rated transient recovery voltage	364 kVP (Terminal fault) (IEC:62271-100, table II D)	
20	Rated characteristics for short line fault.	According to IEC 62271 - 100 table IV for Source side table V for	



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		line side	
21	Rated short circuit making current.	125 kA	
22	Rated operating sequence	O-0.3 sec- CO-3 min- CO	
23	Rated out of phase breaking current	12.5 kA	
24	Maximum capacity under phase opposition condition	25% of the rated capacity	
25	Reactor loaded transformer interrupting capacity and corresponding switching surge over voltage.	Yes Reactor current > 100 A and over voltage < 2.3 p.u	
26	Capacity for interrupting in-rush current of transformers and corresponding over voltage.		
27	Data on restriking voltage:		
	a) amplitude factor		
	b) Phase factor		
	c) Natural frequency		
	d) Rate of rise of restriking voltage		

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28	Is the circuit breaker restrike free Yes/No.		
29	Opening time	36 +/- 4 (At rated Voltage)	
30	Maximum break time:		
a)	At 100% rated breaking current	60 msec (At rated voltage)	
b)	At 50% rated breaking current	60 msec (At rated voltage)	
c)	At 25% rated breaking current	60 msec (At rated voltage)	
d)	At 10% rated breaking current	60 msec (At rated voltage)	
e)	At lowest fault current	60 msec (At rated voltage)	
31	Closing time	Not more than 150 Ms	
32	Minimum dead time		
	3 Phase reclosing	300 ms	
	Single phase reclosing	300 ms	

33	Make time and arcing time	Make time 81 +/- 8 Arcing time < 21 msec	
34	Linking mechanism for single pole units		
35	Details of construction of linking mechanism		
36	Maximum difference in time between the instants of contacts touching during closing.		
	a) Within a pole		
	b) Between poles	< / = 5 ms, 50 Hz	
37	Maximum difference in time between the instants of contacts separating during opening of :		
	a) Within a pole		
	b) Between poles	< = 3.3 50 H2	
38	Contact current (current giving longest arc when a break takes place)		



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39	Maximum voltage factor of the circuit breaker when switching off.		
	a) Unloaded transformers	Within the limits of IEC 62771 - 100	
	b) Loaded transformers	Within the limits of IEC 62771 - 100	
	c) Open circuited lines	Within the limits of IEC 62771 - 100	
40	Total interrupting time measured from instant of trip coil energisation to arc extinction of resistor current.	Less than 60 m sec (at rated voltage)	
41	Minimum reclosing time at full rated interrupting capacity from the instant of trip coil energisation.	440 ms (Including dead time 300 ms for first reclosing)	
42	Minimum clearance in open air		
	a) between phases,		
	b) to earth,		
	c) the safety boundaries during a breaking operation for C.Bs. with an external exhaust for connected gases of flame.		



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43	One minute power frequency withstand test voltage:		
a)	Between line terminal and grounded objects.	400 kV mm	
b)	Between terminals with breaker contacts open	400 kV mm	
44	Switching surge withstand test voltage (if applicable)		
a)	Between line terminal and grounded objects.		
b)	Between terminals with breaker contacts open		
45	1.2/50 full wave impulse withstand test voltage:		
a)	Between line terminal and grounded objects.	1050 kV (Peak)	
b)	Between terminals with breaker contacts open	1050 kV (Peak)	
46	Corona extinction voltage	> 184 KV	
47	Radio interference voltage	< = 1000 Micro Volts	
48	Number of breaks in series per pole		
49	Total length of break per phase		
50	Type of devices used to limit		



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	the rate of restriking voltage		
51	Type of devices, if any, used to obtain uniform grading between breaks.		
52	Type of devices, if any, used to limit the switching surges and its details.		
53	Whether the circuit breaker is fixed trip or trip free	Trip Free	
54	Type of main contacts	Multilam/Heat Cylinder/Contact Finger	
55	Type of arcing contacts / arc control device	Finger Contacts/ Pin/Nozzle	
56	Contact pressure	Adequate	
57	Material of contacts:		
	a) Main		
	Multilam		
	Heat Cylinder		
	Contact fingers		

	b) Arcing		
	Finger Contact		
	Pin		
	c) Auxiliary		
	d) Whether contacts are silver plated or not		
	e) Thickness of Silver plating		
58	Number of spare auxiliary contacts provided:		
a)	Those closed when breaker is closed.	10 Nos.	
b)	Those open when breaker is closed.	10 Nos.	
c)	Those adjustable with respect to the position of main contacts in addition to (a) & (b) above		
d)	Rating of auxiliary contacts	10 A	
e)	Breaking capacity of auxiliary contacts.	2 A at 220 V DC 4 A at 110 V DC	

59	Type of operating mechanism		
60	Rated voltage of trip and closing coils	110/220 V DC	
61	Pick up range of closing coil	70% to 110% of rated voltage	
62	Pick up range of closing coil	85% to 110% of rated voltage	
63	Power required for trip coil and closing coil at rated DC voltage	Maximum 330 Watts	
64	Number of opening at rated capacity the breaker is capable of performing without inspection, replacement of contacts or other main parts.	@ 50 kA: 6 Operations @ rate normal current: upto 6000 operations	
65	Pressure of SF6 gas:	6 bar @ 20 deg C	
a)	Range of gas pressure for satisfactory operation.	5 bar to 6 bar @ 20 deg C	
b)	Whether monitor for SF6 gas provided		
c)	Volume of SF6 gas per pole required at a pressure of 10N/cm.2	Rated pressure is 6.0 bar at 20 deg C, 2.2 kg per pole	

	d) Leakage of SF6 gas	Less than 1% per year	
66	Details of interlock provided against low pressure operation:	Alarm at 5.2 20 deg C, Lockout at 5.0 20 deg C	
	a) Remote operation	Possible	
	b) Manual Operation(Local electrical)	Possible	
67	Insulator:		
	a) Make		
	b) Type		
	c) Dimension		
	Height		

	Diameter (Top)		
	Diameter (Bottom)		
d)	1 minute dry power frequency withstand voltage.		
e)	Flashover voltage		
f)	Full wave impulse withstand voltage		
g)	Switching surge withstand voltage		
h)	Corona discharge voltage		
i)	Nature of the dielectric medium	SF 6 Gas Filled	
j)	Creepage distance	6125 mm	
k)	Permissible safe cantilever load on installed bushing	30.7 KN	
68	Spring charged mechanism:		
a)	Rating of motor	Approx. 500 Watt	

b)	Time required for charging the closing spring		
c)	Number of CO operations possible after failure of auxiliary supply	Two open and one close operation (O-CO)	
d)	Whether indication for spring charged condition provided in central control cabinet.		
e)	Provision for manual charging of spring		
f)	Maximum current taken by the spring charging motor in Amp		
69	Overall dimensions (per phase):		
	a) Height		
	b) Width		
	c) Length		
	d) Weight:		
	i) Each pole		
	ii) Complete breaker		

e)	Impact loading for foundation design		
70	Noise level	< 140 DB	
71	Details of supporting structures		
72	Details of central control cabinet		
73	SF6 gas density monitor provided (Give drawing and descriptive literature)	Part of the operating manual	
a)	Make		
b)	Whether the density monitor is temperature compensated	Yes	
c)	Pressure setting for stage-1 (Alarm)	5.2 bar @ 20 deg C	
d)	Pressure setting for stage-2 (Lock-ou	5.2 bar @ 20 deg C	

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e)	Whether stage 1 contact is of 'fall in make or fall in break'		
f)	Whether stage 2 contact is of 'fall in make or fall in break'		
g)	No. of stage 2 contacts		
74	Details of terminal clamps provided		
a)	Alloy composition of clamp body and bolts		
b)	Range of diameter of conductors that can be received		
c)	Max. temperature rise when carrying rated current at 50 ^o C ambient temperature.		
d)	Weight of each clamp		
e)	Whether horizontal or vertical take off.		
f)	Flexible/rigid		
75	Whether all type test reports as per latest relevant standards are enclosed		



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76	Whether all routine/ acceptance tests as per latest relevant standards will be carried out on each Circuit Breaker		
77	Whether breaker construction suitable for uprating later. If yes, method and extent of uprating possible.		



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Sl. No.	Description		110kV
1	Maker's Name and country of manufacture		

2	Manufacturer's type and designation		
3	Application standards	IEC 62271 - 100	
4	Rated voltage and frequency	145 kV and 50 Hz	
5	Number of poles	3	
6	Class: Indoor or outdoor	Outdoor	
7	Rated insulation level	As per IS	
8	Normal current rating:		
	a) Under normal conditions	3150 A	
	b) Under site conditions	3150 A	
9	Maximum ambient temperature assumed for design.	50 Degree Celsius	

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10	Maximum rise of temperature over ambient for continuous rated current	Within limits as specified in IEC 62271 - 100	
11	Short time current rating:		
	a) 1 Sec.	40 kA	
	b) 3 Sec.	40 kA	
12	Rated line charging breaking current with the over voltage not exceeding 2.5 p.u.	50 A	
13	Rated line charging breaking current and corresponding over voltage recorded in test.	50 A	
	a) Supply side	50 A, 1.4 p.u	
	b) Line side	50 A, 1.4 p.u	
14	Rated cable charging breaking current and corresponding over voltage recorded in tests.		
	a) Supply side	160 A, 1.4 p.u	
	b) Line side	160 A, 1.4 p.u	

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15	Rated (Single) Capacitor breaking current.	400 A	
16	Rated small inductive breaking current	0.5-20 A	
17	Rated short circuit breaking current:		
	a) r.m.s. value of a.c. current	40 kA	
	b) Percentage of d.c. current	43.00%	
	c) Symmetrical breaking current (including d.c. component)	46.8 kA	
18	First-pole-to-clear factor	1.5 as per IEC 62271 - 100	
19	Rated transient recovery voltage	215 kVP (Terminal fault) (IEC:62271 - 100, table II D)	
20	Rated characteristics for short line fault.	According to IEC 62271 - 100 table IV for Source side table V for line side	
21	Rated short circuit making current.	100 kA	
22	Rated operating sequence	O-0.3 sec- CO-3 min- CO	

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23	Rated out of phase breaking current	10 kA	
24	Maximum capacity under phase opposition condition	25% of the rated capacity	
25	Reactor loaded transformer interrupting capacity and corresponding switching surge over voltage.		
26	Capacity for interrupting in-rush current of transformers and corresponding over voltage.		
27	Data on restriking voltage:		
	a) amplitude factor		
	b) Phase factor		
	c) Natural frequency		
	d) Rate of rise of restriking voltage		
28	Is the circuit breaker restrike free Yes/No.		
29	Opening time	29 +/- 4 (At rated Voltage)	
30	Maximum break time:		



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a)At 100% rated breaking current	60 msec (At rated voltage)	
b)At 50% rated breaking current	60 msec (At rated voltage)	
c)At 25% rated breaking current	60 msec (At rated voltage)	
d)At 10% rated breaking current	60 msec (At rated voltage)	
e)At lowest fault current	60 msec (At rated voltage)	
31 Closing time	Not more than 150 Ms	
32 Minimum dead time		
3 Phase reclosing	300 ms	
Single phase reclosing		
33 Make time and arcing time	Make time 61 +/- 8 Arcing time < 21 msec	
34 Linking mechanism for single pole units		
35 Details of construction of		

	linking mechanism		
36	Maximum difference in time between the instants of contacts touching during closing.		
	a) Within a pole		
	b) Between poles	$\leq 5 \text{ ms, } 50 \text{ Hz}$	
37	Maximum difference in time between the instants of contacts separating during opening of :		
	a) Within a pole		
	b) Between poles	$\leq 5 \text{ ms, } 50 \text{ Hz}$	
38	Contact current (current giving longest arc when a break takes place)		
39	Maximum voltage factor of the circuit breaker when switching off.		
	a) Unloaded transformers	Within the limits of IEC 62771 - 100	

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	b) Loaded transformers	Within the limits of IEC 62771 - 100	
	c) Open circuited lines	Within the limits of IEC 62771 - 100	
40	Total interrupting time measured from instant of trip coil energisation to arc extinction of resistor current.	Less than 60 m sec (at rated voltage)	
41	Minimum reclosing time at full rated interrupting capacity from the instant of trip coil energisation.	440 ms (Including dead time 300 ms for first reclosing)	
42	Minimum clearance in open air		
	a) between phases,		
	b) to earth,		
	c) the safety boundaries during a breaking operation for C.Bs. with an external exhaust for connected gases of flame.		
43	One minute power frequency withstand test voltage:		
	a) Between line terminal and grounded objects.	275 kV rms	

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	b) Between terminals with breaker contacts open	275 kV rms	
44	Switching surge withstand test voltage (if applicable)		
	a) Between line terminal and grounded objects.		
	b) Between terminals with breaker contacts open		
45	1.2/50 full wave impulse withstand test voltage:		
	a) Between line terminal and grounded objects.	650 kV (Peak)	
	b) Between terminals with breaker contacts open	650 kV (Peak)	
46	Corona extinction voltage	> 108 KV	
47	Radio interference voltage	< = 1000 Micro Volts	
48	Number of breaks in series per pole		
49	Total length of break per phase		
50	Type of devices used to limit the rate of restriking voltage		
51	Type of devices, if any, used to obtain uniform grading between breaks.		



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52	Type of devices, if any, used to limit the switching surges and its details.		
53	Whether the circuit breaker is fixed trip or trip free	Trip Free	
54	Type of main contacts	Multilam/Heat Cylinder/Contact Finger	
55	Type of arcing contacts / arc control device	Finger Contacts/ Pin/Nozzle	
56	Contact pressure	Adequate	
57	Material of contacts:		
	a) Main		
	Multilam		
	Heat Cylinder		
	Contact fingers		
	b) Arcing		
	Finger Contact		
	Pin		

	c) Auxiliary		
	d) Whether contacts are silver plated or not		
	e) Thickness of Silver plating		
58	Number of spare auxiliary contacts provided:		
a)	Those closed when breaker is closed.	10 Nos.	
b)	Those open when breaker is closed.	10 Nos.	
c)	Those adjustable with respect to the position of main contacts in addition to (a) & (b) above		
d)	Rating of auxiliary contacts	10 A	
e)	Breaking capacity of auxiliary contacts.	2 A at 220 V DC 4 A at 110 V DC	
59	Type of operating mechanism		
60	Rated voltage of trip and closing coils	110/220 V DC	

61	Pick up range of closing coil	70% to 110% of rated voltage	
62	Pick up range of closing coil	85% to 110% of rated voltage	
63	Power required for trip coil and closing coil at rated DC voltage	Maximum 330 Watts	
64	Number of opening at rated capacity the breaker is capable or performing without inspection, replacement of contacts or other main parts.	@ 40 kA: 10 Operations @ rate normal current: upto 6000 operations	
65	Pressure of SF6 gas:	6 bar @ 20 deg C	
a)	Range of gas pressure for satisfactory operation.	5 bar to 6 bar @ 20 deg C	
b)	Whether monitor for SF6 gas provided		
c)	Volume of SF6 gas per pole required at a pressure of 10N/cm.2	Rated pressure is 6.0 bar at 20 deg C, 2.2 kg per pole	
d)	Leakage of SF6 gas	Less than 1% per year	

66	Details of interlock provided against low pressure operation:	Alarm at 5.2 20 deg C, Lockout at 5.0kg 20 deg C	
a)	Remote operation	Possible	
b)	Manual Operation(Local electrical)	Possible	
67	Insulator:		
a)	Make		
b)	Type		
c)	Dimension		
	Height		
	Diameter (Top)		
	Diameter (Bottom)		



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d)1 minute dry power frequency withstand voltage.		
e)Flashover voltage		
f)Full wave impulse withstand voltage		
g)Switching surge withstand voltage		
h)Corona discharge voltage		
i)Nature of the dielectric medium	SF 6 Gas Filled	
j)Creepage distance	6125 mm	
k)Permissible safe cantilever load on installed bushing	30.7 KN	
68 Spring charged mechanism:		
a)Rating of motor	Approx. 500 Watt	
b)Time required for charging the closing spring		

c)	Number of CO operations possible after failure of auxiliary supply	Two open and one close operation (O-CO)	
d)	Whether indication for spring charged condition provided in central control cabinet.		
e)	Provision for manual charging of spring		
f)	Maximum current taken by the spring charging motor in Amp		
69	Overall dimensions (per phase):		
	a) Height		
	b) Width		
	c) Length		
	d) Weight:		
	i) Each pole		
	ii) Complete breaker		
e)	Impact loading for foundation design		



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70	Noise level	< 140 DB	
71	Details of supporting structures		
72	Details of central control cabinet		
73	SF6 gas density monitor provided (Give drawing and descriptive literature)	Part of the operating manual	
a)	Make		
b)	Whether the density monitor is temperature compensated	Yes	
c)	Pressure setting for stage-1 (Alarm)	5.2 bar @ 20 deg C	
d)	Pressure setting for stage-2 (Lock-ou)	5.2 bar @ 20 deg C	
e)	Whether stage 1 contact is of 'fall in make or fall in break'		



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f)	Whether stage 2 contact is of 'fall in make or fall in break'		
g)	No. of stage 2 contacts		
74	Details of terminal clamps provided		
a)	Alloy composition of clamp body and bolts		
b)	Range of diameter of conductors that can be received		
c)	Max. temperature rise when carrying rated current at 50 °C ambient temperature.		
d)	Weight of each clamp		
e)	Whether horizontal or vertical take off.		
f)	Flexible/rigid		
75	Whether all type test reports as per latest relevant standards are enclosed		
76	Whether all routine/acceptance tests as per latest relevant standards will be		



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	carried out on each Circuit Breaker		
77	Whether breaker construction suitable for uprating later. If yes, method and extent of uprating possible.		



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32) SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 66kV SF6 CIRCUIT BREAKERS

Sl. No.	Description		66kV
1	Maker's Name and country of manufacture		
2	Manufacturer's type and designation		
3	Application standards	IEC 62271 - 100	
4	Rated voltage and frequency	72.5kV and 50 Hz	
5	Number of poles	3	
6	Class: Indoor or outdoor	Outdoor	
7	Rated insulation level	As per IS	
8	Normal current rating:		

	a) Under normal conditions	2500 A	
	b) Under site conditions	2500 A	
9	Maximum ambient temperature assumed for design.	50 Degree Celsius	
10	Maximum rise of temperature over ambient for continuous rated current	Within limits as specified in IEC 62271 - 100	
11	Short time current rating:		
	a) 1 Sec.	40 kA	
	b) 3 Sec.	40 kA	
12	Rated line charging breaking current with the over voltage not exceeding 2.5 p.u.	10 A as per Specification	
13	Rated line charging breaking current and corresponding over voltage recorded in test.		
	a) Supply side	10 A, 2.5 p.u	
	b) Line side	10 A, 2.5 p.u	



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14	Rated cable charging breaking current and corresponding over voltage recorded in tests.		
	a) Supply side	125 A, 2.5 p.u	
	b) Line side	125 A, 2.5 p.u	
15	Rated (Single) Capacitor breaking current.	400 A	
16	Rated small inductive breaking current	0.5-20 A	
17	Rated short circuit breaking current:		
	a) r.m.s. value of a.c. current	40 kA	
	b) Percentage of d.c. current	46%	
	c) Symmetrical breaking current (including d.c. component)	47.7 kA	
18	First-pole-to-clear factor	1.5 as per IEC 62271 - 100	
19	Rated transient recovery voltage	As per IEC:62271-100,	
20	Rated characteristics for short line fault.	As per IEC:62271-100,	

21	Rated short circuit making current.	100 kA	
22	Rated operating sequence	O-0.3 sec- CO-3 min-CO	
23	Rated out of phase breaking current	10 kA	
24	Maximum capacity under phase opposition condition	25% of the rated capacity	
25	Reactor loaded transformer interrupting capacity and corresponding switching surge over voltage.	As per IEC:62271-100,	
26	Capacity for interrupting in-rush current of transformers and corresponding over voltage.	As per IEC:62271-100,	
27	Data on restriking voltage:		
	a) amplitude factor		
	b) Phase factor		
	c) Natural frequency		
	d) Rate of rise of restriking voltage		
28	Is the circuit breaker restrike free Yes/No.		

29	Opening time	<35 ms	
30	Maximum break time:		
a)	At 100% rated breaking current	60 msec (At rated voltage)	
b)	At 50% rated breaking current	60 msec (At rated voltage)	
c)	At 25% rated breaking current	60 msec (At rated voltage)	
d)	At 10% rated breaking current	60 msec (At rated voltage)	
e)	At lowest fault current	60 msec (At rated voltage)	
31	Closing time	Not more than 150 Ms	
32	Minimum dead time		
	3 Phase reclosing	300 ms	
	Single phase reclosing	-	

33	Make time and arcing time	Make time 81 +/- 8 Arcing time < 21 msec	
34	Linking mechanism for single pole units		
35	Details of construction of linking mechanism		
36	Maximum difference in time between the instants of contacts touching during closing.		
	a) Within a pole		
	b) Between poles	< / = 5 ms, 50 Hz	
37	Maximum difference in time between the instants of contacts separating during opening of :		
	a) Within a pole		
	b) Between poles	< = 3.3 50 H2	
38	Contact current (current giving longest arc when a break takes place)		



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39	Maximum voltage factor of the circuit breaker when switching off.		
	a) Unloaded transformers	Within the limits of IEC 62771 - 100	
	b) Loaded transformers	Within the limits of IEC 62771 - 100	
	c) Open circuited lines	Within the limits of IEC 62771 - 100	
40	Total interrupting time measured from instant of trip coil energisation to arc extinction of resistor current.	Less than 60 m sec (at rated voltage)	
41	Minimum reclosing time at full rated interrupting capacity from the instant of trip coil energisation.	440 ms	
42	Minimum clearance in open air		
	a) between phases,		
	b) to earth,		
	c) the safety boundaries during a breaking operation for C.Bs. with an external exhaust for connected gases of flame.		



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43	One minute power frequency withstand test voltage:		
a)	Between line terminal and grounded objects.	140 kV rms	
b)	Between terminals with breaker contacts open	140 kV rms	
44	Switching surge withstand test voltage (if applicable)		
a)	Between line terminal and grounded objects.		
b)	Between terminals with breaker contacts open		
45	1.2/50 full wave impulse withstand test voltage:		
a)	Between line terminal and grounded objects.	325 kV (Peak)	
b)	Between terminals with breaker contacts open	325 kV (Peak)	
46	Corona extinction voltage	> 184 KV	
47	Radio interference voltage	< = 1000 Micro Volts	
48	Number of breaks in series per pole		
49	Total length of break per phase		



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50	Type of devices used to limit the rate of restriking voltage		
51	Type of devices, if any, used to obtain uniform grading between breaks.		
52	Type of devices, if any, used to limit the switching surges and its details.		
53	Whether the circuit breaker is fixed trip or trip free		
54	Type of main contacts	Multilam/Heat Cylinder/Contact Finger	
55	Type of arcing contacts / arc control device	Finger Contacts/ Pin/Nozzle	
56	Contact pressure	Adequate	
57	Material of contacts:		
	a) Main		
	Multilam		
	Heat Cylinder		
	Contact fingers		

	b) Arcing		
	Finger Contact		
	Pin		
	c) Auxiliary		
	d) Whether contacts are silver plated or not		
	e) Thickness of Silver plating		
58	Number of spare auxiliary contacts provided:		
a)	Those closed when breaker is closed.	10 Nos.	
b)	Those open when breaker is closed.	10 Nos.	
c)	Those adjustable with respect to the position of main contacts in addition to (a) & (b) above		
d)	Rating of auxiliary contacts		
e)	Breaking capacity of auxiliary contacts.		

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59	Type of operating mechanism		
60	Rated voltage of trip and closing coils	110 V / 220V DC	
61	Pick up range of closing coil	70% to 110% of rated voltage	
62	Pick up range of closing coil	85% to 110% of rated voltage	
63	Power required for trip coil and closing coil at rated DC voltage	Maximum 330 Watts	
64	Number of opening at rated capacity the breaker is capable or performing without inspection, replacement of contacts or other main parts.	@ 50 kA: 6 Operations @ rate normal current: upto 6000 operations	
65	Pressure of SF6 gas:	6 bar @ 20 deg C	
a)	Range of gas pressure for satisfactory operation.	5.5 bar to 6 bar @ 20 deg C	
b)	Whether monitor for SF6 gas provided		
c)	Volume of SF6 gas per pole required at a pressure of 10N/cm.2	Rated pressure is 6.0 bar at 20 deg C, 2.2 kg per pole	

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	d) Leakage of SF6 gas	Less than 1% per year	
66	Details of interlock provided against low pressure operation:	Alarm at 5.2 20 deg C, Lockout at 5.0 20 deg C	
	a) Remote operation	Possible	
	b) Manual Operation(Local electrical)	Possible	
67	Insulator:		
	a) Make		
	b) Type		
	c) Dimension		
	Height		



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	Diameter (Top)		
	Diameter (Bottom)		
d)	1 minute dry power frequency withstand voltage.		
e)	Flashover voltage		
f)	Full wave impulse withstand voltage		
g)	Switching surge withstand voltage		
h)	Corona discharge voltage		
i)	Nature of the dielectric medium	SF 6 Gas Filled	
j)	Creepage distance	25 mm/kV	
k)	Permissible safe cantilever load on installed bushing	110kN	
68	Spring charged mechanism:		
a)	Rating of motor	750 Watt	



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b) Time required for charging the closing spring	15 sec.	
c) Number of CO operations possible after failure of auxiliary supply	Two open and one close operation (O-CO)	
d) Whether indication for spring charged condition provided in central control cabinet.		
e) Provision for manual charging of spring		
f) Maximum current taken by the spring charging motor in Amp		
69 Overall dimensions (per phase):		
a) Height		
b) Width		
c) Length		
d) Weight:		
i) Each pole		
ii) Complete breaker		

e)	Impact loading for foundation design		
70	Noise level	< 140 DB	
71	Details of supporting structures		
72	Details of central control cabinet		
73	SF6 gas density monitor provided (Give drawing and descriptive literature)		
a)	Make		
b)	Whether the density monitor is temperature compensated		
c)	Pressure setting for stage-1 (Alarm)		



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d)	Pressure setting for stage-2 (Lock-ou		
e)	Whether stage 1 contact is of 'fall in make or fall in break'		
f)	Whether stage 2 contact is of 'fall in make or fall in break'		
g)	No. of stage 2 contacts		
74	Details of terminal clamps provided		
a)	Alloy composition of clamp body and bolts		
b)	Range of diameter of conductors that can be received		
c)	Max. temperature rise when carrying rated current at 50 ° C ambient temperature.		
d)	Weight of each clamp		
e)	Whether horizontal or vertical take off.		
f)	Flexible/rigid		



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75	Whether all type test reports as per latest relevant standards are enclosed	
76	Whether all routine/acceptance tests as per latest relevant standards will be carried out on each Circuit Breaker	
77	Whether breaker construction suitable for uprating later. If yes, method and extent of uprating possible.	



Name and address of the bidder