

KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

SECTION- CIRCUIT BREAKER

CONTENTS

1.0	GENERAL	3
2.0	FEATURES OF CONSTRUCTION.....	3
3.0	SF6 CIRCUIT BREAKERS	3
4.0	OPERATING MECHANISM	6
5.0	OPERATING MECHANISM HOUSING	13
6.0	BUSHING/INSULATORS	14
7.0	CONTACTS	15
8.0	DUTY REQUIREMENTS	15
9.0	PORTABLE TYPE SF6 GAS HANDLING UNIT :.....	19
10.0	TERMINALS.....	19
11.0	SUPPORT STRUCTURE:.....	19
12.0	TERMINAL CONNECTOR PAD:.....	19
13.0	INTERPOLE CABLING:.....	20
14.0	FITTINGS AND ACCESSORIES.....	20
15.0	MANDATORY & RECOMMENDED SPARES	22
16.0	TESTS AND TEST REPORTS	22
17.0	PRE-COMMISSIONING TESTS	25

1.0 GENERAL

- 1.1 The circuit breakers and accessories shall conform to IEC: 62271-100, IEC:62271-01 and other relevant IEC standards except to the extent explicitly modified in the specification and shall also be in accordance with requirements specified in **GTR**.
- 1.2 420/245/72.5kV circuit breakers offered would be of sulphur hexafluoride (SF6) type only and of class C2-M2 as per IEC. The bidder may also offer circuit breakers of either live tank type or dead tank type of proven design.
- 1.3 The circuit breaker shall be complete with terminal connectors, operating mechanism, control cabinets, piping, interpole cable, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanised support structure for CB and control cabinets, their foundation bolts and all other circuit breaker accessories required for carrying out all the functions the CB is required to perform.
- 1.4 All necessary parts to provide a complete and operable circuit breaker installation such as main equipment, terminals, control parts, connectors and other devices whether specifically called for herein or not shall be provided.
- 1.5 Painting shall be done in line with Section **GTR**. Shade-697 as per IS-5 or REL 5032 or similar shades can be used for painting. The support structure of circuit breaker shall be hot dip galvanised. Exposed hardware items shall be hot dip galvanised or Electro-galvanised.
- 1.6 The circuit breakers shall be designed for use in the geographic and meteorological conditions as given in Section GTR.

2.0 FEATURES OF CONSTRUCTION

- 2.1 Circuit breakers, if three phase type, shall be supplied with a common base, factory installed inter-phase wiring and common control cubicle. Circuit breakers with three single phase units shall be supplied with wiring between individual terminal boxes on each pole and common control cubicle.

3.0 SF6 CIRCUIT BREAKERS

- 3.1 SF6 circuit breakers shall be of 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.

- 3.2 Each SF6 circuit breaker pole shall be provided with its own self-contained gas system.
- 3.3 The SF6 breaker shall be designed to ensure that condensation of moisture is controlled by proper selection of organic insulating materials.
- 3.4 The service connections for gas handling shall be located on each pole tank to facilitate servicing.
- 3.5 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 0.5% per year and the leakage rate shall be guaranteed for at least 10 years. In case the leakage under the specified conditions is found to be greater than 0.5% 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.
- 3.6 In the interrupter assembly there shall be an absorbing product box to minimise 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.
- 3.7 Each pole shall form an enclosure filled with SF6 gas independent of two other poles and the SF6 density of each pole shall be monitored.
- 3.8 The dial type SF6 density monitor shall be adequately temperature compensated to model the pressure changes due to variations 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:
- 3.9 It shall be possible to dismantle the density monitor for checking/replacement without draining the SF6 gas by providing suitable interlocked non return valve coupling.
- 3.10 Each Circuit Breaker shall be capable of withstanding a vacuum of minimum 8 millibars without distortion or failure of any part.

3.11 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 shall be supplied in separate unused cylinders as per requirements specified in Scope of work.

3.12 Sulphur Hexafluoride Gas (SF6 Gas):

- a) The SF6 gas shall comply with IEC 60376, 60376A and 60376B and shall be suitable in all respects for use in the switchgear under the operating conditions.
- b) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the relevant standards and regulations.
- c) Test: SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water content as per IEC 60376, 60376A and 60376B and test certificates shall be furnished to Employer indicating all the tests as per IEC 60376 for each lot of SF6 gas in stipulated copies as indicated in Section **GTR**. Gas bottles should be tested for leakage during receipt at site.

3.13 Dead tank type circuit breaker

- a) In case dead tank type circuit breaker is offered, the Bidder shall offer bushing type CTs (whose secondary parameters are given in Instrument transformers (Section D)) on either side of dead tank circuit breaker instead of conventional outdoor CTs.
- b) The enclosure shall be made of either Al/Al Alloy or mild steel (suitably hot dip galvanised).
- c) The enclosure shall be designed for the mechanical and thermal loads to which it is subjected in service. The enclosure shall be manufactured and tested according to the pressure vessel codes {i.e., latest edition of the ASME code for pressure vessel - Section VIII of BS-5179, IS4379, IS-7311 (as applicable) and also shall meet Indian Boiler Regulations}.
- d) The maximum temperature of enclosure with CB breaker carrying full load current shall not exceed the ambient by more than 20 deg C.

- e) The enclosure has to be tested as a routine test at 1.5 times the design pressure for one minute. A bursting pressure test shall be carried out at 5 times the design pressure as type test on the enclosure.

4.0 OPERATING MECHANISM

- 4.1 Circuit breakers shall be power operated either by pneumatic mechanism or by a motor charged spring operated mechanism or by hydraulic mechanism. The mechanism shall be housed in a weather proof and dust proof control cabinet. The mechanism shall be antipumping and trip free (as per IEC definition) under every method of closing. One O-CO operation shall be possible after failure of control supply.
- 4.2 It shall be non-pumping electrically and mechanically, pneumatically or hydraulically under every method of closing (except during manual closing of a breaker for maintenance).
- 4.3 The operating mechanism shall be strong, rigid, not subject to rebound and shall be readily accessible for maintenance for a man standing on ground.
- 4.4 The trip coils shall have sufficient continuous rating to cater to the trip coil supervision relay current.
- 4.5 Disagreement circuit shall be provided which shall detect pole position discrepancy.
- 4.6 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.
- 4.7 A mechanical indicator shall be provided inside the operating mechanism box to show open and closed positions, visible through a glass window from ground level. An operation counter shall also be provided.
- 4.8 Two stage 'Density' switches shall be provided to monitor SF6 gas pressure inside the interrupting chambers. The first stage shall initiate tripping of the breaker and lockout of closing. The second stage shall initiate lockout of tripping. One contact of each stage shall be wired to the terminal block of operating mechanism for OWNER's use. The actual gas pressure of Circuit Breaker shall be made available at Substation Automation HMI. The required Gas pressure transmitters (4-20mA signals) shall be provided for the same.

- 4.9 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.
- 4.10 The bidder shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker. The instruction manuals shall contain exploded diagrams with complete storage, handling, erection, commissioning, troubleshooting, servicing and overhauling instructions.

The bidder shall confirm if the offered breaker will reach obsolescence and service / spares will become an issue after 5 or 10 years. If so, the bidder should bring this out in his offer in deviation schedule.

4.11 Spring Operated Mechanism

- 4.11.1 Spring operated mechanism shall be complete with motor in accordance with Section **GTR**, opening spring, closing spring with limit switch for automatic charging and all necessary accessories to make the mechanism a complete operating unit shall also be provided.
- 4.11.2 As long as power is available to the motor, a continuous sequence of at least 10 closing and opening operations shall be possible. After failure of power supply to the motor, at least one open-close-open operation of the circuit breaker shall be possible.
- 4.11.3 Breaker operation shall be independent of the motor operation which shall be used solely for compressing the closing spring.
- 4.11.4 Motor rating shall be such that it requires a maximum of 30 seconds for fully charging the closing spring. Motors shall conform to specification no. titled "Induction Motors (General Purpose)".
- 4.11.5 Closing action of the circuit breaker shall compress the opening spring to keep it ready for tripping.
- 4.11.6 Facility for manual charging of closing springs shall be provided.
- 4.11.7 Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position. Provision shall be made to prevent a closing operation to be carried out with the springs partially charged.

4.11.8 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.

4.11.9 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.

4.12 Pneumatically Operated Mechanism

4.12.1 Pneumatically operated mechanism shall obtain the supply from a unit compressed air system.

4.12.2 The operating mechanism shall include necessary monitoring and safety interlocks such as pressure gauges with alarm contacts for high/low/minimum and lockout pressure signals. The minimum operating pressure shall be such that the breaker shall be capable of one opening if the breaker is in closed position before the lockout pressure blocks breaker opening/closing/reclosing.

4.12.3 Independently adjustable pressure switches with electrically insulated contacts shall be provided on the circuit breaker for purposes of low and high pressure alarm and lockout in case of insufficient pressure to complete a closing, opening or reclosing duty. The scheme should permit operation of all blocking and alarm relays as soon as the pressure transient present during the rapid pressure drop has been damped and a reliable pressure measurement can be made. Such facilities shall be provided for following conditions:

- | | | |
|----------------------------------|---|--------|
| a) Trip lockout pressure | - | 2 Nos. |
| b) Close lockout pressure | - | 1 No. |
| c) Auto reclose lockout pressure | - | 1 No. |
| d) Extreme low pressure | - | 1 No. |

4.12.4 Local air receiver shall be sufficient to carry out at least two CO operations at the lowest pressure for auto reclosing duty without refilling.

4.12.5 The compressed air mechanism shall be capable of operating the circuit breaker under all duty conditions with the air pressure immediately before operation between 85% and 110% of the rated supply pressure. The make/break time at this supply pressure

shall not exceed the specified make/break time within any value of trip coil supply voltage as specified.

4.12.6 Unit compressed air system for circuit breakers:

4.12.6.1 The unit compressed air system shall meet the following requirements:

- a) The compressed air system shall be provided with necessary piping, piping accessories, control valves, safety valves, filters, reducing valves, isolating valves, drain ports, etc. The Unit compressed air system shall be provided with suitable antivibration pads wherever required.
- b) The compressors or pumps shall be of the air cooled type and mounted within the operating mechanism housing or a separate weather-proof and dust-proof housing.
- c) The air receiver shall have stored energy for 2 CO operations of the breaker at the blocking pressure for auto reclosing duty without refilling. The unit compressor shall be capable of building up required pressure for another 2 CO operations within 30 minutes.
- d) The size of the compressor shall be determined by the bidder. The compressor shall be of sufficient capacity for performing all the operations above mentioned.

4.12.6.2 Air Compressor:

- a) The air compressor shall be of air cooled type complete with cylinder lubrication, drive motor etc. The compressor shall be rated for the following duty:
 - i) Total running time of compressor to build up the rated pressure from atmospheric pressure Not exceeding 80 minutes.
 - ii) Normal running air charging Not exceeding 15 minutes considering 10% leakage/day.
 - iii) Air charging time after one close-open operation from rated pressure not exceeding 15 minutes.
- b) Compressor shall be driven by automatically controlled motors conforming to requirements of the Section-**GTR**

- c) The compressor shall be provided with automatic adjustable unloading device during starting.
- d) The compressor shall be equipped with a Time totaliser and a Pressure gauge.

4.12.6.3 Intercooler and After cooler: (If applicable)

Intercooler between compressor stage and after cooler at discharge if any of H.P. Cylinder shall be included in Contractor's scope. They shall be of air cooled type and shall be designed as per ASME Code of IEMA Standards. The design pressure on the air side of cooler shall be 1.25 times the working pressure. A corrosion allowance of 3 mm shall be included for all steel parts.

4.12.6.4 Air Receivers:

- a) Air receiver shall be designed in accordance with the latest edition of the ASME Code for Pressure Vessel - Section VIII of BS: 5179. If the air receiver is not fully hot dip galvanised, it shall be coated on the inside face with antirust medium and a corrosion allowance of 3.0 mm shall be provided for shell and dished ends.
- b) Connections for air inlet and outlet, drain and relief valves shall be flanged type or screwed type. Pressure gauge and pressure switch connections shall be screwed type only.
- c) Accessories such as suitable sized safety valve to relieve full compressor discharge at a set pressure equal to 1.1 times the maximum operating pressure, blow off valve, auto drain tap with isolating and bypass valve, dial type pressure gauge with isolating and drain valve and test connection shall be provided.
- d) Air receiver shall be offered with atleast 50% spare capacity, calculated on the basis of total air requirement for 2 CO operations of the breaker at the lowest pressure for auto reclosing duty without refilling.

4.12.6.5 Quality of Air:

Compressed air used shall be dry and free of dust particles and fully compatible with the materials used in the pneumatic operating mechanism. Arrangement for conditioning the

compressed air if required shall be provided as an integral part of air compressor system.

If situation warrants, because of the severe ambient conditions, the supplier may offer centralised compressed air system.

4.12.6.6 Control and Control Equipment:

- a) The compressor control shall be of automatic start/stop type initiated by pressure switches.
- b) Duplicate incoming supply of 415 V, AC shall be provided by the Employer at switchyard bay marshaling box from where the Contractor shall take the feed to the operating mechanism.
- c) All the necessary compressor control equipment shall be housed in a totally enclosed sheet steel cabinet also conforming to requirements of **GTR**. Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet.
- d) A glass window shall be provided for viewing the indicating instrument/gauges. The maximum height shall be 2000 mm.

4.12.6.7 Compressed Air Piping, Valves and Fittings:

- a) The flow capacity of all valves shall be at least 20% greater than the total compressor capacity.
- b) The high pressure pipe and air system shall be such that after one O-0.3 sec-CO-operation the breaker shall be capable of performing one CO operation within 3 minutes.
- c) All compressed air piping shall be bright annealed, seamless phosphorous Deoxidized Non-Arsenical Copper alloy as per BS: 2874 or stainless steel pipe (C - 106 of BS: 2871-1957).
- d) All joints and connections in the piping system shall be brazed or flared as necessary.
- e) All compressed air piping shall be carried out in accordance with BS:162.
- f) Compressed air piping system shall be complete with Saddle clamps to support the piping system at suitable intervals.

Necessary bolts, nuts, pipe fixing clamps etc shall be included in the scope of Contractor.

4.13 Hydraulically Operated Mechanism

- 4.13.1 Hydraulically operated mechanism shall comprise of operating unit with power cylinder, control valves, high and low pressure reservoir, motor. Electrically driven motor shall comply to GTR.
- 4.13.2 The hydraulic oil used shall be fully compatible for the specified temperature range.
- 4.13.3 The hydraulic oil used shall be fully compatible for the specified temperature range.
- 4.13.4 The oil pressure switch controlling the oil pump and pressure in the high pressure reservoir shall have adequate number of spare contacts to be used for continuous monitoring of low pressure, high pressure etc.
- 4.13.5 The mechanism shall be suitable for atleast two close open operations after failure of AC supply to the motor starting at pressure equal to the lowest pressure of auto reclose duty plus pressure drop for one close open operation.
- 4.13.6 The mechanism shall be capable of operating the circuit breaker correctly and performing the duty cycle specified under all conditions with the pressure of hydraulic operated fluid in the operating mechanism at the lowest permissible pressure before make up. The opening time at the lowest pressure for a particular operation shall not exceed the guaranteed operating time within any value of trip coil supply voltage as specified.
- 4.13.7 Trip lockout shall be provided to prevent operations of the circuit breaker below the minimum specified hydraulic pressure. Alarm contacts for loss of Nitrogen shall be provided.
- 4.13.8 All hydraulic joints shall have no oil leakage under the site conditions and joints shall be tested at factory against oil leakage at a minimum of 1.5 times maximum working pressure.

4.14 Operating Mechanism Control

- 4.14.1 Operating mechanism shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. Provision shall be made for local electrical control.

'Local/Remote' selector switch shall be provided in the operating mechanism cubicle.

- 4.14.2 The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.
- 4.14.3 Each breaker pole shall be provided with two (2) independent tripping circuits and coils each to be fed from separate DC sources and connected to a different set of protective relays.
- 4.14.4 The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker. The trip circuit supervision relay would be provided on relay panels.
- 4.14.5 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 open. 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.
- 4.14.6 Density Meter 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 annunciations 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.
- 4.14.7 The auxiliary switch of the breaker shall be positively driven by the breaker operating rod.

5.0 OPERATING MECHANISM HOUSING

- 5.1 Operating mechanism, motor spring, pneumatic or Oil-Hydraulic, as applicable and all associated accessories shall be enclosed in a 'weather-proof' mechanism cabinet of hot dip galvanised sheet steel construction, the thickness of which shall not be less than 2 mm. Hinged doors giving access to the mechanism at the front and sides shall be provided. Suitable gaskets shall be provided to make

the mechanism housing water-proof and dust-proof. Padlock and duplicate keys shall be provided.

5.2 Common marshaling box with necessary tubing and cables shall be provided. A light point with door switch and one 15A, 3 pin, 240 V, AC socket outlet shall be provided in the housing.

5.3 In all other respects, operating mechanism housing and marshaling box shall conform to specification.

6.0 BUSHING/INSULATORS

6.1 The porcelain of the insulators shall conform to the requirements stipulated in Section-GTR.

6.2 The mechanical characteristics of insulators shall match with the requirements specified in this specification.

6.3 All hollow insulators shall conform to IEC-62155. 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 a 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.

6.4 Hollow Porcelain for pressurized columns/chambers should be in one integral piece in green and fired stage.

6.5 Puncture strength of bushings/insulators shall be greater than the dry flashover value.

6.6 All iron parts shall be hot dip galvanised and all joints shall be air-tight. Surface of the joints shall be trued-up; porcelain parts by grinding and metal parts by machining.

6.7 All current carrying contact surfaces shall be silver faced. Silver facing shall not be less than one mil in thickness.

7.0 CONTACTS

- 7.1 If multi-break interrupters are used, they shall be so designed and augmented that a fairly uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstand of the grading elements shall be adequate for the service conditions and duty specified.
- 7.2 The gap between the open contacts shall be such that it can withstand atleast the rated phase to ground voltage for 8 hours at zero gauge pressure of SF6 gas due to the leakage. The breaker should be able to withstand all dielectric stresses imposed on it in open condition at lock out pressure continuously (i.e. 2 p.u. across the breaker continuously).
- 7.3 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 analyser is already available at a particular site, the contractor shall have to supply a suitable adopter/transducer so that the offered circuit breaker can be used with the operational analyser.

8.0 DUTY REQUIREMENTS

- 8.1 The rated operating duty of the circuit breaker shall be O-0.3 sec.-CO-3 min.-CO.
- 8.2 The circuit breaker shall meet these duty requirements for any type of fault or fault location also for line switching when used on a 420/245/72.5kV effectively grounded system, and perform make and break operations as per the stipulated duty cycles satisfactorily.

8.3 Pre-insertion resistors

420 kV circuit breakers wherever specified shall be provided with single step pre-insertion closing resistors to limit the switching surges to a value of less than 2.3 p.u. The value of the pre-insertion resistor and the duration of pre- insertion time shall be as specified in technical parameters.

- 8.4 The resistor shall have thermal rating for the following duties:
- i) Terminal Fault

Close.... 1 Min..... Open..... Close open 2 min..... close
..... 1 Min..... open close open.

ii) Reclosing against trapped charges

Duty same as under (i) above. The first, third and fourth closures are to be on de-energised line while second closing is to be made with lines against trapped charge of 1.2 p.u. of opposite polarity.

iii) Out of phase closing

One closing operation under phase opposition that is with twice the voltage across the terminals.

iv) No allowance shall be made for heat dissipation of resistor during time interval between successive closing operations. The resistors and resistor supports shall perform all these duties without deterioration. Calculations and test reports of resistors proving thermal rating for duties specified above shall be furnished along with the bid. The calculations shall take care of adverse tolerances on resistance values and time settings.

8.5 Circuit breakers shall be restrike free.

8.6 Transient recovery voltage for terminal faults and short line faults shall be as per relevant standards.

8.7 The percentage value of the DC component of the breaking current shall be as per relevant standards.

8.8 The BIDDER shall highlight the design features provided to effectively deal with :

- a) breaking of inductive currents and capacitive currents;
- b) charging of long lines and cables;

8.9 The circuit breakers shall be capable of performing their duties without opening resistors.

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

8.11 The circuit breaker shall also be capable of:

- a) Interrupting line/cable charging current as per IEC without use of opening resistors.
- b) Clearing short line fault (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
- c) Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.
- d) 400kV breakers shall be able to switch in and out the 400kV shunt reactor for any value from 50MVAR upto 150MVAR without giving rise to overvoltage more than 2.3 p.u. Laboratory test and or field test reports in support of the same shall be furnished along with the bid.

8.12 a). 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 under the clause-Technical parameters.

b). Withstanding all dielectric stresses imposed on it in open condition at lock out pressure continuously (ie., 2 p.u. across the breaker continuously, for validation of which a power frequency dielectric withstand test conducted for a duration of at least 15 minutes is acceptable).

8.12 c). Controlled Switching Requirements for Reactors:

The circuit Breaker shall be equipped with controlled switching with consequent optimization of switching behavior when used in switching of 400kV Bus reactor & switchable Line reactor. The controller shall be provided in Main & Tie circuit breakers of Bus reactors.

The controlling relay shall also record and monitor the switching operations and make adjustments to the switching instants to optimize the switching behavior as necessary. It shall provide self diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.

Technical Requirement for controlled switching device:

1. The controller shall be designed to operate at the correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified in section – GTR.
2. The controller shall meet the requirements of IEC-60255-4 Appendix 'E' class III regarding HF disturbance test and fast transient test shall be as per IEC-61000-4 level III and insulation test as per 60255-5.

3. The controller shall have functions for switching ON & OFF the circuit breakers.
4. The controller shall get command to operate the breakers manually or through auto reclose relay at random. The controller shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.
5. The controller shall also have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of next operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, hydraulic/pneumatic pressure of the operating mechanism, control voltage variation, SF6 gas density variations etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the controller shall be better than + 0.5ms.
6. The controller should have display facility at the front for the settings and measured values.
7. The controller should be PC compatible for the setting of various parameters and down loading of the settings and measured values date time of witching etc. Window based software for this purpose shall be supplied by the contractor to be used on the owner's PC.
8. The controller shall have self-monitoring facility.
9. The controller shall be suitable for current input of 1 amp from the secondary of the CTs and 110V (ph to ph) from the CVTs. The controller shall also take care of transient and dynamic state values of the current from the secondary of the CTs and CVTs.
10. The controller shall have time setting resolution of 0.1ms or better
11. The controller shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.

8.13 Total break time:

- 8.13.1 The total break time as specified under this Chapter shall not be exceeded under any of the following duties:
 - a) Test duties 1,2,3,4,5 (TRV as per IEC: 62271-100)
 - b) Short line fault L75, L90 (- do -)
- 8.13.2 The total break time of the breaker shall not exceed under any duty conditions specified such as with the combined variation of the trip coil voltage, (70-110%), pneumatic/hydraulic pressure and arc extinguishing medium pressure etc. While furnishing

the proof of 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.

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

9.0 PORTABLE TYPE SF6 GAS HANDLING UNIT :

9.1 Purification, Evacuation and Refilling Equipment:

This unit shall be supplied if called for in the price templet of the bid and shall consist of the following:

- a) Vacuum pump for evacuating the chambers to be filled with SF6 gas,
- b) Compressor with storage cylinders for storing SF6 gas in gaseous state at a pressure higher than the operating pressure in the breaker.
- c) Provision for drying and filtering of the gas and
- d) Gas regulator with manometer for filling gas in the breaker.

10.0 TERMINALS

- 10.1 If specified in Data Sheet A1, the VENDOR shall supply the clamps and connectors.

11.0 SUPPORT STRUCTURE:

- 11.1 The structure design shall be such that during operation of circuit breaker vibrations are reduced to minimum.
- 11.2 If required, the Contractor shall provide suitable platform with steps on both sides of the circuit breaker for easy accessibility for monitoring the density/pressure of gas.

12.0 TERMINAL CONNECTOR PAD:

- 12.1 The circuit breaker terminal pads shall be made up of high quality electrolytic copper or aluminium and shall be conforming to Australian standard AS-2935 for rated current. The terminal pad shall have protective covers which shall be removed before interconnections.

13.0 INTERPOLE CABLING:

- 13.1 All cables to be used by contractor shall be armoured and shall be as per IS -1554 (1100 Volts Grade). All cables within & between circuit breaker poles shall be supplied by the CB manufacturer.
- 13.2 Only stranded conductor shall be used. Minimum size of the conductor for interpole control wiring shall be 1.5 sq.mm. (Copper).
- 13.3 The cables shall be with oxygen index Min-29 and temp. index as 250°C as per relevant standards.

14.0 FITTINGS AND ACCESSORIES

- 14.1 A partial list of some of the major fittings and the accessories to be furnished by the VENDOR as an integral part of the equipment is given below. Number and exact location of these parts shall be indicated by the MANUFACTURER.
- 14.2 Operating mechanism housing complete with :
 - a) Padlocks and duplicate keys
 - b) Space heaters equipped with automatic thermostatic control
 - c) Local/remote changeover switch
 - d) Manually operated emergency tripping push button/lever (mechanical) conveniently located to trip all three phases simultaneously
 - e) Operation counter
 - f) Terminal blocks with minimum 20% spare terminals
 - g) Control switches to cut off control power supplies
 - h) Fuses as required
 - i) Two earthing terminals
 - j) Auxiliary relays
 - k) Motor contactor with thermal release for spring charging motor/Compressor motor/Oil Hydraulic pump motor.

- l) Local breaker control switch
- m) 15A, 3 pin, 240 V, 1 ph, AC receptacle with switch and cubicle lamp.
- n) Pressure switches, Density switches and Limit switches as applicable.
- o) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for future use.
- p) Antipumping relay.
- q) Pole discrepancy relay.
- r) D.C. Supervision relays.
- s) Cable glands (Double compression type), Lugs, Ferrules etc.)
- t) Name Plate:

Rating and diagram plate in accordance with IEC incorporating year of manufacture.

14.3 Each breaker shall be provided with a nameplate in English, with the following data indelibly marked on it;

- a) Manufacturer's name
- b) Serial number and type designation
- c) Rated voltage
- d) Rated current
- e) Rated insulation level
- f) Rated frequency
- g) Rated breaking capacities (symmetrical and asymmetrical)
- h) Weight including gas, weight of SF6 gas/pole, for SF6 Circuit Breaker.
- i) Rated short time (1 second) withstand current.
- j) Normal SF6 gas pressure/density, for SF6 Circuit Breaker.

- k) SF6 Temp/density curve, for SF6 Circuit Breaker.
 - l) Circuit Breaker maintenance curve showing Current Vs No. of operations.
- 14.4 Additional fittings for pneumatically operated circuit breaker
- a) Unit compressed air system
 - b) Breaker air receivers.
 - c) Pressure gauge, spring loaded safety valve and pressure switch with adjustable contacts.
 - d) Pressure switch to initiate an alarm if the pressure in the auxiliary reservoir remains below a preset level for longer than it is normally necessary to refill the reservoir.
 - e) Stop, non-return and other control valves, pipings and all accessories upto breaker mechanism housing.
- 14.5 Pre-insertion resistors
- 14.6 Name plates for compressed air system
- 14.7 Clamps and connectors
- 14.8 Special tools required for installation and maintenance, if any

15.0 MANDATORY & RECOMMENDED SPARES

The bidder shall include in his proposal spare parts and maintenance equipment in accordance with Section-Project. Calibration certificates of each maintenance equipment shall be supplied along with the equipment.

Unit prices of each of the mandatory & recommended spares, as applicable, shall be quoted together with their recommended quantities and catalogue numbers.

16.0 TESTS AND TEST REPORTS

- 16.1 In accordance with the requirements stipulated in specifications, the circuit breaker along with its operating mechanism shall conform to IEC:62271-100.
- The Circuit Breakers offered shall be fully type tested as per the relevant standards.

Type tested Circuit Breakers shall be offered. The type test reports shall not be older than FIFTEEN (15) years as on the last date of submission of bid.

a) For Circuit Breakers manufactured in India:

- i). The type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by the Government or the laboratories accredited by the National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.
- ii). The type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.
- iii). The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of NABL accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

b) For Circuit Breakers manufactured Abroad:

- i). Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National accreditation body of the country where the Type test has been conducted.
- ii). The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

In case of in-house type tested imported equipment of foreign OEM, the term "Purchasing Utility" covers the foreign Utility who has purchased that equipment.

16.2 The test reports of the type tests and the following additional type tests shall also be submitted for Purchaser's review:

- i) Corona extinction voltage test
- ii) Out of phase closing test as per IEC:62271-100.
- iii) Line charging breaking current for proving 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 unpressurised condition.
- vi) Verification of the degree of protection.
- vii) Low & high temperature test.(if applicable)
- viii) Humidity test.(if applicable)
- ix) Static Terminal Load test.
- x) Critical Currents test (if applicable).
- xi) Switching of Shunt Reactors.

16.3 Routine Tests:

Routine tests as per IEC:62271-100 shall be performed on all circuit breakers. In addition to the mechanical and electrical tests specified by IEC, the following tests shall also be performed.

- a) 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, pneumatic/hydraulic 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 analyser alongwith necessary transducers, cables, console, etc. where included in scope of supply shall be furnished and utilised. In case of substations where operation analyser is existing the bidder shall utilise the same. However necessary adopter and transducers etc. if required shall have to be supplied by the bidder.
- b) Measurement of Dynamic Contact resistance measurement for arcing & main contacts. Signature of 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.

- 16.4 All vessels and accessories which operate under pressure shall be tested according to relevant standards and adequate number of copies of test certificates incorporating the following minimum information shall be submitted. Description of item, CONTRACTOR/MANUFACTURER's serial numbers, date of manufacture and tests, drawing number, material composition, working and design pressures, details of tests carried out and reference standards, test results, identification mark, name and seal of approval of testing authority.
- 16.5 A copy of the test results shall be supplied for approval before shipment of the circuit breakers. Bound copies of complete test results shall be furnished with the circuit breakers. These shall include complete reports and results of the routine test as also certified copies of type tests carried out on circuit breakers of identical design.
- 16.6 The test equipment, meters, instruments etc. used for testing shall be calibrated at recognised test laboratories at regular intervals and valid certificates shall be made available to OWNER's representative at the time of testing. The calibrating instrument used as standard shall be traceable to national/international standards.

17.0 PRE-COMMISSIONING TESTS

- 17.1 An indicative list of tests is given below. All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site. The Contractor shall arrange all instruments required for conducting tests along with calibration certificates and shall furnish the list of instruments to the Employer for approval.
- a) Insulation resistance of each pole.
 - b) Check adjustments, if any suggested by manufacturer.
 - c) Breaker closing and opening time.
 - d) Slow and Power closing operation and opening.
 - e) Trip free and anti pumping operation.
 - f) Minimum pick-up voltage of coils.
 - g) Dynamic Contact resistance measurement.

- h) Functional checking of compressed air plant and all accessories.
- i) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation. Functional checking of Control switching device (CSD).
- j) Insulation resistance of control circuits, motor etc.
- k) Resistance of closing and tripping coils.
- l) SF6 gas leakage check.
- m) Dew Point Measurement
- n) Verification of pressure switches and gas density monitor.
- o) Checking of mechanical 'CLOSE' interlock, wherever applicable.
- p) testing of grading capacitor.
- q) resistance measurement of main circuit.
- r) checking of operating mechanisms
- s) Check for annunciations in control room.

17.2 The contractor shall ensure that erection, testing and commissioning of circuit breaker shall be carried out under the supervision of the circuit breaker manufacturer's representative. The commissioning report shall be signed by the manufacturers representative.

17.3 Additional data to be furnished along with the offer:

- a) Drawing, showing contacts in close, arc initiation, full arcing, arc extinction and open position.
- b) The temperature v/s pressure curves for each setting of density monitor along with details of density monitor.
- c) Method of checking the healthiness of voltage distribution devices (condensers) provided across the breaks at site.
- d) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100%

fault currents to load currents of the lowest possible value without requiring any maintenance or checks.

- e) The effect of non-simultaneity between contacts between poles and also show how it is covered in the guaranteed total break time.
- f) Sectional view of non-return couplings if used for SF6 pipes.
- g) Details & type of filters used in interrupter assembly and also the operating experience with such filters.
- h) Details of SF6 gas
- i) The test methods used in controlling the quality of gas used in the circuit breakers particularly purity and moisture content.
- j) Proposed tests to assess the conditions of the SF6 within a circuit breaker after a period of service particularly with regard to moisture contents of the gas.
- k) A complete catalogue on operation analyser satisfying all the requirements of the specification.
- l) Curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and pneumatic/hydraulic pressure.
- m) Detailed literature and schematic diagrams of switching mechanism for closing resistor showing the duration of insertion shall also be furnished along with the calculations in respect of thermal rating of resistors for the duties specified in the specification.
- n) All duty requirements specified, shall be provided with the support of adequate test reports to be furnished along with the bid failing which the bid is likely to be rejected.
- o) Field test report or laboratory test report in case of CB meant for reactor switching duty.

DRAWING/DATA TO BE FURNISHED FOR APPROVAL
AFTER AWARD OF CONTRACT

- 1.0 General outline drawing showing front and side elevation and plan of the equipment with detailed final dimensions and weight
- 2.0 Foundation plans including weights of various components and impact loading, values on short-circuit opening and rated making current in terms of equivalent static load
- 3.0 Detailed drawing for the mounting structure
- 4.0 Wiring diagram showing the control scheme of the breaker including alarms, indicating devices, instruments, space heaters, etc.
- 5.0 a) Dimensional drawing of the clamps and connectors for the terminals
b) Test certificates of the terminal clamps
- 6.0 Operating and maintenance instructions manuals

Routine and Type Test Certificates shall be submitted at least 2 weeks prior to delivery. (Equipment shall not be dispatched before approval of test certificates).

7.0 TECHNICAL PARAMETERS:

(In addition to those indicated in Chapter-GTR)

A. 420 kV CIRCUIT BREAKER:

- | | | |
|-------|---|--|
| A 7.1 | Type of Circuit Breaker | SF6
Class C2-Very low probability of
restrike during capacitive current
breaking as per IEC- 62271-100 Class
M2-10000 operations as per
IEC – 62271-100 |
| A7.2 | Rated continuous current 2000 / 3150 (as applicable) (A) at design ambient Temperature 50°C. | |
| A7.3 | Rated short circuit (applicable) current breaking capacity with percentage DC component as per at rated voltage corresponding | 40 kA / 50 kA / 63kA (as applicable) IEC: 62271-100
to minimum opening time
under operating conditions |

specified.

A7.4	Symmetrical interrupting capability (kA rms)	40 / 50 / 63 (as applicable)
A7.5	Rated short circuit making current (kAp)	100 / 125 / 157.5 (as applicable)
A7.6	i) Short time current carrying capability for one second (kArms)	40 / 50 / 63 (as applicable)
	ii) Out of phase breaking current capacity (kArms)	10/12.5/ 15.75(as applicable)
A7.7	Rated operating duty	O-0.3sec-CO-3min-CO cycle
A7.8	Reclosing	Single phase & three phase auto reclosing
A7.9	First pole to clear factor	1.3
A7.10	Rated line charging interrupting current at 90 deg. leading power factor angle (A. rms)	600 A
	(The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of $U/\sqrt{3}$ & 1.4 as per IEC: 62271-100).	
A7.11	Cable Charging Breaking current(A)	400
A7.12	Capacitor Breaking Current(A)	400
A7.13	Small inductive Breaking current(A)	As per IEC 61233
A7.14	Out of Phase Switching (Required)	Yes
A7.15	Temperature rise over the 100 design ambient temperature	As per IEC: 62271-100

A7.15	i) Total break time as per IEC (ms)	45
A7.16	ii) Rated break time as per IEC (ms)	40
A7.17	Total closing time (ms)	Not more than 150
A7.18	Operating mechanism	Motor compressed spring
A7.19	Max. difference in the instants of closing/opening of contacts (ms)	
	i) Within a pole	2.5
	ii) Between poles(opening)	3.3
	iii) Between poles (closing)	5.0
	The above shall be at rated control voltage and rated operating and quenching media pressures.	
A7.20	Trip coil and closing coil voltage	220 V DC with variation as specified
A7.21	Noise level at base and upto 50 m (distance from base of breaker)	140 dB (Max.)
A7.22	Rated terminal load	As per IEC or as per the value calculated by
A7.23	Auxiliary contacts	Besides requirement of specification, the bidder shall wire up 5 NO + 5 NC contacts for future use of purchaser.
A7.24	No of Terminals in common to be	All contacts & control circuits
	Control cabinet	wired out upto common control cabinet plus 24 terminals exclusively for Purchaser's use.
A7.25	Maximum allowable p.u. switching overvoltage under any switching condition	2.3

- A7.26 Pre-insertion resistor requirement
- i) Rating (ohms) 400
 - ii) Minimum pre-insertion 8 time (ms)
 - iii) Opening of PIR contacts
 - a) PIR Contacts should open immediately after closing of main circuits.
 - b) Atleast 5 ms prior to opening of main contacts at rated air/gas pressure, where the PIR Contacts remain closed.

(Auxiliary switch shall also comply with requirements stipulated under Chapter-GTR).

B. 245 kV CIRCUIT BREAKER:

- B 7.1 Type of Circuit Breaker SF6
Class C2-Very low probability of restrike during capacitive current breaking as per IEC- 62271-100 Class M2-10000 operations as per IEC – 62271-100
- B7.2 Rated continuous current (A) at design ambient temperature. 1600 / 2500 / 3000 (as applicable)
- B7.3 Rated short circuit current breaking capacity component as per at rated voltage corresponding 40 kA / 50 kA (as applicable) with percentage DC IEC: 62271-100
to minimum opening time under operating conditions specified.
- B7.4 Symmetrical interrupting capability (kArms) 40 / 50 (as applicable)
- B7.5 Rated short circuit making current (kAp) 100 / 125 (as applicable)

B7.6	Short time current carrying capability for one second (kArms)	40 / 50 (as applicable)
B7.7	Rated operating duty	O-0.3sec-CO-3min-CO cycle
B7.8	Reclosing	Single phase & three phase auto-reclosing
B7.9	First pole to clear factor	1.3
B7.10	Rated line charging Breaking current at 90 deg. leading power factor angle (A. rms)	125A
	(The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of $U/\sqrt{3}$ & 1.4 as per IEC: 62271-100).	
B7.11	Cable charging breaking current (A)	250A
B7.12	Capacitor breaking current(A)	250A
B7.13	Small inductive breaking current (A)	As per IEC 61233
B7.14	Temperature rise over the 100 design ambient temperature	As per IEC: 62271-100
B7.15	i) Total break time as per Cl.3.0 of this Chapter (ms)	65
B7.16	ii) Rated break time as per IEC (ms)	60
B7.17	Total closing time (ms)	Not more than 200
B7.18	Operating mechanism	Pneumatic/spring/hydraulic or a combination of
B7.19	Max. difference in the instants of closing/ opening of contacts (ms)	
	i) Between poles (opening)	3.3

ii) Between poles (closing) 5.0

The above shall be at rated control voltage and rated operating and quenching media pressures.

B7.20	Trip coil and closing specified coil voltage	220 V DC with variation as
B7.21	Noise level at base and upto 50 m (distance from base of breaker)	140 dB (Max.)
B7.22	Rated terminal load	As per IEC or as per the value calculated by Chapter-GTR,
B7.23	Auxiliary contacts	Besides requirement of specification, the bidder shall wire up 5 NO + 5 NC contacts for future
B7.24	No of Terminals in common Control cabinet	All Contacts & control circuits to be wired out upto common control cabinet plus 24 terminals exclusively for
B7.25	Maximum allowable switching overvoltage under any switching condition	As per IEC

(Auxiliary switch shall also comply with requirements stipulated under Chapter-GTR).