



BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

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TITLE SPECIFICATION FOR 400kV CIRCUIT BREAKER		SIGN	-SD-	-SD-	-SD-
		DATE	23.07.13		
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CUSTOMER/ CONSULTANT	Rajasthan Rajya Vidyut Utpadan Nigam Ltd. , Jaipur / Tata consulting Engineer Ltd. , Bangalore				
PROJECT	2X660MW Super –Critical Thermal Power Station, Stage –V, Unit 7 & 8-400kV Switchyard at Suratgarh				

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SECTION 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.1 SCOPE:-

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of Circuit Breakers complete with accessories as listed under this specification.

This section covers the specific technical requirements of Circuit Breakers. This constitutes minimum technical parameters for the above item as specified by the customer (RRVUNL). The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

The specification comprise of following sections:

- Section-1: Scope, specific technical requirements & Bill of Quantities.
- Section-2: Equipment specification under scope of supplies.
- Section-3: General technical requirements for all equipments under the project.
- Section-4: Equipment Data Sheet

In case of any conflict between various sections, order of precedence shall be in the same order as listed above.

The equipment is required for the following project:

Name of customer : Rajasthan Rajya Vidyut Utpadan Nigam Ltd. , Jaipur.

Name of Consultant : Tata consulting Engineer Ltd. , Bangalore

Name of the project : 2X660MW Super –Critical Thermal Power Station, Stage – V, Unit 7 & 8-400kV Switchyard at Suratgarh

1.2 SPECIFIC TECHNICAL REQUIREMENTS:-

TECHNICAL PARAMETERS	
Rated voltage kV (rms)	420
Standard to be followed	IEC-62271-100
Rated frequency (Hz)	50
No.of poles	3
Design ambient Temperature (deg. C)	50
Rated insulation levels	
Full wave impulse withstand voltage (1.2/50 micro sec.)	
-between line terminals and ground	± 1425 kVp
-between terminals with circuit breaker open	± 1425 kVp impulse on one terminal and 240kVP power frequency voltage of opposite polarity on other terminal
One minute power frequency dry withstand voltage	
-between line terminals and ground	520 kV (rms)
-between terminals with circuit breaker open	610 kV (rms)

Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	
-between line terminals and ground	± 1050 kVp
-between terminals with circuit breaker open	900 kVp impulse on one terminal and 345kVP power frequency voltage of opposite polarity on other terminal
Maximum radio interference voltage for frequency between 0.5MHZ and 2MHZ at 266kV rms	1000 Micro volt
Corona extinction voltage (kVrms) with circuit breaker open or close	320 (min.)
Minimum creepage distance:	
Phase to ground (mm)	13020
Between CB terminals (mm)	13020
System neutral earthing	Effectively Earthed
Seismic acceleration	0.3g horizontal(it is coming under zone –II)
Thermal rating of auxiliary contacts	10 A at 220 V DC
Breaking capacity of auxiliary contacts constants	2 A DC with circuit time not less than 20 ms
Phase to phase spacing (mm)	7000
Rated continuous current at design Ambient temperature 50°C	3150A
Rated short circuit Breaking current	50 kA for 3 second
Symmetrical interrupting capability (kA rms)	50 kA for 3 second
Rated short time making current(kAp)	125
Short time current carrying capability for three second (kArms)	50
Rated line charging interrupting current at 90 deg. Leading power factor angle (Arms)	600A
(The breaker shall be able to interrupt the rated line charging current with a test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.5 as per IEC - 62271-100)	
Maximum allowable switching over-voltage under any switching condition.	2.3 p.u
Rated small inductive current switching capability with over-voltage less than 2.3pu	0.5 A to 10 A
No. of trip coil	2 per pole
No. of closing coil	1 per pole
Total break time	Not exceeding 45 ms
closing time	Not more than 150ms
Rated operating duty cycle	O-0.3 sec.-CO-3 min-CO
Auto Reclosing	single phase & three phase auto reclosing
Max. difference in the instants of closing / opening of contacts (ms)	

Within a pole	2.5ms
Between poles opening	3.3ms
Between poles closing	5ms
Operating mechanism	Spring or Pneumatic or combination of these
Auxiliary voltage for closing coil	220 volt DC (85% -110%)
Auxiliary voltage for tripping coil	220 volt DC (70% -110%)
Auxiliary AC supply for Illumination and heaters etc	240V, 1-phase two wire AC supply
Auxiliary DC supply for motor	220V DC
Auxiliary contacts	Besides requirement of this spec., the bidder shall wire up 15 NO +1 5 NC per pole as a spare
Noise level at base and upto 50 m.(distance from base of breaker)	140 db max
Rated terminal load	as per IEC
Temperature rise over the design ambient temperature	as per IEC -62271-100
First pole to clear factor	1.3
Number of terminals in common control cabinet	all contacts circuits are to be wired out upto common control cabinet plus 24 terminals exclusively for Owner's use
Mounting	On Galvanised steel structure
Interpole cabling (FRLS) of CB in supplier scope	Yes
Terminal connector of CB in supplier scope	NO
Pre –Insertion resistor requirement	
Rating(Ohms)	400
Minimum pre-insertion time(ms)	8
Opening of PIR contacts	(a)PIR contacts should open immediately after closing of main contacts OR (b) Atleast 5 ms prior to opening of main contacts at rated air/gas pressure , where the PIR contacts remains closed
Auxiliary contact switch shall be double – decker type	No

Note – Circuit breaker shall be suitable for **DC** operated motor only.

1.3 QUANTITIES:-

1.3.1 MAIN QUANTITY

Sl. no.	Description	Unit	Qty.
3.	420 kV, 3150 A, 50 kA for 3 Sec, Three phase SF6 Circuit Breaker, without closing resistor , with controlled switching device for 50MVAR/80MVAR/125MVAR shunt reactor with signal cable , corona shielding, operating mechanism, Insulators , base frame, HV terminal Plates, control cabinet, support structure, fixing foundation bolts, cable glands and other accessories, complete in all respects	Nos.	1
4.	Lumpsum supervision charges for erection, testing and commissioning of all breakers with special tools and test instruments	Lot	1

Note-1 –For deciding the length of Signal cables following guidelines shall be follow.

Average distance between relay panel (located in switchyard control room) and control cabinet of circuit breaker is 350m per breaker. Average distance may be varies by $\pm 20\%$, and same shall be intimated during detailed engineering.

Signal cables shall be supplied in single drum length after confirmation by BHEL during detailed engineering . Along with signal cables all applicable necessary accessories like sensors, timers, relay glands and lugs etc. shall be in bidder scope.

Note -2 - It may be noted that, BHEL will provide following special tools and test instruments for erection, testing and commissioning of breaker at site.

- i) Operational analyzer along with transducer
- ii) DCRM kit along with Transducer
- iii) Timing kit
- iv) SF-6 gas filling & evacuating trolley
- v) Megger

- vi) Multimeter
- vii) Dew Point Meter

Note -3- -following test instruments/kits shall be brought out at site by successful Bidder/supplier for ETC of breaker.

- i) SF-6 Gas leakage detector
- ii) SF-6 gas filling adaptor

Note -4 – Total quantity may vary upto $\pm 20\%$ at contract stage. However, individual quantities may vary upto any extent.

Note -5- The bidder shall provide break-up price of individual type test as per Annexure-1. It is on the discretion of BHEL to conduct any or all the tests as listed in Annexure-1.

Note -6- The terminal connector of CB shall be in BHEL scope .

Note -7- Galvanizing of CB structure shall be as per cl. No. 3.8 of section -3 of technical specification.

1.3.2 Mandatory Spares :-

Sl. no.	Description	Unit	Qty.
1.	Auxiliary contactors indicating lamps, fuses etc. for electrical control circuit	Sets	2
2.	SF6 density switch (of each type)	No.	1
3.	Aux. switch block (of each type)	Nos.	5
4.	Pressure switch for compressed air (if applicable) (of each type)	Nos.	2
7.	Trip coils and closing coils (of each type)	Nos.	2
8.	Gaskets (of each type)	Set	1
9.	SF6 gas filling attachment (of each type)	Set	1
10.	Auxiliary relay (of each type)	Nos.	2
11.	Breaker Control switch (of each type)	No.	1
12.	Breaker Selector switch (of each type)	No.	1
13.	Insulator column (of each type)	No.	1

1.4 TYPE TESTS:-

If type test conducted on CB then type test shall be witnessed by BHEL/Customer. Type test of Circuit breaker shall be conducted in NABL accredited Lab only.

In addition to that CB to be supplied shall conform to type tests as per relevant standards and proven type. The Bidder / Contractor shall furnish the reports of all the type tests carried out within last **five years from the date of opening of the tender** (i.e. 03.12.2012) as listed in relevant clauses in respective electrical specification. These reports should be for the tests conducted on similar CB to be supplied under this contract.

Type tests done in an independent government laboratory or in the presence of representative of State Electricity Board or other reputed public undertakings, the type test reports of the same shall be submitted for scrutiny /approval.

1.5 QUALIFYING REQUIREMENTS :-

There are no PQR for customer approved **Vendors**.

Pre-qualifying requirements of Vendors not approved by customer shall be as mentioned below .

- 1 Documentation to show that the 400kV equipments has been supplied.
- 2 Documentation in the form of certificate that the 400kV equipments has been operating satisfactorily for two years as on the scheduled date of bid opening (i.e. 03.12.2012) .
- 3 The list proposed by the bidder shall be subject to the approval of purchaser/consultant.

Note 1- Bidder shall get the approval for sub vendors proposed by him from owner/consultant during detailed engineering stage.

1.6 INSPECTION & TESTING

Before being fitted on the equipment, all components shall be subjected to routine tests at the Contractors factory, as per the relevant IEC/IS standards. A detailed test report proving the successful passing of such tests shall be provided.

Prior to dispatch, the routine & acceptance tests shall be carried out on equipment in accordance with the applicable IEC /IS and the material shall be offered for final inspection to BHEL and RRVUNL in accordance with agreed quality plan with 3 weeks advance information.

1.7 QUALITY PLAN:-

The contractor shall carry out contract works in accordance with sound quality management principles which shall include such as controls which are necessary to ensure full compliance to all requirements of the specification & applicable international standards. These quality management requirement shall apply to all activities during design, procurement, manufacturing, inspection, testing, packaging, shipping, inland transportation, storage, site erection & commissioning. Contractor shall submit detailed Quality Plan for BHEL / customer's approval within 1 week of P.O. placement.

Annexure-1

Applicable Type test list of 400kV Circuit breaker for Suratgarh project

Sl. No.	Description of type test as per IEC 62271-100:2008
1.	Dielectric tests
2.	Measurement of the resistance of the main circuit
3.	Temperature rise tests
4.	Short time withstand current and peak withstand current tests
5.	Additional test on Auxiliary and control circuits
6.	Mechanical operation test at ambient temperature
7.	Short circuit current making and breaking tests
8.	Radio Interference voltage tests
9.	Verification of the degree of protection
10.	Tightness test
11.	Extended mechanical endurance tests (class M2)
12.	Static terminal load tests (Calculation in scope)
13.	Short lines fault tests
14.	Out of phase making and breaking tests
15.	Single phase test (Included in above sl. No. 4)
16.	Capacitive current switching tests
17.	Switching of shunt reactors test
18.	Seismic withstand test

Remarks- 1 -It is on the discretion of BHEL to conduct any or all the tests as listed above.

Remarks -2 - Switching of shunt reactors type test shall be conducted suitable for 50MVAR/80 MVAR /125MVAR Reactor.

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SECTION-2

2.0 EQUIPMENT SPECIFICATION

2.1 General

This section covers the general technical requirements of outdoor type SF6 circuit breakers.

- 2.1.1 The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 60694 and other relevant IEC standards except to the extent explicitly modified in the specification and shall also be in accordance with requirements specified in Section 3.
- 2.1.2 420 kV 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.
- 2.1.3 The circuit breaker shall be complete with operating mechanism, control cabinets, piping, inter-pole 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.
- 2.1.4 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. The support structure of circuit breaker as well as that of control cabinet shall be hot dip galvanised.
- 2.1.5 The circuit breakers shall be designed for use in the geographic and meteorological conditions as given in Section-3.

2.2 Applicable Standards

The circuit breakers shall strictly conform to the following Indian and International standards as appropriate:

IEC 60056 (1987)	Specification for high voltage alternating-current circuit breaker.
IEC 376: 1971	Specification and acceptance of new sulphur hexafluoride.
IEC 376A: 1973	First supplement - Section 13 : Mineral oil contents
IEC 376B: 1974	Second supplement: Clause 26
IEC 62271-100	High voltage Switchgear and control gear, HV-AC Circuit Breaker
IS 13947 (Part 1):1993	Low voltage switchgear and control gear, General rules

IS 13947 (Part 2): 1993	Low voltage switchgear and control gear, Circuit Breakers.
IS 325: 1978	Three phase induction motors.
IS 2629: 1985	Recommended practices for hot dip galvanizing on iron and steel.
IEC 60 (Part 1) 1989	High voltage test techniques, General definition and test requirement.
IEC 60 (Part 3): 1976	Measuring devices
IEC 60 (Part 4):1977	Application guide for measuring devices
IEC 60694: 1980/ 1996	Common clauses for high voltage switchgear and controlgear standards
IEC 71 (Part 1): 1993	Insulation coordination, Definition Principle and rules
IEC 71 (Part 2): 1976	Insulation coordination, Application Guide
CIGRE WG Report No. 13-02-1973	Switching over-voltage in EHV and UHV systems with special reference to closing and re-closing transmission lines
IS 2633 : 1986	Method for Testing Uniformity of coating on zinc coated articles.
IS 2544 : 1973	Specification for Porcelain Post Insulators for systems with nominal voltages greater than 1000 volts.
IS 5561 : 1970	Electric Power Connectors.
IS 5621 : 1980	Hollow insulators for use in electrical equipments.
IEC 233 : 1974	Tests on hollow insulators for use in Electrical Equipment.
IS 4379 : 1981	Identification of contents & industrial gas cylinders.
IS 7285 : 1988	Seamless steel cylinders for permanent and high pressure liquifiable gases.
IEC 427(1989)	Synthetic testing of High Voltage alternating current Circuit Breaker

2.3 Duty Requirements

- 2.3.1 The circuit breaker shall be restrike free as per IEC under all duty conditions and shall be capable of performing their duties without opening resistors.
- 2.3.2 The circuit breaker shall meet the duty requirements for any type of fault or fault location also for line switching when used on an effectively grounded system, and perform make and break operations as per the stipulated duty cycles satisfactorily.
- 2.3.3 The switching surge over voltage while re-energizing shall be as per standards. The circuit breaker shall be able to meet the duty given below .

i)	Terminal fault	O-0.3 sec.-CO-3 min-CO
ii)	Reclosing against trapped charges	Same as above but with the first being on de-energized line and second closing against trapped charges of 1.2p.u of opposite polarity
iii)	Out of phase closing	One closing operation under phase opposition i.e. With twice the voltage across terminals

2.3.4 PRE INSERTION RESISTER

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 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 deenergised 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 alongwith the bid. The calculations shall take care of adverse tolerances on resistance values and time settings.

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

2.3.6 The circuit breaker shall also be capable of

- Clearing short line fault (kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.
- Interrupting line/cable charging current as per IEC without any restrikes and without use of opening resistors
- .Breaking small inductive current of 0.5 to 10A without switching over voltage exceeding the limits specified in IEC.
- Breaking 25% of the rated fault current at twice rated voltage under phase opposition condition.
- 400 kV breakers shall be able to switch in and out the 400 kV shunt reactor for any value from **50 MVAR upto 125 MVAR** without giving rise to overvoltage more than 2.5 p.u. Laboratory test and or field test reports in support of the same shall be furnished alongwith the bid.

2.3.7 The Breakers 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 specification.

2.4 Controlled Switching requirements

2.4.1 The controlling shall be provided in circuit breaker of switchable line Reactor and bus Reactors as per BOQ .

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

- 2.4.2 The controller shall be designed to operate at the correctly and satisfactorily with the excursion of auxiliary A/C & DC voltage and frequency as specified in section -3.
- 2.4.3 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.
- 2.4.4 The controller shall have functions for switching ON & OFF the circuit breakers.
- 2.4.5 The controller shall bet command to operate the breakers manually of through auto re-close 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.
- 2.4.6 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, 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+ 0.5 ms.
- 2.4.7 The controller should have display facility at the front for the settings and measured values.
- 2.4.8 The controller should be PC compatible for the setting of various parameters and down loading of the settings and measured values date time of switching etc. Window based software for this purpose shall be supplied by the contractor to be used on the owner's PC.
- 2.4.9 The controller shall have self-monitoring facility.
- 2.4.10 The controller shall be suitable for current input of 1 amp from the secondary of the CTs. And 110 V (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.
- 2.4.11 The controller shall have time setting resolution of 0.1 ms or better.
- 2.4.12 The controller shall have two switching functions (ON & OFF) .
- 2.4.13 The Controller shall be able to give closing as well as tripping command to at least two breakers with intended discrimination.
- 2.4.14 The controller shall have sufficient number of output/input potential free contracts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.

2.5 Total Break Time

- 2.5.1 The total break time as specified under section 1 of this specification shall not be exceeded under any of the following duties :
- i) Test duties T10, T30, T60, T100 (TRV as per IEC: 62271-100)

ii) Short line fault L75, L90 (TRV as per IEC: 62271-100)

2.5.2 The Bidder may please note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with combined variation of the trip coil voltage, (70-110%), pneumatic pressure 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.

2.5.3 The values guaranteed shall be supported with type test reports.

2.6 Constructional Features

The features and constructional details of circuit breakers shall be in accordance with requirements stated hereunder:

2.6.1 Contacts:

2.6.1.1 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, for validation of which a power frequency dielectric withstand test conducted for a duration of at least 15 minute is acceptable).

2.6.2.2 If multibreak interrupters are used, these shall be so designed and augmented that a uniform voltage distribution is developed across them. Calculations/ test reports in support of the same shall be furnished. The thermal and voltage withstand of the grading elements shall be adequate for the service conditions and duty specified.

2.6.3.3 The SF6 circuit breaker shall meet the following additional requirements:

- a) The circuit breakers shall be single pressure type. The design and construction of the circuit breaker shall be such that there is 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 minimize distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF6 media) shall have adequate seals. The SF6 gas leakage should not exceed + 0.5% per year. In case the leakage under the specified condition 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.
- 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) Each pole shall form an enclosure filled with SF6 gas independent of two other poles, the SF6 density of each pole shall be monitored.

- e) 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:
 - i) 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.
 - ii) Suitable protection to prevent circuit breaker operation under low gas and/or pneumatic pressure shall be provided . Suitable pressure switches for loss of air pressure shall be provided .
- f) Each circuit breaker shall be capable of withstanding a vacuum of minimum 8 milibars without distortion or failure of any part.
- g) 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 requirement specified.

2.6.4 Provisions shall be made for attaching an operational analyzer after installation of circuit breakers at site to record contact travel, speed and making measurement of operating timings, preinsertion timings of closing resistor if used, synchronization of contacts in one pole.

2.6.5 Terminal Connector Pad

The circuit Breaker terminal pad shall be made up of high quality electrolytic copper or aluminium. The terminal pad shall have protective covers which shall be removed before interconnections.

The circuit breaker shall be designed to withstand the rated terminal loads, wind load/ earthquake load, short circuit forces.

2.7 Sulphur Hexa Fluoride Gas (SF6 Gas)

- 2.7.1 Sufficient SF6 gas including that required for gas Analysis during filling shall be provided to fill all the circuit breakers installed.
- 2.7.2 The SF6 gas shall comply with IEC 376, 376A and 376B and shall be suitable in all respects for use in the switchgear under the operating conditions.
- 2.7.3 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.
- 2.7.4 **Test:** SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water content as per IEC 376, 376A and 376B and supplier's test certificates shall be furnished indicating all the tests as per IEC 376 for each lot of SF6 gas in stipulated copies as indicated in Section-3 of this specification. Gas bottles should be tested for leakage during receipt at site.

2.8 Insulators

- a) The porcelain of the insulators shall conform to the requirements stipulated under this specification as applicable.
- b) The mechanical characteristics of insulators shall match with the requirements specified under this specification.
- c) All insulators shall conform to IEC 61264(for pressurized hollow column insulators) and IEC-233 (for others). All routine and sample tests shall be conducted on the hollow col-

umn insulators as per these standards with requirements and procedures modified as under:

- Pressure test as a routine test
- Bending load test as a routine test
- Bending load test as a sample test on each lot
- Burst pressure test as a sample test on each lot
- In addition to above, ultrasonic test shall be carried out as additional routine test.

- d) Hollow Porcelain for pressurized columns/chambers should be in one integral piece in green and fired stage. No Joint on porcelain shall be accepted.

2.9 Support structure

Support structures for Circuit Breaker and central Control cabinet shall be hot dip galvanized. **These support structures along with foundation bolts shall be supplied by the Supplier.**

The support structure of the circuit breaker shall meet the following mandatory requirement : The minimum vertical distance from the bottom of the lowest porcelain part of the enclosures to the circuit breaker base, where it rests on the foundation pad shall be 2.55 metres. The structure design shall be such that during operation of circuit breaker vibrations are reduced to minimum.

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.

The support structure shall also meet the other requirements given under this specification.

2.10 Operating Mechanism and Control

2.10.1 General Requirements

Circuit breaker shall be operated by spring charged mechanism or Pneumatic mechanism or a combination of these. The mechanism shall be housed in a weather proof and dust proof control cabinet as stipulated under this specification.

The operating mechanism shall be strong, rigid, not subject to rebound and shall be readily accessible for maintenance for a man standing on ground.

The operating mechanism shall be suitable for high speed reclosing and other duties specified. During reclosing the breaker contacts shall close fully and then open. The mechanism shall be anti-pumping and trip free (as per IEC definition) under every method of closing. The mechanism of the breaker shall be such that the position of the breaker is maintained even after the leakage of operating media and/or SF6 gas.

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.

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

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.

The pole control cabinet and central control cabinet shall comply with requirements specified under this specification.

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.

2.10.2 Control

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

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

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 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. D.C circuit for trip coils shall be separate and each shall be monitored.

Closing coil and associated circuit 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 up to 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.

Density monitor contacts and pressure switch contacts 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 and operation lock-out in case of DC failures. Density monitors are to be so mounted that the contacts do not change on vibration during operation of circuit breaker.

The auxiliary switch of the breaker shall be positively driven by the breaker operating rod. The auxiliary switch shall conform to the requirements of this specification.

The preferred basic control schematic of the circuit breaker shall be furnished to the successful bidder and it is expected to be followed by the bidder. This, however, does not absolve the bidder from the responsibility for safe and reliable operation of the breaker in its lifetime.

2.10.3 Spring operated mechanism

- a) Spring operated mechanism shall be complete with DC 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.
- b) 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. The motor shall have adequate thermal rating for this duty.
- c) After failure of power supply to the motor, one close open operation shall be possible with the energy contained in the operating mechanism.
- d) 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.
- e) Closing action of circuit breaker shall compress the opening spring ready for tripping.
- f) When closing springs are discharged after closing a breaker, closing spring shall be automatically charged for the next operation and an indication of this shall be provided in the local and remote control cabinet.
- g) Provisions shall be made to prevent 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 for closing springs when the breaker is already in the closed position.
- h) 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.

2.10.4 Pneumatically - Operated Mechanism

- 1. The pneumatic operated breaker shall be equipped with compressed air system in accordance with cl. No. 2.11 .
- 2. The breaker local air receivers shall have sufficient capacity for atleast two CO operations of the breaker at the lowest pressure for auto reclosing duty without refilling.
- 3. Independently adjustable pressure switches with potential free, ungrounded contacts to actuate a lockout device shall be provided. This lockout device with provision of remote alarm indication shall be incorporated in the circuit breaker to prevent operation whenever the pressure of the operating mechanism is below that required for satisfactory operation of the circuit breaker. 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.

-Trip Lockout pressure	-	2 Nos.
-Close Lockout pressure	-	1 No.

- | | | |
|--------------------------------|---|-------|
| -Auto-reclose Lockout pressure | - | 1 No. |
| -Extreme low pressure | - | 1 No. |

4. The compressed air mechanism shall be capable of operating the circuit breaker under all duty conditions with 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.
5. The compressed air piping shall comply to requirements under clause 2.11.

2.11 UNIT COMPRESSED AIR SYSTEM FOR CIRCUIT BREAKERS

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

1. The compressed air system shall be provided with necessary piping, piping accessories, control valves, safety valves, filter reducing valves, isolating valves, drain ports, etc. Also the Unit compressed air system shall be provided with suitable anti-vibration pads.
2. The compressor 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.
3. 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.
4. 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.

2.11.2 AIR COMPRESSOR

1. 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 :

Total running time of compressor to build up the rated pressure from Atmospheric pressure	Not exceeding 80 minutes
Normal running air charging	Not exceeding 15 minutes considering 10% leakage/day
Air charging time after one close-open operation from rated pressure	Not exceeding 15 minutes

2. Compressor shall be driven by automatically controlled motors conforming to requirements given in section 3.
3. The compressor shall be provided with automatic adjustable unloading device during starting.
4. The compressor shall be equipped with a Time totalize and a Pressure gauge.

2.11.3 AIR RECEIVERS

1. Air receivers shall be designed in accordance with the latest edition of ASME code for Pressure Vessels – Section VIII of BS: 5179. A corrosion allowance of 3 mm shall be provided for shell and dished ends.
2. Connection for air inlet and outlet, drain and relief valves shall be flanged type or screwed type. Pressure gauge and pressure switch connection shall be screwed type only.
3. 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.
4. Air receivers shall be offered with atleast 50% spare capacity, calculated on the basis of total air requirement for 2 CO operations.

2.11.4 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 and integral part of air compressor system.

2.11.5 CONTROL AND CONTROL EQUIPMENT

1. The compressor control shall be of automatic start/stop type initiated by pressure switches
2. Duplicate incoming supply of 415V, AC shall be provided by the Owner at switchyard bay marshalling box from where the Contractor shall take the feed to the operating mechanism.
3. All the necessary compressor control equipment shall be housed in a totally enclosed sheet steel cabinet also conforming to requirements of Section 3. Pressure gauges and other indicating devices, control switches shall be mounted on the control cabinet.
4. A glass window shall be provided for viewing the indicating instrument/gauges. The max. height shall be 2000 mm.

2.11.6 COMPRESSED AIR PIPING, VALVES AND FITTINGS

1. The flow capacity of all valves shall be at least 20% greater than the total compressor capacity.
2. 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.
3. 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)
4. All joints and connections in the piping system shall be brazed or flared as necessary.
5. All compressed air piping shall be carried out in accordance with BS: 162.

6. 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.

2.11.7 Test

In accordance with the requirements stipulated under section 3, the compressors and its accessories shall conform to the type tests and shall be subjected to routine tests as per applicable standards.

2.12 Interpole Cabling

- a) All cables to be used by contractor shall be armoured and shall be as per IS-1554 (1100 Volts Grade). All cables within and between circuit breaker poles shall be supplied by the CB manufacturer.
- b) Only stranded conductor shall be used. Minimum size of the conductor shall be 1.5/ 2.5 sq.mm (copper).
- c) The cables shall be with oxygen index Min.-29 and temp. index as 250°C as per relevant standards.

2.13 Fittings and accessories

2.13.1 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.

- i. Cable glands (Double compression type), Lugs, Ferrules etc.
- ii. Local/remote changeover switch
- iii. Operation counter
- iv. Pneumatic pressure gauges
- v. Control switches to cut off control power supply
- vi. Fuses as required
- vii. The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for future use.
- viii. Anti-pumping relay
- ix. Pole discrepancy relay
- x. D.C. Supervision relays
- xi. Rating and diagram plate in accordance with IEC incorporating year of manufacture
- xii. **Controlled switching equipments like sensors, timers , relay etc. (as applicable).**

2.13.2 Additional fittings for pneumatically operated circuit breaker:

1. Unit compressed air system in accordance with clause 2.11
2. Breaker air receivers.
3. Pressure gauge, spring loaded safety valve and pressure switch with adjustable contacts.
4. 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.
5. Stop, non-return and other control valves, pipings and all accessories upto breaker

mechanism housing.

2.14 Dead Tank Type Circuit Breaker

In case dead tank type circuit breaker is offered, the bidder shall offer bushing type CTs (whose secondary parameters shall be furnished to successful bidder) on either side of dead tank circuit breaker instead of conventional outdoor CTs.

The enclosure shall be made of either Al/Al alloy or mild steel (suitably hot dip galvanized)

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}.

The maximum temperature of enclosure with CB breaker carrying full load current shall not exceed the ambient by more than 20 °C.

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.

2.15 Tests

In accordance with the requirements stipulated as under the circuit breaker along with its operating mechanism shall conform to IEC:62271-100.

2.15.1 Type test

Type test shall be conducted as per Annexure -1 of section -1 .

2.15.2 Routine tests

The Bidder shall indicate the Manufacturer's standard routine tests. The Supplier shall completely assemble and test each breaker to ensure satisfactory working of all component parts and also assembled as a whole. The following shall constitute routine tests and shall be carried out as per clause Nos. of IEC:62271-100/ IEC 56:1987 indicated against each test.

- a) Power frequency voltage withstand (dry) tests on the main circuit
- b) Voltage withstand tests on control and auxiliary circuits
- c) Measurement of the resistance of the main circuit
- d) Tightness test
- e) Mechanical operating test
- f) Design and visual checks

In addition to above tests following tests shall also be performed:

Speed curves for each breaker shall be obtained with the help of a suitable operation analyzer to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic pressure etc.). The tests shall show the speed of contacts directly at vari-

ous 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 under normal condition shall also be performed at site for which the necessary operation, analyzer along with necessary transducers, cables, etc. where included in scope of supply shall be furnished and utilized.

However necessary adapter and transducers etc. if required shall have to be supplied by the bidder.

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.

Controlled switching equipments validation test.

2.15.3 Site tests

All routine tests except power frequency voltage dry withstand test on main circuit shall be repeated on the completely assembled breaker at site.

2.16 Testing & Commissioning

An indicative list of tests is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests alongwith 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.
- (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) Calibration of pressure switches and gas density monitor.
- (o) Checking of mechanical 'CLOSE' interlock, wherever applicable.
- (p) Testing of grading capacitor
- (q) Resistance measurements of main circuits
- (r) Checking of operating mechanism
- (s) Checking of annunciation in control circuits
- (t) Point of wave switching test (wherever applicable)

2.17 Information to be furnished

- 1 Outline general arrangement drawing of CB
2. Outline general arrangement drawing of control cabinets and their foundation plan.
3. Support structure/foundation plan drawing with necessary support structure design calculation.
4. Outline general arrangement drawing of Support Insulator and Interrupter Insulator
5. Electrical schematic diagram including brief write up on operation.
6. Rating and name plate drawing.
7. Hydraulic/Air/SF6 gas connection diagram.
8. Schematic diagram of Pneumatic /spring operated mechanism
9. Wiring diagram.
10. Sectional view of Interrupter
- 12 Sectional view of SF6 gas couplings.
13. Sectional view of interrupter, voltage grading device identifying each part of the assembly.
14. Drawing showing contacts in close, arc initiation, full arcing, arc extinction and open position.
15. The temperature v/s pressure curves for each setting of density monitor along with details of density monitor.
16. Method of checking the healthiness of voltage distribution devices (condenser) provided across the breaks at site.

- 17 Data on capability 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 with out requiring any maintenance or checks.
18. The effect of non-simultaneity between poles and also show how it is covered in the guaranteed total break time.
19. Details of type of filters used in interrupter assembly and also the operating experience with such filters
- 20 Details of SF6 gas :
 - i) The test method used in controlling the quality of gas used in the circuit breakers particularly purity and moisture contents.
 - ii) Proposed test 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.
 - iii) The precise procedure to be adopted by maintenance personnel for handling equipment who are exposed to the products of arcing in SF6 gas so as to ensure that they are not affected by possible irritants of the skin and respiratory system. Recommendations shall be submitted for suitable protective clothing, methods of disposal of circuit breaker cleaning utensils and other relevant matters.
21. A complete catalogue on operation analyzer satisfying all the requirements.
22. The bidders shall furnish along with the bid, curves supported by test data indicating the opening time under close open operation with combined variation of trip coil voltage and pneumatic/hydraulic pressure.
23. Field test report or laboratory test report in case of CB meant for reactor switching duty.
24. 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.
25. Other information as required to be submitted by the specification.

SECTION-3

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

The provisions under this section are intended to supplement general requirements for the materials, equipments and services covered under other respective sections and are not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall hold good.

3.1 PROJECT INFORMATION AND SYSTEM PARAMETERS

a)	Customer/ Purchaser/ Owner	Rajasthan Rajya Vidyut Utpadan Nigam Ltd. , Jaipur
b)	Consultant	Tata consulting Engineer Ltd. , Bangalore
c)	Project Title	2X660MW Super –Critical Thermal Power Station, Stage –V, Unit 7 & 8-400kV Switchyard at Suratgarh
d)	Location	Prabat Nagar , Suratgarh Sriganganagar district, Rajasthan
e)	Altitude and longitude	Latitude:29 deg. 10 min. N Longitude: 74 deg. 01 min. E
f)	Elevation above mean sea level	186 m(approximately)
g)	Transport Facilities	Suratgarh project is located 27 km from Suratgarh , 15 km from Suratgarh to Biradhwal on NH15, 12km in east from NH15.
h)	Postal Address	To follow
SITE CONDITIONS		
a)	Mean of daily maximum temperature	32.3 deg. C
b)	Mean of daily minimum temperature	19.6 deg. C
c)	Highest temperature recorded	50 deg. C
d)	Lowest temperature recorded	-2.8 deg. C
e)	Design ambient temperature for electrical equipment design	50 deg. C
f)	Relative humidity	Varies between 21 % and 81%
g)	Pollution Severity	Heavily Polluted
h)	Seismic zone	II
i)	Basic Wind speed	47 m/sec

j)	Annual mean wind speed	4km/hr
k)	Terrain category	2
l)	Annual average rain fall	312 mm

SYSTEM PARAMETERS

Nominal system voltage	400 kV	11kV
Highest system voltage	420 kV	12kV
Basic Impulse level(dry /wet)	1425kVP	75kVP
Power frequency withstand voltage	630kVrms	28kVrms
Switching Impulse withstand voltage	1050 kVP	NA
Rated short time current	50 kA for 3 sec	40 kA for 1 sec
Frequency	50 Hz	50 Hz
Creepage distance	31mm/kV	31mm/kV
System Earthing	Effectively Earthed	Effectively Earthed

AUXILIARY POWER SUPPLY

3 phase A.C power supply	415V $\pm$ 10%, 50 Hz, 3-phase 4 wire, solidly earthed with variation in frequency of $\pm$ 5%
1 phase A.C power supply	240V $\pm$ 10%, 50 Hz, 1-phase , 2 wire , AC supply with variation in frequency of $\pm$ 5%
D.C. power supply	220V $\pm$ 15%, 2-wire ungrounded 48V $\pm$ 10%, 2 wire system positively earthed

Combined variation of voltage and frequency shall be +/- 10%

3.2 GENERAL TECHNICAL REQUIREMENT

3.2.1 CODES AND STANDARDS

All materials and equipment shall generally comply in all respect with the latest edition of relevant international electro-technical commission (IEC) or any other internationally accepted standard which ensure equal or better quality or relevant Indian standard(IS) mentioned against each equipment and this specification.

3.3 MATERIAL/WORKMANSHIP

3.3.1 General Requirement

Where the specification does not contain characteristics with reference to workmanship, equipment, materials and components of the covered Equipment it is understood that the same must be new, of highest grade of the best quality of their kind conforming to best engineering practice and suitable for the purpose for which they are intended.

The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements and shall be used throughout the design. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from purchaser.

Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall be interchangeable with, and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.

All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be constructed as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, leveling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances and instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacture's limits suitable guards shall be provided for the protection of personal on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purpose. The spare equipment(s) shall be installed at designated locations and tested for healthiness.

The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him. All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. If such is the case, he shall declare in the proposal, where such oil or grease is available. He shall help purchaser in establishing equivalent Indian make and Indian

Contractor. The same shall be applicable to other consumables too.

3.3.2 Provisions For Exposure to Hot and Humid climate

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favorable to the growth of fungi and mildew. The indoor equipments located in non-air conditioned areas shall also be of same type.

3.4 COLOUR SCHEME AND CODES FOR PIPE SERVICE/PANELS

The contractor shall propose a color scheme for those equipment/Items for which the colour scheme has not been specified in the specification for the approval of purchaser. The decision of purchaser shall be final. The scheme shall include:

Finishing colour of Indoor equipment

Finishing colour of Outdoor equipment.

Finish colour of all cubicles.

Finishing colour of various auxiliary system equipment including piping

Finishing colour of various building items.

All the steel works shall be thoroughly cleaned of rust , scale , oil , grease, dirt and scarf by pickling , emulsion cleaning , etc. The sheet steel shall be phosphated /oven dried and then painted with two coats of zinc rich primer paints . After application of the primer, two coats of finished synthetic enamel paint shall be applied. The colour of the finished coats inside shall be **glossy white** and exterior of the treated sheet steel shall be **shade 631 of IS 5 /RAL 7032** for all switchboard /MCC/distribution board , control panels etc.

Sufficient quantities of touch paint shall be furnished for application at site. All the indoor cubicles shall be the same as exterior surface and for other miscellaneous items, colour scheme will be approved by the purchaser.

3.5 PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves, pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner. Screens of corrosion resistant material shall be furnished on all ventilating louvers to

prevent entry of insects.

3.6 FUNGI-STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on the parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interface with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application to the varnish.

3.7 SURFACE FINISH

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

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

3.8 GALVANIZING

All ferrous parts including all sizes of nuts, bolts, Plain and spring washers, support channels, structures, shall be hot dip galvanized conforming to latest version of IS:2629 or any other equivalent authoritative standard. However, hardware less than M12 size shall be electro-galvanized. Minimum weight of zinc coating shall be **610 gm/sq.m** and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6 mm thickness, requirement of coating shall be as per relevant ASTM. Average weight of zinc coating shall be **750gm/sq.m**.

3.9 PACKING

The following details are to be clearly indicated in the material forwarding documents:

- a) Name and address of the consignee.
- b) Purchase order number.
- c) Name of supplier/s.
- d) Description of equipment / material.
- e) Net weight.
- f) Gross weight.

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent

damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the purchaser, the Contractor shall also submit packing details/associated drawing for any equipment material under his scope of supply, to facilitate the purchaser to repack any equipment/ material at a later date, in case the need arises. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost. The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution symbol i.e. fragile, handle with care, use no Hooks etc.

3.10 HANDLING, STORING AND INSTALLATION

Contractor may engage manufacturer's Engineers to supervise if required for unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

Where assemblies are supplied in more than one section, contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning.

Contractor shall be responsible for examining all the shipment immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. Any demurrage, pilferage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. The Contractor shall be fully responsible, for the equipment/material until the same is handed over to the purchaser in an operating condition after commissioning.

The minimum phase to earth, phase to phase and section clearance along-with other technical parameters for the various switchyard voltage levels to be maintained shall be strictly as per the approved drawings.

The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances, the Contractor shall immediately proceed to correct the discrepancy at his risks and costs.

3.11 DEGREE OF PROTECTION

The enclosures of the Control Cabinets, Junction boxes and Marshalling boxes panels etc to be installed shall be provided with degree of protection as detailed here under:

- a) Installed out door: IP-55
- b) Installed indoor in air conditioned area: IP-42
- c) Installed in covered area IP:52

d) For LT switchgear (AC & DC distribution Boards): IP-54

The degree of protection shall be in accordance with IS:13947, (Part-1)/IEC-947(Part-1). Type test report/or degree of protection test on each type of the box shall be submitted for approval.

3.12 RATING PLATES, NAME PLATES AND LABELS

Type or serial number together with details of the loading conditions under which the item of the substation in question has designed to operate and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirements.

All such nameplate instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternately two separate plates one with Hindi and other with English inscriptions may be provided.

3.13 EARTHING

Circuit breakers, LA, Isolator, CVT , CT , BPI shall be provided with two grounding pads suitable for connection to galvanized steel flat. Control panels, Relay panel, outdoor marshalling boxes, Junction boxes, Lighting panels and distribution board shall be provided with two grounding pads, for connection to galvanized steel flat. The two pads shall be provided, one each at the middle of the two opposite sides of the bottom frame of the equipment. Earthing of hinged door shall be done by using a separate earth wire.

3.14 TERMINAL BLOCKS AND WIRING

Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All Inter-phase and external connections to equipment or to control cubicles will be made through terminal blocks.

Terminal blocks shall be **650 V** grade and have continuous rating to carry the maximum expected current on the terminals. Those shall be of moulded piece complete with insulated barriers stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be **non-disconnecting stud type equivalent to Elmex type CATM4**, Phoenix cage clamp type of Wedge or equivalent. The Insulating material of terminal block shall be nylon 6.6 which shall be free of halogens, fluorocarbons etc.

Terminal block for current transformer and voltage transformer secondary leads shall be provided with **test links and isolating facilities**. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

The terminal shall be that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally. The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable. The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement

to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

All circuits except CT circuits :	Minimum of 2 nos. of 2.5 sq.mm, copper flexible.
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All CT circuits :	Minimum of 4 nos. of 2.5 sq.mm, copper flexible..
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The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

There shall be a minimum clearance of 250mm between the first bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm. The Supplier shall furnish all wire, conduits and terminals for the necessary inter-phase electrical connection (where applicable) as well as between phases and common terminal boxes or control cabinets.

All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The supplier shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

3.15 CONTROL CABINETS, JUNCTION BOXES, TERMINALS BOXES AND MARSHALLING BOXES FOR OUTDOOR EQUIPMENTS

All types of boxes, cabinets etc. shall generally conform to and be tested in accordance with IS-5039, IS-8623 or IEC-439, as applicable and the clause given below.

Control cabinet, Junction boxes, Marshalling boxes & Terminal boxes shall be made of sheet steel . Sheet steel used shall be at least 2.0 mm thick cold rolled or 2.5 mm hot rolled . The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements.

Cabinet /boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against

atmosphere. The quality of gaskets shall be such that it does not get damaged/cracked during the operation of the equipment.

All door, removable covers and plates shall be gasketed all around with suitably profiled **Neoprene gaskets**. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged /cracked during the years of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth, straight and reinforced if necessary to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting atleast 150 mm above from the base of the Marshalling Kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland. The gland shall project atleast 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required

3.16 SPACE HEATERS

The heater shall be suitable for continuous operation at 240 V AC supply voltage and shall be provided with on – off switch and fuse shall be provided for heater.

One or more adequately rated, thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heater shall be installed in the lower portion of the compartment and electrical connections shall be made from below the heater to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

The heaters shall be suitably designed to prevent any contact between the heater wire and air and shall consist of coiled resistance wire centered in metal sheath and completely encased in a highly compacted powder of Magnesium Oxide or other material having equal heat conduction and electrical insulation properties, or they shall consist of a resistance wire wound on a ceramic and completely covered with a ceramic material to prevent any contact between the wire and air. Alternatively, they shall consist of resistance wire mounted into a tubular ceramic body built into an envelop of stainless steel or the resistance wire is wound on a tubular ceramic body and embedded in glaze the surface temperature of the heaters shall be restricted to a value which will not shorten the life of the heater sheaths or that of insulated wire or other component in the compartments.

3.17 QUALITY

BHEL quality plan to be followed subject to TBEM / customer's approval.

3.18 DOCUMENTATION

3.18.1 LIST OF DOCUMENTS

The bidder shall submit a detailed list of drawings / documents along with the bid proposal which he intends to submit to the Employer after award of the contract.

The supplier shall necessarily submit all the drawings / documents unless any thing is waived.

All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Document and the entire works performed under this specification shall be performed in strict conformity, unless otherwise expressly requested by the Employer in Writing.

3.18.2 DRAWINGS

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required, the dimensions required for installation and interconnections with other equipments and materials, clearances and spaces required for installation and interconnection between various portions of equipments and any other information specifically requested in the specifications.

Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, name of consultant, the unit designation, RRVUNL contract no. and the name of the Project .If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Employer if so required.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawing shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

3.18.3 APPROVAL PROCEDURE

The scheduled dates for the submission of these as well as for, any data/information to be furnished by the Employer would be discussed and finalised at the time of award. The supplier shall also submit required no. of copies as mentioned in this specification of all drawings/design documents/test reports for approval by the Employer. The following schedule shall be followed generally for approval.

i.	Approval/comments/by employer on Initial submission	Within 3 weeks of receipt
ii.	Resubmission	Within 2 (two) weeks (whenever from date of comments required) Including both ways postal time.
iii.	Approval or comments	Within 2 weeks of receipt of resubmission
iv.	Furnishing of distribution copies	2 weeks from the date of last approval.

Note: The contractor may please note that all resubmissions must incorporate, all comments given in the submission by the Employer failing which the submission of documents is likely to be returned. Every revision shall be a revision number, date and subject, in a revision block provided in the drawing, clearly marking the changes incorporated.

The title block of drawings shall contain the following information incorporated in all contract drawings. Please refer enclosed sheet for details of Title block.

3.18.4 DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

- 1) Drawings
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) Manufacturing Quality Plan

3.18.5 DOCUMENTATION SCHEDULE

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
				Prints	CDs
1	Drawings and Data Sheets	1	7	8	-
2	Drawings "As Built "	-	-	8	05
3	Type Test Reports	1	3	4	-
4	Erection Manuals	-	7	8	-
5	Operation and Maintenance Manuals	-	7	8	-
6	Manufacturing Quality Plan	1	7	8	-
7	Field Quality Plan	1	7	8	-
8	Inspection Test Reports	-	-	8	-

Soft copies of drawings at contract stage shall also be submitted in **PDF format**.

Drawings will also be submitted in CD in AUTOCAD package for all major items.

Final Documentation shall be submitted in bound volumes with Customer & Project etc. written on top.

[illegible]

SECTION 4

GUARANTEED AND TECHNICAL PARTICULARS FOR CIRCUIT BREAKER

1. GENERAL

- a) Name of the Manufacturer
- b) Country of Manufacturer
- c) Type of Circuit Breaker
- d) Manufacturer's type designation
- e) Standard Applicable
- f) Rated Voltage (kV rms)
- g) Rated Current
- i. Under normal condition (A)
- ii. Under site condition (A)
- h) Rated frequency (Hz)
- i) Number of poles
- j) Whether 3 pole or single pole unit
- k) Whether All The 3 poles ganged electrically or mechanically
- l) Whether dead tank or live tank design
- m) Type of installation
- n) No. of break per pole
- o) Latching Current

2. GUARANTEED RATINGS

- a) Rated short circuit breaking current
- i. Symmetrical component at highest system voltage (kA)
- ii. DC Component (%)
- iii. Asymmetrical breaking current at highest system voltage (kA)
- b) Rated Making Capacity
- i. At higher rated voltage (kAp)
- ii. At lower rated voltage (kAp)
- c) (i) Maximum Total break time under any duty condition for any current upto rated breaking current with limiting conditions of voltage and pressure (ms)
- ii. Rated break time
- d) Closing time (ms)
- e) Minimum opening time under any condition with limiting voltage and pressure (ms)
- f) Maximum opening time under any condition with limiting voltage and pressure (ms)
- g) Maximum close open time under any condition with limiting voltages and pressures (ms)
- h) First pole to clear factor
- i) Short time current rating (kA) for 1s
- j) Rated operating duty

- k) Maximum braking capacity under kilometric faults
 and rated TRV characteristic (kAp)
- l) Maximum breaking capacity under phase
 opposition (kAp)
- m) Maximum line charging breaking current with
 temporary over voltage upto 1.4 p.u. (A)
- n) Maximum over voltage (p.u.) on switching
 transformer on no load and corresponding
 charging current
- o) Maximum period between closing of first contact &
 last contact in a pole (ms)
- p) Maximum pole discrepancy (ms)
- q) Maximum arc duration and corresponding current
 under lockout pressure
- r) Pre-insertion resistor
- i. Value/ pole (ohms) / with tolerance
- ii. Minimum and maximum duration of
 insertion per pole (ms)
- iii. Thermal rating for the C-1m-O-CO-2m-
 C-1m-O-CO for terminal fault
 considering maximum resistance and
- iv. Thermal rating for the same duty as (iii)
 above for reclosing against trapped
 charges
- s) Small fault current breaking capacity (kAp)
- t) Maximum temperature rise for main contacts over
 design ambient temperature of 50°C
- u) Rated voltage & pick up range for trip coil (V)
- v) Rated voltage & pick up range for closing coil (V)
- w) Rated pressure and limits of pressure of operating
 mechanism
- x) Rated pressure and limits of pressure of
 extinguishing medium

y) Minimum dead time for

- i. Three phase reclosing (ms)
- ii. Single phase reclosing (ms)

3. DIELECTRIC WITHSTAND OF COMPLETE BREAKER

a) One minute dry & wet power frequency withstand voltage

- i. Between live terminal and ground.....
(kVrms)
- ii. Between terminals with breaker.....
contacts open (kV rms)

b) 1.2/50- micro second impulse withstand test voltage

- i. Between live terminals and ground(kVp.....
)
- ii. Between terminals with breaker.....
contacts open (kVp)

c) 250/2500 micro second switching surge withstand test voltage

- i. Between live terminals and ground.....
(kVp)
- ii. Between terminals with breaker.....
contacts open (kVp)

d) Corona extinction voltage (kV rms)

e) Maximum radio interference voltage (micro V) at.....
1.1 $U_r / \sqrt{3}$

f) Total creepage distance

- i. To ground (mm)
- ii. Between terminals (mm)

4. OPERATING MECHANISM

a) Type of operating mechanism for

- i. Closing
- ii. Opening

b) Manufacturer's type designation

c) Normal power consumption (W) at rated voltage of

- i. Trip coil
- ii. Closing coil

4.1 Pneumatic operating mechanism

- a) Rated operating pressure (kg/sq.cm)
- b) Range of pressure for (kg/sq.cm)
 - i. Closing
 - ii. Opening
- c) Air Consumption at rated pressure for
 - i. Closing (m3)
 - ii. Opening (m3)
 - iii. Close-open (m3)
- d) Pressure drop/ metre length of piping
- e) Number and Capacity (m3) of breaker local air storage receivers
- f) f) No. of close operations for which sufficient air is available in local receiver
- g) g) Capacity of compressor (m3/hr) and working pressure (kg/cm2)
- h) Maximum time for which compressor can operate continuously (min)
- i) Time to fill
 - i. Air receiver after one CO operation (min)
 - ii. For making up of losses occurring in 4 hours (min)
- j) Pressure at which compressor
 - i. Starts (kg/cm2)
 - ii. Stops (kg/cm2)
- k) Material of compressed air piping
- l) Inner & outer dia of main piping (mm)
- m) Whether interpolate piping included in scope of supply
- n) Manufacturer's name for

- i. Compressor
- ii. Air receiver
- iii. Pressure reducer
- iv. Stop valves
- v. Drain valves
- o) Safety valve
 - i. Low pressure stage Blow off at.....
(kg/cm²)
 - ii. Intermediate stage blow off at (kg/cm²)
 - iii. High pressure stage blow off at.....
(kg/cm²)
- p) Safety valve opens at (kg/cm²)
- q) No. of stored CO operation in breaker air receiver
- r) Alarm switch closes on air receiver at (kg/cm²)
- s) Lockout pressure (kg/ cm²)
 - i. Closing
 - ii.
 - iii.

4.2 Hydraulic operating mechanism

- a) Rated pressure of oil in operating cylinder.....
(kg/cm²)
- b) Limits for pressure (kg/cm²)
- c) Quantity of oil (litre)
- d) Details of arrangements to prevent change of.....
position of breaker of position of breaker in the
event of hydraulic
- e) Details of monitoring arrangement for hydraulic.....
pressure
- f) No. of close-open operations possible after loss of.....
AC supply to drive motor
- g) Details of hand pump set provided for emergency.....
operation
- h) Pressure drop starting from lowest pressure at
which motor starts for
 - i. C-operation

- ii. O-operation
- iii. CO-operation
- iv. O-CO-operation
- v. 2-CO-operation
- i) Time required to make up pressure upto loss of nitrogen pressure after
 - i. C-operation
 - ii. O-Operation
 - iii. CO-operation
 - iv. O-CO-operation
 - v. 2-CO-operation

4.3 Spring charged mechanism

- a) Number of close open operations possible after failure of AC supply to motor
- b) Time required for motor to charge the closing spring (min)
- c) Whether indication of spring charged condition provided in central control cabinet

5. TYPE OF BREAKERS

5.1 SF6 Circuit Breakers

- a) Quantity of SF6 per pole (m3) at rated pressure
- b) Guaranteed max. leakage rate per year
- c) Rated pressure of SF6 in operating chamber
- d) Limit of pressure at which breaker operates correctly (kg/ cm2)
- e) Standard to which SF6 gas complies
- f) Whether 20% spare SF6 gas stores in unused gas cylinder, included in proposal
- g) Compacity & filling ration of containers in which SF6 gas would be shipped (m3)
- h) Whether breakers are dispatched filled with SF6 or required to be filled at site
- i) Type and make of SF6 pipe coupling used
- j) Type and make of mandatory maintenance equipment
 - i. SF6 gas filling and evacuation trolley (portable)

- ii. SF6 gas drying, filling, evacuating.....
equipment and its capacity
 - iii. Operating analyzer type and make
 - iv. SF6 gas leak detector
- k) Parameters of SF6 gas for initial filling & satisfactory operation
 - i. Density
 - ii. Dielectric strength/ kVmm
 - iii. Acidity (ppm)
 - iv. Water content (ppm)
 - v. Oil content (ppm)
 - vi. Condensation temperature °C)
 - vii. Resistivity (Ohm-cm)
- l) Whether details of SF6 gas viz test methods,.....
handling etc. enclosed
- m) Type and material of gasket used to ensure gas
tight joints for
 - i. Metal to metal joints
 - ii. Metal to porcelain joints
- n) Method of housing SF6 gas compressors and
equipment
 - i. At circuit breaker
 - ii. In control cubicle
- o) Type and make of
 - i. Densimeter
 - ii. Pressure gauge
- p) Densimeter Settings
 - i. Lockout
 - ii. Alarm
- q) Minimum time interval between each make/ break.....
operation (ms)

5.2 GENERAL

- a) Whether OGA drawing enclosed
- b) Weight of complete 3 phase breaker for foundation.....
design (kg)

- c) Weight of heaviest part of breaker (kg)
- d) Impact loading for foundation design
- e) Seismic level for which breaker is designed
- f) Minimum safety clearance from earthed objects
- g) Noise level in (dB) at base of the breaker
- h) Minimum clearance in air
 - i. Between live parts (mm)
 - ii. Live parts to earth (mm)
 - iii. Live parts to ground level (mm)

6. CONSTRUCTIONAL DETAILS

- a) Whether arcing contacts provided
- b) Type and material of main contacts and arcing contacts
- c) Contact pressure on main contacts (kg/cm²)
- d) Contact separation in arcing position (mm)
- e) Contact separation in open position (mm)
 - i. Main contacts
 - ii. PIR contacts
- f) Whether pressure relief device for each of the gas chamber of SF₆ CB provided
- g) Rate of contact travel
 - i. Opening (m/sec)
 - ii. Closing (m/sec)
- h) Whether the making & breaking contacts are hermetically sealed
- i) Type and capacity of device used to obtain uniform voltage distribution between breaks
- j) Overvoltage withstand capability of grading components (kV/mms)
 - i. Continuous
 - ii. 10 minutes
 - iii. 1 minute
 - iv. 5 seconds
- k) Number of auxiliary contacts per pole provided for Owner's use
- l) Rated voltage of auxiliary contacts (V)

m) Current rating of auxiliary contacts

- i. Continuous (A)
- ii. DC breaking with 20 ms time constant.....
(A)
- n) Whether auxiliary contacts silver plated
- o) Whether support structure included in supply
- p) Height of support structure
- q) Material of support structure
- r) Standard to which the design of support structure.....
conforms
- s) Whether foundation bolts for breakers and.....
cabinets included in scope of supply

7. DETAILED LITERATURE

- i. Type test reports as per IEC-56
- ii. Factory test report & / or filed test report.....
in case of reactor switching duty
- iii. Details of operating mechanism
- iv. Drawing of breaker of support structure
- v. Calculations for compressed
- vi. Details of SF6 gas filling
- vii. Details of SF6 gas leak detector
- viii. Precautions in use of SF6 gas
- ix. Leaflets & literature bringing out salient.....
features of equipment offered
- x. Schematic diagrams of switching.....
mechanism for closing resistor showing
the duration of insertion alongwith
calculation for thermal rating of closing
resistors
- xi. Whether drawings/data data furnished.....
as per cl.12 of chapter switchgear (CB)
- xii. Method of checking of voltage.....
distribution devices at site enclosed
- xiii. Details alongwith a complete catalogue.....
of operation analyzer enclosed
- xiv. Data on capabilities of circuit breaker 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

- xv. Effect of non simultaneity between.....
contact within a pole or between poles
and also show how it is covered in the
guaranteed rated break time.
- xvi. Details and type of filters used in.....
interrupter assembly and also the
operating experience with such filters
- xvii. Curves supported by test data.....
indicating the opening time under close
open operation with combined variation
of trip coil voltage & pneumatic/
hydraulic pressure
- xviii. All duty requirements specified.....
alongwith adequate test reports

CONTROL CABINETS

- 1. Manufacturer's Name
- 2. Indoor/ Outdoor application
- 3. Design ambient air temperature (deg. C)
- 4. Standards applicable
- 5. Thickness of sheet steel (mm) and whether cold
- rolled or hot rolled
- 6. Degree of protection provided
- 7. Bill of material for all the equipment mounted on
- control cabinet giving the following details
- a) Make and type
- b) Applicable Standard
- c) Voltage rating
- d) Current rating
- e) Duty class, if applicable
- f) Manufacturers catalogue No.
- g) Total heat load of cabinet
- (for purpose of ventilation requirement)
- 8. Colour of finish paint IS:5
- a) Outside
- b) Inside
- 9. Control Wiring

- (a) Size of conductor
 - i. For CT circuits
 - ii. For other circuits
- b) Conductor Solid/ Standard
- c) Number of Strands/ conductor
- 10. Terminal Blocks
 - (a) Make & type
 - b) Current rating
 - i) Power terminals (A)
 - ii) Other terminals (A)
- 11. Space Heater Rating at 240 V AC
- 12. Control cabinet drawing showing the following
 - a) Outline dimensions, floor openings, floor/wall/ pedestal fixing arrangements, weights etc.
 - b) Front view, inside view showing the mounting arrangement of various equipment
- 13. Schematic/ Wiring diagram of control cabinet enclosed
- 14. Interconnection drawing showing cable, connections to the control cabinet enclosed
- 15. Type test report to verify design of protection enclosed
- 16. Details of terminal rows:
 - i) Whether aranged
vertical or horizontal
 - ii) Clearance from adjacent components
 - iii) Distance between rows
 - iv) Whether transparent protection cover provided

TERMINAL CLAMPS AND CONNECTORS

- 1. Manufacturer's Name
- 2. Applicable Standards
- 3. Type
- 4. Material of connector
 - a) Clamp body

b) Bolts & Nuts

c) Spring washers

5. Rated Current

6.a) Rated terminal load (kg)

b) Factor of safety

7. Minimum thickness of any part (mm)

8. Weight of clamp complete with hardware (kg)

9. Type test reports as per IS enclosed

10. OGA drawing enclosed

BUSHING/SUPPORT INSULATOR

1.Manufacturer's Name

2.Type

3.Applicable Standards

i) Height

ii. Diameter (Top)

iii. Diameter (Bottom)

4.Total Creepage distance (mm)

5.Rated voltage (kV)

6.Power frequency withstand voltage for 1 Min.
(kVrms) dry and wet

7. 1.2/50 micro sec. Impulse withstand voltage
(kVp)

8. 250/2500 micro sec. Switching impulse withstand
voltage (kVp) dry and wet

9.Corona Extinction voltage (kV)

10.Weight (kg)

11. Max. Allowable span (mm)

12. Cantilever Strength (kg)

13. OGA drawing enclosed

DEVIATION SCHEDULE

SCHEDULE OF TECHNICAL DEVIATIONS

Bidder shall list below all technical deviation clause wise w.r.t. tender specifications:

S.No.	Page No.	Clause No.	Deviation	Reason / Justification
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Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date:

Tenderer's Stamp & Signature