

SECTION - 1

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing & dispatch and supervision of erection, testing & commissioning of 420 kV, 245 kV & 145 kV Circuit Breakers complete with accessories as listed under this specification.

This section covers the scope, specific technical requirements and quantities of 420 kV, 245 kV & 145 kV Circuit Breakers. This constitutes minimum technical parameters for the above item as specified by the customer (POWERGRID). The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

In case of any discrepancies between the requirements mentioned under Section-1/Section-2 and those specified in the Section-3, the specifications given under Section-1/Section-2 shall prevail and shall be treated as binding requirements.

The equipment is required for the following project:

Name of the Customer : POWER GRID CORPORATION OF INDIA LIMITED (PGCIL)
Name of the Project : Extension of I) 400kV Durgapur S/s, II) 400 kV Maithon S/s,
III) 400 kV Biharshariff S/s & IV) 220/132V Purnea S/s

The scope of supplies shall be as per commercial terms and conditions enclosed separately with the enquiry.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

Equipments and system shall be designed to meet the following major technical parameters as brought out hereunder.

Sl No	Description of Parameters	400 kV	220 kV	132 kV
1	Rated voltage (kV, rms)	420	245	145
2	Rated frequency (Hz)	50		
3	No.of poles	3		
4	Design ambient Temperature (deg. C)	50		
5	Rated insulation levels:			
a	Full wave impulse withstand voltage (1.2/50 micro sec.)			
	-between line terminals and ground (kVp)	± 1425	± 1050	± 650 kVp
	-between terminals with circuit breaker open (kVp)	± 1425 (-/+ 240)	± 1050	± 650 kVp
b	One minute power frequency dry withstand voltage			
	-between line terminals and ground kV (rms)	520	460	275
	-between terminals with circuit breaker	610	460	275

	open kV (rms)			
c	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet			
	-between line terminals and ground (kVp)	± 1050	-	-
	-between terminals with circuit breaker open(kVp)	±900 (-/+345)	-	-
d	Corona extinction voltage (kVrms) with circuit breaker in all positions	320(min)	156	105
e	Max. radio interference Voltage (microvolts) for frequency between 0.5 MHz and 2 MHz	1000 (at 266 kVrms)	1000 (at 156 kVrms)	500 (at 92 kVrms)
6	Minimum creepage distance:			
	Phase to ground (mm)	10500	6125	3625
	Between CB terminals (mm)	10500	6125	3625
7	System neutral earthing	Effectively Earthed		
8	Seismic acceleration	0.3g horizontal		
9	Thermal rating of auxiliary contacts	10 A at 220 V DC		
10	Breaking capacity of auxiliary contacts	2 A DC with circuit time constant of not less than 20 ms		
11	Phase to phase spacing (mm)	6000/7000	4000/4500	3000/2700
12	Rated continuous current at design Ambient temperature	2000/3150A	1600A	1250A
13	Rated short circuit current Breaking capacity at rated Voltage (with percentage DC component as per IEC - 62271-100 corresponding to Minimum opening time under operating conditions specified)	40 kA	40 kA	31.5 kA
14	Symmetrical interrupting capability (kA rms)	40	40	31.5
15	Rated short circuit making current (kAp)	100	100	80
16	i) Short time current carrying capability for one second (kArms)	40	40	31.5
	ii) Out of phase breaking current capacity (kArms)	10	As per IEC	As per IEC
17	Rated operating duty	O-0.3 sec.-CO-3 min-CO cycle		
18	Reclosing	1 ph & 3 ph autoreclosing		3 ph autoreclosing
19	First pole to clear factor	1.3		
20	Rated line charging interrupting current at 90 deg. Leading power factor angle (Arms)	600A	As per IEC	As per IEC
	(The breaker shall be able to interrupt the rated line/cable charging current with the test voltage immediately before opening equal to the product of $U/\sqrt{3}$ and 1.4 as per IEC - 62271-100)			

21	Temperature rise over the design ambient temperature	As per IEC -62271-100		
	i) Total break time as per IEC (ms)	45	65	65
	ii) Rated break time as per IEC (ms)	40	60	60
22	Total closing time (ms) Max.	150	200	150
23	Operating mechanism	Pneumatic/sp ring/hydraulic	Spring/hydraulic or a combination of these	
24	Max. difference in the instants of closing/opening of contacts (ms)			
	i) Within a pole	2.5		
	ii) Between poles (opening)	3.3	3.3	3.3
	iii) Between poles (closing)	5.0	5.0	
	The above shall be at rated control voltage and rated operating and quenching media pressures			
25	Trip coil and closing coil voltage	220 volt DC with variation as specified in section-3		
26	Noise level at base and(max) upto 50 m.(distance from base of breaker)	140 db max		
27	Rated terminal load	As per IEC		
28	Auxiliary contacts (Besides requirement of specification , supplier shall wire up these contacts for future use of customer)	15NO+ 15NC		
29	No. of terminals in common control cabinet	All contacts & control circuits to be wired out up to common control cabinet plus 24 terminals exclusively for customer use.		
30	Max. allowable switching overvoltage under any switching condition	2.3 p.u.	As per IEC	As per IEC
31	Rated small inductive current switching capability with overvoltage less than 2.3 pu (A)			0.5 to 10
32	Pre-Insertion resistor requirement			
	i) Rating(Ohms)	400		
	ii) Minimum pre-insertion time (ms)	8		
	iii) 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 remain closed		
33	No. of trip coil	2 per pole		
34	No. of closing coil	1 per pole		

1.3 BILL OF QUANTITIES

Sl. No	Description	Unit	Project Quantity				Total Qty
			Durgapur	Mait hon	Bihars hariff	Purn ea	
1.	420kV, 3150A, 40kA for 1s, 3 Phase Circuit Breaker without closing resistor along with support structure, foundation bolts, interpole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos	2	2	2		6
2.	420kV, 2000A, 40kA for 1s, 3 Phase Circuit Breaker without closing resistor along with support structure, foundation bolts, interpole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos			1		1
3.	245kV, 1600A, 40kA for 1s, 3 Phase Circuit Breaker along with support structure, foundation bolts, interpole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos				2	2
4.	145kV, 1250A, 31.5kA for 1s, 3 Phase Circuit Breaker along with support structure, foundation bolts, interpole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos				2	2
5.	<u>Mandatory Spares (for420kV,3150A CB)</u> One complete pole of CB including closing resistor, Grading capacitor, pole column, interrupter, with driving mechanism and MB but without support structure	Nos	1	1	1		3
6.	<u>Mandatory Spares (for420kV,3150A CB)</u> Grading Capacitor	Nos	1	1	1		3
7.	<u>Mandatory Spares (for420kV,3150A CB)</u> Rubber gaskets, 'O' rings and seals	Set	1	1	1		3
8.	<u>Mandatory Spares (for420kV,3150A CB)</u> Trip coils with resistor	Nos	2	2	2		6
9.	<u>Mandatory Spares (for420kV,3150A CB)</u> Closing coils with resistor	Nos	1	1	1		3
10.	<u>Mandatory Spares (for420kV,3150A CB)</u> Terminal pads	Nos	2	2	2		6
11.	<u>Mandatory Spares (for420kV,3150A CB)</u> Molecular filter	Nos	2	2	2		6
12.	<u>Mandatory Spares (for420kV,3150A CB)</u> Corona rings	Nos	1	1	1		3

13.	<u>Mandatory Spares (for420kV,3150A CB)</u> Relays, Power contactors, switch fuse units, limit switches, push buttons, timers & MCBs etc.	Set	1	1	1		3
14.	<u>Mandatory Spares (for420kV,3150A CB)</u> Pressure switches of each type	Set	1	1	1		3
15.	<u>Mandatory Spares (for420kV,3150A CB)</u> Aux. switch assembly	Set	1	1	1		3
16.	<u>Mandatory Spares (for420kV,2000A CB)</u> One complete pole of CB including closing resistor, Grading capacitor, pole column, interrupter, with driving mechanism and MB but without support structure	Nos			1		1
17.	<u>Mandatory Spares (for420kV,2000A CB)</u> Grading Capacitor	Nos			1		1
18.	<u>Mandatory Spares (for420kV,2000A CB)</u> Rubber gaskets, 'O' rings and seals	Set			1		1
19.	<u>Mandatory Spares (for420kV,2000A CB)</u> Trip coils with resistor	Nos			2		2
20.	<u>Mandatory Spares (for420kV,2000A CB)</u> Closing coils with resistor	Nos			1		1
21.	<u>Mandatory Spares (for420kV,2000A CB)</u> Terminal pads	Nos			2		2
22.	<u>Mandatory Spares (for420kV,2000A CB)</u> Molecular filter	Nos			2		2
23.	<u>Mandatory Spares (for420kV,2000A CB)</u> Corona rings	Nos			1		1
24.	<u>Mandatory Spares (for420kV,2000A CB)</u> Relays, Power contactors, switch fuse units, limit switches, push buttons, timers & MCBs etc.	Set			1		1
25.	<u>Mandatory Spares (for420kV,2000A CB)</u> Pressure switches of each type	Set			1		1
26.	<u>Mandatory Spares (for420kV,2000A CB)</u> Aux. switch assembly	Set			1		1
27.	<u>Mandatory Spares (for245kV,1600A CB)</u> One complete pole of CB including Grading capacitor, pole column, interrupter, with driving mechanism and MB but without support structure	Nos				1	1
28.	<u>Mandatory Spares (for245kV,1600A CB)</u> Grading Capacitor	Nos				1	1
29.	<u>Mandatory Spares (for245kV,1600A CB)</u> Rubber gaskets, 'O' rings and seals	Set				1	1
30.	<u>Mandatory Spares (for245kV,1600A CB)</u> Trip coils with resistor	Nos				2	2

31.	<u>Mandatory Spares (for245kV,1600A CB)</u> Closing coils with resistor	Nos				1	1
32.	<u>Mandatory Spares (for245kV,1600A CB)</u> Terminal pads	Nos				2	2
33.	<u>Mandatory Spares (for245kV,1600A CB)</u> Molecular filter	Nos				2	2
34.	<u>Mandatory Spares (for245kV,1600A CB)</u> Corona rings	Nos				1	1
35.	<u>Mandatory Spares (for245kV,1600A CB)</u> Relays, Power contactors, switch fuse units, limit switches, push buttons, timers & MCBs etc.	Set				1	1
36.	<u>Mandatory Spares (for245kV,1600A CB)</u> Pressure switches of each type	Set				1	1
37.	<u>Mandatory Spares (for245kV,1600A CB)</u> Aux. switch assembly	Set				1	1
38.	<u>Mandatory Spares (for145kV,1250A CB)</u> One complete pole of CB including Grading capacitor, pole column, interrupter, with driving mechanism and MB but without support structure	Nos				1	1
39.	<u>Mandatory Spares (for145kV,1250A CB)</u> Grading Capacitor	Nos				1	1
40.	<u>Mandatory Spares (for145kV,1250A CB)</u> Rubber gaskets, 'O' rings and seals	Set				1	1
41.	<u>Mandatory Spares (for145kV,1250A CB)</u> Trip coils with resistor	Nos				2	2
42.	<u>Mandatory Spares (for145kV,1250A CB)</u> Closing coils with resistor	Nos				1	1
43.	<u>Mandatory Spares (for145kV,1250A CB)</u> Terminal pads	Nos				2	2
44.	<u>Mandatory Spares (for145kV,1250A CB)</u> Molecular filter	Nos				2	2
45.	<u>Mandatory Spares (for145kV,1250A CB)</u> Corona rings	Nos				1	1
46.	<u>Mandatory Spares (for145kV,1250A CB)</u> Relays, Power contactors, switch fuse units, limit switches, push buttons, timers & MCBs etc.	Set				1	1
47.	<u>Mandatory Spares (for145kV,1250A CB)</u> Pressure switches of each type	Set				1	1
48.	<u>Mandatory Spares (for145kV,1250A CB)</u> Aux. switch assembly	Set				1	1
49.	Supervision of Erection, Testing & Commissioning of all supplied Circuit breakers at each site. Testing & commissioning instruments	Lot	1	1	1	1	4

	(Time interval meter (timing kit), SF6 gas leakage detector & any other special tools like gas filling adapter etc) shall be brought by supplier and shall be taken back after successful completion of testing and commissioning						
50.	Training in the field of design of 400 kV, 220 kV & 132 kV Circuit Breakers (as per supplies) in the form of tutorial to Powergrid/BHEL's personnel at Customer's corporate centre for one (1) day	Lot	1	1	1	1	4
51.	Training in the field of erection, testing, operation and maintenance of 400 kV, 220 kV & 132 kV Circuit Breakers (as per supplies) to Powergrid/BHEL's personnel at substation site for three (3) days	Lot	1	1	1	1	4

NOTE:

- 1) For 50 & 51 above: Travel lodging & boarding expenses of Powergrid/BHEL's personal, if any shall be borne by the Powergrid/BHEL.
- 2) For 50 & 51 above: Charges for Tutorials & other training materials for the trainees shall also be included in the price quoted by the bidder.

1.4 TYPE TESTING

Bidder shall submit valid type test reports (as per relevant IEC/IS Standard) for approval. The type test reports submitted shall be of tests conducted within last 10 years prior to the date of bid opening i.e. 23.11.12. The bidder should have conducted type test on identical or similar equipment/ components to those offered. In case type test reports are found to be technically unacceptable to BHEL/PGCIL, the type test shall be conducted without cost and delivery implication to BHEL.

1.5 QUALIFYING REQUIREMENT (Applicable for 400 kV, 220 kV & 132 kV CB)

1.5.(i) (a) The manufacturer(s) whose SF6 Circuit Breaker are offered should have manufactured, type tested and supplied 345kV or above class circuit breaker of 40kA fault level which must be in operation for at least two(2) years as on the date of bid opening provided further that:

@1.5.(i) (b) the offered 400kV class Circuit Breaker should have been manufactured, type tested (to specified fault level in the subject package) and which must be in operation as on the date of bid opening.

OR

the offered 400kV class Circuit Breaker should have been manufactured and type tested (to specified fault level in the subject package) as on the date of bid opening and extended warranty of additional two (2) years over and above the warranty period specified for the package is given

for the Circuit Breaker for which a declaration by the bidder is made in the bid.

@ Clause applicable for 400kV class Breaker for fault level more than 40kA only.

OR

1.5.(ii) (a) who have manufactured, type tested and supplied 220kV or above class circuit breaker and have established its manufacturing facilities in India, based on technological support of a parent company or collaborator for the circuit breaker provided that the parent company (Principals) or collaborator(s) meets criteria stipulated under clause 1.5.(i) (a) & (b)[§] mentioned above. Further the 400kV class circuit breaker manufacturer shall furnish the following document alongwith the bid;

§ 1.5(i) (b) applicable for 400kV Class Breaker for fault level more than 40kA only

(i) a legally enforceable undertaking (jointly with the parent company or collaborator) to guarantee quality, timely supply, performance and warranty obligations as specified for the circuit breakers;

and

(ii) a confirmation letter from the parent company or collaborator alongwith the bid stating that parent company or collaborator shall furnish performance guarantee for an amount of 10 % of the ex-work cost of such equipment (s). This performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the Bidder.

1.6 SUPERVISION OF ERECTION, TESTING & COMMISSIONING

Bidder shall quote lump-sum price for installation and commissioning of all offered breakers at each site. The required instruments for testing & commissioning shall be brought by the bidder and shall be taken back by the supplier after successful completion of testing and commissioning.

1.7 TRAINING :

The successful bidder shall give training in the field of design of 400 kV, 220 kV & 132 kV Circuit Breaker in the form of tutorial to POWERGRID/BHEL's Personnel at POWERGRID'S corporate office for one (1) day at Gurgaon (India).

Further, the supplier shall also impart training to POWERGRID/BHEL's personnel at Powergrid sub-station site (i.e Durgapur, Maithon, Biharshariff & Prunea) in the field of erection, testing, operation and maintenance of 400 kV, 220 kV & 132 kV Circuit Breaker for 3 days.

However, the travel lodging, & boarding expenses of POWERGRID/BHEL's personnel, if any shall be borne by POWERGRID/BHEL.


Note: Charges for Tutorials & other training materials for the trainees shall also be included in the price quoted by the bidder.

1.8 QUALITY PLAN

Bidder to follow valid PGCIL approved Quality Plan as per PGCIL procedure. In case the bidder don't have PGCIL approved QP, it will be the bidder's responsibility to get its QP approved

directly from the ultimate customer.

1.9 PROJECT TITLE BLOCK

CUSTOMER	POWERGRID CORPORATION OF INDIA LIMITED		
PROJECT	Substation Package for Extension of I) 400kV Durgapur S/s, II) 400 kV Maithon S/s, III) 400 kV Biharshariff S/s & IV) 220/132V Purnea S/s		
CONTRACT NO	CC-CS/153-ER1/SS-1945/3/G8/R/NOA-1/4737, dtd. 08.08.13		
BHEL P.O. No.	PROJ. DOC. No.	REV. No.	
CONTRACTOR	BHARAT HEAVY ELECTRICALS LIMITED		
<i>VENDOR'S STANDARD TITLE BLOCK</i>			

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SECTION-2 GENERAL EQUIPMENT SPECIFICATION

1.0 GENERAL

- 1.1 The circuit breakers and accessories shall conform to IEC: 62271-100, IEC: 62271-01 and other relevant IEC standards except to the extent explicitly modified in the specification and shall also be in accordance with requirements specified in Section-3 of this technical specification.
- 1.2 420kV circuit breakers offered would be of sulphur hexafluoride (SF6) type only and of class C2-M2 as per IEC. The bidder may also offer circuit breakers of either live tank type or dead tank type of proven design.
- 1.3 The circuit breaker shall be complete with terminal connectors, operating mechanism, control cabinets, piping, interpole cable, cable accessories like glands, terminal blocks, marking ferrules, lugs, pressure gauges, density monitors (with graduated scale), galvanised support structure for CB and control cabinets, their foundation bolts and all other circuit breaker accessories required for carrying out all the functions the CB is required to perform.
- All necessary parts to provide a complete and operable circuit breaker installation such as main equipment, terminals, control parts, connectors and other devices whether specifically called for herein or not shall be provided.
- 1.4 Painting shall be done in line with Section -3. Shade- 697 as per IS-5 or RAL-7032 or similar shades can be used for painting. The support structure of circuit breaker shall be hot dip galvanised. Exposed hardware items shall be hot dip galvanised or Electro-galvanised.
- 1.5 The circuit breakers shall be designed for use in the geographic and meteorological conditions as given in Section--3.

2.0 DUTY REQUIREMENTS:

- 2.1 *The circuit breakers shall be capable of performing their duties without opening resistors.*
- 2.2 The circuit breaker shall meet the duty requirements for any type of fault or fault location also for line switching when used on a 800/420/245/145 kV effectively grounded system, and perform make and break operations as per the stipulated duty cycles satisfactorily.

2.2.1 PRE INSERTION RESISTER

800/420 kV circuit breakers wherever specified shall be provided with single step preinsertion closing resistors to limit the switching surges to a value of less than 1.9 p.u for 800 kV and 2.3 p.u. for 420 kV respectively. The value of the pre-insertion resistor and the duration of pre-insertion time shall be as given in clause 17.0 of this chapter. 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 during detailed engineering. The calculations shall take care of adverse tolerances on resistance values and time settings.

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

2.4 The circuit breaker shall also be capable of:

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

2.5 The Breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges. The breaker shall also withstand the voltages specified under Clause 17 of this section.

2.6 **CONTROLLED SWITCHING REQUIREMENTS**

The Circuit Breaker shall be equipped with controlled switching with conse-

quent optimization of switching behavior, when used in:

a. for 800 kV

- Switching of transformer
- Switching of shunt reactor

The controller shall be provided in Circuit breaker of switchable line reactor and in Main & Tie circuit breakers of Transformers and Bus reactors.

b. for 400 kV

- Switching of shunt reactor.

The controller shall be provided in Circuit breaker of switchable line reactor and in Main & Tie circuit breakers of Bus reactors.

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

2.6.1 Technical Requirement for controlled switching device.

- a) The controller shall be designed to operate at the correctly and satisfactorily with the excursion of auxiliary A/C & DC voltages and frequency as specified in section - 3.
- b) 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.
- c) The controller shall have functions for switching ON & OFF the circuit breakers.
- d) The controller shall get command to operate the breakers manually or 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.
- e) The controller shall also have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of next operating time of the breaker the controller must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, hydraulic/pneumatic pressure of the operating mechanism, control voltage variation, SF6 gas density variations etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the controller shall be better than +0.5 ms.
- f) The controller should have display facility at the front for the settings and measured values.
- g) 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.
- h) The controller shall have self-monitoring facility.
 - i) 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.
 - j) The controller shall have time setting resolution of 0.1 ms or better.
 - k) The controller shall have sufficient number of output/input potential free contacts for connecting the monitoring equipment and annunciation system available in the control room. Necessary details shall be worked out during engineering the scheme.

3.0 TOTAL BREAK TIME:

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

- i) Test duties T10, T30, T60, T100a, T100s (TRV as per IEC: 62271-100)
- ii) Short line fault L75, L90 (- do -)

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

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

4.0 CONSTRUCTIONAL FEATURES:

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

4.1 Contacts

4.1.1 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 with stand test conducted for a duration of at least 15 minutes is acceptable).

4.2 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.

4.3 The SF6 Circuit Breaker shall meet the following additional requirements:

- a) The circuit breaker shall be single pressure type. The design and construction of the circuit breaker shall be such that there is a minimum possibility of gas leakage and entry of moisture. There should not be any condensation of SF6 gas on the internal insulating surfaces of the circuit breaker.
- b) All gasketed surfaces shall be smooth, straight and reinforced, if necessary, to minimise distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF6 media) shall have adequate seals. The SF6 gas leakage should not exceed 0.5% per year **and the leakage rate shall be guaranteed for at least 10 years.** In case the leakage under the specified conditions is found to be greater than 0.5% after one year of commissioning of circuit breaker, the manufacturer will have to supply free of cost, the total gas requirement for subsequent ten (10) years, based on actual leakage observed during first year of operation after commissioning.
- c) In the interrupter assembly there shall be an absorbing product box to minimise the effect of SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be fully compatible with SF6 gas decomposition products.
- d) Each pole shall form an enclosure filled with SF6 gas independent of two other poles (for 800, 420 & 245 kV CBs) and the SF6 density of each pole shall be monitored. For CBs of voltage class of 145 kV or less, a common SF6 scheme/density monitor shall be acceptable.
- 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.
- f) Each Circuit Breaker shall be capable of withstanding a vacuum of minimum 8 millibars 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 in Section--- 1.

4.4 Provisions shall be made for attaching an operational analyser to record contact travel, speed and making measurement of operating timings, preinsertion timings of closing resistors if used, synchronisation of contacts in one pole.

5.0 SULPHUR HEXAFLUORIDE GAS (SF6 GAS):

- a) The SF6 gas shall comply with IEC 60376, 60376A and 60376B and shall be suitable in all respects for use in the switchgear under the operating conditions.
- b) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the relevant standards and regulations.
- c) Test: SF6 gas shall be tested for purity, dew point, air, hydrolysable fluorides and water content as per IEC 60376, 60376A and 60376B and test certificates shall be furnished to Employer indicating all the tests as per IEC 60376 for each lot of SF6 gas in stipulated copies as indicated in section-3. Gas bottles should be tested for leakage during receipt at site.

6.0 INSULATORS:

- a) The porcelain of the insulators shall conform to the requirements stipulated under Section-3.
- b) The mechanical characteristics of insulators shall match with the requirements specified under this section of the specification.
- c) All hollow insulators shall conform to IEC-62155. All routine and sample tests shall be conducted on the hollow column insulators as per these standards with requirements and procedures modified as under:
 - i) Pressure test as a routine test.
 - ii) Bending load test as a routine test.
 - iii) Bending load test as a sample test on each lot. iv) Burst pressure test as a sample test on each lot.
 - v) In addition to above, ultrasonic test shall be carried out as additional routine test.
- d) Hollow Porcelain for pressurised columns/chambers should be in one integral piece in green and fired stage.

7.0 SPARE PARTS AND MANDATORY MAINTENANCE EQUIPMENT:

The bidder shall include in his proposal spare parts and maintenance equipment in accordance with Section-1 alongwith the equipment. Calibration certificate of each maintenance equipment shall be supplied along with the equipment.

8.0 OPERATING MECHANISM AND CONTROL

8.1 General Requirements

- 8.1.1 Circuit breaker shall be operated by pneumatic mechanism (for 400 kV & 800 kV ratings only) or spring charged mechanism or hydraulic mechanism or a combination of these. The mechanism shall be housed in a weather proof and dust proof control cabinet as stipulated in Section-3.
- 8.1.2 **The operating mechanism shall be strong, rigid, not subject to rebound.**
- 8.1.3 The mechanism shall be antipumping and trip free (as per IEC definition) under every method of closing.
- 8.1.4 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.
- 8.1.5 A mechanical indicator shall be provided to show open and close position of the breaker. It shall be located in a position where it will be visible to a man standing on the ground level with the mechanism housing closed. An operation counter shall also be provided in the central control cabinet.
- 8.1.6 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.
- 8.1.7 The bidder shall furnish detailed operation and maintenance manual of the mechanism alongwith 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.
- 8.2 **Control:**
- 8.2.1 The close and trip circuits shall be designed to permit use of momentary contact switches and push buttons.
- 8.2.2 Each breaker shall be provided with two (2) independent tripping circuits, pressure switches and coils each to be fed from separate DC sources and connected to a different set of protective relays.
- 8.2.3 The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip coils. However, provisions shall be made for local electrical control. For this purpose a local/remote selector switch and close and trip control switch/push buttons shall be provided in the Breaker central control cabinet.
- 8.2.4 The trip coils shall be suitable for trip circuit supervision during both open and close position of breaker. The trip circuit supervision relay would be provided on relay panels.
- 8.2.5 Closing coil and associated circuits shall operate correctly at all values of voltage between 85% and 110% of the rated voltage. Shunt trip coil and associated cir-

uits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. However, even at 50% of rated voltage the breaker shall be able to open. If additional elements are introduced in the trip coil circuit their successful operation and reliability for similar applications on outdoor circuit breakers shall be clearly brought out in the additional information schedules.

8.2.6 Density Monitor contacts and pressure switch contact shall be suitable for direct use as permissive in closing and tripping circuits. **The density monitor shall be placed suitably inclined in such a way so that the readings are visible from ground level with or without using binoculars.** Separate contacts have to be used for each of tripping and closing circuits. If contacts are not suitably rated and multiplying relays are used then fail safe logic/schemes are to be employed. DC supplies for all auxiliary circuits shall be monitored and provision shall be made for remote annunciations and operation lockout in case of D.C. failures. Density monitors are to be so mounted that the contacts do not change on vibration during operation of circuit Breaker.

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

8.3 **Pneumatically operated mechanism (for 420 kV and 800 kV only)**

- a) Each pneumatic operated breaker shall be equipped with compressed air system in accordance with Clause 16.0.
- b) The breaker local air receivers shall comply with the requirements under Clause 16.4 and shall have sufficient capacity for atleast two CO operations of the breaker at the lowest pressure for auto reclosing duty without refilling.
- c) Independently adjustable pressure switches with potential free, ungrounded contacts to actuate a lock out 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:
 - i) Trip lockout pressure - 2 Nos.
 - ii) Close lockout pressure - 1 No.
 - iii) Auto reclose lockout pressure - 1 No.
 - iv) Extreme low pressure - 1 No.
- d) The compressed air mechanism shall be capable of operating the circuit breaker under all duty conditions with the air pressure immediately before operation between 85% and 110% of the rated supply pressure. The

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

- e) The compressed air piping shall comply to requirements under Clause 16.0.

8.4 Spring operated mechanism:

- a) Spring operated mechanism shall be complete with motor in accordance with Section -3. 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.
- 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 springs 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 a closing operation of the breaker when the spring is in the partial charged condition. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of closing springs when the breaker is already in the closed position.
- 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.

8.5 Hydraulically operated mechanism:

- a) Hydraulically operated mechanism shall comprise of operating unit with power cylinder, control valves, high and low pressure reservoir, motor. Electrically driven motor shall comply to requirement mentioned in section-3.

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

9.0 SUPPORT STRUCTURE:

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

10.0 TERMINAL CONNECTOR PAD:

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

11.0 INTERPOLE CABLING:

- 11.1 All cables to be used by contractor shall be armoured and shall be as per IS – 1554/ IEC-502 (1100 Volts Grade). All cables within & between circuit breaker poles shall be supplied by the CB manufacturer.
- 11.2 Only stranded conductor shall be used. Minimum size of the conductor for interpole control wiring shall be 1.5 sq.mm (Copper).
- 11.3 The cables shall be with oxygen index Min-29 and temp. index as 250°C as per relevant standards.

12.0 FITTINGS AND ACCESSORIES

- 12.1 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/hydraulic pressure gauge, pump/compressor start counter (to be provided in case of pneumatic/Hydraulic operating mechanism).
 - 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) Antipumping relay.
 - ix) **Pole discrepancy relay (for electrically ganged CBs).**
 - 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, relays etc.(as applicable)
- 12.2 Additional fittings for pneumatically operated circuit breaker
- a) Unit compressed air system in accordance with Clause 16.0. b) Breaker air receivers.
 - c) Pressure gauge, spring loaded safety valve and pressure switch with adjustable contacts.
 - d) Pressure switch to initiate an alarm if the pressure in the auxiliary reservoir remains below a preset level for longer than it is normally necessary to refill the reservoir.
 - e) Stop, non-return and other control valves, pipings and all accessories upto breaker mechanism housing.

13.0 ADDITIONAL DATA TO BE FURNISHED:

- a) Drawing, showing contacts in close, arc initiation, full arcing, arc extinction and open position.
- b) The temperature v/s pressure curves for each setting of density monitor along-with details of density monitor.
- c) Method of checking the healthiness of voltage distribution devices (condensers) provided across the breaks at site.
- d) Data on capabilities of circuit breakers in terms of time and number of operations at duties ranging from 100% fault currents to load currents of the lowest possible value without requiring any maintenance or checks.
- e) The effect of non-simultaneity between contacts between poles and also show how it is covered in the guaranteed total break time.
- f) Sectional view of non-return couplings if used for SF6 pipes.
- g) Details & type of filters used in interrupter assembly and also the operating experience with such filters.
- h) Details of SF6 gas:
 - i) The test methods used in controlling the quality of gas used in the circuit breakers particularly purity and moisture content.
 - ii) Proposed tests to assess the conditions of the SF6 within a circuit breaker after a period of service particularly with regard to moisture contents of the gas.
- i) Clause deleted
- j) 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.
- k) *Detailed literature and schematic diagrams of switching mechanism for closing resistor showing the duration of insertion shall also be furnished alongwith the calculations in respect of thermal rating of resistors for the duties specified under clause 2.2 of this section in case of 420 kV circuit breaker.*
- l) All duty requirements as applicable to 420 kV, 245 kV & 145 kV CBs specified under Clause 2.0 of this section shall be provided with the support of adequate test reports.
- m) Field test report or laboratory test report in case of CB meant for reactor switching duty.

14.0 TESTS:

- 14.1 In accordance with the requirements stipulated under Section -3 the circuit breaker alongwith its operating mechanism shall conform to IEC:62271-100.
- 14.2 The test reports of the type tests and the following additional type tests shall also be submitted for Purchaser's review:
- i) Corona extinction voltage test (as per details of Section -3).
 - ii) Out of phase closing test as per IEC:62271-100.
 - iii) Line charging breaking current for proving parameters as per clause no. 17.9 of this section.
 - iv) Test to demonstrate the Power Frequency withstand capability of breaker in open condition at Zero Gauge pressure and at lockout pressure (Ref. Clause 4.1.1).
 - v) Seismic withstand test (As per Annexure-B of Chapter-3) in unpressurised condition.
 - vi) Verification of the degree of protection.
 - vii) Low & high temperature test.(if applicable)
 - viii) Humidity test.(if applicable)
 - ix) Static Terminal Load test.
 - x) Critical Currents test (if applicable).
 - xi) Switching of Shunt Reactors.
 - xii) Controlled switching performance and validation tests(whenever applicable)

14.3 Routine Tests

Routine tests as per IEC:62271-100 shall be performed on all circuit breakers.

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

- 1) Speed curves for each breaker shall be obtained with the help of a suitable operation analyser to determine the breaker contact movement during opening, closing, auto-reclosing and trip free operation under normal as well as limiting operating conditions (control voltage, pneumatic/hydraulic pressure etc.). The tests shall show the speed of contacts directly at various stages of operation, travel of contacts, opening time, closing time, shortest time between separation and meeting of contacts at break make operation etc. This test shall also be performed at site for which the necessary operation analyser alongwith necessary transducers, cables, console, etc. where included in scope of supply shall be furnished and utilised. In case of substations where operation analyser is existing,

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

- 2) 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.
- 3) Routine tests on Circuit breakers with Controlled switching equipment as per draft IEC.(if applicable)

15.0 DEAD TANK TYPE CIRCUIT BREAKER

- 15.1 In case dead tank type circuit breaker is offered, the Bidder shall offer bushing type CTs (whose secondary parameters shall be provided during engineering stage).
- 15.2 The enclosure shall be made of either Al/Al Alloy or mild steel (suitably hot dip galvanised).

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 deg C.

- 15.3 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.

16.0 UNIT COMPRESSED AIR SYSTEM FOR CIRCUIT BREAKERS:

- 16.1 The unit compressed air system shall meet the following requirements:
- a) The compressed air system shall be provided with necessary piping, piping accessories, control valves, safety valves, filters, reducing valves, isolating valves, drain ports, **automatic condensate drain valve** etc. The Unit compressed air system shall be provided with suitable antivibration pads wherever required.
 - b) The compressors or pumps shall be of the air cooled type and mounted within the operating mechanism housing or a separate weather-proof and dust-proof housing.
 - c) The air receiver shall have stored energy for 2 CO operations of the breaker at the blocking pressure for auto reclosing duty without refilling. The unit compressor shall be capable of building up required pressure for another 2 CO operations within 30 minutes.

- d) The size of the compressor shall be determined by the bidder. The compressor shall be of sufficient capacity for performing all the operations above mentioned.

16.2 Air Compressor:

- a) The air compressor shall be of air cooled type complete with cylinder lubrication, drive motor etc. The compressor shall be rated for the following duty:
- | | |
|--|--|
| i) Total running time of compressor to build up the rated pressure from atmospheric pressure | Not exceeding 80 minutes |
| ii) Normal running air | Not exceeding 15 minutes charging considering 10% leakage/day. |
| iii) Air charging time one close-open operation from rated pressure. | Not exceeding 15 minutes. after |
- b) Compressor shall be driven by automatically controlled motors conforming to requirements of Chapter-3.
- c) The compressor shall be provided with automatic adjustable unloading device during starting.
- d) The compressor shall be equipped with a Time totaliser and a Pressure gauge.

16.3 Intercooler and After cooler: (If applicable)

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

16.4 Air Receivers:

- a) Air receiver shall be designed in accordance with the latest edition of the ASME Code for Pressure Vessel - Section VIII of BS: 5179. If the air receiver is not fully hot dip galvanised, it shall be coated on the inside face with antirust medium and a corrosion allowance of 3.0 mm shall be provided for shell and dished ends.
- b) Connections for air inlet and outlet, drain and relief valves shall be flanged type or screwed type. Pressure gauge and pressure switch connections shall be screwed type only.

- c) Accessories such as suitable sized safety valve to relieve full compressor discharge at a set pressure equal to 1.1 times the maximum operating pressure, blow off valve, auto drain tap with isolating and bypass valve, dial type pressure gauge with isolating and drain valve and test connection shall be provided.
- d) Air receiver shall be offered with atleast 50% spare capacity, calculated on the basis of total air requirement for 2 CO operations.

16.5 Quality of Air:

Compressed air used shall be dry and free of dust particles and fully compatible with the materials used in the pneumatic operating mechanism. Arrangement for conditioning the compressed air if required shall be provided as an integral part of air compressor system.

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

16.6 Control and Control Equipment:

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

16.7 Compressed Air Piping, Valves and Fittings:

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

- e) All compressed air piping shall be carried out in accordance with BS: 162.
- f) Compressed air piping system shall be complete with Saddle clamps to support the piping system at suitable intervals. Necessary bolts, nuts, pipe fixing clamps etc shall be included in the scope of Contractor.

16.8 Tests:

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.

17.0 TECHNICAL PARAMETERS:

(In addition to those indicated in section-3)

I 420 kV CIRCUIT BREAKER:

A17.1	Rated continuous current (A) at design ambient temperature.	2000 / 3150 (as applicable)
A17.2	Rated short circuit current breaking capacity at rated voltage	40 kA / 50 kA / 63kA (as applicable) with percentage DC component as per IEC: 62271-100 corresponding to minimum opening time under operating conditions specified.
A17.3	Symmetrical interrupting capability (kA rms)	40 / 50 / 63 (as applicable)
A17.4	Rated short circuit making current (kAp)	100 / 125 / 157.5 (as applicable)
A17.5	i) Short time current carrying capability for one second (kArms)	40 / 50 / 63 (as applicable)
	ii) Out of phase breaking current capacity (kArms)	10 / 12.5 / 15.75(as applicable)
A17.6	Rated operating duty	O-0.3sec-CO-3min-CO cycle
A17.7	Reclosing	Single phase & three phase autoreclosing
A17.8	First pole to clear factor	1.3
A17.9	Rated line charging interrupting current at 90 deg. leading power factor angle	600 A

(A. rms)

(The breaker shall be able to interrupt the rated line charging current with test voltage immediately before opening equal to the product of $U/\sqrt{3}$ & 1.4 as per IEC: 62271-100).

A17.10	Temperature rise over the design ambient temperature	As per IEC: 62271-100
A17.11	i) Total break time as per IEC (ms)	45
A17.11	ii) Rated break time as per IEC (ms)	40
A17.12	Total closing time (ms)	Not more than 150
A17.13	Operating mechanism combination of these	Pneumatic/spring/hydraulic or a
A17.14	Max. difference in the instants of closing/ opening of contacts (ms)	
	i) Within a pole	2.5
	ii) Between poles (opening)	3.3
	iii) Between poles (closing)	5.0
	The above shall be at rated control voltage and rated operating and quenching media pressures.	
A17.15	Trip coil and closing	220 V DC with variation as specified coil voltage
A17.16	Noise level at base and upto 50 m (distance from base of breaker)	140 dB (Max.)
A17.17	Rated terminal load	As per IEC or as per the value calculated by Section-3 whichever is higher.
A17.18	Auxiliary contacts	Besides requirement of specification, the bidder shall wire up 15 NO + 15 NC contacts for future use of purchaser.
A17.19	No of Terminals in common Control cabinet	All contacts & control circuits to be wired out upto common control cabinet plus 24 terminals exclusively for Purchaser's use.

A17.20	Maximum allowable switching overvoltage under any switching condition	2.3 p.u. switch-
A17.21	Pre-insertion resistor requirement	
	i) Rating (ohms)	400
	ii) Minimum pre-insertion time (ms)	8
	iii) Opening of PIR contacts	a) PIR Contacts should open immediately after closing of main circuits.
		OR
		b) Atleast 5 ms prior to opening of main contacts at rated air/gas pressure, where the PIR Contacts remain closed.

(Auxiliary switch shall also comply with requirements stipulated under Section-3)

18.0 PRE-COMMISSIONING TESTS

18.1 An indicative list of tests is given below. All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site. Pre-commissioning tests, procedures and formats for circuit breakers, Doc.No.: MR/CF/CB/05/R-2, Dated 01/04/08 under POWERGRID Document no. D-2-01-03-01-02 will be the reference document. This document will be available at respective sites and shall be referred by the supplier. Supplier shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Powergrid without any extra cost to the BHEL. The supplier shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to BHEL/POWERGRID 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) Operation check of pressure switches and gas density monitor during gas filling.
- (o) Checking of mechanical 'CLOSE' interlock, wherever applicable.
- (p) Testing of grading capacitor.
- (q) Resistance measurement of main circuit.
- (r) Checking of operating mechanisms
- (s) Check for annunciations in control room.
- (t) Point of wave switching test(wherever applicable)

18.2 The supplier shall ensure that erection, testing and commissioning of circuit breaker shall be carried out under his supervision . The commissioning report shall be signed by the manufacturers representative, BHEL and Powergrid.

19 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 required to be submitted by the specification.

SECTION-3

PROJECT DETAILS & GENERAL SPECIFICATION

SITE INFORMATION

	Particular	Details
a)	Customer	Power Grid Corporation of India Limited
b)	Project Title	Extension of I) 400kV Durgapur S/s, II) 400 kV Maithon S/s, III) 400 kV Biharshariff S/s & IV) 220/132V Purnea S/s
c)	Location	Durgapur/ Maithon (West Bengal) Biharshafiff/Purnea (Bihar)
d)	Transport Facilities	Nearest Rail Head Durgapur (Durgapur), Maithon (Maithon), Biharshafiff (Biharshafiff) & Purnea (Katihar)
SITE CONDITIONS		
a)	Altitude above sea level	Less than 1000m
b)	Ambient air temp. (Max)	50°C
c)	Average Humidity	Max. 100%
d)	Special corrosion conditions	No
e)	Solar Radiation	1.2 kW/sq mtr
f)	Atmospheric UV radiation	High
g)	Seismic Acceleration	0.3g horizontal
h)	Pollution Severity	High Pollution level (25mm/kV)
WIND DATA		
a)	Wind velocity	As per IS
b)	Average No. of thunderstorm days per annum	As per IS

1.0 GENERAL

This Chapter covers Technical Requirements and requirements of auxiliary items.

- a) Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe

operation of the equipment as required by applicable codes unless included in the list of exclusions.

- b) Material and components not specifically stated in this specification but which are necessary for satisfactory operation of the equipment and accessories specified in this specification shall be deemed to be included unless specifically excluded and shall be supplied at no extra cost.
- c) Whenever a material or article is specified or described by the name of a particular brand, manufacturer or vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.
- d) In case any Deviation Schedule, Bid Proposal Sheet, Schedule of Data Requirements (DRS), test reports or any other document/information are not furnished along-with the bid, the bid is liable to be rejected. Unless brought out clearly, the Bid will be deemed to conform to the specification scrupulously. All deviations from the specification shall be clearly brought out in the respective deviation schedule.
- e) Auxiliary supplies as described below would be available at site.

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral connection
415V	± 10%	50 ± 5%	3/4 Wire	Solidly Earthed.
240V	± 10%	50 ± 5%	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	-	Isolated 2 wire System
110V	95V to 120V	DC	-	Isolated 2 wire System
48V	-	DC	-	2 wire system (+) earthed

NOTE: Combined variation of frequency and voltage shall be limited to ±10 %.

- f) The Bidder shall clearly indicate in the bid, the specific standards in accordance with which the works will be carried out.
- g) The equipment must be new, of highest grade, the best quality of their kind, to best engineering practice and latest state of art, and in accordance with purpose for which they are intended and ensure satisfactory performance throughout the service life.

- h) All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same materials and workmanship as the corresponding parts of the equipment. Where feasible, common components, units shall be employed in different pieces of equipment in order to optimize the spare part stock-up and utilization.
- i) The requirement regarding external RIV as specified for equipment shall include the terminal fittings and the equipment shall have been tested preferably with fittings, if any.
- j) All drawings, schedules, annexures appended to this specification shall form part of the specification.

2.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

- a) The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc.
- b) The equipment shall be able to withstand forces due to wind load, short circuit, system over voltages, fluctuations, frequency variations etc., all forces considered together.

3.0 SUPPORT STRUCTURES

- a) The support structures should be hot dip galvanised with minimum 610 gram/m² net of zinc.
- b) The design calculations taking into account the environmental conditions of the substations shall be furnished for sizing of the structures.

4.0 STANDARDS

- a) The equipment to be furnished under this specification shall conform to latest issue with all amendments of standard specified under respective Chapters of this Specification. The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other. The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC. When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.

- b) Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards referred shall also be accepted.
- c) In case governing standards for the equipment is different from IS or IEC, the salient points of difference shall be clearly brought out in additional information schedule alongwith English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to Employer's approval.

5.0 ENGINEERING DATA AND OTHER REQUIREMENTS

- 5.1 The furnishing of engineering data by the Contractor shall be in accordance with the Schedule for each set of equipment as specified in this Technical Specification and the data furnished under the Schedule of Data Requirements (DRS). The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect overall layout. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.
- 5.2 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 these specifications shall be performed in strict conformity, unless otherwise explicitly requested by the Employer in Writing.
- 5.3 The equipment offered shall also comply to the following:-
 - a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
 - b) The reports for all type tests and additional type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by the representative(s) of POWERGRID or Utility. The test reports submitted shall be of the tests conducted within last 5 (five) years prior to the date of bid opening. In case the test reports are of the test

conducted earlier than 5 (five) years prior to the date of bid opening, the contractor shall repeat these test(s) at no extra cost to the purchaser.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design / manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all additional type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

- c) The Purchaser intends to repeat the type tests and additional type tests on Capacitors for which test charges shall be payable as per provision of contract. The price of conducting type tests and additional type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal Sheets. These Type test charges would be considered in bid evaluation. In case Bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.
- d) Four (4) copies of all test reports shall be submitted for approval before shipment of equipment. The reports shall indicate clearly the standard values specified for each test, to facilitate checking of the test reports. Six (6) bound copies of test reports shall be submitted after approval of test results.
- e) Six (6) copies of documentation of test certificate/ test result alongwith the relevant drawing (wherever applicable) from the raw material stage to final stage as per approved Quality Plan (QP) will be furnished by supplier for each and every equipment immediately after shipment of equipment.
- f) 1 RTF and 8 copies of all drawings for each substation plus 6 copies and one RTF of each drawing for corporate office shall be furnished after approval of drgs. 6 copies of instruction/operation manuals for each substation and corporate centre shall also be furnished after approval of manuals.
- g) The following program shall be followed for approval of drawings/manuals :
 - i. Initial comments/approval by Employer within 4 (four) weeks of receipt of drawings.
 - ii. Resubmission of drawings/manuals within 4 (four) weeks of comments (including both ways postal time).

- iii. Approval of drawings/manuals within 3 weeks of receipt of resubmission. Within 21 days of approval, stipulated number of copies and reproducibles in case of drgs shall be furnished by Contractor.

NOTE : The contractor may please note that all resubmissions must incorporate all comments given in the prior submission by the Employer failing which the submission of documents is likely to be returned.

- h) Six (6) No. of copies of drawings, Schedule of Data Requirements (DRS) and other documents shall be sent for approval. First submission shall be made within 4 weeks of LOA.
- i) All exposed ferrous parts shall be hot dip galvanised as per IS : 2633 & IS : 4579.
- j) All current making and breaking contact surfaces shall preferably be silver plated.
- k) The equipment name plate/ wiring diagram plate should preferably be of stainless steel. In case of aluminium it should be atleast 2 mm thick. The inscription on the name plate/wiring diagram plate shall be engraved and no punching shall be accepted except for equipment Sr. No. and year of manufacture.
- l) Each drawing submitted by the Contractor shall be clearly marked with the name of the Employer, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, notings, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.
- m) 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.
- n) All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings 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 of work by the engineering shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

6.0 DESIGN IMPROVEMENTS

- 6.1 The Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the parties agree upon any such changes, the specification shall be modified accordingly.
- 6.2 The Bidder should however note that changes proposed by him will have to be supported with applicable type test reports.
- 6.3 If any such agreed change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.0 QUALITY ASSURANCE PROGRAMME

- 7.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Employer's site or at any other place of Work are in accordance with the specifications, the Contractor shall adopt suitable quality assurance programme to control such activities at all points necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Employer after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following :
 - a) His organisation structure for the management and implementation of the proposed quality assurance programme.
 - b) System for Document and Data Control.
 - c) Qualification and Experience data of Bidder's key personnel.
 - d) The procedure for purchases of materials, parts components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
 - e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control.
 - f) System for Control of non-conforming products including Deviation Dispositioning, if any and system for corrective and preventive actions based on the feed back received from the Customers and also internally documented system for Customer complaints.
 - g) Inspection and test procedure both for manufacture and field activities.

- h) System for Control of calibration of testing and measuring equipment and the indication of calibration status on the instruments.
- i) System for indication and appraisal of inspection status.
- j) System of Internal Quality Audits and Management review and initiation of corrective and Preventive actions based on the above.
- k) System for authorising release of manufactured product to the Employer.
- l) System for maintenance of records.
- m) System for handling storage and delivery.
- n) A quality plan detailing out the specific quality control measures and procedure adopted for controlling the quality characteristics relevant to each item of equipment furnished and /or service rendered.
- o) System for various field activities i.e. unloading, receipt at site, proper storage, erection, testing and commissioning of various equipment and maintenance of records". In this regard, the Employer has already prepared Standard Field Quality Plan for Switchyard Civil Works Document Code No. CC/QA&I/SFQP/SS/03/970905/Rev.1 which is required to be followed for associated civil works. Field Quality Plan pertaining to receipt, storage, erection, testing and commissioning shall be mutually discussed and agreed upon before placement of order.

The Employer or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

7.2 Quality Assurance Documents

The Contractor shall be required to submit the following Quality Assurance Documents.

- i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication, and reports including radiography interpretation reports.
- ii) Welder and welding operator qualification certificates.
- iii) Welder's identification list, listing welder's and welding operator's qualification procedure and welding identification symbols.

- iv) Raw Material test reports on components as specified by the specification and/or agreed to in the quality plan.
- v) The manufacturing Quality Plan indicating Customer Inspection Points (CIPs) at various stages of manufacturing as mutually agreed upon, and methods used to verify that the inspection and testing points in the quality plan were performed satisfactorily.
- vi) Stress relief time temperature charts.
- vii) Factory test results for testing required as per applicable codes/mutually agreed quality plan/standard referred in the specifications.
- viii) Stress relief time temperature charts/oil impregnation time temperature charts.

8.0 INSPECTION, TESTING & INSPECTION CERTIFICATE

- 8.1 The Employer, his duly authorised representative and/or outside inspection agency acting on behalf of the Employer shall have at all reasonable times access to the Contractor's premises or Works and shall have the power at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection and if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Employer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. The equipment if found unsatisfactory as to workmanship or material is liable to be rejected.
- 8.2 The Employer reserves the right to witness any or all type, acceptance and routine tests specified for which at least 30 days notice in advance shall be given by the Contractor. Contractor shall ensure before giving notice for type test that all drawings and quality plans have been got approved. The equipment shall be dispatched to site only after approval of Routine and Acceptance test results and Issuance of Dispatch Clearance in writing by the Employer.
- 8.3 The Contractor shall give the Employer/Inspector Twenty one (21) days written notice of any material being ready for testing for each stage of testing as identified in the approved quality plan as customer inspection point. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Employer/inspector, unless witnessing of the tests is waived, will attend such tests within Twenty one (21) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to

- have been made in the Inspector's presence and he shall forthwith forward to the Inspector six copies of tests, duly certified.
- 8.4 The Employer or Inspector shall, within Twenty (21) days from the date of inspection as defined herein give notice in writing to the Contractor, of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer/Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.
- 8.5 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/Inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Employer/Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Employer/Inspector. Failure of the Employer/Inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract.
- 8.6 In all cases where the Contract provides for tests whether at the premises or works of the Contractor or of any Sub- Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer/Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Employer/Inspector or to his authorised representative to accomplish testing.
- 8.7 The inspection and acceptance by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract, or if such equipment is found to be defective at a later stage.
- 8.8 Material Inspection clearance certificate (MICC) shall be issued by the Employer after inspection of the equipment. Employer may waive off the presence of Employer's inspecting engineer. In that case test will be carried out as per approved QP and test certificate will be furnished by the supplier for approval. MICC will be issued only after review and approval of the test reports.
- 8.9 The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or

in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

8.10 The Employer reserves the right for getting any field tests conducted on the completely assembled equipment at site.

9.0 ENGINEER'S SUPERVISION

- a) To eliminate delays and avoid disputes and litigation it is agreed between the parties to the Contract that all matters and questions shall be referred to the Engineer and without prejudice to the provision of Section GCC, the contractor shall proceed to comply with the Engineer's decision.
- b) The work shall be performed under the direction and supervision of the Engineer. The scope of the duties of the Engineer, pursuant to the contract, will include but not be limited to the following :
 - i) Interpretation of all the terms and conditions of these documents and specifications ;
 - ii) Review and interpretation of all the Contractor's drawings, engineering data etc. ;
 - iii) Witness or authorise his representative to witness tests and trial either at the manufacturer's works or at site, or at any place where work is performed under the Contract ;
 - iv) Inspect, accept or reject any equipment, material and work under the Contract ;
 - v) Issue certificate of acceptance and/or progressive payment and final payment certificates ;
 - vi) Review and suggest modifications and improvements in completion schedules from time to time ; and
 - vii) Supervise the quality Assurance programme implementation at all stages of the Works.

10.0 TESTS

10.1 Charging

- a) On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Engineer and the Contractor for correctness and completeness of installation and acceptability for charging,

leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in Chapte-TST and shall be included in the Contractor's quality assurance programme.

The pre-commissioning checks for various Switchyard Equipment shall be in line with the Pre-Commissioning checklist, Document code no. OS/T&C/BAY/95 (Rev. 0). Further, as regards to pre-commissioning checks for Series Capacitors and the overall system including Series Capacitor and other equipment, protection etc., shall be mutually discussed and agreed upon.

- b) The Contractor's commissioning engineers, specially identified as far as possible, shall be responsible for carrying out all the pre-commissioning tests. On completion of inspection and checking and after the pre-commissioning tests are satisfactorily over, the complete equipment shall be placed on Initial Operation during which period the complete equipment shall be operated integral with sub-systems and supporting equipment as a complete substation.

10.2 Commissioning Tests

- a) The available instrumentation and control equipment will be used during such tests and the Engineer will calibrate, all such measuring equipment and devices as far as practicable. However, unmeasurable parameters shall be taken into account in a reasonable manner by the Engineer, for the requirement of these tests.
- b) Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- c) The specific tests to be conducted on equipment have been brought out in the Chapter-TST.

10.3 Test Codes

The provisions outlines in the IS & IEC codes or other international and Indian approved equivalents shall generally be used as a guide for all the above test procedures unless otherwise specified in the Technical Specifications.

11.0 HANDLING, STORING AND INSTALLATION

- a) In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the electrical equipment included in the contract. Equipment shall be installed in a neat,

workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

- b) Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.
- c) In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Employer. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.
- d) 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. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.
- e) The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Employer in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Employer, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- f) Where material/equipment is unloaded by Employer before the Contractor arrives at site or even when he is at site, Employer by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.
- g) Contractor shall be responsible for the proper storage and maintenance of all materials/equipment entrusted to him. He shall take all required steps to carry out frequent inspection of material/equipment stored as well as erected until the same is taken over by the Employer.

- h) The words 'erection' and 'installation' used in the specification are synonymous.
- i) Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- j) Clearances and spacings shall be provided as per relevant IS.

Bidder shall confirm in their technical offer that all clearances and spacing as stated above will invariably be provided. Even though phase to earth clearance under normal conditions will be as above at certain points where there can be bird faults (i.e. a bird sitting on the earthed metal part coming in contact with the HT terminal) adequate clearance as required shall be provided between the HT terminal and nearest grounded metal part.

12.0 TAKING OVER

Upon successful completion of all the tests to be performed at Site on equipment furnished and erected by the Contractor, the Engineer shall issue to the contractor a taking over certificate as a proof of the final acceptance of the equipment. Such certificate shall not unreasonably be withheld nor will the Engineer delay the issuance thereof on account of minor omissions or defects which do not affect the commercial operation and/or cause any serious risk to the equipment. Such certificate shall not relieve the Contractor of any of his obligations which otherwise survive, by the terms and conditions of the Contract after issuance of such certificate.

13.0 PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with protecting device. All ends of equipment connections shall be properly sealed with suitable devices to protect them from damage. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner.

14.0 PRESERVATIVE SHOP COATING

- 14.1 All exposed metallic surfaces subject to corrosion shall be protected by shop application of suitable coatings. All surfaces which will not be easily accessible after the shop assembly, shall beforehand be treated and protected for the life of the equipment. All surfaces shall be thoroughly cleaned of all mill scale, oxide and other coatings and prepared in the shop. The surfaces that are to be finish painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Transformers and other electrical equipment, if included shall be shop finished with one or more coats of primer and two coats of

high grade resistance enamel. The finished colours shall be selected and specified by the Employer at a later date.

14.2 Shop primer for all steel surfaces which will be exposed to operating temperature below 95 deg.C. shall be selected by the Contractor, after obtaining specific approval of the Employer regarding the quality of primer proposed to be applied. Special high temperature primer shall be used on surfaces exposed to temperatures higher than 95 deg.C. and such primers shall also be subject to the approval of the Employer.

14.3 All other steel surfaces which are not to be painted shall be coated with suitable dust preventive compound subject to the approval of the Employer.

15.0 PROTECTIVE GUARDS

Suitable guards shall be provided for protection of personnel on all exposed rotating and/or moving machine parts. All such guards with necessary spares and accessories shall be designed for easy installation and removal for maintenance purpose.

16.0 DESIGN CO-ORDINATION

The Contractor shall be responsible for the selection and design of appropriate equipment to provide the best coordinated performance of the entire system. The basic design requirements are detailed out in this Technical Specification. The design of various components, sub-assemblies and assemblies shall be so done so that it facilitates easy field assembly and maintenance. All the rotating components shall be so selected that the natural frequency of the complete unit is not critical at or close to the operating range of the unit.

17.0 DESIGN CO-ORDINATION MEETING

The Contractor will be called upon to attend design co-ordination meetings with the Employer, other Contractor's and the Consultants of the Employer during the period of Contract. The Contractor shall attend such meetings at his own cost at New Delhi or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

18.0 BUS POST INSULATORS

The post insulators shall conform in general to latest IS:2544, IEC-168 and IEC-815.

CONSTRUCTIONAL FEATURES

18.1 Post type insulators shall consist of a porcelain part permanently secured in a

metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

- 18.2 Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.
- 18.3 Glazing of the porcelain shall be of uniform brown in colour, free from blisters, burrs and other similar defects.
- 18.4 The insulator shall have alternate long and short sheds with aerodynamic profile. The shed profile shall also meet the requirements of IEC-815 for the specified pollution level.
- 18.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or injury to conductors or insulators by the formation of substance produced by chemical action.
- 18.6 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.
- 18.7 All ferrous parts shall be hot dip galvanised in accordance with the latest edition of IS:2633 and IS :4579. The zinc used for galvanising shall be grade Zn 99.95 as per IS:209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions.
- 18.8 If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Contractor.

18.9 Tests

The post insulators shall be subject to type, acceptance, sample and routine tests as per IS:2544 and IEC-168.

18.10 TECHNICAL REQUIREMENTS FOR BUS POST INSULATORS

- | | | | |
|----|--|---|------------|
| a) | Type | : | Solid Core |
| b) | Voltage class (kV) | : | 420 |
| c) | Dry & wet one minute power frequency withstand voltage | : | 680 |

		(kV rms)
d)	Dry lightning impulse withstand voltage (kVp)	: ± 1425
e)	Wet switching surge withstand voltage (kVp)	: ± 1050
f)	Max. radio interference voltage (in microvolts) at voltage of 305 KVrms between phase to ground	: 1000
g)	Corona extinction voltage (kV rms)	320 (Min.)
h)	Total minimum cantilever strength (kg)	800
i)	Minimum torsional moment	As per IEC-273
j)	Total height of insulator (mm)	3650
k)	Pollution level as per IEC-815	Heavy (III)
l)	Minimum total creepage distance for heavy pollution (mm)	10500

19.0 REQUIREMENT OF AUXILIARY ITEMS

19.1 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS

- a) Bushings shall be manufactured and tested in accordance with IS : 2099 & IEC : 137 while hollow column insulators shall be manufactured and tested in accordance with IEC:233/IS: 5621/IEC:61264, as applicable. The support insulators shall be manufactured and tested as per IS:2544/IEC:168 and IS:2099/IEC:273. The insulators shall also conform to IEC:815 as applicable.
- b) Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.
- c) Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

- d) Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.
- e) When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.
- f) Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.
- g) All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

h) **TESTS :**

In accordance with the requirements stipulated, bushings, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS : 2099 & IS : 2544.

i) Parameters of bushings/Hollow column insulators/support insulators :

- | | | | |
|----|--|---|-------------------|
| a) | Rated Voltage | : | 420 kV* |
| b) | Impulse withstand voltage (Dry & Wet) | : | ± 1425 kVp* |
| c) | Switching surge withstand voltage(Dry & Wet) | : | ± 1050 kVp* |
| d) | Power frequency with-stand voltage | : | 630 kVrms* |
| e) | Total creepage distance | : | 25mm/kV* |
| f) | Pollution level | : | Class-III : Heavy |

(as per IEC-71)

- g) Insulator shall also meet requirement of IEC - 815, as applicable, having alternate long & short sheds.

NOTE : * The equipment rating is only indicative. Appropriate rating equipment may be supplied if so required in view of the series capacitor requirement.

19.2 CONTROL PANELS, RELAY PANELS, CABINETS, JUNCTION BOXES, TERMINAL BOXES, MARSHALING BOXES AND MARSHALING KIOSKS:

- a) All types of boxes, cabinet/panels shall generally conform to IS : 5039, IS : 8623, IEC : 439, as applicable and the clauses given below :
- b) Control cabinet/panels, junction boxes, Marshaling box & terminal boxes shall be sheet steel/Al. enclosed and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0 mm thick cold rolled/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. In case of Al. enclosed box the thickness of Al. shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.
- c) The enclosures of all outdoor type control cabinets/panel, junction boxes, terminal box & marshaling boxes shall provide a degree of protection of not less than IP 55 as per IS : 13947 and the same for indoor type enclosures shall be IP 31 as per IS : 13947 and one control cabinet/panel, junction box, terminal box & marshaling box of each type shall be tested for the same, if the type test reports submitted are not to the satisfaction of the owner.
- d) Control cabinet/panels, junction boxes, marshaling box & terminal box shall be provided with padlocking arrangements.
- e) All doors, removable covers and plates shall be gasketed all around with neoprene gaskets. The neoprene gasket shall be tested in the presence of Employer's representative.
- f) All sheet steel work shall be degreased, pickled, phosphated and then applied with two coats of zinc chromate primer and two coats of finishing synthetic enamel paint. The colour of finishing paint shall be light admiralty grey in accordance with shade No. 697 of IS : 5 outside and inside shall be glossy white.

- g) All terminal boxes, control cabinet/panels, junction boxes & marshaling boxes shall be designed for the entry of cable from bottom by means of weather proof and dust-proof connections. Boxes and cabinet/panels shall be so 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/panel. Suitable cable gland plate on the base of the box shall be provided for this purpose. Necessary number of cable glands of suitable sizes shall be supplied and fitted on this gland plate. This removable gasketed gland plate shall have provision for spare glands to be used in future. The glands shall project at least 25 mm above the gland plate to prevent the entry of moisture in the cable crutch. The roof of the outdoor cabinet/panels/boxes shall preferably be of sloping design to prevent stagnation of water.
- h) Suitable heaters shall be provided in the cabinet/panel, junction boxes & marshaling boxes to prevent condensation. Heaters shall maintain cubicle temperature approximately 10°C above the outside air temperature. The heaters shall be suitable for 240 V AC supply voltage. On-off switch and fuse for this shall be provided.
- i) **Terminal Block :**

All internal wiring to be connected to the external equipment shall terminate on terminal blocks, preferably vertically mounted on the side of cabinet/panel, junction box, terminal box and marshaling box.

The terminal blocks shall be made of moulded, non-inflammable thermosetting plastic. The material of terminal block moulding shall not deteriorate because of varied conditions of heat, cold, humidity, dryness, etc. that would be anticipated at the location where the equipment is proposed to be installed.

The terminal shall be such 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 terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CAT - M4/CST.

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 of 650 V grade and shall be rated to carry continuously the maximum current that is expected to be carried by the terminals.

The terminal blocks used for CT circuits 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.

The terminals shall be provided with the marking tags for wiring identification.

All boxes shall be provided with 20 % spare terminals unless otherwise specified.

- j) There shall be a minimum clearance of 250 mm between the first row of terminal block and the cable gland plate or side of the box. Also the clearance between two rows of terminal blocks or side of the box shall be a minimum of 150 mm.
- k) 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/panel is live. Cabinet/panel wiring should be suitable for 60°C as the space heaters will keep the temperature 10°C higher than the ambient.
- l) **Wiring :**

All wiring shall be carried out with **650 V** grade, stranded copper wires. The minimum size of the stranded conductor used for internal wiring shall be as follows :

i) All circuits except CT circuits – 1.5/ 0.75.00.4 sq.mm (depending on the device current rating)

ii) CT circuits- 4sq mm; minimum no. of strands shall be 3 per conductor.

iii) Wrapping wires shall be used for electronic rack connection.

All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks.

Wire terminations shall be made with solderless crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from terminal blocks.

All wires directly connected to trip circuit breaker shall be distinguished by the addition of a red coloured unlettered ferrule. Number 6 & 9 shall not be included for ferrule purposes.

All terminals including spare terminals of auxiliary equipment shall be

wired upto terminal blocks. Each equipment shall have its own central control cabinet in which all contacts including spare contacts from all poles shall be wired out.

A 240V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet/panel with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.

For illumination of Control cabinet/panel a 20 Watts Fluorescent Tube/Incandescent Lamp shall be provided.

All control switches shall be of rotary switch type or push button type and toggle/piano switches shall not be accepted.

In accordance with the requirements stipulated under this Chapter control cabinet/panels, junction boxes, terminal boxes & marshaling boxes shall conform to type tests and shall be subjected to routine tests in accordance with IS : 5039. In addition to the type tests, verification of the degree of protection as per IS : 13947, shall be conducted, if the type test reports submitted by the Contractor are not to the satisfaction of the owner. After protection degree tests on control cabinet/panel, power frequency voltage of 2.0 kV rms for 1 minute shall be applied for checking insulation resistance and functional test shall also be conducted.

m) **Earthing :**

Positive earthing of the cabinet/panel shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of star or self etching washers. Earthing of hinged door shall be done by using a separate earth wire.

19.3 MOTORS :

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall conform to type tests and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

19.4 TERMINAL CONNECTORS AND CLAMP CONNECTORS :

The Terminal Connectors of all types shall meet the following requirements:

- a) Terminal connectors shall be manufactured and tested as per IS: 5561.

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

19.5 AUXILIARY SWITCH :

The type test reports or the following tests on auxiliary switch shall be furnished :

- a) Electrical endurance test - A minimum of 2000 operations for 2A DC with a time constant greater than or equal to 20 milliseconds with a subsequent examination of mV drop/visual defects/temperature rise test.
- b) Mechanical endurance test - A minimum of 1,00,000 operations with a subsequent checking of contact pressure test/visual examination.
- c) Heat run test on contacts.
- d) IR/HV test etc.

ANNEXURE - A
SCHEDULE OF TECHNICAL DEVIATIONS

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

<u>S.No.</u>	<u>Page No.</u>	<u>Clause No.</u>	<u>Deviation</u>	<u>Reason / Justification</u>
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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

ANNEXURE-B

GUARANTEED AND TECHNICAL PARTICULARS FOR CIRCUIT BREAKER

Bidder shall furnish the technical parameters for each type/voltage class of offered circuit breaker separately in the below mentioned format.

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 interpole 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 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

ANNEXURE - C

CHECK LIST FOR 420, 245 & 132 KV CIRCUIT BREAKERS

Put a tick mark (√) on 'YES' if the specified requirement is met, or put a tick mark on 'NO', if the specified requirement is not met and give comments in the "Remarks" column.

Sl. No.	Parameters	Data	YES/NO	Remarks
1	Type of Circuit Breaker	1) SF6	YES/NO	
2	Manufacturer's type designation	Bidder to furnish in Remarks Col.		
3	Standard Applicable	IEC 62271 - 100	YES/NO	
4	Rated Voltage (kV rms)	420 245 145	YES/NO YES/NO	
5	Rated Current			
	Under normal condition (A)	(a) 3150 A (b) 2400 A (c) 1600 A (d) 1250 A (e) 800 A	YES/NO YES/NO YES/NO YES/NO YES/NO	
6	Rated frequency (Hz)	50	YES/NO	
7	Number of poles	(a) 3 (b) 1	YES/NO YES/NO	
8	Whether All The 3 poles ganged electrically or mechanically	(a) Electrically (b) Mechanically	YES/NO YES/NO	
9	Whether dead tank or live tank design	(a) Live (b) Dead	YES/NO YES/NO	
10	No. of break per pole	(a) Two (b) One	YES/NO YES/NO	
11	Latching Current (kA Peak)	(a) 100	YES/NO	

12	Rated short circuit breaking current			
	i. Symmetrical component at highest system voltage (kA)	(a) 40	YES/NO	
	ii. DC Component (%)	(a) 49 % (b) 36 %	YES/NO YES/NO	
13	Rated Making Capacity			
	i. At higher rated voltage (kAp)	100	YES/NO	
	ii. At lower rated voltage (kAp)	100	YES/NO	
	i. Maximum Total break time under any duty condition for any current upto rated breaking current with limiting conditions of voltage and pressure (ms)	50	YES/NO	
	ii. Rated break time	50	YES/NO	
15	Closing time (ms)	(a) 150 ms (max) for 245 kV (b) 100 ms (max) for 145 kV	YES/NO YES/NO	
16	Minimum opening time under any condition with limiting voltage and pressure (ms)	(a) 19 ms for 245 kV (b) 30 ms for 145 kV	YES/NO YES/NO	
17	Maximum opening time under any condition with limiting voltage and pressure (ms)	(a) 24 ms for 245 kV (b) 42 ms for 145 kV	YES/NO YES/NO	
18	Maximum close open time under any condition with limiting voltages and pressures (ms)	(a) 60 ms	YES/NO	

19	First pole to clear factor	(a) 1.3 for 245 kV (b) 1.5 for 145 kV	YES/NO YES/NO	
20	Short time current rating (kA) for 1s and 3s	(a) 40 kA	YES/NO	
21	Rated operating duty	O-0.3 Sec –CO 3 min –CO	YES/NO	
22	Maximum breaking capacity under phase opposition (kAp)	(a) 10	YES/NO	
23	Maximum line charging breaking current with temporary over voltage upto 1.4 p.u. (A)	(a) 125 for 245 kV (b) 50 for 145 kV	YES/NO YES/NO	
24	Maximum over voltage (p.u.) on switching transformer on no load and corresponding charging current	(a) ≤ 2.5 pu for 245 kV (b) ≤ 2.3 pu for 145 kV	YES/NO YES/NO	
25	Maximum period between closing of first contact & last contact in a pole (ms)	(a) < 2.5 ms wherever 2 or more poles provided	YES/NO	
26	Maximum pole discrepancy (ms)	(a) Opening – 3.3 ms for both 145 & 245 kV (b) Closing – 5 ms for 245 kV (c) Closing – 3 ms for 145 kV	YES/NO YES/NO YES/NO	
27	Maximum arc duration and corresponding current under lockout pressure	(a) 23 ms for 245 kV (b) 30 ms for 145 kV	YES/NO YES/NO	
28	Small fault current breaking capacity (kAp)	As per IEC	YES/NO	

29	Maximum temperature rise for main contacts over design ambient temperature of 50°C	As per IEC	YES/NO	
30	Rated voltage & pick up range for trip coil (V)	220 V DC, Range – 70 % to 120 %	YES/NO	
31	Rated voltage & pick up range for closing coil (V)	220 V DC, Range 85 % to 120 %	YES/NO	
32	Minimum dead time for			
	i) Three phase reclosing (ms)	300 for both 145 & 245 KV	YES/NO	
	ii) Single phase reclosing (ms)	300 for 245 kV	YES/NO	
33	Dielectric withstand of complete Breaker			
	a) One minute dry & wet power frequency withstand voltage			
	i. Between live terminal and ground (kV rms)	1) 460 for 245 kV 2) 275 for 145 kV	YES/NO YES/NO	
	ii. Between terminals with breaker contacts open (kV rms)	1) 460 for 245 kV 2) 275 for 145 kV	YES/NO YES/NO	
	b) 1.2/50- micro second impulse withstand test voltage			
	i. Between live terminals and ground (kVp)	1) 1050 for 245 kV 2) 650 for 145 kV	YES/NO YES/NO	
	ii. Between terminals with breaker contacts open (kVp)	1) 1050 for 245 kV 2) 650 for 145 kV	YES/NO YES/NO	
	c) Corona extinction voltage (kV)	1) > 156 Kv (for	YES/NO	

	rms)	245 kV Breaker) 2) 92 kV (for 145 kV Breaker)		
	d) Maximum radio interference voltage (micro V) at 1.1 Ur/ /3	1000 (max)	YES/NO	
	e) Total creepage distance			
	i) To ground (mm)	1) 6125 for 245 kV 2) 3625 for 145 kV	YES/NO YES/NO	
	ii) Between terminals (mm)	1) 6125 for 245 kV 2) 3625 for 145 kV	YES/NO YES/NO	
34	Operating Mechanism			
	a) Type of operating mechanism for			
	i. Closing	1) Spring 2) Pneumatic 3) Hydraulic	YES/NO YES/NO YES/NO	
	ii. Opening	1) Spring 2) Pneumatic 3) Hydraulic	YES/NO YES/NO YES/NO	
35	General			
	a) Whether OGA drawing enclosed		YES/NO	
	b) Filled in GTP furnished		YES/NO	
	c) Terminal connector for ACSR Conductor/ AL. Tube included in Scope		YES/NO	
	d) Interpole cabling included in Scope alongwith required Glands, Lugs etc.		YES/NO	
	e) All Type Test Reports as per IEC 62271 – 100, not older		YES/NO	

	than 5 years are available with bidder			
	f) Bidder's unconditional acceptance of "Undertaking on Type Test Reports" – Schedule 8A enclosed.		YES/NO	
	g) Whether GI support structure included in Supply		YES/NO	
	h) Whether foundation bolts for breakers and cabinets included in scope of supply		YES/NO	
	i) Whether documentation schedule as per attached enclosure agreed by bidder.		YES/NO	
	j) No. of Aux. contacts per pole for purchaser's usage	10 NO + 10 NC	YES/NO	
	k) Min clearance in Air (mm)			
	(i) Between Live Parts	4500 for 245 kV 3000 for 145 kV	YES/NO YES/NO	
	(ii) Live Part to Earth	2300 for 245 kV 1300 for 145 kV	YES/NO YES/NO	
	(iii) Live Part to ground with Support Structure / Stool	5900 for 245 kV 4000 for 145 kV	YES/NO YES/NO	
	l) Control Cabinet – Degree of Protection Type Tested for IP 55 within last 5 years	IP 55 (Min.)	YES/NO YES/NO	