BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

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TYPE OF DOC.	TECHNICAL SPECIFICATION			NAME	SK	AS	RS
TITLE				SIGN			
400 kV, 220kV, 132kV & 66 kV CIRCUIT BREAKER				DATE	04.09.15	07/09/15	08/09/15
				GROUP	TBEM	W.O. No	
CUSTOMER	POWER GRID CORPORATION OF INDIA LTD.						
PROJECT	765kV/400kV/220kV Banaskantha S/S & Extn. of 400kV Sankhari S/S						

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SECTION 1
SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.1 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch and erection & commissioning supervision of 400kV , 220kV ,132kV & 66kV Circuit Breakers complete with accessories as listed under this specification.

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

The specification comprise of following sections:

Section-1: Scope, specific technical requirements & Bill of Quantities.
Section-2: Equipment specification under scope of supplies.
Section-3: General technical requirements for all equipments under the project.
Section-4: Equipment Data Sheet
In case of any conflict between various sections, order of precedence shall be in the same order as listed above.

The equipment is required for the following project:

Customer : Power Grid Corporation of India Ltd.

Project : 765kV/400kV/220kV Banaskantha S/S & Extn of 400kV Sankhari S/S.

1.2 SPECIFIC TECHNICAL REQUIREMENTS

(A) 420kV Circuit Breaker:

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

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 kVp impulse on one terminal and 345kVP power frequency voltage of opposite polarity on other terminal
Max. radio interference Voltage (microvolts) for frequency between 0.5 MHz and 2 MHz at 266 kVrms	1000
corona extinction voltage (kV rms) with circuit breaker in all positions	320 (min)
Minimum creepage distance:	
Phase to ground (mm)	**10500**
Between CB terminals (mm)	**10500**
System neutral earthing	Effectively Earthed
Seismic acceleration	0.3g horizontal
Thermal rating of auxiliary contacts	10 A at 220 V DC
Breaking capacity of auxiliary contacts	2 A DC with circuit time constant of not less than 20 ms
Phase to phase spacing (mm)	6000 (Banaskantha) , 7000(Sankhari)
Rated continuous current at design Ambient temperature	3150A
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)	Banaskantha (63 kA for 1 Sec.), Sankhari (40 kA for 3 Sec.)
Symmetrical interrupting capability (kA rms)	Banaskantha (63 kA rms for 1 Sec.), Sankhari (40 kA rms for 3 Sec.)
Rated short time making current(kAp)	*100kAP(Sankhari),* *157.5kAP (Banaskantha)*
Short time current carrying capability (kArms)	**Banaskantha (63 kArms for 1 Sec.), Sankhari (40 kArms for 3 Sec.)**
Out of phase breaking current capacity (kArms)	Banaskantha (15.75kArms), Sankhari (10(kArms))
Rated line/cable charging interrupting current at 90 deg. Leading power factor angle (Arms)	600A
(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/√3 and 1.4 as per IEC - 62271-100)	
Pre –Insertion resistor requirement	
Rating(Ohms)	400
Minimum pre-insertion time(ms)	8
Opening of PIR contacts	(a)PIR contacts should open immediately after closing of main circuits Or

	(b) Atleast 5 ms prior to opening of main contacts at rated air/gas pressure , where the PIR contacts remains closed
No. of trip coil	2 per pole
No. of closing coil	1 per pole
Total break times as per IEC (ms)	45
Rated break time as per IEC (ms)	40
Total closing time (ms) Max.	150
Rated operating duty cycle	O-0.3 sec.-CO-3 min-CO
Reclosing	1 ph & 3 ph auto reclosing
Operating mechanism or a combination of these	**spring**
Trip coil and closing coil voltage	220 volt DC with variation as specified in section-3
Noise level at base and(max) upto 50 m.(distance from base of breaker)	140 db max
Rated terminal load	as per IEC
Temperature rise over the design ambient temperature	as per IEC -62271-100
First pole to clear factor	1.3
Auxiliary contacts (Besides requirement of specification , supplier shall wire up these contacts for future use of customer)	15NO+ 15NC
Number of terminals in common control cabinet	all contacts & control circuits to be wired out upto common control cabinet plus 24 terminals exclusively for Owner's use
Maximum allowable switching over-voltage under any switching condition.	2.3 p.u
Max. difference in the instants of closing / opening of contacts (ms)	
Within a pole	2.5ms
Between poles opening	3.3ms
Between poles closing	5ms

(B) 245kV Circuit Breaker:

TECHNICAL PARAMETERS	
Rated voltage kV (rms)	245
Rated frequency (Hz)	50
No.of poles	3
Design ambient Temperature (deg. C)	50
Rated insulation levels	
Full wave impulse withstand voltage (1.2/50 micro sec.)	
-between line terminals and ground (kVp)	± 1050
-between terminals with circuit breaker open(kVp)	± 1050
One minute power frequency dry withstand voltage	
-between line terminals and ground kV (rms)	460

-between terminals with circuit breaker open kV (rms)	460
Max. radio interference Voltage (microvolts) for frequency between 0.5 MHz and 2 MHz at 156 kVrms	1000
corona extinction voltage (kV rms) with circuit breaker in all positions	156 (min)
Minimum creepage distance:	
Phase to ground (mm)	**6125**
Between CB terminals (mm)	**6125**
System neutral earthing	Effectively Earthed
Seismic acceleration	0.3g horizontal
Thermal rating of auxiliary contacts	10 A at 220 V DC
Breaking capacity of auxiliary contacts	2 A DC with circuit time constant of not less than 20 ms
Phase to phase spacing (mm)	4000
Rated continuous current at design Ambient temperature	1600/2500A
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 for 1 Sec.
Symmetrical interrupting capability (kA rms)	40 kA rms for 1 Sec.
Rated short time making current(kAp)	*100kAP*
Short time current carrying capability (kArms)	**40 kArms for 1 Sec.**
Rated line/cable charging interrupting current at 90 deg. Leading power factor angle (Arms)	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/√3 and 1.4 as per IEC - 62271-100)	
No. of trip coil	2 per pole
No. of closing coil	1 per pole
Total break times	65
Rated break time as per IEC (ms)	60
Total closing time (ms) Max.	200
Rated operating duty cycle	O-0.3 sec.-CO-3 min-CO
Reclosing	1 ph & 3 ph auto reclosing
Operating mechanism or a combination of these	**spring**
Trip coil and closing coil voltage	220 volt DC with variation as specified in section-3
Noise level at base and(max) upto 50 m.(distance from base of breaker)	140 db max
Rated terminal load	As per IEC
Temperature rise over the design ambient temperature	as per IEC -62271-100
First pole to clear factor	**1.3**

Auxiliary contacts (Besides requirement of specification , supplier shall wire up these contacts for future use of customer)	12NO+ 12NC
Number of terminals in common control cabinet	all contacts & control circuits to be wired out upto common control cabinet plus 24 terminals exclusively for Owner's use
Maximum allowable switching over-voltage under any switching condition.	As per IEC
Max. difference in the instants of closing / opening of contacts (ms)	
Between poles opening	3.3ms
Between poles closing	5ms

(C) 145kV Circuit Breaker:

TECHNICAL PARAMETERS	
Rated voltage kV (rms)	145
Rated frequency (Hz)	50
No.of poles	3
Design ambient Temperature (deg. C)	50
Rated insulation levels	
Full wave impulse withstand voltage (1.2/50 micro sec.)	
-between line terminals and ground (kVp)	± 650
-between terminals with circuit breaker open(kVp)	± 650
One minute power frequency dry withstand voltage	
-between line terminals and ground kV (rms)	275
-between terminals with circuit breaker open kV (rms)	275
Max. radio interference Voltage (microvolts) for frequency between 0.5 MHz and 2 MHz at 92kVrms	500
corona extinction voltage (kV rms) with circuit breaker in all positions	105 (min)
Minimum creepage distance:	
Phase to ground (mm)	**3625**
Between CB terminals (mm)	**3625**
System neutral earthing	Effectively Earthed
Seismic acceleration	0.3g horizontal
Thermal rating of auxiliary contacts	10 A at 220 V DC
Breaking capacity of auxiliary contacts	2 A DC with circuit time constant of not less than 20 ms
Phase to phase spacing (mm)	3000
Rated continuous current at design Ambient temperature	**1250A**
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)	31.5 kA for 1 Sec.

Symmetrical interrupting capability (kA rms)	31.5 kA rms for 1 Sec.
Rated short time making current(kAp)	*80kAP*
Short time current carrying capability (kArms)	**31.5 kArms for 1 Sec.**
Rated line/cable charging interrupting current at 90 deg. Leading power factor angle (Arms)	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/√3 and 1.4 as per IEC - 62271-100)	
No. of trip coil	2 per pole
No. of closing coil	1 per pole
Total break times	65
Rated break time as per IEC (ms)	60
Total closing time (ms) Max.	150
Rated operating duty cycle	O-0.3 sec.-CO-3 min-CO
Reclosing	3 ph auto reclosing for 3 phase
Operating mechanism or a combination of these	**spring**
Trip coil and closing coil voltage	220 volt DC with variation as specified in section-3
Noise level at base and(max) upto 50 m.(distance from base of breaker)	140 db max
Rated terminal load	As per IEC
Temperature rise over the design ambient temperature	as per IEC -62271-100
First pole to clear factor	**1.3**
Auxiliary contacts (Besides requirement of specification , supplier shall wire up these contacts for future use of customer)	10NO+ 10NC
Number of terminals in common control cabinet	all contacts & control circuits to be wired out upto common control cabinet plus 24 terminals exclusively for Owner's use
Maximum allowable switching over-voltage under any switching condition.	As per IEC
Max. difference in the instants of closing / opening of contacts (ms)	
Between poles at rated control voltage rated operating and quenching media pressure	3.3ms
Rated small inductive current switching capability with overvoltage less than 2.3 p.u.(A)	0.5 to 10

(D) 72.5kV Circuit Breaker:

TECHNICAL PARAMETERS	
Rated voltage kV (rms)	72.5
Rated frequency (Hz)	50
No.of poles	3

Design ambient Temperature (deg. C)	50
Rated insulation levels	
Full wave impulse withstand voltage (1.2/50 micro sec.)	
-between line terminals and ground (kVp)	± 325
-between terminals with circuit breaker open(kVp)	± 375
One minute power frequency dry withstand voltage	
-between line terminals and ground kV (rms)	140
-between terminals with circuit breaker open kV (rms)	160
Minimum creepage distance:	
Phase to ground (mm)	**1813**
Between CB terminals (mm)	**1813**
System neutral earthing	Effectively Earthed
Seismic acceleration	0.3g horizontal
Thermal rating of auxiliary contacts	10 A at 220 V DC
Breaking capacity of auxiliary contacts	2 A DC with circuit time constant of not less than 20 ms
Phase to phase spacing (mm)	2000
Rated continuous current at design Ambient temperature	**1250A**
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)	25kA for 3 second
Symmetrical interrupting capability (kA rms)	25 kA rms
Rated short time making current(kAp)	63 kAp
Short time current carrying capability (kArms)	**25kArms for 3 second**
Out of phase breaking current capacity (kArms)	As per IEC
Rated line/cable charging interrupting current at 90 deg. Leading power factor angle (Arms)	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/√3 and 1.4 as per IEC - 62271-100)	
No. of trip coil	2 per pole
No. of closing coil	1 per pole
Total break times	Less than 80
Rated break time as per IEC (ms)	<75
Total closing time (ms) Max.	200
Rated operating duty cycle	O-0.3 sec.-CO-3 min-CO
Reclosing	NA
Operating mechanism	**spring**
Trip coil and closing coil voltage	220 volt DC with variation as specified in section-3
Noise level at base and(max) upto 50 m.(distance from base of breaker)	140 db max
Rated terminal load	as per IEC

Temperature rise over the design ambient temperature	as per IEC -62271-100
First pole to clear factor	**1.5**
Number of terminals in common control cabinet	all contacts & control circuits to be wired out upto common control cabinet plus 10 terminals exclusively for Owner's use
Auxiliary contacts (Besides requirement of specification , supplier shall wire up these contacts for future use of customer)	10NO+ 10NC

1.3 QUANTITIES

1.3.1 MAIN QUANTITY

(A) Banaskantha

Sl. No	Description	Unit	Banaskantha Qty
1.	420kV, 3150A, 63kA for 1s 3 Phase Circuit Breaker **with PIR** along with support structure, foundation bolts, inter pole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos	3
2.	420kV, 3150A, 63kA for 1s 3 Phase Circuit Breaker **without PIR** along with support structure, foundation bolts, inter pole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos	9
3.	Control Switching device for 420kV Circuit Breaker	Nos.	10
4.	Cable between Circuit Breaker and Control Switching device	Mtrs	2300
5.	245kV, 1600A, 40kA for 1 sec 3 phase Circuit Breaker with support Structure foundation bolts, interpole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos.	3
6.	245kV, 2500A, 40kA for 1 sec 3 phase Circuit Breaker with support Structure foundation bolts, interpole cables, operating mechanism, control boxes and all accessories complete in all respect	No.	1
7.	145kV, 1250A, 31.5kA for 1 sec **1 phase** Circuit Breaker **(for NGR by passing)** with support Structure foundation bolts, interpole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos.	2
8.	72.5kV, 1250A, 25kA for 3 sec Circuit Breaker with support Structure foundation bolts, interpole cables, operating mechanism, control boxes and all accessories complete in all respect	No.	1
9.	Supervision of erection, testing and commissioning of all 420kV Circuit breaker.	Lot	1
10.	Supervision of erection , testing and commissioning of all 245kV Circuit breaker.	Lot	1
11.	Supervision of erection , testing and commissioning of all 145kV Circuit breaker.	Lot	1

12.	Supervision of erection , testing and commissioning of all 72.5kV Circuit breaker.	Lot	1
13.	Training charges for 420kV Circuit breaker at Site for 1 day	Lot	1
14.	Training charges for 245kV Circuit breaker at Site for 1 day	Lot	1
15.	Training charges for 145kV Circuit breaker at Site for 1 day	Lot	1
16.	Training charges for 72.5kV Circuit breaker at Site for 1 day	Lot	1

(B) Sankhari

Sl. No	Description	Unit	Saankhari Qty
1.	420kV, 3150A, 40kA for 3s 3 Phase Circuit Breaker **without PIR** along with support structure, foundation bolts, inter pole cables, operating mechanism, control boxes and all accessories complete in all respect	Nos	2
2.	Supervision of erection, testing and commissioning of all 420kV Circuit breaker.	Lot	1
3.	Training charges for 420kV Circuit breaker at Site for 1 day	Lot	1

NOTE:

1. Total quantity may vary upto ±50% at contract stage. However, individual project wise quantities may vary upto any extent.
2. The terminal connector of CB shall be in BHEL scope.

1.3.2 MANDATORY SPARES

(A) Banaskantha -420kV circuit breaker

Sl. No	Description	Unit	Banaskantha Qty
1.	One Complete Pole of 420kV Circuit Breaker **without PIR** including grading capacitor , Pole column Interrupter , with driving mechanism and marshalling box but without support structure (3150A, 63kA for 1s)	Pole	1
2.	One Complete Pole of 420kV Circuit Breaker **with PIR** including grading capacitor , Pole column Interrupter , with driving mechanism and marshalling box but without support structure (3150A, 63kA for 1s)	Pole	1
3.	Grading Capacitor (If Applicable)	No.	1
4.	Rubber gaskets, 'O' rings and seals (For complete replacement for one phase)	Set	1
5.	Trip coils with resistor	No.	3
6.	Closing coils with resistor	Nos.	3
7.	Terminal pads	Nos.	2
8.	Molecular filter (For complete replacement for one phase)	Nos.	2

9.	Corona rings (of each type)	No.	1
10.	Relays, Power contactors, switch fuse units, limit switches, push buttons, timers & MCB etc .(one no. of each type)	Set	1
11.	Pressure switches of each type and Density Monitor (one no. of each type)	Set	1
12.	Auxiliary Switch assembly (For one Phase of CB)	Set	1

(B) Banaskantha -245kV circuit breaker

Sl. No	Description	Unit	Banaskantha Qty
1.	One Complete Pole of 245kV Circuit Breaker Pole column Interrupter , with driving mechanism and marshalling box but without support structure (1600A, 40kA for 1s)	No,	1
2.	One Complete Pole of 245kV Circuit Breaker Pole column Interrupter,with driving mechanism and marshalling box but without support structure (2500A, 40kA for 1s)	No,	1
3.	Rubber gaskets, 'O' rings and seals (For complete replacement for one phase)	Set	1
4.	Trip coils with resistor	No.	3
5.	Closing coils with resistor	Nos.	3
6.	Terminal pads of each rating	Nos.	2
7.	Molecular filter (For complete replacement for one phase)	Nos.	2
8.	Corona rings (of each type)	No.	1
9.	Relays, Power contactors, switch fuse units, limit switches, push buttons, timers & MCB etc .(one no. of each type)	Set	1
10.	Pressure switches of each type and Density Monitor (one no. of each type)	Set	1
11.	Auxiliary Switch assembly (For one Phase of CB)	Set	1

(C) Sankhari -420kV circuit breaker

Sl. No	Description	Unit	Sankhari Qty
1.	One Complete Pole of 420kV Circuit Breaker **without PIR** including grading capacitor , Pole column Interrupter , with driving mechanism and marshalling box but without support structure (3150A, 40kA for 3 s)	Pole	1
2.	Grading Capacitor (If Applicable)	No.	1
3.	Rubber gaskets, 'O' rings and seals (For complete replacement for one phase)	Set	1
4.	Trip coils with resistor	Nos.	3
5.	Closing coils with resistor	Nos.	3
6.	Terminal pads	Nos.	2

7.	Molecular filter (For complete replacement for one phase)	Nos.	2
8.	Corona rings (of each type)	No.	1
9.	Relays, Power contactors, switch fuse units, limit switches, push buttons, timers & MCB etc .(one no. of each type)	Set	1
10.	Pressure switches of each type and Density Monitor (one no. of each type)	Set	1
11.	Auxiliary Switch assembly (For one Phase of CB)	Set	1

1.4 TYPE TESTS

Bidder shall submit valid type test reports (as per relevant IEC/IS standard) for the tests carried out within last ten years from the date **24.02.15.** The reports should have been conducted on identical or similar equipment/components to those offered. In case type test reports are more than 10 years old or if any type report is found to be technically unacceptable , such type test(s) shall be conducted by the vendor without cost and delivery implication to BHEL.

1.5 QUALIFYING REQUIREMENT (Applicable for 400 kV, 220kV & 132kV 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 originally scheduled 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 originally scheduled 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 originally scheduled 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.

Note: @ 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;

Note: $ 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 in the event of award 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.

Note: Originally scheduled date of bid opening is 24.02.15.

1.6 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.

1.7 TRAINING :

The successful bidder shall impart training to PGCIL Personnel at substation site in the field of erection, testing, operation and maintenance for 1 days.

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

1.8 SPECIAL TOOLS AND TACKLES:

Bidder shall supply all special tools and tackle (other than maintenance tools mentioned in BOQ) free of cost which are specifically required for 420kV & 72.5kV Circuit Breakers and are proprietary in nature . List of such special tools and tackle should be clearly listed along with the technical offer. Any special tool which is not listed in the list but required during the erection/commissioning of Circuit Breakers shall also be supplied free of cost by the supplier.

In case , special tools and tackles which is proprietary in nature is not required for Erection/testing/commissioning or for smooth operation of Circuit Breaker, supplier has to submit a certificate mentioning that no special tools and tackles is required for Circuit Breakers.

1.9 SUPERVISION OF ERECTION , TESTING & COMMISSIONING:

Bidder shall quote lump-sum price for installation and commissioning of all offered breakers. Supplier's testing engineer shall bring SF6 gas leak detector, SF6 gas filling adopter, timing kit and Transducer for operational analyzer(if required).

Following Instruments shall be made available by BHEL to testing engineer

a) DCRM (Operational analyzer) Kit
b) 5kV Insulation tester
c) 1kV Insulation tester
d) Single phase variac
e) Dew Point meter
f) Capacitance and Tan Delta Kit
g) Contact Resitance measurement kit
h) Multimeter

Any other instrument(s), if required for Testing/commissioning of Circuit Breaker shall be arranged by Circuit Breaker supplier without any price implication to BHEL.

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.

1.2 400/220/132/66kV 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 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 RAL-7032** shall 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.

1.6 All Circuit Breakers shall be provided with all necessary accessories like limit switches, auxiliary switches, terminal blocks and wiring etc. Required for controlled switching application.

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 400/220/132/66kV effectively grounded system, and perform make and break operations as per the stipulated duty cycles satisfactorily.

2.2.1 PRE INSERTION RESISTER

400 kV circuit breakers **wherever specified** shall be provided with single step pre-insertion closing resistors to limit the switching surges to a value of less than 2.3 p.u. for 400 kV. 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 Breaker shall be able to switch in and out the 400kV Shunt reactor for any value from 80MVAR and above , without giving rise to overvoltage ,ore than 2.3p.u. Laboratory test and/or field test reports in support 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.

2.6 **CONTROLLED SWITCHING REQUIREMENTS**

400kV Circuit Breaker shall be equipped with controlled switching with consequent optimization of switching behavior, when used in:

- 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 Transformerr, line with non switchable line reactors and 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 gasketted 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 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.(If applicable)

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 resisters if used, synchronisation of contacts in one pole.

4.5 The CO (Close-Open) operation and it's timing shall be such as to ensure complete travel/insertion of the contact during closing operation and then follow the opening operation.

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.

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(if applicable) along with the equipment. Calibration certificates 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 spring charged mechanism . 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 along with the operation manual for the circuit breaker. The instruction manuals shall contain exploded diagrams with complete storage, handling, erection, commissioning, troubleshooting, servicing and overhauling instructions.

8.1.8 Size of common Marshalling kiosk shall be such that adequate space is available for working in the panel and all wiring shall be routed through non inflammable wire troughs with covers.

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 circuits shall operate correctly under all operating conditions of the circuit breaker upto the rated breaking capacity of the circuit breaker and at all values of supply voltage between 70% and 110% of rated voltage. However, even at 50% of rated voltage the breaker shall be able to open. If additional elements areintrduced 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. Two separate alarm levels shall be provided (For SF6 density very low), apart from the operation lockout. 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.

8.2.8 for changeover arrangement of all contacts , alarms, signals, indications, interlocks and lockouts.

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.

i) The separate MCB shall be provided for each phase of spring charging motor and the rating of MCBs shall be suitably selected to match the starting running and stalling time.

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^{o}C as per relevant standards.

11.4 All interpole cabling of circuit breakers and up to common marshalling box shall be done by plugin type arrangement. The plug in type cable termination shall be conforming to IP-67 as per IEC 60529.

11.5 Cable termination shall be done with stud type terminals and ring type lugs. More Than two wires shall not be connected on each side of terminal.

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) Control switches to cut off control power supply.

v) Fuses as required.

vi) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for future use.

vii) Antipumping relay.

viii) Pole discrepancy relay (for electrically ganged CBs).

ix) D.C. Supervision relays.

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

xi) Controlled switching equipments like sensors, timers, relays etc.(as applicable)

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 .

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 sectionr in case of 420 kV circuit breaker.

l) All duty requirements as applicable to CB 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 .

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(wherever 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 PRE-COMMISSIONING TESTS

16.1 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.: CF/CB/03/R-4, Dated 01/04/13 under POWERGRID Document no. D-2-01-03-01-04 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 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)

16.2 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.

16.3 During testing of CB, dynamic contact resistance measurement (DCRM) shall be carried out for close-Open (CO) operations with delay of 300ms between close and trip operations. Minimum 100A current shall be injected for DCRM test. Travel characteristics, injected current, trip/close coil current shall also be recorded slongwith DCRM test.

17 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 hexaflouride.

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)	Owner	POWERGRID
b)	Customer	POWERGRID
c)	Project Title	765kV/400Kv/220kV Banaskantha (New) Substation and Extn. of 400kV Sankhari (GETCO) Substation
d)	Location	Banaskantha, Gujrat Sankhari , Gujrat
e)	Transport Facilities	RAOD/TRAIN, For both Site Nearest Rail Head: Palanpur
	SITE CONDITIONS	
a)	Max. ambient air temp.	50°C
b)	Min. ambient air temp.	0°C
c)	Max. design ambient temp.	50°C
d)	Design reference temp.	50°C
e)	Average Humidity	Max. 100%
f)	Special corrosion conditions	No
g)	Solar Radiation	1.2kW/sqmtr
h)	Atmospheric UV radiation	High
i)	Altitude above sea level	Less than 1000meter
j)	Pollution Severity	High Polution (25mm/kV)
k)	Seismic Zone	As per the seismic zone defined in the relevant BIS but not less than 0.3g horrizontal
	WIND DATA	
	Wind velocity	As per IS

	Average No. of thunderstorm days per annum	As per IS
	Main Electrical Parameters:	
	Fault Levels:	**For Banaskantha** **765kV: 50kA for 1 sec** **400kV: 63kA for 1 sec** **220kV: 40kA for 1 sec** **For Sankhari** **400kV: 40kA for 3 sec**
	Creepage Distance	**25mm/kV**

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.

Auxiliary supplies as described below would be available at site.

Normal	Variation	Frequency	Phase	Neutral

Voltage (Volts)	in voltage	(Hz)		connection
415	+ 10 %	50 + 5 %	3 Ph- 4wire	Solidly earthed
240	+ 10 %	50 + 5 %	1 Ph-2wire	Solidly earthed
220	+ 10 %	DC		Isolated(2 wire system)
48		DC		Isolated(2 wire system) (+ Earthed)

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.

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 (If in the scope of Bidder)

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 bidder 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 POWERGRID's approval.

5.0 ENGINEERING DATA AND DRAWINGS

5.1 The list of drawings/documents which are to be submitted to the Purchaser shall be discussed and finalised by the Purchaser at the time of award.The supplier shall necessarily submit all the drawings/ documents unless anything is waived.

5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports for the approval of the Purchaser. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings

5.3.1 All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

5.3.2 Drawings submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. POWERGRID has standardized a large number of drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings alongwith type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

5.3.3 The review of these data by the Purchaser 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 substation layout. This review by the Purchaser 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 Purchaser 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.

5.4 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 Purchaser. Approval of Contractor's drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.

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

5.7 Approval Procedure

The scheduled dates for the submission of the drawings as well as for, any data/information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval and for providing final documentation.

i)	Approval/comments/ Purchaser on initial	As per agreed by schedule submission
ii)	Resubmission (whenever required)	Within 3 (three) weeks from date of comments
iii)	Approval or comments	Within 3 (three) weeks of receipt of resubmission.
iv)	Furnishing of distribution copies (5 hard copies per substation and one scanned copy (pdf format) for Corporate Centre)	2 weeks from the date of approval
v)	Furnishing of distribution copies of test reports	
(a)	Type test reports (one scanned softcopy in pdf format per substationplus one for corporate centre & one hardcopy per substation)	2 weeks from the date of final approval
(b)	Routine Test Reports (one copy for each substation)	-do-
vi)	Furnishing of instruction/ manuals (2 copies per substation and one softcopy	As per agreed schedule operation

(pdf format) for corporate centre & per substation)

(vii) As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre& per substation) — On completion of entire works

NOTE :

(1) The supplier may please note that all resubmissions must incorporate all comments given in the earlier submission by BHEL/POWERGRID or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.

(2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.

(3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection,commissioning,testing, operation, trouble shooting, servicing and overhauling procedures.

(4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/ additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the supplier to BHEL/POWERGRID.

(5) The manufacturer shall furnish to the Purchaser catalogues of spare parts.

(6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

6.0 MATERIAL WORKMANSHIP

6.1 General Requirement

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

6.1.2 Incase where the equipment, materials or components are indicated in the specification as "similar" to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the supplier.

6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the

component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the BHEL/POWERGRID.

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

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

6.1.6 The supplier shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The supplier shall apply all operational lubricants to the equipment installed by him.

6.1.7 All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help POWERGRID in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

6.1.8 Corona and radio interference voltage test and seismic withstand test (for 132kV and above voltage level) procedures for equipments shall be in line with the procedure given at Annexure-A and B respectively.

6.2 Provisions For Exposure to Hot and Humid climate

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

6.2.1 Space Heaters

6.2.1.1 The heaters shall be suitable for continuous operation at 240V as supply voltage. On-off switch and fuse shall be provided.

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

6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

6.2.2 FUNGI STATIC VARNISH

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

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

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

a) Installed out door: IP- 55
b) Installed indoor in air conditioned area: IP-31
c) Installed in covered area: IP-52
d) Installed indoor in non air conditioned area where possibility of entry of water is limited: IP-41.
e) For LT Switchgear (AC & DC distribution Boards) : IP-52

The degree of protection shall be in accordance with IS:13947 (Part-I) / IEC-60947(Part-I) / IS 12063 / IEC-60529. Type test report for degree of protection test, shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

6.4 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into successful Operation, shall be furnished by the supplier unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor agree upon any such changes, the specification shall be modified accordingly.

7.2 If any such agreed upon 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.

7.3 The supplier shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The supplier has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.

7.5 The supplier will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at POWERGRID Corporate Centre, Gurgaon (Haryana) or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the supplier's Works or at his Sub- contractor's premises or at the Purchaser's site or at any other place of Work are in accordance with the specifications, the supplier shall adopt suitable quality assurance programme to control such activities at all points necessary. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the supplier shall generally cover the following:

(a) His organisation structure for the management and implementation of the proposed quality assurance programme:

(b) Documentation control system;

(c) Qualification data for 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) Control of non-conforming items and system for corrective actions;

(g) Inspection and test procedure both for manufacture and field activities.

(h) Control of calibration and testing of measuring instruments and field activities;

(i) System for indication and appraisal of inspection status;

(j) System for quality audits;

(k) System for authorising release of manufactured product to the Purcahser.

(l) System for maintenance of records;

(m) System for handling storage and delivery; and

(n) A quality plan detailing out the specific quality control measures and procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

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

8.2 Quality Assurance Documents

The supplier would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of POWERGRID/BHEL inspection of equipment/material

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICATE

9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.

9.2 The reports for all type tests as per technical specification shall be furnished by the supplier alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all project with similar requirement. 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 POWERGRID or representative authorized by POWERGRID or Utility or representative of accredited test lab or reputed consultant.

The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the date of bid opening i.e. 24.02.15. In case the test reports are of the test conducted earlier than 10 (ten) years prior to the date of bid opening, the contractor shall repeat these test(s) at no extra cost to BHEL.

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the date of bid opening.

i) Lightning Impulse Test

ii) Switching ImpulseTest

iii) Multiple Chopped Impulse Test (For CT)

iv) Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the date of bid opening i.e. 24.02.15, the contractor shall repeat these test(s) at no extra cost to the purchaser.

Further, 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 type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.
The supplier shall intimate the BHEL/POWERGRID the detailed program about the tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

Further, in case type tests are required to be conducted/repeated and the deputation of Inspector/Purchaser's representative is required, then all the expenses shall be borne by the supplier.

9.3 The Purchaser intends to repeat the type tests on Power Transformer and Shunt Reactor except Dynamic short circuit tests on transformers, for which test charges shall be payable as per provision of contract. The price of conducting 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. BHEL/POWERGRID reserves the right to witness any or all the type tests. The BHEL/POWERGRID also reserves the right to waive the repeating of type tests partly or fully and in case of waival, test charges for the same shall not be payable.

The Purchaser shall bear all expenses for deputation of purchaser's representative(s) for witnessing the type tests under this clause except in the case of re-deputation if any, necessitated due to no fault of the purchaser.

For outdoor receptacles, trefoil clamps, diesel engine, alternator, motors, cable glands, lighting fixtures, ACSR/AAC conductor, IPS aluminum tube and junction boxes, type test reports are not required to be submitted for the makes indicated at Annexure-E /POWERGRID approved list of subvendors. For the

new makes(other than those indicated at Annexure-E / POWERGRID approved list of subvendors), type test reports as per relevant standard shall be submitted for POWERGRID's approval.

9.4 The Purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractor's/sub-vendors 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 if part of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer 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. Inspection may be made at any stage of manufacture, despatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

9.5 The supplier shall give the Purchaser /Inspector fifteen (15) days written notice for on-shore and six (6) weeks notice for off-shore material being ready for joint testing including contractor and POWERGRID. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Purchaser/inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.

9.6 The Purchaser or Inspector shall, within fifteen (15) 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 Purchaser /Inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

9.7 When the factory tests have been completed at the Contractor's or Sub- Contractor's works, the Purchaser/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 Purchaser /Inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/Inspector. Failure of the Purchaser /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 Purchaser to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of CIP by the Purchaser.

9.8 In all cases where the Contract provides for tests whether at the premises or at the 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 Purchaser /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 Purchaser /Inspector or to his authorised representative to accomplish testing.

9.9 The inspection by Purchaser 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.

9.10 The Purchaser 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.

9.11The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipments for these tests shall be provided by the Purchaser.

10.0 TESTS

10.1 Pre-commissioning Tests

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 Purchaser 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 respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

10.2.1 The available instrumentation and control equipment will to be used during such tests and the Purchaser will calibrate, all such measuring equipment and devices as far as practicable.

10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.

10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

10.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed by POWERGRID on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Purchaser, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling

and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

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

12.0 FINISHING OF METAL SURFACES

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro galvanized to service condition 4.All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS:2629.

12.2 HOT DIP GALVANISING

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq. m minimum.

12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

12.2.3 After galvanizing. no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

12.2.4The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich

paint at site shall not be allowed.

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

12.3.2 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Glossy white colour inside the equipments /boards/panels/junction boxes is also acceptable. The exterior colour for panels shall bematching with the existing panels in case of extension of a substation. Each coatof primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.

12.3.5 In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted alongwith the Bids for Purchaser's review & approval.

12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air
Conditioning systems

S.No.	PIPE LINE	Base colour	Band colour
Fire Protection System			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line – Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
Air Conditioning System			

5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting.

13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the 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.

13.2 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.

13.3 The contractor shall have to ensure that the hard and flat indoor and outdoor storage areas are in place prior to commencement of delivery of material at site. Contractor shall also ensure availability of proper unloading and material handling equipment like cranes etc. and polyester/nylon ropes of suitable capacity to avoid damage during unloading and handling of material at site. All indoor equipments shall be stored indoors. Outdoor equipment may be stored outdoors but on a hard and flat raised area properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress. However, all associated control panels, marshalling boxes operating boxes etc. of outdoor equipments are to be stored indoors only.Storage of equipment on top of another one is not permitted if the wooden packing is used. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations.During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

13.5 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 properoperation of circuit breakers,isolators and their operating mechanisms. All components shall beprotected 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.

13.6 Supplier shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the Purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.

13.7 The supllier shall be fully responsible for the equipment/material until the same is handed over to the Purchaser 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 Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.

13.8 Where material / equipment is unloaded by Purchaser before the Contractor arrives at site or even when he is at site, Purchaser 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.

13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.

13.10The words 'erection' and 'installation' used in the specification are synonymous.

13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.

13.12 Equipment Bases

A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

14.0 TOOLS AND TACKLES

The Contractor shall supply with the equipment one complete set of all special tools and tackles for the erection, assembly, dis-assembly and maintenance of the equipment. However, these tools and tackles shall be separately, packed and brought on to Site.

15.0 AUXILIARY SUPPLY

15.1 The sub-station auxiliary supply is normally met through a system indicated

under section "Electrical & Mechanical Auxiliaries" having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following.

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
48V	_	DC	_	2 wire system (+) earthed

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

16.0 SUPPORT STRUCTURE (If in the scope of supplier)

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 14.0 meter, 8.0 meter and 5.9 meter from plinth level for 765 kV,420 kV and 245 kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

16.2 Support structure shall meet the following mandatory requirements:

16.2.1 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

17.1 All power clamps and connectors shall conform to IS:5561 & NEMA CC1 and shall be made of materials listed below :

a)	For connecting ACSR conductors	Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617
b)	For connecting equipment terminals made of copper with ACSR conductors	Bimetallic connectors made from aluminum alloy casting, conforming to designation A6 of IS:617 with 2mm thick bimetallic liner and all test shall conform to IS:617
c)	For connecting G.I	Galvanised mild steel shield
d) i)	Bolts, nuts & Plain, washers	i) Electrogalvanised for sizes below M12, for others hot dip galvanised.
ii)	Spring washers items 'a' to 'c'	ii) Electro-galvanised mild for steel suitable for atleast service condition-3 as per IS:1573

17.2 Necessary clamps and connectors shall be supplied for all equipment and connections.The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

17.3 Where copper to aluminum connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.

17.4 Low voltage connectors, grounding connectors and accessories for grounding allequipment as specified in each particular case, are also included in the scope of Work.

17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminum body or 2 mm thick bi-metallic strips shall be provided for Bi-metallic clamps.

17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of 4" IPS AL. tube as required. In both the cases the clamp height (topof the mounting pad to centre line of the tube) should be same.

17.8 Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

17.10 Clamps and connectors shall be designed to be corona controlled.

17.11 Tests

17.11.1 Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval as per clause 9.2 above except for sl. no.(ii) & (iii) for which type test once conducted shall be applicable (i.e. the requirement of test conducted within last ten years shall not be applicable).

i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)

ii) Short time current test

iii) Corona (dry) and RIV (dry) test (for 220 KV and above voltage level clamps)

iv) Resistance test and tensile test

18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-60439, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. 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 aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

18.3 A canopy and sealing arrangements for operating rods shall be provided inmarshalling boxes / Control cabinets to prevent ingress of rain water.

18.4 Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan, IS:11149 and IS:3400. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by meanof weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.

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

18.8 For illumination, a fluorescent tube or CFL of approximately 9 to 15 watts shall be provided. The switching of the fittings shall be controlled by the door switch. .

For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.

18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.

18.10 Positive earthing of the cabinet 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 self etching washer. Earthing of hinged door shall be done by using a separate earth wire.

18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.

18.12 a) The following routine tests alongwith the routine tests as per IS:5039 shall also be conducted:

i) Check for wiring

ii) Visual and dimension check

b) The enclosure of bay marshalling kiosk, junction box, terminal box shall conform to IP-55 as per IS:13947 including application of, 2.5 KV rms for 1
(one) minute, insulation resistance and functional test after IP-55 test.

19.0 Deleted.

20.0 TERMINAL BLOCKS AND WIRING

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

20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non breakable type. These shall be of moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type of Elmex or Phoenix or Wago
or equivalent make.

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

20.4 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.

20.5 The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable.

20.6 The terminal blocks shall be of extensible design.

20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

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

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

a)	All circuits except CT/PT circuits	Minimum of two of 2.5 sq copper flexible.
b)	All CT/PT circuits	Minimum of 4 nos. of 2.5 sq copper flexible.

20.10 The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

20.11 Atleast 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

20.13 The supplier shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge overvoltages either transferred through the equipment or due to transients induced from the EHV circuits.

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

21.0 LAMPS & SOCKETS

21.1 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

21.2 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

21.3 Switches and Fuses:

21.3.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switchfuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

21.3.2 All fuses shall be of HRC cartridge type conforming to IS:9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

22.0 Bushings, Hollow Column Insulators, Support Insulators:

22.1 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC- 60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155/IS:5621.The support insulators shall be manufactured and tested as per IS:2544/IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable.The bidder may also offer composite hollow insulators, conforming to IEC-61462.

22.2 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.

22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

22.4 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.

22.5 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.

22.6 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.

22.7 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.

22.8 Tests

In bushing, 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 & IS : 5621.

23.0 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 be subjected to routine tests as per applicable standards. The motors shall be of approved make.

23.1 Enclosures

a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IS: 4691. For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691.

b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.

c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.

d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

23.2 Operational Features

a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.

b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

23.3 Starting Requirements:

a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:325.

d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding atleast two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

23.4 Running Requirements:

a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325 (for 3 - phase induction motors) after adjustment due to increased ambient temperature specified.

b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the

relevant standard for the driven equipment when measured at the motor bearings.

c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

23.5 TESTING AND COMMISSIONING

An indicative list of tests is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

(a) Insulation resistance.

(b) Phase sequence and proper direction of rotation.

(c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

ANNEXURE-A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona (for 400kV & above) both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV) for 132kV and above.

2. Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3. Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

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

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, and 110% of the specified RIV test voltage for all equipment unless otherwise specified.The specified RIV test voltage for 765kV, 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

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

3.6 The RIV measurement may be made with a noise meter. A calibration procedure
of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noisel meter.

4. Test Methods for Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of specified corona extinction voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

For recording purpose, modern devices utilizing UV recording methods such as image intensifier may also be used.

4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.

4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

4.4 However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

5. Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

a) Background noise before and after test.

b) Detailed procedure of application of test voltage.

c) Measurements of RIV levels expressed in micro volts at each level.

d) Results and observations with regard to location and type of interference sources detected at each step.

e) Test voltage shall be recorded when measured RIV passes through 100microvolts in each direction.

f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

ANNEXURE-B

SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test on the complete equipment (for 132kV and above)shall be carried out along with supporting structure.

The Bidder shall arrange to transport the structure from his Contractor's premises/POWERGRID sites for the purpose of seismic withstand test only.The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Purchaser. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the POWERGRID.

SECTION 4

GUARANTEED AND TECHNICAL PARTICULARS FOR CIRCUIT BREAKER

Bidder shall furnish the technical parameters for offered circuit breaker 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 Ur/_/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 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	.....	.....

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	.....	.....

SECTION - 5

CHECK LIST FOR 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	400 kV	220kV	132kV	66kV	YES/NO	Remarks
1	Type/class of Circuit Breaker	Outdoor SF6,	Outdoor SF6,	Outdoor SF6,	Outdoor SF6,	YES/NO	
2	Standard Applicable	IEC 62271 - 100	IEC 62271 - 100	IEC 62271 - 100	IEC 62271 - 100	YES/NO	
3	Rated Voltage (kV rms)	420	220	145	72.5	YES/NO	
4	Operating Mechanism	Spring	Spring	Spring	Spring	YES/NO	
5	Rated Current						
	Under normal condition (A)	3150A	1600A/ 2500A	1250A	1250A	YES/NO	
	Max fault level (1S/3 S)	Banaskantha (63 kA for 1 Sec.), Sankhari (40 kA for 3 Sec.)	40 kA ,1 S	31.5kA ,1S	25 kA ,3 S	YES/NO	
6	Phase to phase spacing	6000 (Banaskantha) , 7000(Sankhari)	4000mm	3000mm	2000mm	YES/NO	
7	Rated frequency (Hz)	50	50	50	50	YES/NO	
8	Paint Shade	RAL7032	RAL7032	RAL7032	RAL7032	YES/NO	
9	Support structure along with Foundation bolts are included in supply	Included	Included	Included	Included	YES/NO	
11	Special tools and tackles (if applicable) as per clause 1.8 of Section-1 are included in the quoted price of Main Item	Included	Included	Included	Included	YES/NO	
12	Inter pole cables are included in the supply	Included	Included	Included	Included	YES/NO	

Sl. No.	Parameters	400 kV	220kV	132kV	66kV	YES/NO	Remarks
13	Type of interpole cabling of circuit breakers and up to common Marshalling Box	Plug In type	Plug In type	Plug In type	Plug In type	YES/NO	
14	Number of poles	3	3	3	3	YES/NO	
15	Whether All The 3 poles ganged electrically or mechanically	Electrically	Electrically	Mechanically	Mechanically	YES/NO	
16	Whether dead tank or live tank design	Live	Live	Live	Live	YES/NO	
17	Rated short circuit breaking capacity at rated Voltage (kA)	Banaskantha (63 kA for 1 Sec.), Sankhari (40 kA for 3 Sec.)	40 kA for 1 Sec.	31.5 kA for 1 Sec.	25kA for 3 sec.	YES/NO	
18	Rated short circuit Making Current (kAp)	*100kAP(Sankhari), 157.5kAP (Banaskantha)*	*100kAP*	80	63	YES/NO	
19	Total break time as per IEC (ms) (less than)	45 ms	65 ms	65ms	80 ms	YES/NO	
20	Rated break time as per IEC (less than)	40 ms	60 ms	60 ms	75 ms	YES/NO	
21	Total closing time (ms) not exceeding	150 ms	200 ms	150 ms	200 ms	YES/NO	
22	First pole to clear factor	1.3	1.3	1.3	1.5	YES/NO	
23	Rated operating duty	O-0.3 Sec –CO -3 min –CO	O-0.3 Sec –CO -3 min –CO	O-0.3 Sec –CO -3 min –CO	O-0.3 Sec –CO -3 min –CO	YES/NO	
24	Out of phase breaking current(kArms	Banaskantha (15.75kAr	As per IEC	As per IEC	As per IEC	YES/NO	

Sl. No.	Parameters	400 kV	220kV	132kV	66kV	YES/NO	Remarks
		ms), Sankhari (10(kArms)					
25	Rated line charging interrupting current at 90 deg leading power factor angle current	600A	As per IEC	As per IEC	As per IEC	YES/NO	
26	Temperature rise over ambient temperature of 50°C	As per IEC: 62271-100	As per IEC: 62271-100	As per IEC: 62271-100	As per IEC: 62271-100	YES/NO	
27	Reclosing	Single and three phase auto reclosing	Single and three phase auto reclosing	----	----	YES/NO	
28	Auxiliary contacts (besides requirement of specification, spare contacts (wire up) for future use of customer)	15NO +15NC	12NO +12NC	10NO+10 NC	10NO+ 10NC	YES/NO	
29	**Dielectric withstand of complete Breaker**						
a)	One minute dry & wet power frequency withstand voltage						
	i. Between live terminal and ground (kV rms)	520	460	275	140	YES/NO	
	ii. Between terminals with breaker contacts open (kV rms)	610	460	275	160	YES/NO	
b)	1.2/50- micro second impulse withstand test voltage						
	i. Between live terminals and ground (kVp)	±1425	±1050	±650	±325	YES/NO	
	ii. Between terminals with breaker contacts open (kVp)	±1425kVp(-/+ 240kVp)	±1050	±650	±375	YES/NO	

Sl. No.	Parameters	400 kV	220kV	132kV	66kV	YES/NO	Remarks
c)	250/2500 micro second switching surge withstand test voltage						
	i. Between live terminals and ground (kVp)	±1050	-	---	---	YES/NO	
	ii. Between terminals with breaker contacts open (kVp)	900kVp / (-345kVp)	-	---	---	YES/NO	
d)	Corona extinction voltage (kV rms)	320(min).	156(min).	--	--	YES/NO	
e)	Maximum radio interference voltage for Frequency between 0.5 MHz and 2 MHz in all position	1000 (max) at voltage 266 kV rms.	1000 (max) at voltage 156 kV rms.	500 (max) at voltage 92 kV rms.	---	YES/NO	
f)	Minimum creepage distance						
	i) Phase to ground (mm)	10500	6125	3625	1813	YES/NO	
	ii) Between terminals (mm)	10500	6125	3625	1813	YES/NO	
	Breaking capacity of auxiliary contacts	2A DC with circuit time constant of not less than 20 ms	2A DC with circuit time constant of not less than 20 ms	2A DC with circuit time constant of not less than 20 ms	2A DC with circuit time constant of not less than 20 ms	YES/NO	
30	**Pre-insertion resistor requirement**						
	Rating (ohms)	400 (Max)	-	---	---	YES/NO	
	Minimum pre-insertion time (ms)	8ms	-	---	---	YES/NO	
31	**General**						
a)	Whether OGA drawing enclosed	Enclosed	Enclosed	Enclosed	Enclosed	YES/NO	
b)	Filled in GTP furnished	Enclosed	Enclosed	Enclosed	Enclosed	YES/NO	

Sl. No.	Parameters	400 kV	220kV	132kV	66kV	YES/NO	Remarks
c)	Interpole cabling included in Scope alongwith required Glands, Lugs etc. Termination chart shall be submitted along with the drawings. (cable shall be supplied in one length & suitable lugs shall be supplied as loose items)	Enclosed	Enclosed	Enclosed	Enclosed	YES/NO	
d)	TBs for auxiliary supply	Provided	Provided	Provided	Provided	YES/NO	
e)	L/R switch	Provided	Provided	Provided	Provided	YES/NO	
f)	Control Cabinet –						
	Degree of Protection	IP 55 (Min.)	IP 55 (Min.)	IP 55 (Min.)	IP 55 (Min.)	YES/NO	
g)	All items required for Control Switching Device such as signal armored cable etc. included in scope of supply	Included	-	-	-	YES/NO	
h)	Mandatory maintenance included in scope of supply as per section 1	Included	Included	Included	Included	YES/NO	
i)	Supervision of Erection, testing and commissioning included in scope	Included	Included	Included	Included	YES/NO	
j)	Bidder to comply requirements as per Technical Specification	Complied	Complied	Complied	Complied	YES/NO	
k)	Bidder will be responsible of getting approval from customer	Yes	Yes	Yes	Yes	YES/NO	
32	Powergrid standard approval on 400kV/220kV/132kV/66kV CB drawings	YES	YES	YES	YES	YES/NO	

Sl. No.	Parameters	400 kV	220kV	132kV	66kV	YES/NO	Remarks
33	Powergrid standard Type test approval for 400kV/220kV/132kV/66kV CB with validity as on 24.02.15.	YES	YES	YES	YES	YES/NO	
34	MQP approval from Powergrid with validity	YES	YES	YES	YES	YES/NO	
35	All valid Type test reports(as per IEC 129) not older than 10 years, available as on 24.02.15.	Yes, available	Yes, available	Yes, available	Yes, available	YES/NO	
36	Conduction of type test (if any)	Free of cost/chargeable	Free of cost/chargeable	Free of cost/chargeable	Free of cost/chargeable	YES/NO	

Date:
Place:

Phone:
Fax:
E-mail:
Mobile:
Website:

(Signature of the authorized representative of Bidder / Firm / Company)
Name:
Designation:
Company Seal:

ANNEXURE - A
SCHEDULE OF TECHNICAL DEVIATIONS

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

S.No.	Page No.	Clause No.	Deviation	Reason / Justification

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