

**KARNATAKA POWER TRANSMISSION CORPORATION**  
**LIMITED**

**TECHNICAL SPECIFICATION**

**SECTION –**

**CIRCUIT BREAKER**

**TECHNICAL SPECIFICATION**  
**FOR**  
**145/ 72.5 / 36 KV SF - 6 CIRCUIT BREAKERS**  
**FOR**  
**110KV/66KV SUB-STATIONS**

**TECHNICAL SPECIFICATION  
FOR 145KV / 72.5KV / 36KV SF6 CIRCUIT BREAKERS FOR  
VARIOUS SUB-STATIONS OF KPTCL GRID**

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# TECHNICAL SPECIFICATION FOR 145KV / 72.5KV / 36KV SF6 CIRUIT BREAKERS FOR VARIOUS SUB- STATIONS OF KPTCL GRID

## 1.0.0 SCOPE

1.1.0 This specification covers design, manufacture, assembly, testing at manufacturer's works / testing laboratories before supply, inspection, packing and delivery of outdoor type circuit breakers, erection and commissioning of circuit breakers of rated insulation class of 145kV, 72.5kV and 36kV. The Circuit Breakers shall be of Sulphur hexafluoride (SF6) type and shall be complete with all the accessories and auxiliary equipments and mounting structures required for their satisfactory operation in various sub-stations of KPTCL grid.

1.2.0 It is not the intent to specify completely here in all the details of design and construction of the circuit breaker. However, the breaker shall conform, in all respects to high standards of engineering, design and workmanship as listed in clause No. 3.0. It shall be capable of performing in continuous commercial operation up to the supplier's guarantee in a manner acceptable to the purchaser who will interpret the meanings of drawings and specifications and shall have power to reject any work or material which, in his judgment, is not in accordance therewith. The circuit breaker offered shall be complete with all components necessary for its effective and trouble free operation. Such components shall be deemed to be within the scope of supplier's supply, irrespective of whether those are specifically brought out in this specification and / or in the commercial order or not.

## 2.0.0 SERVICE CONDITIONS

2.1.0 Environmental Conditions :

The circuit breakers and accessories to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

- |   |   |                |
|---|---|----------------|
| a) Maximum ambient air temperature [Deg. C]       | - | 50             |
| b) Minimum ambient air temperature [Deg. C]       | - | 5              |
| c) Average daily ambient air temperature [Deg. C] | - | 30             |
| d) Relative humidity [%]                          | - | 10 to 100      |
| e) Average rainfall per annum [mm]                | - | 1000-3000/5000 |
| f) Maximum altitude above mean sea level [Mtrs]   | - | 1000           |
| g) Maximum wind pressure [Kg. / Sq. M]            | - | 150            |

- h) Isoceraunic level [stormy days per year] - 46
- i) Seismic level [horizontal acceleration] - 0.3g
- j) Moderately hot and humid tropical climate, conducive to rust and fungus growth.

## 2.2.0 AUXILIARY POWER SUPPLY

The Rating, quality and location of electrical supply system that will be made available by the purchaser for operation of the circuit breaker are described below. The auxiliary electrical equipments provided by the tenderer for specified operation of the circuit breaker, shall be suitable for operation on the same.

### 2.2.1 Ratings :

i) For power devices (like drive motors)	415V, 3 phase, 4 wire, 50 Hz neutral grounded AC supply
ii) For AC Control & Protective devices, lighting fixtures, space heaters and f.h.p. motors	240V, single phase, 2 wire, 50 Hz, AC supply with one point grounded.
iii) For DC alarm, control and protective devices	2 wire ungrounded DC supply from batteries & battery charger. i) 110V DC for 110, 66 & 33KV Sub-Stations. ii) 220V DC for 220kV Sub-Station The ripple content in the DC supply from the battery charger will be less than 2%

### 2.2.2 Variation :

The above supply systems may have variations as follows :

1) AC supply voltage variation	+10% to -30%
2) Frequency variation	+5%
3) DC supply voltage variation	+10% to -20%

## 3.0.0 STANDARDS:

### 3.1.0 The circuit breakers shall conform to the latest revision and amendments of standards as given below :

Sl. No.	Standard ref. No.	Title
1	IS : 13607	Ready mixed paints, brushings, finishing etc.,
2	IS : 325	Specification for 3 phase induction motor
3	IS : 2099	High voltage porcelain bushing

	IEC :60137	
4	IS : 2147	Degree of protection provided for enclosures for low voltage switch gear and control gear
5	IS : 2629	Recommended practice for hot dip galvanizing of iron and steel
6	IS : 13947	General requirement of switch gear and control gear for voltages not exceeding 1000V
7	IS : 4379	Identification of contents of industrial gas cylinders
8	IS : 5561	Electrical power connectors
9	IS : 7285	High pressure cylinder in which SF6 gas is transported and stored at site.
10	IS : 13118	Specification for HV AC circuit breakers
11	CIGRE working group report No. 13-02-1973	Switching over-voltages in EHV and UHV systems with special reference to closing and re-closing transmission lines.
12	Indian electricity rules	
13	IEC : 62271-100	Specification for AC circuit breakers
14	IEC :60060-3 & IS: 2071	High voltage test techniques
15	IEC : 60071&IS:2165	Insulation coordination, terms, definitions, principles and rules
16	IEC : 60270	Partial discharge measurements
17	IEC : 60376	Specification and acceptance of new supply of SF6
18	IEC : 62271-1	Common clauses for high voltage switchgear and control gear controls.
19	IEC 60427	Synthetic testing of high voltage alternating current circuit breaker

- 3.2.0 Equipments meeting with the stipulations of equivalent IEC, ANCI, CSA, DIN standards, which ensure equal or better quality than the standards listed above shall also be acceptable. In such a case the bidder should submit along with his offer, two copies of such standards in authentic English translation, if the language of the standard is other than English. In case of dispute, the stipulations in the English translation, submitted by the bidder, shall prevail.

Further, in the event of the conflict between the stipulations of the standard adopted by the bidder and the corresponding Indian standard specifications, the stipulation of Indian standards specification shall prevail.

#### 4.0.0 PRINCIPAL PARAMETERS:

The breakers shall conform to the specific Technical requirements specified here under:

Sl. No.	Item	Requirements		
1	Rated voltage of the breaker (KV rms)	145	72.5	36
2	Nominal system voltage (KV)	110	66	33
3	Highest system voltage (KV)	145	72.5	36
4	System frequency	←-----50 Hz -----→		
5	System Neutral grounding	←-----effectively earthed-----→		
6	Continuous current rating (A) (at site conditions)	3150	2500	1250
7	Installation (Indoor / Outdoor)	←-----Outdoor -----→		
8	Type of breaker	←-----SF6 -----→		
9	Mounting	On hot dip galvanized steel support structure or on the operating mechanism box, as the case may be, to be supplied by the bidder.		
10	Number of poles	3	3	3
11	Type of operation	Three single poles gang operated	Three single poles gang operated	Three single poles gang operated
12	Phase to phase spacing in the switchyard i.e., preferred inter pole spacing for breaker (in mm)	2000/ 2700	2000	1500
13	Required ground clearance from the lowest live part of the breaker from the ground level(mm). (If both the terminals are not in the same horizontal plane then the above mentioned heights are to be reckoned for lower terminal)	4600	4250/ 4600 for strung bus	4000
14	Height of concrete plinth above ground level (mm)	300	300	300
15	Minimum height of the lowest part of the support insulator from ground	2500	2500	2500

	level (mm)			
16	Operating mechanism	←spring operated / semi pneumatic / pneumatic refer clause 5.12 →		
17	Type of tripping	← Trip free →		
18	Auto re-closing duty	Three phase	Three phase	Three phase
19	Rated operating duty cycle	0-0.3 seconds – CO-3-minutes – CO-as per IEC-62271-100		
20	First pole to clear factor	1.5	1.5	1.5
21	Max. closing time (ms)	150	150	150
22	Max. total break time at rated breaking capacity (ms)	60	60	60
23	1.2 / 50 micro second impulse withstand voltage: i. to earth (KVP) ii. Across open contacts: (Impulse on one terminal and power frequency voltage on opposite terminal (KVP))	550 550	325 325	170 170
24	One minute power frequency withstand voltage (KV rms)	230	140	70
25	Max. radio interference voltage (micro volts)	---	---	---
26	Rated breaking current capacity: i. Line charging at rated voltage (A) ii. Small inductive current (A) iii. Cable charging at rated voltage (A) Note:- The rated cable charging breaking current for circuit breakers used for switching under ground cables shall be confirmed by the bidder  iv. Short Circuit current a) A.C Component (KA rms) b) Percentage D.C component	31.5   140   40 1sec	10   125   40 1 sec/	10   50   25 1sec  corresponding to minimum opening time as per IEC-62271-100
27	Rated short circuit making current capacity (KA peak)	100	100	62.5
28	Permissible limits of temperature	Refer clause No. 5.11.0		



	rise			
29	Max. acceptable difference in the instants of closing / opening of contacts: i. Within a pole (ms) ii. Between poles (ms)	---	---	---
		10	10	10
30	Minimum creepage distance of support insulator (mm)	3075	1815	900
31	Rating of auxiliary contact	10A at 110 Volts D.C		
32	Breaking capacity of auxiliary contacts	2A D.C with the circuit time constant not less than 20 ms.		
33	Noise level at base and up to 50 meters	140 db(max)		

### 5.0.0 Technical requirement:

#### 5.1.0 General

5.1.1 Circuit breaker offered shall be sulphur hexafluoride (SF6) type of 145KV, 72.5KV & 36KV rating. SF6 gas shall serve as the quenching medium and insulation between open contacts of the circuit breakers.

5.1.2 Similar parts of the breaker, especially the removable ones, shall be freely interchangeable without the necessity of any modification at site.

5.1.3 The circuit breaker shall comprise of three identical single pole units. For 145KV, 72.5KV & 36KV circuit breaker the type of operation shall be three single poles gang operated suitable for three pole re-closing. These units shall be linked together electrically / pneumatically / mechanically complete in all respects.

Complete circuit breaker with all the necessary items for successful operation shall be supplied, including but not limited to the following.

- a) Breaker assemblies with bases, support structures for Circuit Breaker as well as for individual control cabinet / central control cabinet and foundation bolts for main structure as well as individual control cabinet / central control cabinet (except concrete foundations), terminals and operating mechanism.
- b) Compressed SF6 gas, Pneumatic system complete including compressors, tanks, piping, fittings, valves and controls and

necessary supports for inter-pole piping for pneumatic systems.

- c) One central control cabinet for each breaker with all the required electrical devices mounted therein and the necessary terminal blocks for termination of inter-pole wiring.
- d) Instruments, gauges and other devices for SF6 gas pressure, pneumatic pressure supervision.
- e) All necessary Parts to provide a complete and operatable circuit breaker installation such as main equipment, terminal, control parts, connectors and other devices, whether specifically called for herein or not,

5.1.4 The circuit breaker shall be designed for three pole re-closing for 145KV, 72.5KV and 36KV rating with an operating sequence and timing as specified in clause 4.0 "Principal Parameters".

5.1.5 The support structure of circuit breaker and that of control cabinet shall be hot dip galvanized.

5.1.6 Circuit Breaker shall be suitable for hot line washing.

5.1.7 Facility for up-rating:  
The design of the breaker shall be such that it should be possible to up-rate the rupturing capacity of the breakers at a later date either by adding additional interrupter assemblies or parallel resistors, etc. the supplier should highlight in his offer, the special features available for up-rating the breakers offered.

5.2.0 CONTACTS:

5.2.1 All making and breaking contacts shall be sealed free from atmospheric effects. Contacts shall be designed to have adequate thermal and current carrying capacity for the duty specified and to have a life expectancy so that frequent replacements due to excessive burnings will not be necessary. Provision shall be made for rapid dissipation of heat generated by the arc on opening.

5.2.2 Main contacts shall be first to open and the last to close so that there will be little contact burning and wear. If arcing contacts are used they shall be first to close and the last to open. Tips of arcing contacts and main contacts shall be silver plated or made of superior material like graphite or tungsten alloy.

5.2.3 Any device provided for voltage grading to damp oscillations or to prevent re-strike prior to the complete interruption of the circuit or to limit over voltages on closing shall have a life expectancy comparable to that of the breaker as a whole.

- 5.2.4 Breakers shall be so designed that when operated within their specified rating, the temperature of each part will be limited to values consistent with a long life of the material used. The temperature shall not exceed that indicated in IEC-56 under specified ambient conditions.
- 5.2.5 Contacts shall be kept permanently under pressure of SF6 gas. The gap between the open contacts shall be such that it can withstand at-least the rated phase to ground voltage continuously at zero gauge pressure of SF6 gas due to its leakage.
- 5.2.6 If multi-break 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 along with the bid. The thermal and voltage withstands of the grading elements shall be adequate for the service conditions and duty specified.
- 5.2.7 The inside operating rod or insulated fiber glass connecting rods wherever used, shall be sturdy and shall not break during the entire life period of the breaker. The insulated rods shall have anti-tracking quality towards electrical stresses.
- 5.3.0 PORCELAIN HOUSING:
- 5.3.1 The porcelain housing for the interrupter shall be of a single piece construction without any joint. It shall be made of homogeneous, vitreous porcelain of high mechanical and dielectric strength. Glazing of porcelain shall be of uniform brown or dark brown colour with a smooth surface arranged to shed away rain water or condensed water particles (fog).
- 5.4.0 SUPPORT INSULATORS:
- 5.4.1 In the live type tank construction, the tank containing SF6 gas and interrupters which is at the potential of the circuit to which circuit breaker is connected when the breaker is in service, shall be insulated from earth by providing suitable support insulators.
- 5.4.2 The basic insulation level of the external insulator supports shall be 550KV for 145KV, 325KV for 72.5KV and 170KV for 36KV system and shall be suitable for installation in contaminated atmosphere. The porcelain used shall be homogenous and free from

cavities or other flaws. They shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified above. All bushings of identical ratings shall be interchangeable. The puncture strength of the bushings shall be greater than the flashover value.

The bushings shall be entirely free from radio disturbances when operating at a voltage up to 10% above rated voltage and also be free from external and internal corona.

#### 5.5.0 ADDITIONAL REQUIREMENTS:

- a) The Circuit breakers shall be single pressure type and shall utilise puffer cylinder for interrupting circuit currents. Each SF6 circuit breaker pole shall be provided with its own self obtained gas system. The design and construction of the circuit breaker shall be such that there is no possibility of gas leakage and ingress of moisture. There should not be any condensation of SF6 gas on the internal insulating surface of the circuit breaker.
- b) All gasketed surfaces shall be smooth, straight and reinforced, if necessary to minimize distortion and to make a tight seal, the operating rod connecting the operating mechanism to the arc chamber (SF6 media) shall have adequate seals, Double-O-ring seals shall be provided on each static joint.
- c) In the interrupter assembly there shall be an absorbing product box to eliminate SF6 decomposition products and moisture. The material used in the construction of the circuit breakers shall be fully compatible with SF6 gas.
- d) The SF6 gas density monitor shall be adequately temperature compensated.

The density monitor shall meet the following requirements.

- i. It should be possible to dismantle the density monitor for checking / replacement without draining the SF6 gas by using suitable interlocked non-return couplings.
  - ii. It shall damp the pressure pulsation while filling the gas in service so that the flickering of the pressure switch contacts does not take place.
  - iii. A pressure indicator shall also be supplied.
- e) **VOID**

- f) Facility shall also be provided to reduce the gas pressure within the breaker to a value not exceeding 8millibars within 4 hours or less. Each circuit breaker shall be capable of withstanding this degree of vacuum without distortion or failure of any part.
- g) Sufficient SF6 gas shall be provided to fill all the circuit breakers installed. In addition to this 20% of the total gas requirement shall be supplied as spare requirements.
- h) Provisions shall be made for attaching an operation analyzer after installation at site to record contact travel, speed and making measurement of operation timings, pre-insertion timing of closing resistor and synchronization of contacts.

#### 5.6.0 SULPHUR HEXAFLUORIDE GAS (SF6 GAS):

- a) The SF6 gas shall comply with IEC-60376, 376A AND 376B and be suitable in all respects for use in the switch gear under the worst operating conditions.
- b) The high pressure cylinders in which the SF6 gas is shipped and stored at site shall comply with requirements of the following standards and regulations :  
 IS: 4379 - Identification of the contents of industrial gas cylinders  
 IS: 7311 -Seamless high carbon steel cylinders for permanent and high pressure liquefiable gases.

The cylinders shall also meet Indian Boiler regulations.

#### 5.6.1 The SF6 gas shall have the following characteristics :

Sl. No.	Particulars	Characteristics
1.	Physical properties	Colourless. odourless, non-toxic and nonflammable
2.	Density at 20°C and 1 bar	6.08 grams/ litre
3.	Electric strength	2 ½ times that of Nitrogen
4.	Compatibility	Up to temperature of about 180°C its compatibility with material used in electrical construction shall be similar to that of Nitrogen.
5.	Toxic impurities	SF6 gas shall comply with the requirements of the test as per clause 22 of IEC : 487 – 1971.

		<p>Impurity or group permitted of impurities % by</p> <p>Maximum concentration</p> <p>Mass</p> <p>CF<sub>4</sub> 0.05%</p> <p>Oxygen + Nitrogen (Air) 0.05%</p> <p>Water 15PPm</p> <p>Acidity expressed as HF 0.3ppm</p> <p>Hydrolysable fluorides expressed as HF 1.0ppm</p> <p>Oil Content substantially free from oil</p> <p>There shall be no traces of carbon or carbon oxides what so ever in the gas.</p>
6.	Preferred size of cylinders	10 and 40 liters
7.	Test pressure of cylinder	According to gas cylinder rules 1981 and to comply with IS : 7285-1974.
8.	Maximum filling ratio for tropical country	According to gas cylinder rules 1981 and to comply with IS : 7285 – 1974
9.	<p>TESTS :</p> <p>a) Toxicity test</p> <p>b) Water content and condensation temperature</p> <p>c) Carbon tetra fluoride oxygen and nitrogen contents</p> <p>d) Hydrolysable Fluoride content.</p> <p>e) Acidity</p> <p>f) Oil content</p>	<p>Clause No.22 of IEC :60376 – 1974</p> <p>Clause Nos. 23, 24, 25 and 26 of IEC :60 376B 1974</p> <p>Clause Nos. 27, 28, 29, 30 and 31 of IEC :60 376 – 1976.</p> <p>Clause Nos. 32,33,34,35,36 and 42 of IEC : 60376 – 1976</p> <p>Clause Nos. 38, 39,40,41 and 42 of IEC :60376 –1976</p> <p>Section 13 of IEC60 376A - 1973</p>

5.6.2 The gas shall be non-flammable, nontoxic, odourless, inert and thermally stable and shall have a high specific heat to enable quick removal of the heat produced by the arc.

5.6.3 The deterioration or decomposition of the SF<sub>6</sub> gas due to arcing should be practically negligible and even when decomposed it

should recombine immediately to form the original SF6 gas within an extremely short time such as one micro-sec.

- 5.7.0
- a) SF6 breaker shall be so designed that upon loss of pressure the gap between open contacts shall be adequate to withstand at least the rated voltage at atmospheric pressure of gas.
  - b) Bidder shall clearly bring out in his offer, the precautions to be taken in the use of SF6 breaker.
  - c) Following features shall be provided for monitoring of SF6 gas in the breaker:
    - 1) SF6 gas density meter with two potential free contacts of suitable rating. One of these contacts shall be used for annunciation of low density. The other contact shall be used by the bidder to ensure breaker lockout in the event of low SF6 gas pressure. The successful bidder shall furnish a chart showing relation between pressure and density of SF6 gas, as well as settings for alarm and lockout.
    - 2) Suitable pressure gauges shall be provided for SF6 gas, pneumatic air, hydraulic oil as applicable. Gauge dials shall be clearly visible with naked eye to an observer standing on ground.
    - 3) Adequate number of pressure switches, shall be provided for monitoring pressure of SF6 gas. The pressure switches shall be provided with sufficient number of potential free NO & NC contacts for purchaser's use in control, protection and alarm circuits. Integrated pressure monitor cum density meter with inbuilt contacts for alarm and lockout.
  - d) For 145KV, 72.5KV and 36KV CB's common gas system with pressure gauge, density monitor, gas filling port with non return valve, piping between poles should be provided.

#### 5.8.0 DUTY REQUIREMENTS:

##### 5.8.1 Recovery voltage and power factor:

The circuit breaker shall be capable of interrupting rated power with recovery voltage equal to the rated maximum line to line service voltage at rated frequency and at a power factor not exceeding 0.15.

##### 5.8.2 Re-striking voltage:

- a) The circuit breaker shall be totally re-strike free under all duty conditions, opening resistors shall not be used.

- b) The measures adopted for ensuring proper operation at high rate of rise of re-striking voltage and for limiting the actual voltage values across the breakers shall be described in the tender. The type, characteristics and rating of the resistor used if any to shunt the breaker contacts and of the auxiliary switching devices used for interrupting the resistor current shall be clearly stated.

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

5.8.4 The circuit breaker shall be capable of :

- i) Interrupting the steady and transient magnetizing current of 145kV & 72.5kV class upto 20/31.5 MVA Power Transformers and 36KV class 5MVA Power Transformers.
- ii) Interrupting line charging current and cable charging current as given in Clause 4.0 "Principal parameters" of this specification.

The circuit breaker shall be designed so as to be capable of interrupting line charging and cable charging currents without undue rise in the voltage on the supply side and without any re-strike and without showing signs of undue stress. The guaranteed over voltage which will not be exceeded while interrupting the line charging current and cable charging current as specified in IEC – 62271-100 (having a time constant not less than 0.1Sec.) shall be indicated in the tender.

The over voltage caused while interrupting the above charging currents, shall preferably not exceed the designed switching over voltage specified in table IX of IEC – 62271-100.

The results of the tests along with copies of the oscillographs, conducted to prove the ability of the breakers to interrupt these and lower line charging current values shall be furnished with the tender.

- iii) Clearing short line faults:  
Clearing short line faults (Kilometric faults) with source impedance behind the bus equivalent to symmetrical fault current specified.



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

The 145/72.5 kV breaker shall have the capacity to interrupt capacitor bank of 145/72.5kV, 20/30 MVAR capacity connected back to back without exceeding the switching over voltage specified in IEC -62271-100, The breaker shall also have rated capacitor bank inrush making current as specified in IEC -62271-100.

- iv) Breaking inductive currents of 0.5 to 10A without switching over voltage exceeding 2.0 p.u. as given in clause 4.0 "Principal Parameters"
- v) The breaker shall be capable of satisfactory operation even under conditions of phase opposition that may arise due to faulty synchronizing. The maximum power which the breakers can satisfactorily interrupt under phase opposition shall be stated in the tender.

5.8.5 The critical current, which gives the longest arc duration at lock out pressure of extinguishing medium and the arc duration shall be indicated.

5.8.6 The breaker shall satisfactorily withstand the high stresses imposed on them during fault clearing, load rejection and re-energisation of lines with trapped charges. The breaker shall also withstand the voltage specified in clause 4.0 "Principal Parameters" of this specification.

5.9.0 TOTAL BREAK TIME :

5.9.1 The "Total Break Time" as specified in Clause 4.0 "Principal Parameters" of this section shall not be exceeded under any of the following duties:

- i) Basic short circuit Test duties as per IEC – 62271-100 (with TRV as per IEC – 62271-100).
- ii) Short line fault L90, L75 (with TRV as per IEC – 62271-100).

5.9.2 The Bidder may please note that there is only one specified break time of the breaker which shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, (70-110%) pneumatic / arc extinguishing medium pressure etc., while furnishing the proof for the total break time of

complete circuit breaker, the Bidder may specifically bring out the effect of non-simultaneity between contacts within a pole or between poles and show how it is covered in the guaranteed total break time.

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

#### 5.10.0 INSULATION OF CIRCUIT BREAKER:

5.10.1 The insulation to ground, the insulation between open contacts and the insulation between phases of the completely assembled circuit breaker shall be capable of withstanding satisfactorily dielectric test voltages corresponding to the basic insulation level as specified in Clause 4.0 "Principal Parameters"

5.10.2 If SF6 gas is utilized for insulating purposes across open contacts, the insulation strength of the break at the lowest permissible pressure and at atmospheric pressure shall be stated.

#### 5.11.0 LIMITS OF TEMPERATURE RISE:

The temperature rise on any part of equipment shall not exceed the maximum temperature rise specified below under the conditions specified in test clauses. The permissible temperature rise indicated is for a maximum ambient temperature of 50 deg C. If the maximum ambient temperature rises, permissible values shall be reduced accordingly.

Nature of the part of the material and of the dielectric	Maximum permissible temperature (deg. C)	Values of Temperature rise at a max. air temperature not exceeding 50deg C
1) Contacts (see note-3)		
3) Bare Copper and Bare copper alloy		
- In air	75	25
- In SF6 (Sulphur Hexafluoride)	90	40
- In oil	80	30
Silver coated or nickel coated (see note-4)		
- in air	105	55
- in SF6	105	55
- in oil	90	40
Tin coated (see note 4)		

& 5)		
- in air	90	40
- in SF6	90	40
- in oil	90	40
2. Connections, bolted or the equivalent (see note-6)		
Bare copper, bare copper alloy or Aluminum alloy		
-in air	90	40
-in SF6	105	55
-in oil	100	50.
Silver coated or nickel coated		
-in air	115	65
-in SF6	115	65
-in oil	100	50
Tin coated		
-in air	105	55
-in SF6	105	55
-in oil	100	50
3. All other contacts or connections made of bare metals or coated with other materials	See Note- 7	See Note- 7
4. Terminals for the connection to external conductors by screws or bolts(see note-8)		
-bare	90	40
-silver, nickel or tin coated	105	55
-other coatings	See Note 7	See Note 7
5. Oil for oil switching devices (See Notes 10 & 11)	90	40
6. Metal parts acting as springs	See Note 12	See Note 12
7. Material used as insulation and metal parts in contact with insulation of the following classes (See		

Note 9) -Y (for non-impregnated materials)	90	40
- A (for materials immersed in oil or impregnated )	100	50
-E	120	70
-B	130	80
-F	155	105
-Enamel : oil base	100	50
-synthetic in air	120	70
-H	180	130
-C	See Note 13	See Note 13
8. Any part of metal or insulating materials in contact with oil, except contacts.	100	50

#### NOTES :

- 1) According to its function, the same part may belong to several categories as listed in table. In this case the permissible maximum value of temperature and temperature rise to be considered are the lowest among the relevant categories.
- 2) Care shall be taken to ensure that no damage is caused to the surrounding Insulating material.
- 3) When contact parts have different coating, the permissible temperature and temperature rises shall be those of the part having the lower value permitted in table.
- 4) The quality of the coated contacts shall be such that a layer of coating material remains at the contact area :
  - a) after making and breaking test (if any):
  - b) after short time withstand current test:
  - c) after the mechanical endurance test ;

According to the relevant specification for each equipment. Otherwise, the contacts shall be regarded as "bare".
- 5) For fuse contacts, the temperature rise shall be in accordance with IEC publications on High Voltage Fuses.
- 6) When connection parts have different coatings, the permissible temperature rises shall be those of the parts having the higher value permitted in table.

- 7) When materials other than those given in table are used, their properties shall be considered, notably in order to determine the maximum permissible temperature rises.
- 8) The values of temperature and temperature rise are valid even if the conductor connected to the terminals is bare.
- 9) The following classification of insulating materials is in accordance with IEC - 85.

Class-Y: Insulation consists of materials or combinations of materials such as cotton, silk and paper when suitably impregnated. Other materials may be included in this class if by experience or accepted tests they can be shown to be capable of operation at Class-Y temperature.

Class - A: Insulation consists of materials or combinations of materials such as cotton, silk and paper when suitably impregnated or coated or when immersed in a dielectric liquid such as oil. Other materials or combination of materials may be included in this class if by experience or accepted tests they can be show to be capable of operation at Class - A temperatures.

Class - E : Insulation consists of materials which by experience or accepted tests can be shown to be capable of operation at Class - E temperatures.

Class -B : Insulation consisting of materials or combinations of materials such as mica, glass fiber, asbestos, etc., with suitable bonding substances. Other materials or combinations of materials, not necessarily inorganic, may be included in this class if by experience or accepted tests they can be shown to be capable of operation at Class - B temperatures.

Class - F : Insulation consists of materials or combinations of materials such as mica, glass fiber, asbestos with suitable bonding substances. Other materials or combinations of materials not necessarily inorganic, may be included in this class if by experience or accepted tests they can be shown to be capable of operation at Class - F temperatures.

Class - H : Insulation consists of materials such as siliconed elastomer and combination of materials such as mica, glass fiber, asbestos etc., with suitable bonding substances such as appropriate silicone resin. Other materials or combination of materials may be included in this class if by experience or by

accepted tests they can be shown to be capable of operation at Class - H temperatures.

Class - C ; Insulation consists of materials or combination of materials such as mica, porcelain, glass and quartz with or without an inorganic binder. Other materials or combinations of materials may, be included in this class if by experience or accepted tests they can be shown to be capable of operation at temperatures above the Class-H limit. Specific materials or combinations of materials in this class will have a temperature limit, which is dependent upon their physical chemical and electrical properties.

- 10) At the upper portion of the oil.
- 11) Special consideration should be given when low flash point oil is used in regard to vaporization and oxidation.
- 12) The temperature shall not reach a value where elasticity of the material is impaired.
- 13) Limited only by requirement to any damage to surrounding parts.

#### 5.12.0 OPERATING MECHANISM AND ASSOCIATED EQUIPMENTS

- 5.12.1 The circuit breaker shall be designed for electrical local as well as remote control. In addition there shall be provision for local mechanical control (emergency trip).
- 5.12.2 The operating mechanism shall be of spring charging type (both for closing and opening operation) or semi pneumatic operation type in which closing operation is of spring charging type and opening operation is by pneumatic type or pneumatic type for both opening & closing operations. The mechanism shall be adequately, designed for the specified tripping and re-closing duty. The entire operating mechanism control circuitry, individual breaker compressor unit, hydraulic pump, spring charging motor etc., as required, shall be housed in an outdoor type, steel enclosure. This enclosure shall conform to the degree of protection IP-55 of IS-2147 and shall be suitable for mounting on a separate concrete plinth.
- 5.12.3 All working parts in the mechanism shall be of corrosion resistant material. All bearings which require greasing shall be equipped with pressure grease fittings.
- 5.12.4 The design of the operating mechanism shall be such that it shall be practically maintenance free. The guaranteed number of years of maintenance free operation, the number of full load and full rated

short circuit current breaking operations without requiring any maintenance or overhauling shall be clearly stated in the tender bid. As far as possible, the need for lubricating the operating mechanism shall be kept to the minimum and eliminated altogether, if possible.

- 5.12.5 The operating mechanism shall be anti-pumping and trip free, for all method of closing operations i.e., electrical, mechanical, pneumatic, semi-pneumatic type and hydraulic type. There shall be no rebounds in the mechanism and it shall not require any critical adjustments at site. Operation of the power operated closing device, when the circuit is already closed, shall not cause damage to the circuit breaker or endanger the operator. Provision shall be made for attaching an operation analyzer to facilitate testing of breaker at site.
- 5.12.6 a) 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.
- b) All the control knobs, manual spring charge etc., shall be easily approachable. Suitable arrangement (ladder/platform) shall be made for the same. . The height of these locations should be not more than 2000 mm from ground level.
- 5.12.7 The supplier shall furnish detailed operation and maintenance manual of the mechanism along with the operation manual for the circuit breaker.
- The detailed drawing indicating all the individual parts of the breakers and control mechanism duly marking parts number shall be furnished.
- 5.12.8 SEMI - PNEUMATIC OPERATING MECHANISM:
- Pneumatic type operating mechanism for tripping and spring charging type operating mechanism for closing.
- A) Closing operation:
- i. Closing operation is made by closing spring. When the closing signal energises the closing coil, the trigger is released and the closing spring closes the breaker.

- ii. 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.  
The mechanism shall be capable of performing 5CO operations.
  - iii. The spring charging motor shall not take more than 30secs for fully charging the closing springs and provision shall be made for automatic charging of the closing springs as soon as they are discharged in a closing operation. For this, the mechanism shall be such that the charging of the springs by the motor does not interfere with the operation of the breaker.
  - iv. The motor shall be adequately rated to carryout a minimum of 5 close and open operations continuously. Also provision shall be made to protect the motor against overloads.
  - v. Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of the closing springs when the breaker is already in the closed position. Provision shall also be made to prevent a closing operation to be carried out with the spring partially charged.
  - vi. Facility shall be provided for manual charging of the closing springs.
- B) Opening operation:  
The opening operation is affected by compressed air. When the opening signal energizes the trip coil, the latch and cam are released. Control valve is opened, which allows the compressed air and pushes down the opening piston and effects opening of the circuit breaker. The opening piston is held against the spring force.
- a) Circuit breakers with pneumatic operating mechanism shall be provided with individual compressed air system with an adequate compressor motor unit, rated to meet full requirements of the respective circuit breaker.
  - b) The ICU shall be complete with air piping and accessories, all stop valves, tees, pressure reducers, etc., required for normal operation of the breaker.
  - c) The compressed air mechanism shall be capable of operating the circuit breaker under all duty conditions with air pressure immediately before operation between 85% and 105% of rated supply pressure. The make / break time at this supply pressure shall not exceed the specified make/break time written any values of trip coil supply voltage as specified.



- d) The semi - pneumatic operating mechanism shall consist of pilot or auxiliary and main valves for closing and opening operation of the circuit breaker. The pilot valves shall be suitable for operations either electrically by electrical solenoids or by local control push buttons. The accessories shall include an intake filter, stop valve, non-return valve, drain valve, breaker position indicator, auxiliary contacts, operation counter, space heater, a set of terminal blocks, etc.
- e) The operating mechanism shall also include necessary monitoring and safety interlocks such as pressure gauges with electrical alarm contacts for low/ high pressure signals, pressure switches for low pressure lock-out for closing, opening and auto re-closing operations and a safety valve. Local manual control shall not be provided. The closing and auto re-closing lock-out pressure shall be such that the breaker shall be able to open immediately after closing or re-closing operation as the case may be. Provision shall exist for both local and remote electrical operation of the breaker. The mechanism shall be provided with anti-pumping features.
- f) The compressed air stored in the local air receiver shall, at least, be sufficient to carry out 5CO operations and the charging time to restore the pressure shall be sufficiently short to complete the rated operating sequence viz., O-0.3Sec.-CO-3min-CO.
- g) Compressed Air system:
  - i) Compressed air piping shall be carried out in accordance with BS : 162.
  - ii) Compressor shall be oil less rotary type complete with drive motors.
  - iii) Compressor shall be provided with automatic adjustable un-loading device.
  - iv) Compressor shall be provided with automatic start/ stop control along with hour meter to check the running of the compressor. Supplementary manual control shall also be provided.
  - v). Compressor drive motor shall be 3 phase, full voltage direct-on-line starting, constant speed, squirrel cage induction type, rated for continuous operation in the specified climatic conditions. The motor shall be totally enclosed fan cooled type with-Class 'E' insulation. Maximum permissible temperature rise of motor shall

not exceed 65 ° C over an ambient temperature of 50° C measured by resistance.

- h) Air receivers:
  - i) Air receivers of circuit breakers shall be capable of performing the operating duties as listed against clause 20 of IEC Publication 62271-100.
  - ii) Air receivers shall have a manhole with cover for inspection and cleaning.
  - iii) Connections for air inlet and outlet, drain and relief valves on receiver shall be flanged type.
  - iv) Pressure gauge & pressure switch connection shall be of the screw type.
  - v) Accessories supplied along with the air receiver shall include but not be limited to the following :
    - a. Suitable safety valve to relieve full compressor discharge, at a set pressure equal to 1.1 times the maximum operating pressure.
    - b. Blow off valve auto drain tap with isolating and by-pass valve.
    - c. Dial type pressure gauge with isolating and drain cock and test connection and fitting for mounting on the receiver.
    - d. Isolating and drain cocks for the pressure switches.
    - e. Black flange with bolts, gasket, etc., for the test connection.
  - vi) Air receivers shall be hydro-statically tested to a pressure of 1.5 times the design pressure.
  - vii) Air receiver shall be designed in accordance with the latest edition of the ASME code for pressure vessel-section VIII of BS : 5197. A corrosion allowance of 3.0mm shall be provided for shell and dished ends. Receivers shall be coated on the inside face with antirust medium.
- i) Compressor control and compressed air piping :
  - i) Compressor control shall be of the automatic start stop type initiated by pressure switches.
  - ii) All control equipment shall be housed in a totally enclosed sheet steel cabinet. Pressure gauge and such other indicating devices shall also be mounted on the control cabinet.

- iii) In all other respect control cabinets shall be in accordance with the specification for "Control Cabinet as per Clause No. 5.23.
  - iv) All compressed air piping shall be of adequate diameter, bright annealed, seamless phosphorous, De-oxidized, non-Arsenical copper alloy or stainless steel pipe (C-106 of BS 2871- 1957).
  - v) The flow capacity of all valves shall be at least 20% greater than the total compressor capacity.
  - vi) All joints and connections in the piping system shall be brazed or flared as necessary.
- j) **Quality of Air :**  
Compressed air used shall be dry and free of dust particles. Arrangement for conditioning compressed air shall be provided as an integral part of air compressor system. Air shall condense at working pressure at a temperature of minus 10 deg. C. Measures of achieving this shall be brought out clearly in the bid. All instruments required for checking the quality of air shall be furnished as special tools along with the breakers.
- k) **Operating mechanism Housing:**  
Operating mechanism of unit compressor and all accessories shall be enclosed in a weather proof cabinet of sheet steel construction, the thickness of which shall not be less than 3mm. Hinged doors giving access to the mechanism at the front and sides shall be provided.
- Suitable space heaters shall be mounted in the housing to prevent condensation. Heaters shall be controlled by differential thermostat so that the cubicle temperature is always, maintained approximately 10 deg. C above the outside air temperature. On/Off switch and fuse shall be provided for the heaters. Heaters shall be suitable for 240 V AC single phase supply. The heater leads shall be covered with porcelain material up to sufficient length to avoid melting of insulation of the leads.

#### 5.12.9 PNEUMATIC OPERATING MECHANISM

Pneumatic operating mechanism for both closing and opening of the breaker -operations affected by compressed air. Other details are similar to the clause Nos. 5.12.8 (B) (a) to (k) above.

NOTE: In addition to the above details the Clause No. 5.23 for specification for control cabinet is applicable wherever necessary.

#### 5.12.10 SPRING OPERATING MECHANISM :

Spring charging type operating mechanism for both closing and tripping.

Closing and opening operation :

- i) Closing operation is made by closing spring. When the closing signal energises the closing coil, the trigger is released and the closing spring closes the breaker.
- ii) 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 required energy for the tripping mechanism.
- iii) The spring charging motor shall not take more than 30 secs for fully charging the closing springs and provision shall be made for automatic charging of the closing springs as soon as they are discharged in a closing operation. For this, the mechanism shall be such that the charging of the springs by the motor does not interfere with the operation of the breaker.
- iv) The motor shall be adequately rated to Carryout a minimum of 5 close and open operations continuously. Also provision shall be made to protect the motor against overloads.
- v) Mechanical interlocks shall be provided in the operating mechanism to prevent discharging of the closing springs when the breaker is already in the closed position. Provision shall also be made to prevent a closing operation to be carried out with the spring partially charged.
- vi) Facility shall be provided for manual charging of the closing springs.

#### 5.13.0 CONTROL CIRCUIT :

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

The control circuit shall include the following features

- i) Two electrically independent trip circuits including two trip coils for 110 KV, 66 KV & 33 KV breakers to operate the three poles simultaneously.
- ii) The breaker shall normally be operated by remote electrical control. Electrical tripping shall be performed by shunt trip

coils. However, provision shall be made for local electrical control. For this purpose a local / remote selector switch and close and trip push buttons shall be provided in the breaker central control cabinet. Remote located control switches and indicating lamps shall be provided in the control panel by the purchaser.

- iii) Conveniently located manual emergency trip.
- iv) Anti-pumping feature.
- v) Auxiliary switches as specified elsewhere.
- vi) Independence of trip circuit from local remote selection.
- vii) Alarms, indications, monitoring equipments and interlocks as specified elsewhere.
- viii) Trip circuit supervision for pre-trip as well as post-trip.

5.13.2 Closing coil shall operate correctly at all values of D.C voltage between 85% and 110% of the rated control voltage and shunt trip coil shall operate correctly under all operating conditions of the circuit breaker, up to the rated breaking capacity of the circuit breaker and at all values of D.C. control voltage between 70-110% of rated voltage.

5.13.3 To safeguard against the failure of D.C. supply for control circuits, the capacitor tripping device shall be provided. In case of D.C. supply failure the capacitor shall automatically discharge its energy through the trip coil causing it to operate and trip, the breaker, except when the breaker is in lockout condition due to low SF6 gas pressure.

5.13.4 A separate cabinet shall be provided for housing operating mechanism and control circuitry. These control cabinets shall meet the requirements specified in clause No. 5.23.

5.13.5 The tenderer shall furnish along with the tender bid, detailed schematic drawings showing all types of control, protection, monitoring schemes to be employed by the tenderer. The successful tenderer shall be required to modify the schemes, if necessary, after discussions with the purchaser.

5.13.6 Auxiliary switches:

Each operating mechanism of the circuit breaker shall be provided with Cam / Snap type auxiliary switches with ten (10) normally open and ten (10) normally closed contacts (10NO+10NC) contacts for each breaker for 145KV, 72.5KV & 33KV rating, exclusively for the purchaser's use with continuous current rating of 16A DC.

Breaking capacity of the contacts shall be minimum 5A with circuit time constant less than 20 milliseconds at the rated DC voltage. Normal position of auxiliary switches refers to contact position when circuit breaker is open. There shall be provision to add more auxiliary switches at a later date if required. Additional contacts required for pole discrepancy relay etc., should be provided separately. The make of auxiliary switches shall be preferably of Siemens, Crompton Greaves Limited, L&T and Alsthom make.

#### 5.13.7 Alarms and Indications:

Potential free contacts shall be provided, duly wired up to the operating mechanism housing / control cabinet for the following alarms and indications to be provided by the purchaser **both** on his control panels and **SCADA**. To cater to this requirement, sufficient number of potential free contacts shall be provided.

a) Alarms :

- i) General lockout for SF6 gas / air / oil / Nitrogen gas.
- ii) Low pressure of SF6 gas / low oil level.
- iii) Auxiliary AC / DC supply failure.
- vi) Low operating air pressure.
- vii) Low operating nitrogen / gas pressure.

b) Indication :

- i) Breaker on / off
- ii) Spring charged

c) Mechanical Indication:

The operating mechanism housing shall be provided with the following mechanical indication / counters

- i) Breaker on / off.
- ii) Operation counter to register the number of breaker operations.

#### 5.13.8 INTERLOCKS:

It is proposed to electrically interlock the circuit breaker with Purchaser's air break isolating switches in the switchyard in accordance with switchyard safety interlocking scheme. The details of the scheme shall be furnished to the successful bidder. The requirement of auxiliary contacts to be provided in breaker operating mechanism for successful operation of the scheme has been specified in clause 5.13.6.

#### 5.14.0 MOUNTING:

- 5.14.1 The design and supply of support structure, required for mounting the circuit breaker in Purchaser's switchyard, shall be in the bidder's scope. The bidder's scope shall also include foundation bolts, nuts, plain washers, spring washers etc., necessary for the support structure. The support structure can be lattice type or tubular type and shall be made out of hot dip galvanised steel. Wheel mounted type support shall not be accepted. The support structure shall be installed on a concrete plinth of 300mm height to be arranged by the Purchaser. The foundation plan for the breakers have been furnished in the bid document. The mounting structures are to be designed suitable to foundation plans furnished. The height of the support structure shall meet the following requirements.
- i) Vertical clearance of lowest live part as specified in clause 5.21.4.
  - ii) Minimum height of 2200mm above the top of concrete plinth (This is a statutory regulation).
- 5.14.2 The circuit breaker shall be connected to adjacent equipment in the switchyard through ACSR conductor. The maximum unsupported length of conductor on both sides of the Circuit Breaker is 10mtrs.
- 5.14.3 The loading data to be considered by the bidder for design of support structure shall include the following:
- i. Dead weight of the circuit breaker, structure, Bus bars.
  - ii. Operational steady state and impact loading.
  - iii. Wind load on a circuit breaker, structure, Bus bars.
  - iv. Short circuit forces.
- The support structure shall be designed on the basis of applicable Indian / International standards and codes of practice.
- 5.14.4 The foundation drilling plan shall be exactly in line with the details given in annexure. This is intended to ensure voltage class wise common foundation for circuit breaker irrespective of its make.
- 5.15.0 FITTINGS AND ACCESSORIES:
- 5.15.1 Following is a partial list of some of the major fittings and accessories to be furnished by supplier in the central control cabinet. Number and exact location of these parts shall be indicated in the bid

- a) Central control cabinet in accordance with clause No.5.23 complete with
  - i) Cable glands.
  - ii) Local / remote changeover switch
  - iii) Operation counter
  - iv) Pneumatic / pressure gauges.
  - v) Control switches to cut off control power supply.
  - vi) MCB's / Fuses as required.
  - vii) The number of terminals provided shall be adequate enough to wire out all contacts and control circuits plus 24 terminals spare for owner's use.
- b) Anti - pumping relay or anti - pumping contactor.
- c) Rating and diagram plate in accordance with IEC incorporating year of manufacture.

5.15.2 Additional fittings for pneumatic & semi - pneumatically operated circuit breaker:

- a) Unit compressed air system in accordance with Clause No. 5.12.8 (g).
- b) Breaker local air receivers.
- c) Pressure gauge spring loaded safety valve, pressure switch with adjustable contacts and explosion vents.
- d) Pressure switch to initiate an alarm if the pressure in the auxiliary reservoir remains below a preset level for longer than it is normally necessary to refill the reservoir.
- e) Stop, non-return and other control valves, piping and all accessories up to breaker mechanism housing.

5.16.0 PAINTING:

- 5.16.1 All metal sheet surfaces exposed to atmosphere shall be given two primer coats of zinc phosphate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped or otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limits specified. The paints shall be gray shade No. 631 of IS-5. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.



- 5.16.2 Paint inside the metallic housing shall be of anti-condensation type and the paint on outside surfaces shall be suitable for outdoor installation.
- 5.16.3 All components shall be given adequate treatment of climate proofing as per IS : 3202 as to withstand corrosive and severe service condition.
- 5.17.0 GALVANISING:  
All ferrous parts including nuts, bolts, plain and spring washers of size M10 and above, support channels, structures, etc., shall be hot dip galvanized to conform to latest version of IS : 2629 or any other equivalent authoritative standard. All other fixing nuts, bolts, washers of size below M10 shall be electro galvanized.
- 5.18.0 EARTHING:  
The operating mechanism housing, dead tank, support structures etc., shall be provided with two separate earthing terminals for bolted connection to 50x8mm GI flat to be provided by the purchaser for connection to station earth mat. The connecting point shall be marked with "Earth" symbol No. 86 of IEC publication 117-1 Part - I
- 5.19.0 NAME AND RATING PLATE:
- 5.19.1 Circuit breaker and its operating device shall be provided with rating plate/s made out of Anodized Aluminum, marked with the following data. The data shall be either punched or engraved on the plate/s.
- Manufacturer's name or trade mark by which he may be readily identified.
  - Serial number and type designation of CB operating mechanism.
  - Year of manufacture.
  - Rated Voltage.
  - Rated Lightning impulse withstand voltage.
  - Rated Normal current.
  - Rated short circuit breaking current.
  - Rated Duration of short circuit.
  - Mass of circuit breaker with support structure.
  - Rated Auxiliary D.C. supply voltage of closing and opening devices.
  - Rated pressure of compressed air/ gas.
  - Rated out of phase breaking current.
  - Rated A.C. supply voltage of auxiliary circuits.

- n) Rated Insulation level.
- o) Rated Frequency.
- p) Rated line charging breaking current and cable charging breaking current for EHV CBs.
- q) Purchase Order reference.
- r) Rated Operating sequence.
- s) Weight of SF6 gas per pole / breaker.

The ratings plates shall be installed in such positions that the same are clearly visible to a man standing on ground.

5.19.2 Schematic diagram plate indicating the control circuit scheme shall be provided. The diagram plate shall be of Anodised Aluminium plate and shall be installed in such a position that the same is clearly visible to a man standing on ground.

5.20.0 The coils of operating devices shall be marked clearly with the catalogue number / reference number as indicated in control wiring diagram.

5.21.0 TAKE OFF TERMINAL PADS:

5.21.1 Terminal pads shall be provided with silver plating of the least 25 microns thickness if these are made of metal other than Aluminum. No such plating shall be required if the terminal pad is made out of Aluminum. The pads shall be suitably designed to take the approximate terminal loads, specified below.

5.21.2 The breaker shall be designed to withstand the rated terminal load, wind load / Earth quake load and short circuit forces. The short circuit forces to be considered for the design shall be based on length of bus bars consisting of conductors and phase to phase spacing shown below.

Voltage	Jumper length in mtrs.	Size of ACSR conductor	Phase to phase spacing in mts.
			110 / 66 / 33KV Stations
145 KV	Max. 10 M	Drake	2.00/2.70
72.5 KV	Max. 10 M	Drake / Twin Drake	2.00
36 KV	Max.10 M	Drake / Lynx	1.50

5.21.3 The current density adopted for the design of the terminal pad shall in no case exceed 1.6A/sq. mm for copper pad and 1.0A/sq. mm for pad made of other material.

5.21.4 The vertical clearance of lowest live part of the breaker (i.e., not the center of the terminal pad) from ground level (including concrete foundation plinth) shall be as given below. In no case the height less than that indicated will be accepted.

145 KV Breaker - 4600 mm.

72.5 KV Breaker - 4250 mm for Rigid bus/4600mm for strung bus

36 KV Breaker - 4000 mm

#### 5.22.0 TERMINAL CONNECTORS:

5.22.1 The terminal connectors required for connecting circuit breaker to other equipments for mounting on aforesaid terminal pad shall meet the following requirements.

- a) Terminal connectors shall be manufactured and tested as per IS: 5561.
- b) All castings shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- c) Pad part of a clamp shall not be less than 10mm thick
- d) All ferrous parts shall be hot dip galvanized conforming to IS: 2633.
- e) For bimetallic connectors, copper alloy liner of minimum thickness of 2mm shall be cast integral with Aluminum body. Current density adopted for design of pad shall be 1.6A / 1A per sq. mm for copper / Aluminum respectively.
- f) Flexible connectors shall be made from tinned copper.
- g) All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- h) Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS : 5561.
- i) Terminal connectors shall be suitable for receiving ACSR conductors as detailed in Clause No. 5.21.2.

#### 5.23.0 CONTROL CABINETS:

The Control cabinet shall conform to the following requirement.

- a) Control cabinets shall be free standing floor mounting type.
- b) Control cabinets shall be sheet steel enclosed and shall be dust, water and vermin proof. Control cabinets of the

operating mechanism shall be made out of 4mm HR thick sheet steel or equivalent CR sheet steel (3mm thick for load bearing members and 2mm thick non load bearing members) or 10mm thick aluminum plate or casting. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. Control cabinets shall be provided with double hinged door and padlocking arrangement. The door shall be provided with handle for opening / closing. The door hinges shall be of union joint type to facilitate easy removal and the distance between hinges shall not exceed 350mm. Door shall be properly braced to prevent wobbling. Sloping rain-hood shall be provided to cover all sides. 15mm thick neoprene or better type of gaskets shall be provided to ensure degree of protection of at least IP : 55 as per IS 2147.

- c) Equipment and devices shall be suitable for operation on specified auxiliary AC / DC supply system.
- d) Motors rated 1KW and above being controlled from the control cabinet would be suitable for operation on a 415V, 3 phase, 50Hz system. Fractional KW motors would be suitable for operation on a 240V, single phase, 50Hz AC supply system.
- e) Push button shall be rated for not less than 16Amps, 415Volts AC or 5Amp, 230V / 110V DC with 2 NO + 2 NC contacts and shall be flush mounted on the cabinet door and provided with appropriate name plates.
- f) For motors up to 5KW, contactors shall be direct-on-line, air break, single throw type and shall be suitable for making and breaking the stalled current of the associated motor which shall be assumed equal to 6.5times the full load current of the motor at 0.2 p.f. For motors above 5KW, automatic star delta type starters shall be provided. 3 pole contactors shall be furnished for 3 phase motors and 2 pole contactors for single phase motors. Reversing contactors shall be provided with electrical interlocks between forward and reverse contactors. If possible, mechanical interlocks shall also be provided. Contactors shall be suitable for uninterrupted duty and shall be of duty category class AC4 as defined in IS : 2959. The main contacts of the contactors shall be silver-plated and the insulation class for the coils shall be class E or better.

The dropout Voltage of the contactors shall not exceed 70% of the rated voltage.

- g) Contactor shall be provided with a three element, positive acting ambient temperature compensated, time lagged, hand reset type thermal over load relay with adjustable setting. Hand reset button shall be flush with the front door of the cabinet and suitable for resetting with starter compartment door closed.
- h) Single phasing preventor relay shall be provided for 3 phase motor, to provide positive protection against single phasing.
- i) Mini starters shall be provided with no volt coils when required.
- j) Power cables will be of 1100 volt grade, standard copper conductor, PVC insulated, PVC sheathed single steel wire armoured and PVC jacketed. All necessary cable terminating accessories such as glands, crimp type tinned copper lugs etc. for power as well as control cables shall be included in bidder's scope of supply. Suitable brass cable glands shall be provided for cable entry.
- k) Wiring for all control circuits shall be carried out with 1100 Volts grade PVC insulated tinned copper stranded conductors of sizes not smaller than 2.5sq. mm. At least 10% spare terminal blocks for control wire terminations shall be provided on each panel. The terminal blocks shall be of non-disconnecting stud type. All terminals shall be provided with ferrules indelibly marked or numbered and these identifications shall correspond to the designations on the relevant wiring diagrams. The terminals shall be rated for adequate capacity, which shall not be less than 10 Amps. Terminals for receiving purchaser's cables should be marked or numbered.
- l) Control cabinet shall be provided with 240V, 1 phase, 50Hz, 20W fluorescent lighting fixture with On / Off switch and 240V, 1 phase, 15Amp, 3 pin socket for hand lamp, with electrical & mechanical cover with chain.
- m) Suitable strip heaters shall be provided inside cabinet with thermostat to prevent moisture condensation. Heaters shall be controlled by suitable toggle switch of industrial quality.
- n) All AC control equipment shall be suitable for operation on 240V, 1 phase, 2 wire, 50Hz system.
- o) Items inside the cabinet made of organic material shall be coated with a fungus resistant varnish.

6.0.0 TESTS :

6.1.0 Type Tests :

6.1.1 The Circuit Breakers offered shall be fully type tested as per the relevant standards.

Type tested Circuit Breakers shall be offered. The type test reports shall not be older than ten (10) years as on the last date of submission of bid.

**a) For Circuit Breakers manufactured in India:**

- i. Type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by Government or accredited by National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.
- ii. Type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.
- iii. The type tests conducted in-house by manufacturers shall also be acceptable provided the lab (manufacturer's) is accredited by National accreditation body of the country and the tests have been witnessed by a representative of NABL accredited Independent laboratory/Power utility.

**b) For Circuit Breakers manufactured Abroad:**

- i. Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National accreditation body of respective country.
- ii. Type tests conducted in-house by manufacturers shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests have been witnessed by a representative of accreditation body/Power utility.

6.1.2 The following constitute the type tests :

- 1) Short circuit Current making and breaking tests including terminal fault tests-Cl.No.6.102 to 6.106 of IEC-62271-100.  
(Basic short Circuit duties-Cl.No.6.106)
- 2) Short Line fault tests-Cl.No.6.109 of IEC 62271-100

- 3) Capacitive current switching tests Cl.No.6.111 of IEC 62271-100.
- 4) Small inductive current tests
- 5) Short time with stand current and peak withstand current tests- Cl.No.6.6 of IEC 62271-100.
- 6) Mechanical endurance tests.
- 7) Dry power frequency test.
- 8) Wet power frequency test.
- 9) Lightning impulse test,
- 10) Temperature rise test.

6.1.3 The following additional type tests are proposed to be conducted. The type test charges for these tests shall be quoted along with other type tests as per IEC -62271 -100 in the relevant schedule and the same shall be included in the total bid price.

- i) Corona extinction voltage test
- ii) Out of phase closing test as per IEC-60267 and IEC-62271
- iii) Line charging breaking current test as per IEC -62271
- iv) Cable charging breaking current as per IEC-62271
- v) Seismic withstand test in un-pressurized condition

#### 6.2.0 ACCEPTANCE AND ROUTINE TESTS:

6.2.1 All acceptance and routine tests as stipulated in IEC -62271 shall be carried out by the supplier in the presence of Purchaser's representative.

The following constitute routine tests:

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

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

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 re-closing and trip-free operation under normal as well as limiting operating conditions (control voltage pneumatic pressure etc.). The tests shall show the speed of contacts directly at 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 analyzer along with necessary transducers, cables, console, etc., should be arranged by the bidder.

- 6.2.3 Immediately after finalization of the Programme of type/ acceptance / routine testing, the supplier shall give sufficient advance intimation to the purchaser to enable him to depute his representative for witnessing the tests.

#### 6.3.0 ADDITIONAL TESTS

The purchaser reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier / laboratory or at any other recognized laboratory / research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the purchaser to satisfy that the material complies with the intent of this specification.

#### 7.0.0 INSPECTION:

- 7.1.0 The inspection may be carried out by the Purchaser or his representative at any stage of manufacture. The successful tenderer shall grant free access to the purchaser's representative/s at a reasonable notice when the work is in progress. Inspection and acceptance of any equipment under this specification by the purchaser shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

- 7.2.0 The supplier shall keep the purchaser informed in advance, about the manufacturing Programme so that arrangement can be made for stage inspection.

- 7.3.0 The purchaser reserves the right to insist for witnessing the acceptance/routine testing of the bought out items. The supplier shall keep the purchaser informed in advance, about such testing programme.

- 7.4.0 No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested unless the same is waived by the purchaser in writing.

#### 8.0.0 QUALITY ASSURANCE PLAN :

- 8.1.0 The tenderer shall invariably furnish following information along with his offer, failing which his offer shall be liable for rejection.



Information shall be separately given for individual type and voltage rating of circuit breaker :

- i) Statement giving list of important raw materials, including but not limited to
  - a) Contact Material
  - b) Insulation
  - c) Porcelain
  - d) Oil
  - e) Sealing Material
  - f) Contactor, limit switches etc., in control cabinet.Names of sub-suppliers for the raw materials, list of standards according to which the raw-materials are tested, list of test normally carried out on raw materials in presence of purchaser's/tenderer's representative, copies of test certificates.
- ii) Information and copies of test certificates as in (i) above in respect of bought out accessories.
- iii) List of areas in manufacturing process, where stage inspections are normally carried out by the purchaser / tenderer for quality control and details of such tests and inspections.
- iv) Special features provided in the equipment to make it maintenance free.
- v) List of testing equipment available with the bidder for final testing of breakers vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. The limitations in testing facilities shall be very clearly brought out in the relevant schedule i.e., schedule of deviations from specified test requirements.

8.2.0 The successful tenderer shall, within 30 days of placement of order, submit following information to the purchaser.

- i) List of raw-materials as well as bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
- ii) Type test certificates of the raw-material and bought out accessories.
- ii) Quality assurance plan (QAP) with hold points for purchaser's inspection. The quality assurance plan and purchaser hold points shall be discussed between the purchaser and supplier before the QAP is finalised.

- 8.3.0 The supplier shall submit the routine test certificate of bought out items and raw-material, at the time of routine testing of the fully assembled breaker.
- 9.0.0 DOCUMENTATION AND DRAWINGS :
- 9.1.0 Documentation:  
All drawings shall conform to relevant international standard organization (ISO) specification. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in System International Units.
- 9.2.0 Drawings:  
The Tenderer shall furnish four sets of relevant descriptive and illustrative published literature/pamphlets and the following drawings/documents for preliminary study.
- a) General outline drawings showing outside dimensions, shipping dimensions, weights, quantity of insulating media, air receiver capacity and such other prominent details.
  - b) Sectional views showing the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts, with lifting dimensions for maintenance.
  - c) Schematic diagrams of the scheme for control, supervision and re-closing.
  - d) Structural drawing, design calculations and loading data for support structures.
  - e) Foundation drilling plan and loading data for foundation design.
  - f) Type test reports of circuit breakers.
  - g) Test reports, literature and pamphlets of bought out items and raw materials.
  - h) Guaranteed technical particulars of circuit breakers.
- 9.3.0 The supplier shall, within two weeks of placement of order, submit four sets of final versions of all the above said drawings/documents for purchaser's approval. The purchaser shall communicate his comments/approval on the drawings/documents to the supplier within reasonable period. The supplier shall, if necessary, modify the drawings/documents and resubmit four copies of the modified drawings for purchaser's approval within two weeks from the date of purchaser's comments. After receipt of purchaser's approval, the supplier shall, within three weeks, submit 20 prints duly laminated and two good quality reproducible of the approved drawings.
- 9.4.0 The supplier shall furnish twenty copies of bound manual covering erection, commissioning, operation and maintenance instructions

and all relevant information and drawings pertaining to the main equipment as well as auxiliary devices. Marked erection drawings shall identify the component parts of the equipment as shipped to enable Engineer/Purchaser to carryout erection with his own personnel. Each manual shall also contain one set of all the approved drawings, type test reports and as well as acceptance test reports to corresponding consignment dispatched.

9.5.0 The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the supplier's risk.

9.6.0 Approval of drawings/documents/work by the purchaser shall not relieve the supplier of any of his responsibility and liability for ensuring correctness and correct interpretation of the drawings/documents for meeting the requirements of the latest revisions of applicable standards, rules and codes of practices.

#### 10.0.0 TEST REPORTS:

- i) Four copies of type test reports shall be furnished to the purchaser within one month of conducting the tests. One copy will be returned duly certified by the purchaser to the supplier within three weeks thereafter and on receipt of the same, supplier shall commence with the commercial production of the concerned material.
- ii) Four copies of acceptance test reports shall be furnished the purchaser. One copy will be returned, duly certified by the purchaser and only there afterwards shall the material be dispatched.
- iii) All works of routine test reports shall be maintained by the supplier at his works for periodic inspection by the purchaser.
- iv) All test reports of tests conducted during manufacture shall be maintained by the supplier. These shall be produced for verification as and when requested for by the purchaser.

#### 11.0.0 PACKING AND FORWARDING:

11.1.0 The equipment shall be packed in crates suitable for vertical/horizontal transport as the case may be and suitable to withstand handling during transport and outdoor storage during transit. The supplier shall be responsible for any damage to the

equipment during transit, due to improper and inadequate packing. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

11.2.0 Each consignment shall be accompanied by a detailed packing list containing the following information:

- a. Name of the consignee.
- b. Details of consignment.
- c. Destination.
- d. Total weight of consignment.
- e. Sign showing upper/lower side of the crate.
- f. Handling and unpacking instructions.
- g. Bill of materials indicating contents of each package and spare materials.

The supplier shall ensure that the packing list and bill of materials are approved by the purchaser before dispatch.

12.0.0 SUPERVISION OF ERECTION, TESTING AND COMMISSIONING (ET&C):

The erection, testing and commissioning of the breakers shall be supervised, by trained personnel (Engineer) of the supplier who shall direct the sequence of ET&C at no extra cost to KPTCL and make the necessary adjustments to the apparatus and correct in the field any errors or omissions in order to make the equipment and material properly perform in accordance with the intent of this specification. The Engineer shall also instruct the Plant Operators in the operation and maintenance of equipment supplied. The supplier shall be responsible for any damage to the equipment, on commissioning the same, if such damage results from faulty or improper ET&C procedure. Purchaser shall provide adequate number of skilled/semi-skilled workers as well as all ordinary tools and equipment and cranes required for breaker erection, at his own expense. Apart from the above, purchaser shall not be responsible for any other expenses incurred by the supplier and expenses such as Engineer's salary, insurance against personal injuries to Engineer etc., shall be to supplier's account. Special tools, if

required for erection and commissioning shall be arranged by the supplier at his cost and on commissioning these shall be supplied to the Purchaser, free of cost, for future use.

#### 13.0.0 TRAINING OF ENGINEERS:

13.1.0 The successful tenderer shall be required to provide facilities for in-plant training at no extra cost to the purchaser to at least 8 engineers to be nominated by the purchaser for a period of one week (i.e., 4 man weeks) at his works, where the equipment's offered shall be manufactured. The scope of the training shall cover assembly, factory testing, site testing, periodical maintenance, operation and troubleshooting of the breakers.

13.2.0 The period and the programme of the training (generally for one week) shall be mutually discussed and finalized by the purchaser with the supplier/s.

13.3.0 To and fro travel expenses, lodging and boarding charges as well as allowances for out of pocket expenses in respect of trainees, shall be borne by the purchaser. However, the supplier shall provide for suitable facilities for lodging as well as to and fro transport to place of training.

#### 14.0.0 RECOMENDED SPARES:

The tenderer shall furnish in his offer, a list of recommended spares with unit rates for each circuit breaker that may be necessary for satisfactory operation and maintenance of the circuit breaker for a period of 5 years. The Purchaser reserves the right of selection of items and quantities of these spares to be ordered. The cost of such spares shall not be considered for tender evaluation. The unit prices should be valid for two years from the date of issue of detail A/T.

#### SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS

	<b>Bidder's Name</b>	
	<b>Circuit Breaker Rating</b>	
1	General	
	a. Name of the Manufacturer	
	b. Country of Manufacture	

	c. Type of Circuit Breaker	
	d. Manufacturer's type designation	
	e. Standard Applicable	
	f. Rated Voltage (kV ms)	
	g. Rated Current :	
	i. Under normal condition (A)	
	ii. Under site conditions (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 (kA)	
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 up to rated breaking current with limiting conditions of voltage and pressure (ms)	
	ii. Rated breaking time (ms)	
	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 voltage and pressure (ms)	
	h. First pole to clear rating	
	i. Short time current rating (kA) for 1 Sec.	
	j. Rated operating duty	
	k. Maximum breaking 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 up to 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. Small fault current breaking capacity (kAp)	
	s. Pre-insertion resistor (if applicable)	
	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 time setting.	
	iv. Thermal rating for the same duty as (iii) above for reclosing against trapped charges.	
	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)	
	z. Data of restriking voltage	
	i. Amplitude factor	
	ii. Phase factor	
	iii. Natural frequency	
	iv. Rate of rise of restriking voltage	
3	Dielectric withstand of complete breaker	
	a. One minute dry & wet power frequency withstand voltage	
	i. Between live terminal and ground (kV rms)	
	ii. Between terminals with breaker contacts open (kV ms)	
	b. 1.2/50 micro impulse withstand test voltage	
	i. Between live terminals and ground (kVp)	
	ii. Between terminals with breaker contacts open (kVp)	
	c. Corona extinction voltage (kV rms)	
	d. Maximum radio interference voltage (micro V) at $1.1 U_r/\sqrt{3}$	
	e. 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	
	i. Trip coil	
	ii. Closing coil	
4.1	Pneumatic operating mechanism	
	a. Rated operating pressure (kg/sq.cm)	
	b. Range of pressure for (kg/sq.cm)	



	i. Closing	
	ii. Opening	
	c. Air Consumption at rated pressure for	
	i. Closing (m3)	
	ii. Opening (m3)	
	iii. Close-open (m3)	
	d. Pressure drop/meter length of piping	
	e. Number and Capacity (m3) of breaker local air storage receivers	
	f. No. of close operations for which sufficient air is available in local receiver	
	g. Capacity of compressor (m3/hr) and working pressure (kg/cm2)	
	h. Maximum time for which compressor can operate continuously (min)	
	i. Time to fill	
	i. Air receiver after one CO operation (min)	
	ii. For making up of losses occurring in hours (min)	
	j. Pressure at which compressor	
	i. Starts (kg/cm2)	
	ii. Stops (kg/cm2)	
	k. Material of compressed air piping	
	l. Inner & outer dia of main piping (mm)	
	m. Whether interpolate piping included in scope of supply	
	n. Manufacturer's name for	
	i. Compressor	
	ii. Air receiver	
	iii. Pressure reducer	
	iv. Stop valves	
	v. Drain valves	
	o. Safety valve	
	i. Low pressure stage blow off at (kg/cm2)	
	ii. Intermediate stage blow off at (kg/cm2)	
	iii. High pressure stage blow off at (kg/cm2)	
	p. Safety valve opens at (kg/cm2)	
	q. No.of stored CO operation in breaker air	

	receiver	
	r. Alarm switch closes on air receiver at (kg/cm <sup>2</sup> )	
	s. Lockout pressure (kg/cm <sup>2</sup> )	
	i. Closing	
	ii. Opening	
	iii. Auto reclose	
4.2	Hydraulic operating mechanism	
	a. Rated pressure of oil in operating cylinder (Kg/cm <sup>2</sup> )	
	b. Limits for pressure (Kg/cm <sup>2</sup> )	
	c. Quantity of oil (liter)	
	d. Details of arrangements to prevent change of position of breaker in the event of loss of hydraulic pressure.	
	e. Details of monitoring arrangement for hydraulic pressure.	
	f. No. of close -open operations possible after loss of AC supply to drive motor.	
	g. Details of hand pump set provided for emergency operation.	
	h. Pressure drop starting from lowest pressure at which motor starts for	
	i. C – operation	
	ii. O - operation	
	iii. CO - operation	
	iv. O - CO - operation	
	v. 2 - CO - operation	
	i. Time required to make up pressure upto loss of nitrogen pressure after	
	i. C – operation	
	ii. O - operation	
	iii. CO - operation	
	iv. O - CO - operation	
	v. 2 - CO - operation	
4.3	Spring charged mechanism	
	a. Number of close open operations possible after failure of AC supply to motor.	
	b. Time required for motor to charge the closing spring (min).	

	c. Whether indication of spring charged condition provided in central control cabinet.	
5	<b>Type of Breakers</b>	
5.1	SF6 Circuit Breakers :	
	a. Quantity of SF6 per pole (m3) at rated pressure.	
	b. Guaranteed maximum leakage rate per year.	
	c. Rated pressure of SF6 in operating chamber (kg/cm2).	
	d. Limits of pressure at which breaker operate correctly (kg/cm2)	
	e. Standard to which SF6 gas complies.	
	f. Whether 20% spare SF6 gas. Stored in unused gas cylinders, included in proposal.	
	g. Capacity & filling ratio of containers in which SF6 gas would be shipped (m3) and the corresponding pressure (kg/cm2)	
	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 and satisfactory operation.	
	i. Density	
	ii. Dielectric strength kV/mm	
	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/cm <sup>2</sup> )	
	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. Over voltage withstand capability of grading components (kV rms)	
	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 conform	
	s. Whether foundation bolts for breakers and cabinets included in scope of supply	
7	Detailed Literature	
	a. Whether the following are enclosed.	
	i. Type test reports as per IEC-56	
	ii. Factory test report and/or field test report incase of reactor switching duty	
	iii. Details of operating mechanism	
	iv. Drawing of breaker of support structure.	

	v. Calculations for compressed air plant sizing	
	vi. Details of SF6 gas filling, evacuating and testing plant	
	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 along with calculation for thermal rating of closing resistors.	
	xi. Whether drawings showing contacts in close, arc initiation, full arcing, arc extinction and open position enclosed	
	xii. Method of checking of Voltage distribution devices at site enclosed	
	xiii. Details along with 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. Effects of non simultaneity between contacts 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 interruptor 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 and pneumatic/hydraulic pressure.	
	xviii. All duty requirements specified along with adequate test reports.	
	<b>CIRCUIT BREAKER - CONTROL CABINETS</b> :	
1	Manufacturer's Name	
2	Indoor/Outdoor application	
3	Design ambient air temperature (°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. Manufacturer's 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/Stranded	
	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 opening, 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 degree of protection enclosed	
16	Details of terminal rows:	
	i. Whether arranged vertical or horizontal	
	ii. Clearance from adjacent components.	
	iii. Distance between rows.	
	iv. Whether transparent protection cover provided.	
	<b>CIRCUIT BREAKERS - TERMINAL CLAMPS AND CONNECTORS</b>	
1	Manufacturer's Name	
2	Applicable Standards	
3	Type	
4	Material of connector	
	a. Clamp body	
	b. Bolts & Nuts	
	c. Spring Washers	
5	Rated Current	
6	a. Rated terminal load (kg)	
	b. Factor of Safety	
7	Minimum thickness of any part (mm)	
8	Weight of clamp complete with hardware (kg)	
9	Type test reports as per IS enclosed	
10	OGA drawing enclosed.	
	<b>CIRCUIT BREAKERS - BUSHING/SUPPORT INSULATOR :</b>	
1	Manufacturer's Name	
2	Type	
3	Applicable Standards	
4	i. Height	
	ii. Diameter (Top)	
	iii. Diameter (Bottom)	
5	Total creepage distance (mm)	
6	Rated voltage (kV)	
7	Power frequency withstand voltage for 1 minute (kVrms) dry and wet	
8	1.2/50 micro sec. impulse withstand voltage	



	(kVp)	
9	250/2500 micro sec. switching impulse withstand voltage (kV p) dry and wet	
10	Corona Extinction voltage (k V)	
11	Weight (kg)	
12	Maximum allowable span (mm)	
13	Cantilever Strength (kg)	
14	OGA drawing enclosed.	
	<b>Motors</b>	
1	Manufacturer's Name & address	
2	Equipment driven by motor	
3	Motor type	
4	Country of origin	
5	Frame size	
6	Type of duty	
7	Type of enclosure and method of cooling	
8	Applicable standard to which motor generally conforms	
9	Type of mounting	
10	Direction of rotation as viewed from non-driving end	
11	Standard continuous rating at 40 deg. C ambient temperature as per Indian Standard (KW)	
12	Derated rating for specified Normal condition ie., 50 deg. C ambient temperature (KW)	
13	Rated Voltage (V)	
14	Rated speed at rated voltage and frequency(rpm)	
15	Full load current at rated voltage and frequency (A)	
16	Power factor at rated load	
17	Efficiency of motor at rated voltage and frequency (with out any tolerance) at	
i.	Density duty point(%)	
ii.	100% of full load (%)	
18	Starting current (Amps) at	
i.	100% Voltage	
ii.	85% Voltage	
19	Torques at	

	a) Starting (Kg-Metre)	
	b) Pull up (Kg-Metre)	
	c) Pull Out(Kg-Metre)	
20	Stator winding Insulation	
	i) Class & type	
	ii) Tropicalised	
	iii) Temperature rise over specified ambient of 50 deg. C ( deg. C)	
	iv) Method of temperature measurement	
21	Stator winding connector	
22	Number of star terminals brought out	
23	Type of terminal box for stator leads	
24	Bearing type	
	i. Driving End	
	ii. Non Driving End	
25	Type of Construction of Rotor	
26	Weight of Motor	
	i. Stator (Kg.)	
	ii. Rotor (Kg.)	
	iii. Total Weight (Kg.)	
27	Type Test Report Enclosed	