

MATERIAL SPECIFICATION CELL

TECHNICAL SPECIFICATION

OF

22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH
DOUBLE STAR ARRANGEMENT & ASSOCIATED
EQUIPMENTS IN 33/22KV SUBSTATIONS

INDEX

Sr.No	Particulars	Page No
1.	Scope	3
2.	Service Conditions	4
3.	Operating Conditions	5
4.	Standards	5
5.	Principle Technical Parameters	5
6.	General Technical Requirements	5
7.	Capacitor Bank	8
8.	22 kV Circuit Breaker	11
9.	22 kV Current Transformers	13
10.	Neutral Current Transformer	16
11.	Support Structures	16
12.	22kV Series Reactor	18
13.	22kV Lightning Arrestors	19
14.	22kV Isolators	20
15.	Control & Protection Equipments	23
16.	Tests	27
17.	Documentation	28
18.	Errection & commissioning	30
19.	Earthing System	30
20.	Control Cables	33
21.	Fitting & accessories	34
22.	Annexure-I	35
23.	Annexure-II- A	36
24.	Annexure-II- B	38
25.	Annexure-II- C	40
26.	Annexure-II- D	41
27.	Annexure-II- E	42
28.	Annexure-II- F	43
29.	Annexure-II- G	44
30.	Annexure-II- H	46
31.	Annexure-III	48

1.00 SCOPE

- 1.01** This specification covers design & supply of 22KV, 1.2/2.4/3.0 MVAR capacitor bank along with all required equipments to be installed in 33/22kV sub stations. The capacitor bank shall consist of capacitor bank, circuit breaker, Series Reactor, control & relay panel, isolators, LAs, CTs and NCT, conductor, all type of necessary connectors along with suitable mounting structure. All these equipment shall have suitable terminal/equipment connectors as detailed under clause No.11.2 of the specification.
- 1.02** The equipments to be supplied against this specification are required for vital installations where continuity of service is very important. The design, materials and manufacture of the equipment shall, therefore, be of the highest order to ensure continuous and trouble-free service over the years.
- 1.03** The equipment offered shall be complete with all parts necessary for their effective and trouble-free operation. Such parts will be deemed to be within the scope of the supply irrespective of whether they are specifically indicated in the commercial order or not.
- 1.04** Configuration: The major equipments involved for each mechanically switched shunt capacitor bank are as follows.

Sr. No.	Particulars	Qty. Reqd.
1.	22 kV ,1.2/2.4 /3.0 MVAR capacitor bank	1Set.
2.	22 kV Circuit Breaker	1No.
3.	22 kV Isolator with earth blade	1No.
4.	22 kV lighting Arrestors	3No.
5.	22 kV Current Transformer	3No.
6.	22 kV Neutral current transformer	1No.
7.	22 kV Single phase Current Limiting Reactors	6No.
8.	Control & Protection Equipment.	1Set.

- 1.05** It is not the intent to specify herein complete details of design and construction. The equipment offered shall conform to the relevant standards and be of high quality, sturdy, robust and of good design and workmanship complete in all respects and capable to perform continuous and satisfactory operations in the actual service conditions at site and shall have sufficiently long life in service as per statutory requirements. The dimensional drawings attached with this specification and the notes thereto are generally of illustrative nature.

In actual practice, notwithstanding any anomalies, discrepancies, omissions, in-completeness, etc. in these specifications and attached

drawings, the design and constructional aspects, including materials and dimensions, will be subject to good engineering practice in conformity with the required quality of the product, and to such tolerances, allowances and requirements for clearances etc. as are necessary by virtue of various stipulations in that respect in the relevant Indian Standards, IEC standards, I.E. Rules, I.E. Act and other statutory provisions.

- 1.06** The Tenderer/supplier shall bind himself to abide by these considerations to the entire satisfaction of the purchaser and will be required to adjust such details at no extra cost to the purchaser over and above the tendered rates and prices.
- 1.07** The tenderer shall furnish in his offer a list of recommended spares with unit rates for each set of equipment that may be necessary for satisfactory operation and maintenance of circuit breaker and Isolators for a period of 10 years. The purchaser reserves 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.
- 1.08** The tenderer shall submit a list and unit rates of all the special tools, equipment and instruments required for erection, testing, commissioning and maintenance of the equipment. The purchaser shall decide the quantity of tools to be ordered. Prices of these tools shall not be considered for tender evaluation. However, the list of necessary tools/equipment which will be supplied free of cost with each CB may be furnished separately.
- 1.09** The equipment/material offered shall be entirely satisfactory for operation under the conditions indicated below.

2.00 SERVICE CONDITIONS

Sr. No.	Particulars	Specified value
1	Maximum Ambient Temperature (Degree C)	50
2	Minimum Ambient Temperature (Degree C)	3.5
3	Relative Humidity (%)	10 to 100
4	Maximum annual rain fall (mm)	1450
5	Maximum wind pressure (Kg/m sq)	150
6	Maximum wind velocity	45
7	Isoceraunic level (days/year)	50
8	Maximum altitude above mean sea level meter	1000
9	Seismic level (Horizontal acceleration)	0.3g
10	Moderately hot and humid tropical climate conducive to rust and fungus growth	

3.00 OPERATING CONDITIONS

Sr. No.	Particulars	Specified value
1	Nominal system voltage	22kV
2	Highest system voltage	24 kV
3	Frequency	50Hz \pm 3%
4	Number of Phases	3
5	Neutral Earthing	Solidly grounded
6	Fault level	25 kA for 3 sec.
7	Auxiliary AC supply	240 Volts \pm 10%
8	Auxiliary DC supply	30 Volts +10% - 15%

4.00 STANDARDS

Unless otherwise specified elsewhere in the specifications equipments shall confirm to the latest revisions of all relevant standards available at the time of placement of the order. The standards are listed in Annexure 'I'.

In the event of offered equipment conforming to Standards other than the above, the salient points of comparison between the Standard(s) adopted and the relevant IS/IEC shall be indicated in the technical offer to bring out clearly how the chosen standard is equal to or better than the ones stipulated in this specification. Copies of the Standard(s) adopted shall be furnished

5.00 PRINCIPAL TECHNICAL PARAMETERS

Principal technical parameters of various equipments shall meet the requirements listed in Annexure II (A to H)

6.00 GENERAL TECHNICAL REQUIREMENTS

6.01 The capacitor bank and all other equipments other than the indoor control panel shall be suitable for being installed outdoors & would be located at switchyards of various substations.

6.02 The equipment shall remain functional during and subsequent to the application of seismic loading. The exact value of seismic level (Horizontal acceleration) and maximum wind pressure may be considered as 0.3 g and 150 kg per sq. meter respectively.

6.03 The shunt capacitor should be designed for satisfactory operation even with presence of harmonics in the system. Suitable devices of required ratings should be included in the scope of supply. The general arrangement drawing along with the detailed lay out plan of the capacitor bank shall be submitted for necessary approval.

6.04 Each bank shall be of 1.2/2.4/3.0 MVA rating at 22kV and shall be double star connected bank with neutral point connected through NCT. If there are more than one capacitor banks in the sub-station,

damping reactors should be used on the neutral side of the capacitor bank. The inductance value will control amplitude and frequency of the inrush current at back to back switching. Peak capacitor inrush current shall be less than 100 times rated current of the capacitor and less than the breaker making current.

- 6.05** The protective scheme shall be by a current relay arranged as follows:
- 6.05.1** If the failure of one or more elements cause an over voltage of less than 10% tolerable on the other remaining healthy units, then the unbalance current shall cause in the first step to sound an alarm. But if more than the above numbers of elements fail causing the voltage rise of more than 10% on the other healthy units or the over voltage on the remaining healthy elements exceeds 65%, then the unbalance current shall cause to trip and isolate the capacitor bank instantaneously in the second step.
- 6.05.2** The per phase and individual star group rating shall be built up if required by series- parallel combination of 7.3 kV rated individual units so as to achieve the desired bank rating.
- 6.05.3** Internal fuses shall comply with IS- 12672 and shall be provided for the several individual elements within each unit.
- 6.05.4** Although the tolerances in the output rating of each individual unit shall be as per clause 13.1 of IS- 13925 (Part I) 2012, yet it shall be ensured that in a completely assembled bank, the departures from the nominal rating and with in the specified tolerance values shall not cause nuisance alarm or tripping since such alarm or tripping shall be to meet only with the protective requirements specified in (iii).
- 6.05.5** Individual units shall be designed to meet the requirements of the permissible overloads & with internal discharge devices as specified in IS- 13925 (Part I) 2012.
- 6.05.6** Internal fuses for individual elements within unit shall be as per the manufacturer's design and shall be ensured for adequacy such as to withstand normal switching inrush transient currents, discharge current when the bank is switched off. Fuses shall be capable of disconnecting a faulty unit or element over a wide range of unit terminal voltages from 70 to 150 %. In case all the elements in the same row are fused out in cascade in an internal fuse unit then the fuse element blown out shall be capable of successful disconnection, with a voltage of not less than 100% rated voltage appearing across its terminals. The unit shall withstand this voltage successfully and continuously. An internal element/elements fuse blowing out shall not cause, case rupture of the container of the unit.

- 6.05.7** The individual capacitor units shall be of ungrounded type with two bushings and fully insulated for rack potential. The capacitance shall be built up with high grade, all polypropylene dielectric film and aluminum foil. The polypropylene film shall cover the aluminum foil smoothly evenly and without any locked air pockets or voids. The containers shall be of CRCA sheet with minimum thickness 2mm duly welded and hermitically sealed. All welded joints shall be finished smoothly. The interior of the capacitor shall be degreased and derusted and shall not be painted. The insulating liquid shall be such that it shall remain chemically inert to the dielectric film. Aluminum foil shall not chemically degrade itself while in service.
- 6.05.8** Guaranteed failure rate i.e. no. of units failing per year should not be more than 0.5% per annum during warranty period. In case the failure rate exceed 0.5% per annum, then the supplier will have to give as free replacement two capacitor units for each failed unit in excess to the above guaranteed figure.
- 6.05.9** The raw material used for capacitor manufacturing i.e. PP film, non PCB non toxic oil & aluminium foil shall be of best quality obtainable in international market. Thickness of PP film (both sides hazy) shall be indicated in the technical particulars by weight method. No. of layers of dielectric shall not be less than three. Low loss capacitors shall be preferred. Offers with less than three layers of dielectric will not be considered. List of sources of raw material shall be enclosed alongwith the offer.
- 6.05.10** The capacitor elements shall be thoroughly dried & impregnated with an impregnant which had been completely refined & degasified so as not to have any gas or impurities which may cause deterioration of the dielectric. The impregnant used shall have low viscosity & high chemical stability. The impregnant should be non-PCB (NPCB)

6.06 Clearances and spacing as indicated below shall be provided.

a)	Phase to phase (Electrical) clearance for Breaker poles (minimum)	1250 mm
b)	Phase to phase (Electrical) clearance for C.T.s & P.T.s (minimum)	430 mm
c)	Phase to earth clearance (H.T. Terminal to nearest grounded metal part)	430 mm
d)	Height of 22 kV terminals from ground level (min)	3885 mm
e)	Spacing between isolator poles (Centre to Centre) (fixed)	1500 mm

f)	Height of lowest part of support insulator from ground level (minimum)	3400 mm
----	--	---------

Tenderers shall confirm in their technical offer that all clearances and spacing as stated above will invariably be provided. Offers without such confirmation are liable to be rejected.

7.00 CAPACITOR BANK

7.01 The capacitors shall be arranged in double star. Neutral Current transformer provided shall detect any unbalance due to Capacitor unit failure. Neutral Current transformer shall be provided between two Star points of the bank. Star point shall be ungrounded.

Capacitor unit should be made up of all polypropylene film dielectric with NON PCB impregnant liquid and provided with internal fuse element. The containers shall be made from CRCA sheet of thickness not less than 2mm (14 SWG). The Capacitor unit should be arranged in open galvanized steel rack with copper tinned conductors for their interconnections and aluminium bus bar for interconnections between capacitor bank, L.A., series reactor and neutral current transformer.

7.02 The container shall be hermetically sealed by controlled arc welding/tig welding process. The metal flanges of the bushing should be soldered/welded to the container and covered with epoxy compound providing a strong hermetical seal to the container. Suitable mounting brackets, as required by the purchaser shall be welded to the container. The minimum creepage distance of the bushing shall be 375mm. The container of each capacitor unit shall be provided with suitable earthing terminal clearly marked.

7.03 The capacitor bank shall be designed, manufactured and tested as per IS-13925 (Part-I) 2012. The shunt Capacitor bank would be out door type & would be Located at switchyards of various substations. Unless otherwise specified, the capacitors shall be suitable for upper limit of temperature category 50° C as per IS-13925 (Part-I) 2012.

7.04 The standard rated output of a switched capacitor bank shall be 1.2/2.4/ 3.0 Mvar as specified at 22 kV rated voltage. The bank shall comprise of single phase units of 121/242/165 KVAR for 1.2/2.4/ 3.0 Mvar capacitor bank respectively. Each unit shall be rated for 7.3kV phase to earth voltage with series-parallel combination connected in double star with neutrals interconnected through NCT. All capacitor units shall be mounted on 22 kV post insulators as per the requirement. The maximum permissible overloads with regard to voltage, current and reactive output shall conform to IS: 13925 (part I) 2012 with latest amendments.

- 7.05** The power loss in capacitors shall not exceed 0.2 Watt/kVAr. Suitable discharge device shall be connected across the capacitor units in accordance with the provision of IS: 13925 (part I) 2012. The discharge device shall reduce the residual voltage from the cross value of the rated voltage to 75V or less within 10 minutes after the capacitor is disconnected from the source of supply.
- 7.06** Better configuration with appropriate capacity of cell units may also be acceptable subject to approval of the Chief Engineer (Testing) prior to tender finalization.
- 7.07** The outside of the container should have smooth and tidy look and should be coated with weather-proof and corrosion-resistant paint of white or light gray shade. The container/enclosure shall be painted with light gray colour, shade 631 as per IS: 5.
- 7.08** The capacitor shall be provided with a rating plate and terminal markings as stipulated in IS: 13925 (part I) 2012.
- 7.09** Other details of capacitor bank shall be as per Annexure II 'A' of Guaranteed Technical Parameters attached.
- 7.10** Mounting structure
- 7.10.1** The mounting racks shall be fabricated from suitable steel sections and shall be duly hot dip galvanized as per applicable IS. Mounting racks along with support insulators shall be suitable for mounting on elevating structure.
- 7.10.2** The racks shall be complete with insulators, bolts & nuts, foundation bolts and other hardware, etc. for assembly into complete bank. Interconnecting materials and suitable bimetallic terminal connectors for connection with other equipments shall also be provided.
- 7.10.3** The height of the racks of capacitor bank shall be such that for making electrical connection with the other equipments, proper electrical clearance is maintained.
- 7.10.4** The hot dip galvanized elevating structure shall be provided of capacitor bank & isolator. Provision for mounting of LA, SR & NCT shall be made on the capacitor bank elevating & mounting structure.
- 7.11 Protection**
- 7.11.1** Fuses:
- i) The fuses shall withstand repeated application of transient conditions associated with normal duty of capacitor unit.
 - ii) Fuses shall be capable of limiting arc energy within the case of faulty capacitor to such small proportions that the danger of case rupture is eliminated.

- iii) It shall have adequate rupturing capacity for the fault levels at the terminals of the capacitor.
- iv) It shall have adequate thermal capacity to cater for increased heating which may occur due to harmonics.
- v) It shall have an ampere rating which will provide proper co-ordination between its total clearing time current curve and capacitor unit's case rupturing capacity

7.11.2 The capacitor banks shall be provided with the following others protections.

- a) Over current and earth fault protection to cover bus faults between the capacitor banks and its controlling circuit breaker.
- b) Over voltage protection.
- c) Unbalance protection.
- d) No volt protection.
- e) Leading Power factor Protection.

Requirement of each of the above protection are described below.

- a) Over-current & Earth fault protection :
Combination of two IDMT relays having 50-200% settings and one EIF relay of IDMT characteristic with 20-80% setting shall be used with suitable current transformer.
- b) Over-voltage Protection
Over-voltage shall have an inverse time characteristics and shall be energized through VT connected to the main bus bars on the source side of the circuit breaker controlling the capacitor banks. Relay shall have variable settings from 100% to 130% in steps of at least 1% to 2%.
- c) Unbalance Protection :
Unbalance protection shall be provided with current operated relay with separate one no. NCT for each group capacitor bank. The relays used shall be provided with a time delay device to prevent operation under transients and to allow individual fuses to isolate the faulty units. Inverse time delay relay may be used.
- d) No volt Protection :
Under voltage protection shall be provided to disconnect the bank under low voltage conditions. A time delay relay must be provided with adjustable setting of 0 to 10 minutes to provide a time lag before which the bank shall not be again switched on (to avoid closing of the circuit breaker on a trapped charge).

7.11.3 The under-voltage protection shall not operate in the event of fault on 22 KV lines which may dip the bus bar voltage to 50%. There should be provision for adjustments in settings of voltage and time to coordinate the 22 KV line protections with the under-voltage protection to avoid malfunctioning of under-voltage relay under line fault conditions.

7.11.4 The power factor meter should be provided.

7.12 Associated equipments

The associated equipments as mentioned in clause 1.4 above of this Tech. Specification having detailed specification described herein after shall be supplied along with the capacitor banks. The hot dip galvanized elevating structure shall be provided of capacitor bank & isolator. The general arrangement of equipments is shown in the single line diagram appended with this specification.

8.00 22 KV VACUUM CIRCUIT BREAKER

Technical specifications of Circuit Breaker used for switching on & off of the Capacitor bank shall be as follows.

The 22KV circuit breakers offered shall be three phase, out door type, 3-pole gang operated, Vacuum circuit breakers having 800 Amps continuous current rating & short circuit rating of 25 KA for 3 sec. Circuit breaker shall be suitable for switching IN and OUT capacitor bank with out restrike. Circuit breaker shall have operating duty cycle of O-0.3 sec-CO- 3min-CO as per IEC 56/IS-13118. Circuit breaker shall conform to IEC 60056/IS-13118 amended up to date.

8.01 Breaker Contacts

8.01.1 Main contacts shall have ample area and contact pressure for carrying continuous rated and short time current without excessive temperature rise, which may cause pitting or welding.

8.01.2 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 rod shall have anti tracking quality towards electrical stresses.

8.02 Operating Mechanism

Operating mechanism and control circuitry shall be housed in suitable metallic enclosure. It shall be painted white on the interior and Dark Admiralty Grey to shade no 632 of IS-5 on exterior surface. The enclosures shall be dust, moisture and vermin proof, to provide a Degree of protection to IP 55 in accordance with IS: 13947. Control cubicle for local operation of the breaker shall be mounted at a convenient height to enable easy operation from ground level. It shall have backwards slanting hood of 2 mm thick (14 SWG) sheet for protection against rain water. It shall accommodate the following items.

Sr. No.	Item	Quantity Required
1.0	Mechanical ON & OFF knobs.	1 No.
2.0	Electrical ON/OFF push buttons	1 No. each
3.0	Mechanical ON/OFF indicator.	1 No. each
4.0	Electrical ON/OFF indicator	1 NO. each
5.0	Mechanical spring charged indicator.	1 No.
6.0	Electrical spring charge indicator	1 No.
7.0	Auxiliary A.C./D.C. supply indication	1 No. each
8.0	Conveniently located manual emergency trip	1 No.
9.0	Auxiliary switches as specified else where in this specification	1 set
10.0	Control cable termination connector blocks with stud type brass terminals of min 4 mm dia	1 set
11.0	One power plug along with control switch (240V,10A).	1 set
12.0	Space heater along with ON/OFF switch and thermostat	1 set
13.0	Cubical illumination lamp with switch.	1 set
14.0	Mechanical Operation counter to register the number of breaker operations.	1 No.
15.0	Local/Remote switch	1 No.

8.03 Auxiliary Switches

- 8.03.1** Each operating mechanism of the circuit breaker shall be provided with adequate number of Cam/Snap type auxiliary switches of normally open and normally closed contacts for the control and operation of the equipment with continuous current rating of 10 Amp. The Breaking capacity of the contacts shall be minimum 2 A with circuit time constant less than 20 milli seconds at the rated D.C. voltage. Normal position of auxiliary switches refers to contact position when circuit breaker is open.
- 8.03.2** All spare auxiliary contacts of the circuit breakers shall be wired up and brought to the terminal block. Minimum 4 N/O+ 4 N/C contacts shall be available on each breaker for this purpose. Auxiliary contact multiplier, if any used, shall be connected to the DC supply only.
- 8.03.3** Insulation level of auxiliary contacts shall be 630 volts, 2.5 kV for 1 min.
- 8.03.4** In case the control cubicle mounting height is more, there shall be provision of suitable folding type ladder attached to the breaker support structure, by means of which it will be possible to reach the control cubicle/operating mechanism box conveniently. Further, electrical ON/OFF push buttons/switch shall be accessible from the ground.

- 8.03.5** The circuit breaker shall be provided with motor operated spring charged closing. Spring charging motor shall be suitable for 240V, 50 Hz, single phase AC. Spring release coil for closing shall be suitable for 30V DC. Provision shall be available for charging the springs manually as well, and to close CB mechanically.
- 8.03.6** Tripping of the circuit breakers shall be through "Shunt trip" coils rated for 30V DC operation. It shall be possible to trip the breaker manually in case of necessity.
- 8.03.7** In each circuit breaker, one potential free contact of the limit switch of spring charging motor shall be provided for remote indication of spring charged. This contact shall be wired up and brought to the terminal block.
- 8.03.8** Electrical antipumping device shall be provided for breaker.
- 8.03.9** The breaker shall be provided with CT mounting Bracket.
- 8.03.10** Requisites number of suitable and matching bimetallic terminal connectors shall also be supplied along with the breaker.

Other details of 22KV circuit breaker shall be as per Annexure II 'B' of Guaranteed Technical Parameters attached.

9.00 22 KV CURRENT TRANSFORMERS

- 9.01** All 22kV current transformers including neutral current transformers shall be single phase outdoor, oil cooled or dry type units. Oil cooled current Transformers shall be of dead tank design with the insulator housing of porcelain material. CTs shall be hermetically sealed conforming to IS-16227. CTs shall be of suitable ratio with ratio changing arrangement on primary side. The mounting arrangement of current Transformers shall have four holes equispaced at 350 ± 5 mm. distance suitable for 16mm. stud/foundation bolt.
- 9.01.1** In case of dry type current Transformers tenderer shall give full technical and constructional details, without which offered Instrument Transformer shall not be technically acceptable.
- 9.01.2** CTs shall have short time rating of 25 KA for 3 second. The primary and secondary windings of CTs shall be of copper.
- 9.01.3** In case all three CTs are mounted on the same structure, clearances as specified elsewhere in the specification shall be maintained.
- 9.01.4** CTs shall be only of reputed make approved by the Board. Performance certificates and type test certificates for CTs shall be furnished along with the technical offer.

- 9.02** The metal tank shall be fabricated from M. S. Sheet of minimum 3.15 mm thick. The metal tanks shall be coated with at least two coats of zinc rich epoxy paint. In case of oil cooled its inside all sides of tank shall be painted with oil resistant white enamel paint. All the ferrous hardware, exposed to atmosphere, shall be hot dip galvanized. All other fixing nuts, bolts, washers in the electric current path shall be made out of stainless steel.
- 9.03** Nuts and bolts or screws used for fixation of the interfacing porcelain bushings for taking out terminals shall be provided on flanges cemented to the bushings and not on the porcelain. If gasketed joints are used, nitrile /butyl rubber gaskets shall be used. The gasket shall be fitted in properly machined groove with adequate space for accommodating the gasket under compression.
- 9.04 Oil cooled Instrument transformers**
- 9.04.1** The Instrument transformer shall be provided with prismatic type oil level indicator at suitable location so that the oil level is clearly visible with naked eye to an observer standing at ground level.
- 9.04.2** The unit shall be filled with oil under vacuum after processing to eliminate air and moisture from the winding and shall be hermetically sealed.
- 9.04.3** Oil filling and/or oil sampling cocks if provided to facilitate factory processing shall be properly sealed before dispatch of the instrument transformers. It is preferable to provide leakage proof threaded plugs / caps instead of cocks for oil filling & sampling outlets.
- 9.04.4** The porcelain housing for instrument transformer shall be of single piece construction without any joint or construction. The housing 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 to shade away rainwater or condensed water particles. The profile of porcelain shall be aerodynamic type confirm to IEC 815 / IS 2099.
- 9.04.5** Out door type bushing shall have a creepage distance of 25 mm/kV. The bushing housing shall have a rated voltage not less than 24 kV at rated current of 2000 amps. Vertical clearance of porcelain housing shall be at least 450 mm.
- 9.05 Dry type Instrument transformers**
- 9.05.1** The Instrument Transformers shall be so constructed as to ensure that the dry insulation media (resin, epoxy or any other polymer used) does not absorb moisture or develops cracks or breaks in to pieces

during its life span when installed in outdoor. The media shall also have anti-tracking properties against electrical stresses.

- 9.05.2 The HV/LV windings shall be made of HCE grade copper and cast under high vacuum using pure liquid epoxy resin or nyloner system to achieve void less embedment of windings. Use of mica and fiberglass insulation shall be avoided.
- 9.05.3 The material used for encapsulation shall be finely and scientifically graded well bounded polymer resin with good electrical, mechanical weathering properties.
- 9.05.4 The insulation coordination between phase to earth shall be in accordance with IS 2165 (Part I).
- 9.05.5 Enamel, if used for conductor insulation, shall be either polyvinyl acetate type or amide type and shall meet the requirements of IS 4800. Polyester enamel shall not be used. Double cotton cover, if used, shall be suitably covered to ensure that it does not come in contact with oil.
- 9.05.6 The dimensions of the terminal box and its openings shall be adequate to enable easy access and working space with use of normal tools.
- 9.05.7 Correct polarity shall be invariably marked on each primary and secondary terminal. Facility shall be provided for short circuiting and grounding of the C.T. secondary terminals inside the terminal box.
- 9.05.8 The instrument security factor of metering core shall be low enough but not greater than 5. This shall be demonstrated on all the ratios of the metering core, in accordance with procedure specified in IEC 185 or IS 16227.

9.06 Primary Winding

Primary winding shall be hair pin type or wound type made out of high conductivity copper, Conductors used for the primary winding shall be rigid. Unavoidable joints in the primary winding shall be welded type preferably lap type. The details of such welded joints shall be indicated in the drawings submitted with the offer. For primary winding current densities shall not exceed the limit of 1.6 Amp/sq mm for normal current.

9.07 Secondary Winding

Suitably insulated copper wire of electrolytic grade shall be used for secondary windings. Type of insulation used shall be described in the offer. For multi ratio C.T. design, the multi ratio shall be achieved by reconnection of the secondary windings/ tapping.

9.08 Primary terminal

The primary terminals shall be of stud type of size of 30mm dia x 80mm length for all CTs. The primary terminals shall be of heavily tinned electrolytic copper of 99.9% conductivity. The minimum thickness of tinning shall be 15 microns.

9.09 Secondary terminal

9.09.1 Secondary terminal studs shall be provided with at least three nuts and two plain and two spring washers for fixing the leads. The studs, nuts and washers shall be of brass, duly nickel plated. The minimum out side diameter of the studs shall be 6 mm. The length of at least 15mm shall be available on the studs for inserting the leads. The space clearance between adjacent nuts when fitted shall be at least 10 mm from the outside circum dia. of the nuts.

9.09.2 The instrument transformer shall be provided with non-corrosive, legible name and rating plates, with the information specified in relevant standards, duly engraved/punched on it.

Details of 22kV current transformers shall be as per Annexure II 'C' of Guaranteed Technical Parameters attached.

10.00 NEUTRAL CURRENT TRANSFORMERS

22 kV Neutral Current Transformer shall be single phase, outdoor; oil immersed dead tank type or dry type. The ratio of the neutral current transformer shall be compatible with unbalance calculations of the capacitor bank & it shall be selected on the basis of the unbalance current flowing through neutral of capacitor bank during the failure of elements in one capacitor unit (at alarm stage & trip stage).

Details of 22 KV NCT shall be as per Annexure II 'D' of Guaranteed Technical Parameters attached.

11.00 SUPPORT STRUCTURE AND EQUIPMENT FRAME

11.01 Equipment frame, support structure, angles, channels etc. meant for the outdoor switch gear and other equipment viz. CTs, NCT, LAs, Series reactor, Isolators etc. shall all be hot dip galvanized. All the ferrous metal parts shall be hot dip galvanized smoothly as per IS 3638(as amended up to date), IS or any other equivalent authoritative standard. The material shall be galvanized only after shop operations upon it have been completed. The metal parts before galvanization should be thoroughly cleaned of any paint, grease, rust, scales or alkalis or any foreign deposits which are likely to come in the way of galvanization process. The metal parts coating shall withstand minimum four one minute dips in copper sulphate solution as per

IEC-168. Fasteners (nut-bolts) shall be of non-magnetic stainless steel. No spring washer shall be used, instead one check nut of suitable size shall be provided with each bolt.

- 11.01.1** Support structure shall be supplied for each of the outdoor equipment and shall be suitable to maintain the clearances and spacing stipulated for various equipments. Current transformers may be mounted on the extended structure of the circuit breaker provided the requisite electrical and mechanical clearances are properly maintained. Typical bay arrangements indicating sectional clearances are shown in the enclosed drawings.
- 11.01.2** The main structure shall be fabricated out of hot dip galvanized angle of minimum 75 x 75 x 6 mm or equivalent strength.
- 11.01.3** Successful tenderers shall clearly indicate on the relevant G.A. drawings the total dead weight coming on each support structure. Impact load, if any, shall also be stated on relevant drawing. These details are required for designing suitable foundations for the support structure for CBs, Isolators, etc.

11.02 Equipment Terminal Connectors (HV)

- 11.02.1** Tenderers shall include in their scope suitable connectors for each outdoor equipment. In the case of equipment with copper terminals, the terminal connectors shall be made of electrolytic grade copper, and shall be suitable for crimping type connection. Material required for inter connection between various bay equipment in between the two isolators of each bay shall be included in the tenderer's scope of supply. Details of the inter connector and the material used for the terminals/jumpers shall be furnished in the offer. In order to fix the jumper length, size etc. standard layout drawing is enclosed. Successful tenderer shall have to adopt Board's standard foundation plan.
- 11.02.2** Take-off terminals of both the isolators of each bay and for Cu-Al bimetallic connections shall be of electrolytic grade aluminium and suitable for crimping ACSR jumper along with suitable bimetallic plate of minimum 2 mm thickness. These connectors shall be suitable for 200 mm sq. ACSR conductor. All nut-bolts used in the connectors shall be of non-magnetic stainless steel. In place of spring washers, check nut of suitable size shall be provided.

11.03 Earthing

Metal tanks of the instrument transformers and all other equipment, C & R panels, mechanism boxes, structures etc. shall be provided with two separate earthing terminals of size 16 mm dia. x 30 mm

length H.D.G., with one plane washer and one nut, for connection to station earth-mat.

11.04 Lifting arrangement

Instrument transformers and switchgear equipment shall be provided with suitable lifting arrangement to lift the entire unit. Lifting arrangement (lifting eye) shall be positioned in such a way so as to avoid any damage to the porcelain housing, primary terminals or the tanks during the process of lifting for installation/transport. The general arrangement drawing shall show clearly the lifting arrangements provided such as lifting eye, guide etc.

11.05 Painting

11.05.1 All sheet metal parts (panel, mechanism box, metal housing, Instrument transformer etc.) for outdoor installation shall be designed and fabricated with special care to avoid rust/fungus formation and corrosion. All metal parts shall preferably be hot dip galvanized. If this is not possible due to practical difficulties, cold galvanizing or epoxy coating shall be provided for all sheet metal parts, used for outdoor installation. Sheet steel shall be treated as per the 7 tank process. In case tank process for treating the sheet metal is not possible, alternate process adopted shall be clearly explained in the technical offer which shall be got approved by the Board. Dark Admiral Grey shade as per colour shade no. 632 of IS-5 shall be used for epoxy coating.

11.05.2 The sheet metal works, after final painting shall present an esthetically pleasing appearance, free of any dent or uneven surface.

11.06 Labels

11.06.1 All front mounted as well as externally mounted items including fuses shall be provided with individual identification labels. Labels shall be mounted directly below the respective equipment and shall clearly indicate the equipment designation. Labeling shall be on aluminum anodized plates of 1 mm thickness. The letters are to be properly engraved.

11.06.2 All the equipment and their parts shall be provided with suitable labels or identification and ease of operation and maintenance.

12.00 22 KV SERIES REACTOR

Suitable 0.2% current limiting reactors shall be provided on the neutral side of the Capacitor bank in rural areas having low total harmonic distortion (THD) level. However 6% series reactor shall be provided on the line side of the Capacitor bank to be provided in

Urban areas where THD level is more. The inductance value will control the amplitude and frequency for the inrush current. Peak inrush current shall be less than 100 times the rated current of the capacitor bank and less than the breaker making current.

- 12.01** The series reactors shall be out door type, single phase, air cored, air cooled, Dry type with Aluminum winding. The normal current rating of the reactor shall be 130% of rated continuous current of the capacitor bank. The Voltage rating of the series reactor's base insulators shall be nominal system voltage of 22 KV.
- 12.02** For both capacitor and reactor, the method of mounting and minimum clearance required from live parts shall be indicated clearly. The provision for mounting of reactor is to be made on capacitor bank structure.
- 12.03** The reactor shall be free from annoying hum or vibration. The design shall be such as not to cause any undesirable interference with radio or communication circuits. All routine tests shall be carried out as per IS- 5553 or equivalent international standard.
- 12.04** The complete assembly of the Capacitor bank shall be on a mild steel galvanized steel structure.
- 12.05** Other details of 22kV series reactor shall be as per Annexure II 'E' of Guaranteed Technical Parameters attached.

13.00 22 KV LIGHTING ARRESTORS

- 13.01** 22KV Lightning arrestors shall be of station class, heavy duty, Metal oxide gapless type 18kV, 10KA conforming to IS-3070/1993/IEC-60099-4 with pressure relief device and shall be suitable for handling higher Capacitor energy discharge. Lightning arrestor shall perform the following operations.
- 13.02** The Lightning Arresters shall conform in all respects to high standards or engineering design, workmanship.
- 13.03** The LA shall be provided with pressure relief device.
- 13.04** Each individual unit of Lightning Arresters shall be hermetically sealed and fully protected against ingress of moisture. The supplier shall furnish sectional view showing details of sealing employed and sectional view of pressure relief device employed with the offer.
- 13.05** The creepage distance of Arrester shall be more than 600mm.
- 13.06** All ferrous parts exposed to atmosphere shall be hot dip galvanized as per IS 2629 as amended from time to time.

- 13.07 The grounding terminal shall be suitable for accommodating purchaser's grounding connection to steel earth mat.
- 13.08 The lightning Arrester shall confirm to type tests in accordance with IEC-60099-4.
- 13.09 All acceptance and routine test as stipulated in the relevant standards shall be carried out on each unit by the bidder and in presence of purchaser's representative during inspection of desired so.
- 13.10 Each Lightning Arrester shall be provided with galvanised mounting steel structure with foundation bolts template.
- 13.11 Porcelain/ Polymer Rubber Housing shall be free from lamination cavities or other flaws affecting the mechanical and electrical strengths.
- 13.12 Porcelain/ Polymer Rubber Housing shall be thoroughly vitrified and non-porous.

Other details shall be as per Annexure II 'F' of Guaranteed Technical Parameters attached.

14.00 22 KV ISOLATORS

- 14.01 22KV isolators shall be three phase, out door type, with double break central pole rotating arrangement with 800A continuous current rating. Earthing blades shall be capable to discharge the trapped charge of the line. Isolator main switch shall be required to make or break the line charging current when no significant change in voltage occurs across the isolating distance on account of make or break. Other details shall be as per Guaranteed Technical Parameters attached. Isolators shall conform to IS/IEC-62271-102 amended up to date. All isolators shall have a short time rating of 25 KA for 3 second. The contacts and blades of the isolators shall be of electrolytic grade copper. The fasteners (nut-bolts) used for current carrying parts shall be of nonmagnetic stainless steel. Spacing between phases for all isolators shall be of 1000mm. Further the current density for copper current carrying parts shall not be more than 1.6 Amp /mm. sq in solid conductor and 2 Amp/sq. mm. in hollow tubes.
 - 14.01.1 Isolators shall have built-in mechanical inter lock between the main and earth blades so that the closing of the main blade is not possible without opening the earth blade and closing of the earth blade will not be possible without opening the main blade.
 - 14.01.2 All the fixed contacts shall be provided with a sheet metal rain hood. This shall be fabricated out of at least 2 mm thick Galvanized iron sheet metal and shall be designed such that it will in no case shall

obstruct or restrict the movement of moving contracts (blades) and arcing horns, if provided.

14.02 Operating mechanism

Manual operating mechanism gang operated through Hand operated lever shall be provided for main switch and earth switch separately. The operating mechanism shall provide quick, simple and effective operation. The design shall be such that one man shall be able to operate the isolator without undue effort. The operating mechanism shall be suitable to hold the main switch or earth switch in closed or opened position to prevent operation by gravity, wind, short circuit, seismic acceleration, vibration, shock, accidental touching etc.

14.03 Padlocking device

The isolator and earthing switch shall be provided with padlocking device to permit locking of the isolator and earthing switch in both fully open and fully closed positions.

14.04 Earthing

Flexible branded copper connections shall be provided between rotating earth blades and the frame which shall have a cross section of at least 50 sq mm and shall be tinned or suitably treated against oxidation.

The frame of each disconnect and earthing switch shall be provided with two reliable earthing terminals for connection to the purchaser's earthing conductor/flat so also clamping screw suitable for carrying specified short time current. Flexible ground connectors shall be provided for connecting operating handle to the earthing flat. The diameter of clamping screw shall be at least 12 mm. The connecting point shall be marked with earth symbol.

14.05 Moving blades

Contact surface of moving blades and associated connectors/contacts and terminal pads shall be heavily silver plated to at least 15 microns thick. The surface shall be wiped during closing and opening operations to remove any film, oxide coating etc. Wiping action shall not cause scouring or abrasion of surfaces.

Material of Earthing blades & contacts shall be the same as those of the main moving blades and contacts respectively. Cross-sectional area of the Earthing blades and contacts shall not be less than 50% of corresponding area of main moving blades and contacts.

14.06 Bearings

All the friction locations and rotating parts shall be provided with two nos. of bearings of at least 75 mm ID. 50 mm clear spacing between the bearings shall be provided. The housing for bearings shall be made of gravity dia cast metal with smooth surface and suitably machined for seating the bearings. The bearings bushes, joints, springs etc. shall be so designed that no lubrication shall be required during the service.

14.07 Tandem Pipe

Tandem pipe shall be of at least 25 mm ID and class B Mild steel galvanized. One single tandem pipe shall be used for phase coupling of double break isolators. Base plate of rotating insulators for connection of tandem pipe shall be made out of one piece of at least 6 mm thick M.S. plate. Bolt and shackle device shall be used to connect tandem pipe to the base plate. Whenever unavoidable sliding clamps are to be used, these clamps shall be made out of at least 6 mm thick M.S. flat with four nos. of nuts and bolts. A grub screw shall be provided for securing connection on tandem pipes.

14.08 Down pipe

50 mm ID, class B, Mild steel galvanized single piece pipe shall be provided for operating disconnects. The pipe shall be terminated into a suitable swivel type joint between the tandem pipe driving mechanism and the operating mechanism if required to take care of marginal angular misalignment at site.

14.09 Insulators

14.09.1 All outdoor type Porcelain insulators shall have a creepage distance of 25mm/kV (i.e. 600mm). The insulators shall be of outdoor post type conforming to IEC 60168. All insulators shall have a rated voltage not less than 24 kV and rated current of 2000 Amps.

14.09.2 Post type insulators with 76 mm PCD shall only be provided. Pin type or polycone insulator shall not be acceptable.

14.09.3 The insulators shall be provided with a completely galvanized steel base designed for mounting on the support. The base and mounting arrangement shall be such that the insulator shall be rigid and self standing. Cap provided on top of the insulator shall be of high grade cast iron/malleable steel casting or aluminum alloy. It shall be machine faced and hot dip galvanized in case of first two options. The cap shall have four nos. of tapped holes with PCD same of that of insulator base. The holes shall be suitable for bolts with threads

having anticorrosive protection. The effective depth of threads shall be adequate.

- 14.09.4** The insulator shall be made of homogeneous and vitreous porcelain of high mechanical and dielectric strength. It shall have sufficient mechanical strength to sustain electrical and mechanical loading on account of wind load, short circuit stresses etc. Glazing of the porcelain shall be of uniform brown or dark brown colour with a smooth surface arranged to shed away rain water. The porcelain shall be free from lamination and other flaws or imperfections that might affect the mechanical or dielectric quality. It shall be thoroughly vitrified, tough and impervious to moisture.
- 14.09.5** The porcelain and metal parts shall be assembled in such a manner and with such material that any thermal differential expansion between the metal and porcelain through the range of temperature specified in this specification shall not loosen the parts or create undue internal stresses which may affect the mechanical or electrical strength or rigidity. The assembly shall not have excessive concentration of electrical stresses in any section or across leakage surfaces. The cement used shall not give rise to chemical reaction with metal fittings. The insulator shall be suitable for water washing by rain or artificial means in service condition.
- 14.09.6** The insulator unit shall be assembled in a suitable jig to ensure correct positioning of the top and bottom metal fittings relative to one another. The faces of the metal fittings shall be parallel and at right angle to the axis of the insulator and corresponding holes in the top and bottom metal fittings shall be in a vertical plane containing the axis of the insulator.
- 14.09.7** It shall be the sole responsibility of the supplier to carry out thorough inspection and quality checks on the insulators at the insulator supplier's works, before offering the insulators for purchaser's inspection.

Other details shall be as per Annexure II 'G' of Guaranteed Technical Parameters attached

15.00 CONTROL & PROTECTION EQUIPMENTS

15.01 Constructional details

- 15.01.1** Capacitor bank should be provided with a separate indoor type Control & Relay panel. It shall be painted white on the interior and Dark Admiral Grey to shade No.632 of IS-5 on the exterior surface.

- 15.01.2** Control and relay panel detailed in this section is required for indoor installation for controlling switching ON & OFF operations of the 22 kV Capacitor bank.
- 15.01.3** Panel shall be made of rigid welded structural frames enclosed completely with smooth finished sheet steel of thickness not less than 2 mm. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transport and installation. Panel shall be completely metal enclosed and shall provide a minimum degree of protection to IP 34 in accordance with IS: 13947.
- 15.01.4** The doors shall be provided with 3-point locks operated by suitable handle. Bottom plates of the panels shall be fitted with removable brass cable glands to allow cable entries from the bottom. Terminal Connectors and Test terminal blocks for cables shall be fixed at an elevated height of at least 200 mm above the bottom plate. Adequate quantity of cable glands of suitable size shall be provided.
- 15.01.5** Design, materials selection and workmanship shall be such as to result in a neat appearance both inside and outside, with no welds rivets or bolt heads apparent from outside. Steel sheets shall be suitably treated to achieve neat appearance and long life.
- 15.01.6** Each panel shall be provided with cubicle illumination lamp in shrouded holder, controlled by door operated switch. Space heater of 80 W rating along with control switch shall be provided inside each panel. Cubicle lamp and space heater shall be suitable to work on 240 V AC supply. In each panel, one 3-pin 10 Amp industrial type power plug along with control switch shall be provided for extending 240 V AC supply.
- 15.01.7** Each panel shall be provided with one earth bus of size 25x3mm (minimum). The earth bus shall be of tinned/nickel plated copper. All metallic cases of relays, meters, instruments etc. shall be connected to this bus independently for their effective earthing.
- 15.01.8** Other details of Control and relay panel shall be as per Annexure II 'H' of Guaranteed Technical Parameters attached.
- 15.02 Protective relays**
- 15.02.1** For the capacitor bank, one non-directional IDMTL triple pole relay having O/C elements on R and B poles and E/F element on middle pole may be provided for this purpose. All these relays shall be of 3 seconds IDMTL characteristics, the O/C elements having current setting variable from 50% to 200% of CT secondary ratings, and the E/F elements having current setting variable from 20% to 40%. Numerical type IDMTL O/C & E/F relays shall be self powered (i.e.

suitable for operation without external D.C. supply) or D.C. operated flag-coil type or mechanical flag type.

- 15.02.2 Separate Numerical type over voltage and under voltage relays shall be provided with adjustable timer.
- 15.02.3 Numerical type Neutral unbalance current sensing Relay with adjustable time setting shall also be provided.
- 15.02.4 Static type Trip circuit supervision relay shall be provided for circuit breaker. Trip circuit supervision scheme shall be such that testing of trip circuit healthiness is possible irrespective of whether the C. B. is in the closed or open position.
- 15.02.5 Separate auxiliary relay shall be provided for alarm & tripping circuits.
- 15.02.6 Static type High speed relay for tripping HV breaker & suitable time delay relays shall be provided.
- 15.02.7 Lead power factor relay which should be microprocessor based intelligent auto control unit and user friendly setting. Whenever LV loads are running at leading PF, the regulator / relay shall give alarm and as well as trip command to breaker so that bank can not be permitted to switch on. At lead PF the bank should be off / cut off through relay.
- 15.02.8 In case Static/Numerical/microprocessor based relays are offered these shall be suitable for the station auxiliary supply (30V D.C.) and shall have facility of a test push button to test the relay functioning.
- 15.02.9 All other relays shall be suitable for flush mounting, with only the flanges projecting on the front and connections at the back. Relays shall have dust-tight covers removable from the front. Protective relays shall have built-in test terminals.
- 15.02.10 One more switch shall be provided to select Service, Test and Off positions.
- 15.02.11 The relays shall be mounted on the control and relay panel. The relay should be as per DIN Standard and suitable for panel mounting. The relay should be supplied ready to mount with the necessary terminal block provided on the relay. Connecting terminals should be suitable to take 2.5sq. mm cable. The entire electronic component used should have high reliability and should be of defense/industrial grade conforming to latest IS.

15.03 Wiring and control wiring terminals

- 15.03.1 All wiring shall be carried out with 1100 volts grade single core, multi strand, flexible tinned copper wires with PVC insulation. The

conductor size shall 2.5 sq mm (minimum) for circuits. Wiring trough may be used for routing the cables. Wire numberings and colour code for wiring shall be as per IS: 5578 & IS: 11353. The wiring diagram for various schematics shall be made on thick and durable white paper in permanent black ink and same should be encased in plastic cover, thermally sealed. It should be kept visibly in a pocket of size 350 x 400 mm of MS sheet of 1 mm thickness, on the interior surface of the door of C & R Panel.

- 15.03.2** Terminal blocks shall be of clip-on design made out of non-crackable insulating material of 1100 V grade. All terminals shall be stud type, with all current carrying and live parts made of tinned/nickel plated brass. The studs shall be of min 4 mm dia. brass. The washers, nuts, etc. used for terminal connectors shall also be of tinned/nickel plated brass.
- 15.03.3** The terminal connector/blocks shall be similar to ELMEX type CAT- 44. Non- disconnecting type terminal connectors with automatic shorting of C.T. secondary terminals shall be provided in CT secondary circuit. All other terminal connectors shall be disconnecting type. At least 20% spare terminals shall be provided. All terminals shall be provided with ferrules indelibly marked or numbered and identification 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.
- 15.03.4** All fuses used shall be of HRC type. The fuse base and carrier shall be plug-in type molded case kit Kat of bakelite/DMC. All current carrying and live parts shall be of tinned/ nickel plated copper. No fuse shall be provided on DC negatives and AC neutrals. Tinned copper links shall, however, be provided on DC negatives and AC neutrals.
- 15.03.5** Test terminal blocks used in metering circuit shall be suitable for 3 phase 8 wire type connections (2 watt meter method) with 3 no LCDs glowing on face plate to indicate 3 phase potential available to the energy meter.
- 15.03.6** Necessary protections as per clause 6.5 of this specification shall be provided. Control and relay panel shall be provided with Relays, ammeter, KV meter, MVAR meter, Power factor meter, Annunciator & other accessories as mentioned bellow.

Indoor type Control and relay panel shall have remote control of the shunt Capacitor bank.

Following main components shall be provided on C & R panel

Sr. No.	Particulars	Qty
	<u>Protective Relays</u>	
1.	2 O/C + 1 E/F IDMT protection relay	1no.
2.	Unbalanced protection (Neutral current sensing)relay	1no.
3.	Over Voltage protection relay	1no.
4.	Under Voltage protection relay	1no.
5.	Trip circuit supervision relay	1no.
6.	Static type High speed relay	1no.
7.	Static type time delay relay	1no.
8.	Lead power factor relay	1 no.
	<u>Measuring Instruments</u>	
9.	96 X 96 mm Digital Ammeter with 4 position selector switch.	1no
10.	<u>96 X 96 mm Digital KV meter with 7 position selector switch</u>	1no
11.	Digital MVAr meter	1no
12.	Digital Power factor meter	1no
13.	12 window static Annunciater	1no
	<u>Other accessories</u>	
14.	Neon type indicating lamps for CB ON, CB OFF, Isolator 1 ON, Isolator 1 OFF, Isolator 2 ON, Isolator 2 OFF, Trip ckt. Healthy, Auto trip, D. C. Supply Healthy, R,Y,B Indication	12nos
15.	<u>Mimic Diagram</u>	
16.	Push Buttons for Accept, Reset, Lamp test, & Sound cancel	4nos
17.	Semaphore indicator 1no.for circuit breaker & 2nos.for Isolators.	
18.	12 way control switch for circuit breaker & for two Isolators only if motorized.	
19.	Hooter	1no.
20.	Panel Heater	1no
21.	Panel illumination Lamp with door switch	1set
22.	Power Plug point	1no

16.00 TESTS

16.01 Type tests

16.01.1 The equipments offered in the tender should have been successfully type tested for the tests indicated in the enclosed Annexure III in line with the relevant standard and technical specification. The bidder

shall be required to submit complete set of the type test reports along with the offer.

16.02 Acceptance tests

The inspecting officer will carry out the acceptance tests on the equipments as specified in the relevant standard with latest amendments and technical specifications.

16.03 Routine Tests

All the equipment offered shall be subjected to the routine tests at the manufacturer's works as specified in the relevant standards.

16.04 Type tests reports

The tenderer shall furnish detailed type test reports of the offered Capacitor Banks for the tests as per relevant IS mentioned in this specification. All these Type Tests shall be carried out at laboratories that are accredited by the National Accreditation Board of Testing and Calibration Laboratories (NABL) of Government of India. These tests should have been carried out within the years as per CEA guidelines prior to the date of opening of the tender. i.e. the validity of the Type Test reports will be considered as per CEA guidelines.

The detailed type test reports along with the relevant oscillograms/certified drawings, etc. or undertaking seeking exemption from their submission in the format schedule 'F', are to be submitted in sealed cover along with the offer.

The purchaser reserve the right to demand repetition of some or all the Type Tests in presence of purchaser's representative at purchaser's cost. For this purpose, the tenderer shall quote unit rates for carrying out each Type Test. However, such unit rates will not be considered for evaluation of the offer. In case the unit fails in the type tests, the complete supply shall be rejected.

The successful tenderer shall take approval of type tests from C.E. (Testing), M.S.E.D.C.L. Prakashgad, Bandra, Mumbai, prior to commencement of supply.

16.05 Documentation

- 16.05.1** After issue of letter of acceptance, the successful tenderers shall submit 3 identical sets of complete drawings along with detailed bill of materials for approval, to the Chief Engineer, (Testing), 5th floor, Prakashgad, MSEDCL, Bandra (E), Mumbai-400051. If any modifications are required on these, the same will be conveyed to the supplier who shall modify the drawings accordingly and furnish final

drawings for approval. In no case delivery extension will be granted for any delay in drawing approval.

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

16.05.3 After approval of the drawings and bills of materials, the suppliers shall submit detailed packing lists for approval. After approval, copies of these packing lists shall be forwarded to the respective consignees. Copies of packing lists shall also be submitted to the Chief Accounts Officer (SB), MSEDCL, Prakashgad, Bandra (East) along with the bills for payment.

16.05.4 Before dispatch of equipment to various consignees, the suppliers shall furnish sets of final drawings, including bills of materials and wiring schedules and also sets of technical literature and commissioning manuals. These shall be in five sets and shall be furnished to the Testing department, Bandra (E) positively before the dispatch of equipment. All drawings shall preferably be of A3 size. No drawing of width more than 35 cm will be acceptable. One set each of the final drawings; bill of materials, wiring schedules and commissioning manuals shall invariably be forwarded to the consignee along with the each set of capacitor bank consignment and shall be listed out in the packing list, when submitted for approval.

16.05.5 In case the supplier fails to furnish contractual drawings and manuals even at the time of supply of equipment, the date of furnishing of drawings/manuals will be considered as the date of supply of equipment for the purpose of computing penalties for late delivery.

16.05.6 List of drawings to be submitted along with the offer are as under

- a) General arrangement drawing for capacitor bay & capacitor units.
- b) General arrangement drawing for circuit breaker.
- c) General arrangement drawing for series reactor.
- d) General arrangement drawing for Isolator (i) with earth blade and (ii) without earth blade.
- e) General arrangement drawing of current transformers.
- f) General arrangement drawing of Neutral current transformer.
- g) General arrangement drawing for control and relay panels.

Bill of material for complete Capacitor Bank and associated equipments such as, circuit breaker, CTs, NCT, LAs, Isolators, Reactors, Terminal connectors etc

- 16.06** Successful tenderer shall furnish all above drawings and following additional drawings for approval.
- 16.06.1** Support structure for circuit breaker, LAs, Isolators, CTs, capacitor bank, series Reactors & NCT.
- 16.06.2** Common Foundation Plan and design details/data of foundations for incomer bus & outgoing section.
- 16.06.3** Detailed drawing for T-Connector, terminal connector and other connector.
- 16.06.4** Schematic diagram of power control & protection circuit for capacitor bank.
- 16.06.5** Schematic diagram and sequence diagram of circuit breaker.
- 16.06.6** Detailed drawings for every equipment showing Assembly, important cross sections, drawings of relevant parts, joints, gaskets, name plates and other informative drawings etc.
- 16.06.7** The drawings, technical literature and manuals submitted by the tenderer along with his offer shall be treated as purely and generally informative in nature and unless the details incorporated in them are clearly and specifically brought out in the various Schedules for Guaranteed Technical Particulars and Schedules of Deviations, the same shall not be binding upon the purchaser (a) for evaluation of the offer and (b) for the order, if placed.

17.00 ERECTION AND COMMISSIONING

The bidder should quote separately for the following works of erection & commissioning of the complete capacitor bank

- 1) Civil foundations for various equipment including capacitor Bank and associated equipments. The foundations will be casted in plain cement concrete in ratio 1:2:4.
- 2) Providing of earth mat & earthing of equipments etc. wherever required,
- 3) Required cabling works including materials as per the detailed approved drawings.
- 4) ACSR conductor of requisite length shall be supplied by the bidder/ contractor for interconnecting the equipments

18.00 EARTHING SYSTEM

The scope for installation of earthing system associated with the sub station shall include:-

- a. Supply of required materials for installation of earthing system including transporting the materials to the location of installation.
- b. Welding/brazing/bolting of joints as required and treating joints with appropriate paint as specified. Such connections should be bolted tightly using spring & ring washers for proper contact pressure.
- c. Installation of earthing conductor for the main earthing mat/Grid, MS Flat of size 50 x 6 mm or equivalent. These shall be buried in ground at a depth of 500 mm. The work shall include excavation and backfilling, laying the conductor, brazing the joints and providing the risers, wherever necessary.
- d. Installation of earth riser (MS Flat of size 50 x 6 mm), connection leads to the equipments and risers on steel structures wall etc. The position cleating and clamping at regular intervals, welding/brazing of riser/leads as required to the main earth grid and providing bolting joints at the equipment earthing terminals. All welded and brazed joints of riser conductor shall be coated with bituminous paint.
- e. Installation of earthing electrodes (earthing pipe) comprising of 100 mm dia GI Pipe of 3 Meter Length:
- f. After completion of installation of capacitor bank the shut down for charging of capacitor bank will be arranged by MSEDCL. For this, the supplier has to intimate MSEDCL in writing about readiness of the capacitor bank. The 22 KV supply extension from existing bus to the incoming isolator of capacitor bank installation shall be within the scope of MSEDCL. However, the required clamps & conductor is to be arranged by the supplier. If extension of bus / extension of bay is required the same will be arranged by MSEDCL.
- g. As all the capacitor banks are going to be installed in the existing sub station, there is no separate electrical inspectorate approval is required. However, if it is required the same will be arranged by MSEDCL.
- h. At the existing 33/22 KV sub stations wherever space is a constraint or sufficient space is not available for installation of capacitor bank, bidder has to provide supporting PI structures along with PI for maintaining the clearances & adequate supports. Bidder has to include the cost of the same in the quoted prices of capacitor wherever required.

The scope of work shall include installation of these GI pipes in earth and earth pits, providing connection to the main earthing grid, excavation and back filling of earthing pits with all materials as required, placing the rod in position, and connecting to main earth grid conductors.

18.01 Details of earthing system

Sr. No.	Item	Size	Material
1.	Main earthing conductor	50 x 6 mm Flats or equivalent as per the site requirement	M. S.
2.	Earthing for equipments, structures	50 x 6 mm Flats or equivalent as per the site requirement	M. S.
3.	Earthing electrodes	4 mm thick, 100 mm dia, 3000 mm long GI Pipe.	Galvanized. 1 No. to be used in one earth pit
4.	Earth pit (arrangement)	300 mm x 300 mm x 3000 mm.	Earthing electrodes interconnected to each other as per standard practice

18.02 Details of specification for installation of earthing system

- a) The bidder shall install earthing material required for the system and individual equipment earthing. All work such as cutting, bending, supporting, soldering, coating, drilling, brazing, clamping, bolting and connecting into structures, pipes, equipment frames terminals, rails or other devices shall be in the bidder's scope of work. The bidder shall also carryout the excavation and trenching work involved. The bidder shall also back-fill and reinstates the trenches after installation of earthing conductors.
- b) Metallic frames of all electrical equipments shall be earthed by two separate and distinct connections with earthing system.
- c) Neutral connection shall never be used for the equipments earthing.
- d) An earthing pad shall be provided under each operating handle of the isolator. Operating handles of the isolator and supporting structure shall be bonded together by a flexible copper braided conductor (of appropriate rating in consultation with purchaser) connection and connected to the earthing grid of appropriate rating.

- e) A separate earth electrode pit shall be provided adjacent to structures supporting lightning arrester. Earth connections shall be as short and as straight as practicable.
- f) On completion of the installation, continuity of all conductors and efficiency of all bonds and joint shall be tested. The earth resistance shall be tested in the presence of the Purchaser's representative. All equipments necessary for the test shall be arranged by the bidder.
- g) The welding equipments and consumable items such as welding rods required for installation of the earthing system shall be arranged by the bidder.
- h) The earthing installation for the complete 22 KV capacitor installations as described above shall finally be connected to the main earth mat of the sub station existing earthing system by the bidder. The connections to main earthing system will have to be done at minimum of three points between the earthing system of Capacitor installation and main earth mat of existing substations

For earthing system of the installation all associated civil works as described above shall be within the scope of bidder.

19.00 CONTROL CABLES

- A)** The copper control cable shall be of 1.1 KV grade L. T. cable with stranded untinned copper conductor, PVC insulated (Type A), colour coded up to 5 cores, & by number coded above 5 cores, laid up with fillers and/or binder tape where necessary, provided with extruded PVC inner sheath, single galvanized round steel wire armoured and provided with PVC outer-sheath. Both outer & inner sheaths shall be of type ST-1 as per IS: 5831-1984 and cable shall be conforming to IS: 1554(Part-1) -1988(amended up to date) & bearing ISI mark.
- B)** The aluminum control cable shall be of 1.1 KV grade L. T. cable with stranded H2/H4 grade aluminum conductor, PVC insulated (Type A), colour coded, laid up with fillers and/or binder tape where necessary, provided with extruded PVC inner sheath, single galvanized round steel wire armoured and provided with PVC outer- sheath. Both outer & inner sheaths shall be of type ST-1 as per IS: 5831-1984 and cable shall be conforming to IS: 1554(Part-1) - 1988(amended up to date) & bearing ISI mark.
- C)** The cable shall be designed to withstand mechanical, electrical and thermal stresses developed under the steady state and

transient operating conditions. The bidder should assess the quantity of cable required for individual site.

- D) The bidder shall supply, install, test and commission the cables in accordance with the cable schedules approved by the purchaser. Cables shall be laid in accordance with the cable schedules approved by the purchaser. Cables shall be laid in existing cable trench wherever available. If the trench is not available the cable may be laid through PVC pipes of suitable size at a depth of 500 mm. The bidder's scope of work includes supply, unloading, laying, fixing, jointing, bending and termination of cables. The bidder shall also supply necessary materials for jointing and termination of cables.
- E) Identification tags shall be attached to each cable with non-corrosive wire. (Wire must be of non-ferrous materials).
- F) Sharp bending and kinking of cables shall be avoided.
- G) When cables are laid in the proximity of communication cable, required horizontal and vertical separation shall be maintained.
- H) No Jointing of cables shall be done.
- I) Special tools, clips and saddles, glands, seals, PVC sealing compound, locknut etc, for the connection and termination of cables shall be arranged by the bidder.
- J) As a standard practice following are the sizes of Cables used for capacitor bank installation:
 - 1. 2 core X 2.5 sq.mm copper
 - 2. 4 core X 2.5 sq.mm copper
 - 3. 19 core X 2.5 sq.mm copper
 - 4. 2 core X 4 sq.mm aluminum
 - 5. 4 core X 10 sq.mm aluminum

20.00 FITTING AND ACCESSORIES

Any fitting or accessories which might not have been mentioned in the specifications but which are usual or are necessary in the equipment of similar nature, are to be provided by the contractor without extra cost. All equipments must be complete in all details whether mentioned in the specifications or not

ANNEXURE 'I'

STANDARDS TO BE ADOPTED FOR CAPICATOR BANK.

Sr. No.	Indian Standard	Title	International Standard
1	IS:13925 part 1.2012	Shunt capacitors for AC Power systems having a rated voltage above 1000V	-
2	IS:12672	Internal Fuses for Shunt capacitors	-
3	IS:2099	Bushings for voltage above 1000V	IEC:60137
4	IS:5553	Reactors	IEC:60289
5.	IS: 13118	High Voltage AC Circuit Breakers	IEC:60056
6.	-	AC Disconnectors (Isolators) & earthing switches	IS/IEC 62271-102/IEC:60129
7.	-	High Voltage Switches	IEC 62271-103/IEC:60265
8.	IS:16227	High Voltage Current Transformers	IEC:60185
9.	IS:16227	High Voltage Potential Transformers	IEC:60186
10.	-	Tests on post insulators for system with nominal voltage higher than 1000V	IEC:60168
11.	IS:2071	High Voltage tests	IEC:60060
12.	-	RIV measurements	IEC Recommendations CISPR
13.	IS:2609	Partial Discharge measurements	IEC:60270
14.	IS:3716	Insulation co-ordination & Application Guide.	IEC:71
15.	IS:1554	Low Voltage Cables	IEC: 245,228,229, 189,204.
16.	IS: 3070	Metal Oxide Surge Arrestors	IEC 60099-4
17.	IS:3231	Electrical Relays	IEC:255
18.	IS:11353	Control circuit wiring & Panels.	-
19.	-	Hot Dip Galvanizing	ISO 1459 & ISO 1461
20.	-	Clearances in Air as per IE Rules	-

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

Annexure-II 'A'

Schedule of Guaranteed Technical Particulars of Shunt Capacitor Bank

Sr. No	Particulars	Technical Requirement for			Offered
		1.2 MVAR Cap.Bank	2.4 MVAR Cap.Bank	3.0 MVAR Cap.Bank	
1.	Type, Manufacturers Name & Address				
2.	Rated Voltage KV	25.30	25.30	25.30	
3.	Service Voltage KV	22	22	22	
4.	Rated Frequency Hz	50	50	50	
5.	MVAR of the Cap. Bank at rated voltage & Frequency	1.452	2.904	3.960	
6.	MVAR of the Cap. Bank at service voltage & Frequency	1.2	2.4	3.0	
7.	Temperature Rise (over an ambient of 40° C of the Cap. unit)	As per IS-13925, Part I 2012			
8.	Capacitance of the bank per phase in micro farads	-	-	-	
9.	Rated line current Amps	-	-	-	
10.	Maximum permissible continuous over load current Amps	As per IS-13925, Part I 2012			
11.	Capacitor losses for individual units Watts/KVAR	0.2	0.2	0.2	
12.	No. of Cap. units per Capacitor Bank	12	12	24	
13.	Capacitor unit rating Kv	7.3	7.3	7.3	
14.	Capacitor unit rating kVAR	121	242	165	
15.	Max. capacitor inrush surge with the proposed reactor Amps	Less than 100 times the rated current.			
16.	Discharge time with internal discharge device	With in 600 Secs.	With in 600 Secs.	With in 600 Secs.	
17.	Min. elect. Clearances in the bank between phase to phase & live parts to earth in mm	As per Electricity Act 2003 & as per Indian Standards			
18.	Maximum permissible over voltage & duration corresponding to the same in % for 1Hr./2Hr./4Hr./continuous	As per IS-13925, Part I 2012			

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

Sr. No.	Particulars	Technical Requirement for			Offered
		1.2 MVAR Cap.Bank	2.4 MVAR Cap.Bank	3.0 MVAR Cap.Bank	
19.	Overall dimensions of the Capacitor Bank				
20.	Layout & dimensions drawings (to be attached separately)				
21.	Maximum over voltage the Unit Capacitor is capable of withstanding continuously in % rated KV	As per IS-13925, Part I 2012			
22.	Insulator strength of bushings & Cap. units	28kV(rms) 75kV(Pk)	28kV(rms) 75kV(Pk)	28kV(rms) 75kV(Pk)	
23.	Power frequency Test Voltage KV (rms)	28	28	28	
24.	Impulse Test Voltage KV (Peak)	75	75	75	
25.	Bushing's minimum Creepage	25mm/KV	25mm/KV	25mm/KV	
26.	No. of Capacitor elements per unit Capacitor with No. of series/parallel elements(Sketch enclosed)				
27.	Mode of internal connection of the Capacitor elements (Sketch enclosed)				
28.	Voltage across each element in unit at rated voltage				
29.	Percentage Loss of Capacitance at which an internally fused Capacitor unit is considered useless.	As per IS-13925, Part I 2012			
30.	Type of dielectric Material used.	All Polypropylene film			
31.	Thickness in mm of insulation system/ dielectric				
32.	Watt loss of paper/film at various dielectric temperatures (enclosed)				
33.	Max. Stress on the dielectric in volts/micron.				
34.	Type test reports on cap. units				

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

Annexure- II 'B'

Schedule of Guaranteed Technical Particulars of Circuit Breaker

Sr. No	Particulars	Technical Requirement for			Offered
		1.2 MVAR Cap. Bank	2.4 MVAR Cap. Bank	3.0 MVAR Cap. Bank	
1.	Make				
2.	Type	Outdoor, vacuum, gang operated			
3.	Reference Standard	IS 13118/IEC:60056			
4.	Nominal system voltage	22 kV			
5.	Highest system voltage	24 kV			
6.	Rated current	800A			
7.	Single capacitor bank breaking current	400A			
8.	Short time rating of circuit breaker	25 kA for 3 secs			
9.	Short circuit breaking current	25 kA			
10.	No. of poles	3			
11.	Frequency	50 Hz			
12.	Basic insulation level	50 kV/125 kV peak			
13.	Rated short circuit making current	62.5 KA peak			
14.	Operation duty	O - 0.3 sec – CO – 3 min - CO			
15.	First pole to clear factor	1.5			
16.	Control Circuit Voltage	30 V DC			
17.	Max. Total break time at 100% rated interrupting breaking capacity	40-60 ms			
18.	Maximum Closing Time	100 ms			
19.	1.2/50 micro second impulse withstand voltage	125 kVp			
20.	One minute power frequency withstand voltage	50kV			
21.	Creepage distance of support insulators	Min. 600mm			
22.	Details of operating mechanism along with the details of spring charging mechanism/motor				
23.	Clearances provided in air in mm between a) Phases b) Live part to live part c) Live part to Earth d) Live part to ground e) Lowest part of support insulator to ground	3700 mm Min 2500 mm			

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE
STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

24.	Whether all other details of Circuit Breaker are as per the specifications & relevant IS		
-----	--	--	--

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

Annexure- II 'C'

Schedule of Guaranteed Technical Particulars of Current Transformers

Sr. No	Particulars	Technical Requirement for			Offered
		1.2 MVar Cap.Bank	2.4 MVar Cap.Bank	3.0 MVar Cap.Bank	
1.	<u>Current Transformer</u>				
1.	Make				
2.	Type	Outdoor, oil immersed/Dry Type, dead tank			
3.	Reference Standard	IS-16227			
4.	Rated voltage	22 kV			
5.	Rated Frequency	50 Hz			
6.	Rated primary current	200-100 or 300-150A			
7.	Rated secondary current	5 A			
8.	Ratio	200-100/5-5A or 300-150/5-5A			
9.	No. of cores	2			
10.	Rated output of each core	15 VA-15 VA			
11.	Class of accuracy	Prot-5P10, Met-Class 0.5			
12.	Over current factor	25 kA for 3Secs.			
13.	Power frequency withstand voltage	50 kV(rms)			
14.	Impulse withstand test voltage	125 kV(peak)			

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

Annexure- II 'D'

Schedule of Guaranteed Technical Particulars of Neutral Current Transformer

Sr. No.	Particulars	Technical Requirement for			Offered
		1.2 MVAR Cap.Bank	2.4 MVAR Cap.Bank	3.0 MVAR	
	Neutral Current Transformer				
01	Make				
02	Type	Outdoor, Oil cooled / Dry Type (Polycrate / Epoxy)			
03	Reference Standard	IS-16227			
04	Rated voltage	22 kV			
05	Rated Frequency	50 Hz			
06	Ratio	5/5A as per the requirement			
07	No. of Cores	1			
08	Rated output of each core	15 VA			
09	Class of accuracy	Prot-5P10, Met-Class 0.5			
10	Power frequency withstand	50 kV (rms)			
11	Impulse withstand test voltage	125 kV (peak)			
12	Over current factor	25 kA for 3 Secs.			
13	Instrument security factor	Not more than 5			

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

Annexure- II 'E'

Schedule of Guaranteed Technical Particulars of Series Reactors

Sr. No	Particulars	Technical Requirement for			Offered
		1.2 MVAR Cap. Bank.	2.4 MVAR Cap. Bank	3.0 MVAR Cap. Bank	
1.	<u>Make</u>				
2.	Type	Outdoor, Single phase, air cooled, air cored, Dry type, aluminum wound, Non magnetically shielded			
3.	Reference Standard	IS-5553 part-III/1990			
4.	% Impedance	6% or 0.2% of corresponding Cap Impedance.			
5.	System Voltage, Frequency, & number of phases	22KV, 50Hz, 3 phase			
6.	Basic insulation level	50 kV/125 kV peak			
7.	Type of cooling	AN			
8.	Overall dimensions Length in mm Width in mm <u>Height in mm</u>				
9.	Over current factor	16.67 times for 2 Secs. & 130% of rated current for continuous operation			
		For 6% Reactor			
10.	Rated continuous through put KVAR	14.52 X 6	29.04 X 6	39.6 X 6 or 79.2 X 3	
11.	Rated current Amps / phase	-	-	-	
12.	Impedance Ohms/Phase	-	-	-	
13.	Load losses in KW for 3 phases				
		For 0.2% Reactor			
14.	Rated continuous through put KVAR	0.484 X 6	0.968 X 6	1.32 X 6	
15.	Rated current Amps / phase	-	-	-	
16.	Impedance Ohms/Phase	-	-	-	
17.	Load losses in KW for 3 phases				

Annexure- II 'F'

Schedule of Guaranteed Technical Particulars of Lightning Arrestors

Sr. No	Particulars	Technical Requirement for			Offered
		1.2 MVAR Cap. Bank.	2.4 MVAR Cap. Bank	3.0 MVAR Cap. Bank	
1.	Make				
2.	Type	Outdoor type, Station Class, Metal Oxide, Gapless, Single unit.			
3.	Reference Standard	IS:3070 (Part-1) / 1985 IS:3070 (Part-3) / 1993			
4.	Rated voltage kV	18			
	Rated Frequency	50 Hz			
5.	Max. Continuous Operating Voltage (M.C.O.V) in KV rms	15			
6.	Nominal Discharge Current corresponding to 8/20 micro seconds	10 KA			
7.	Type of mounting	Pedestal type			
8.	Connection clearance a) between phase to earth b) between phase to phase	430 mm. Min 1250 mm.			
9.	Long duration discharge class	III			
10.	Max. Radio Interference voltage when energized at M.C.O.V. (micro-volts)	PD less than 50 pC			
11.	Requirement for pressure relief test min. prospective symmetrical fault current (KA rms)	Class-A			
12.	Minimum Creepage Distance of arrester housing (mm)	600			
13.	Terminal connectors	Suitable for ACSR Panther Conductor			
15.	Protective characteristics of Arrestors	As per IEC 60099-4			
16.	Pressure relief device	40KA - Class'A'			

Annexure-II 'G'

Schedule of Guaranteed Technical Particulars of Isolators

Sr. No	Particulars	Technical Requirement for			Offered
		1.2 MVar Cap. Bank.	2.4 MVar Cap. Bank	3.0 MVar Cap. Bank	
1.	Make				
2.	Type	Outdoor type, Center rotating, Horizontal double break, 3 Pole Gang operated, With earth blade & without earth blade			
3.	Reference Standard	IS/IEC 62271-102			
4.	Rated voltage kV	22			
5.	Frequency Hz	50			
6.	Continuous current rating	800 Amps			
7.	Rated short time current rating for 3 sec	25 KA(rms) 62.5 KA (peak)			
8.	Maximum temperature rise over specified ambient temperature of 40° C	With in permissible limit as per IS/IEC 62271-102			
9.	1.2/50 micro second full wave positive and negative impulse withstand voltage a) To earth & between poles KV(peak) b) Across the isolating distance for main blades KV(peak)	125 95			
10.	One minute Power Frequency withstand voltage a) To earth & between poles KV(rms) b) Across the isolating distance for main blades KV (rms)	50 50			
11.	Type of main contacts	High pressure Banking type			
12.	Type of arcing contacts	Make before and break after			
13.	Material of contacts a) Arcing b) Main c) contacts	G.I. HDEC Pipe silver plated			
14.	Minimum center to center clearance between two poles	1500 mm			

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

15.	Minimum clearance in air between phase & earth	430 mm	
16.	Minimum clearance in air between rotating post & fixed post on one phase	485 mm	
17.	Material and grade of Moving blades & contacts	Hard drawn electrolytic grade copper	
18.	Cross sectional area of Moving blades	Min 400 sq. mm for hollow tube & 500 sq. mm for solid plate	
19.	Thickness of silver plating provided on contact surface of Moving blades	10 to 15 microns	
20.	Size , length & class of Tandem pipe	At least 25mm ID, Class B	
21.	No. of bearings	Min. 2 Nos.	
22.	Pitch circle diameter of post Insulators	76mm	
23.	Clearance a) between poles (mm) b) between live parts & earth (mm) c) between live parts when switch is open i) On the same pole (mm) ii) Between adjacent poles (mm)		
24.	Type of interlocks a) Mechanical interlock b) Electrical interlock	between Main switch & Earth/ switch between Isolator & circuit breaker	
25.	Type of operating mechanism	Manual	
26.	Total weight in kg.	400 kg approximately	

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

Annexure-II 'H'

Schedule of Guaranteed Technical Particulars of Control and Relay Panel

Sr. No.	Particulars	Technical Requirement for			Offered
		1.2 MVar Cap.Bank	2.4 MVar Cap.Bank	3.0 MVar Cap.Bank	
1.	Cubicle Simplex type	Reputed make			
2.	Mimic Diagram	Reputed make			
3.	12 window static Annunciator with relays etc.	Reputed make			
4.	Accept, Reset, Lamp test, & Sound cancel Push Buttons (4nos.)	Reputed make			
5.	96 X 96 mm Digital Ammeter with selector switch.	Reputed make			
6.	96 X 96 mm Digital Voltmeter with selector switch	Reputed make			
7.	Digital MVar meter	Reputed make			
8.	Digital Power factor meter	Reputed make			
9.	12 way control switch for circuit breaker	Reputed make			
10.	Numeric type 2 O/C + 1 E/F IDMT relay	Reputed make			
11.	Numeric type Over Voltage Relay	Reputed make			
12.	Numeric type Under Voltage Relay	Reputed make			
13.	Numeric type Unbalanced protection (Neutral current sensing) relay	Reputed make			
14.	Static type Trip circuit supervision relay	Reputed make			
15.	Static type High speed relay	Reputed make			
16.	Static type time delay relay	Reputed make			
17.	DC control ON/OFF switch.	Reputed make			
18.	Neon type indicating lamps for breaker & Isolator status (12nos.)	Reputed make			
19.	Semaphore indicator for circuit breaker & Isolator (3nos.)	Reputed make			
20.	Timer for breaker closing Interlock	Reputed make			
21.	Test terminal block	Reputed make			
22.	Lead Power factor relay	Reputed make			

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

23.	Set of fuses for control circuits	Reputed make	
24.	Illumination lamp with door limit switch	Reputed make	
25.	Space heater & toggle switch	Reputed make	
26.	3 Pin plug & socket	Reputed make	
27.	Earth Bus 25 X 6 mm	Reputed make	
28.	Set of disconnecting type terminal block	Reputed make	
29.	Set of non disconnecting type terminal block	Reputed make	
30.	Bell & Hooter for annunciation trip & non-trip alarm	Reputed make	

Annexure III

List of Type Test Reports to be enclosed with the offer

CAPACITOR BANK: IS 13925(Part-I): 2012	
Sr.No	Description of Type Test
1.	Thermal stability test
2.	Measurement of tangent of the loss angle (tan delta) of the capacitor at elevated temperature
3.	Ac voltage test between terminals and container
4.	Lightening impulse Voltage test between terminals and containers
5.	Short circuit discharge test
6.	Endurance Testing as per IS 13925 : Part 2 : 2002
Circuit Breaker: IS: 13118/IEC-60056	
1.	Lightning Impulse Voltage withstand Test
2.	Power Frequency Voltage Withstand Test a) Dry b) Wet
3.	Temperature Rise Test of main circuit
4.	Measurement of resistance of main circuit
5.	Short Time Withstand Current and Peak Withstand Current Test
6.	Mechanical Operation Test
7.	Short Circuit Making and Breaking current Tests a) No load operation before and after test b) Basic test duties no. 1 to 5 c) Single Phase Short circuit test d) Condition of breaker after short circuit test
Current Transformers IS: 16227	
1.	Short Time Current Test
2.	Impulse Voltage withstand Test on primary Terminals
3.	Temperature Rise Test
4.	Tests for accuracy
5.	Wet Test for outdoor type Transformer
Series Reactors IS: IS-5553	
1.	Measurement of winding resistance
2.	Measurement of Insulation resistance
3.	Measurement of impedance of continuous current (if applicable)
4.	Measurement of Loss (if applicable)
5.	Separate-source voltage withstand test
6.	Induced over voltage withstand test
7.	Temperature-rise test at rated continuous current
8.	Lightening Impulse test
Lightening Arrestors: IS-3070(Part-3):1993/IEC 60099-4	
1.	Insulation withstand test on arrester housing
2.	Residual voltage test

TECHNICAL SPECIFICATIONS OF 22 KV, 1.2/2.4/3.0 MVAR CAPACITOR BANK WITH DOUBLE STAR ARRANGEMENT & ASSOCIATED EQUIPMENTS

3.	Long duration current impulse withstand Test
4.	Operating duty test
5.	Pressure relief test
6.	Tests of arrester disconnectors
7.	Artificial pollution test on porcelain housed arrestors
8.	Temperature cycle test on hollow porcelain housings
9.	Porosity test
10.	Galvanizing test on exposed ferrous metal parts
Isolators (with and without E.B.) IS/IEC 62271-102	
1.	Lightning Impulse Voltage withstand Test
2.	Power Frequency Voltage Withstand Test a) Dry b) Wet
3.	Temperature Rise Test
4.	Short Time Withstand Current and Peak Withstand Current Test
5.	Mechanical Endurance Test
Control & Relay Panel	
1	Degree of protection test
2	Induce over voltage test