

CHAPTER -1

PEDESTAL MOUNTED HT CAPACITORS

SECTION – I

STANDARD TECHNICAL REQUIREMENTS

1. SCOPE

1.1 This section of the specification covers the standard technical requirements for design, manufacture, testing at the manufacturer's works before dispatch, supply and delivery of shunt capacitor banks with associated equipments such as circuit breakers, instrument transformers, reactors, control and relay panels, lightning arresters etc. for their efficient and trouble free operation and is to be read together with section II of this specification which covers the specific technical requirement.

1.2 The scope of the work may also include, at the option of the purchaser, supervision of testing and commissioning of all the equipment furnished under this specification.

2. SPECIFIC TECHNICAL REQUIREMENTS

2.1 The specific technical requirements for the shunt capacitor banks and the associated equipment including the quantity, technical parameters, delivery etc., are specified in section II of this specification.

3. STANDARDS

3.1 The shunt capacitor banks and associated equipments shall conform to the latest edition of the following standards (as amended upto date) except where specified otherwise in this specification.

Capacitors	IS:2834, IS:13925
Circuit breakers	IEC:56
Current transformers	IS:2705
Potential transformers	IS:3156
Isolators	IS:9921
Fuses(external)	IS:2208
Protection Relays	IS:3342
Motors	IS:325
Surge Arresters	IS:3070

3.2 Equipment meeting the requirement of any other authoritative standards which ensure a quality equal to or better than that as per the standards mentioned above, shall also be acceptable. Where the equipment conforms to any other standards, salient point of difference between the standards adopted and the specified standards shall be clearly brought out in the tender.

4. DESIGN

4.1 All apparatus shall be designed to ensure satisfactory operation under such sudden variations in voltage as may be met with under working condition in the system including those due to short circuits.

4.2 All material used shall be of the best quality and of the class most suitable for working under the climatic

conditions specified.

5. CAPACITOR BANKS

5.1 The capacitor banks shall be complete with neutral CT/RVT and series reactor as required. Circuit breaker, offload type isolators, instrument transformer, control and relay panels, connecting material and any other material required for capacitor bank may be included in the scope of supply of capacitor bank supplier or procured separately by the purchaser. However, tenderer should quote for all the equipments covered in this specification.

6. GENERAL ARRANGMENT

6.1 The capacitor banks shall be outdoor type suitable for operation in the climatic conditions as given in Annexure I of this specification, and mounting on steel racks to be supplied by the tenderer.

6.2 The tenderer shall also furnish details of the connections between the capacitor units and groups, together with layout diagrams showing the physical arrangements of banks, complete with dimensions.

7. CAPACITOR UNITS

7.1 Each capacitor unit of the bank shall be self-contained outdoor type, to give the required total bank capacity at 50 Hz. Bushing shall be of porcelain and shall be joined to the case by cementing.

7.2 The capacitor units should be manufactured using HAZY polypropylene as dielectric media and non PCB impregnant. The impregnation shall be carried out under high degree of vacuum and the unit shall be of totally sealed type

7.3 The chemical properties of the insulating fluid used in capacitor units shall be such that contamination of the environment from the points of view of bio-degradability toxicity and bioconcentration will be minimum

7.4 Each capacitor unit shall be provided with an internal discharge resistor designed to drain out the residual charge upto 50 Volts or less within 5 minutes after disconnection from supply.

7.5 Each capacitor unit shall be individually protected by a external fuse suitably rated for load current. External fuse shall be expulsion type and the fuse body shall drop out from bus bar to serve as an indication for operation of the fuse. The characteristics of the fuse shall be such that it shall isolate the faulty unit only and prevent it from mechanical destruction due to internal faults. The capacitor units together with external fuses shall be arranged in the bank by providing adequate clearance between the body of the capacitor unit of a phase and the line terminal or the common bus for units of the other phases to obviate the possibility of occurrence of bird faults. The fuse shall isolate the faulty capacitor unit only and the healthy capacitor units shall not be affected in any way by the isolation of faulty unit.

7.6 The fuses shall not melt or deteriorate when subjected to inrush current which occur during the life of the bank.

7.7 Fuses shall be capable of carrying continuously a current of at least 1.65 times the rated r.m.s. current of the associated unit current.

7.8 Fuses shall be preferably of the current limiting type but the fuse system shall in any event be designed to ensure that the energy released into a faulty capacitor unit is less than the value that will cause rupture or bursting of the container.

7.9 Each capacitor unit shall be suitable for continuous operation of 1.3 times rated current at rated voltage

and frequency. This over current factor shall include the combined effect of presence of harmonics and over voltages upto and including 1.1 times the rated voltage.

7.10 Terminals and mounting arrangement may be in accordance with manufacturer's standard practice, but should be proportioned with adequate safety margins.

7.11 The containers of capacitor units shall be of sheet steel painted with suitable anti rust primer paint and the two finishing coats of paint as per the manufacturer' standards practice.

7.12 Tenderer should clearly indicate whether sun shadow to protect the capacitors from direct sun-rays during the hot part of the year is essential or not. In case the sun shades are needed they will form part of the supply of the capacitors.

8. MOUNTING RACKS

8.1 The mounting racks shall be of hot dip galvanized steels sections. Each end of the rack shall have provision to receive incoming line connection. Sufficient space must be provided between rows in a rack for easy replacement of any capacitor unit. 11 kV capacitor banks shall be connected single tier formation whereas 33 kV and above voltage rating banks shall be connected in two or three tier formation.

8.2 The racks shall be complete with rack insulators, foundation bolts or any other hardware etc., for assembly into complete bank.

8.3 The height of the racks of capacitor bank shall be such that for making electrical connections with the other equipments, proper electrical clearance are maintained.

9. CAPACITOR BANK SWITCHING CONTROL

9.1 Switching of capacitor banks would be performed by circuit breakers through remote electrical control from the control room. In addition there would be local manual/electrical control of circuit breakers.

9.2 A Timer must be included with adjustable setting of 0 to 6 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)

10. PROTECTION

10.1 The capacitor banks shall be provided with the following protections

- a. Over current and earth fault protection to cover the faults in the capacitor banks and its controlling circuit breaker.
- b. Over voltage protection.
- c. Unbalance protection.
- d. No volt protection.

10.2 Requirement of each of the above protections are described below:

10.2.1 Over current and earth fault protection

Combination of two over current IDMT relays having 50-200% settings and one E/F relay of IDMT characteristic with 20-80% setting shall be used with suitable current transformer.

10.2.2 Over voltage protection

Shall be provided with an inverse time characteristic. Over voltage relay shall be energized from a VT

connected to the main bus bars on the source side of the circuit breaker controlling the capacitor banks. Setting shall be variable from 100% to 130% in steps at least 1% to 2%.

10.2.3 Unbalance protection

The unbalance protection shall be provided through current unbalance relay connected to neutral CT in the neutral of capacitor bank connected in double star and through voltage operated relay connected across the open delta voltage of RVT for capacitor bank connected in single star. This relay shall have two independent settings. One setting shall be used for alarm and other setting for tripping the capacitor bank. The setting of current relays shall be 10 % to 40% of CT secondary current followed by a time delay through a timer 0.1 sec. for transient free operation of above protection. Inverse time characteristic may be used for voltage operated relay. The protection shall give an alarm when voltage on healthy units due to failure of one or more units rises to 105% and trip the capacitor bank when voltage rises to 110%.

10.2.4 No Volt protection

No Volt protection should be provided to disconnect the bank under no voltage conditions. This protection shall be energized from the existing bus PT. This protection should not operate in the event of fault on 66 kV and 33 kV lines which may dip the bus bar voltage to 50%. There should be provision for adjustment in setting of voltage and time to coordinate 66 kV and 33 kV lines protection with the no voltage protection to avoid maloperation of No voltage relay under line fault conditions.

11. CIRCUIT BREAKER

11.1 The circuit breaker shall be SF6/vacuum, outdoor/indoor type suitable for a rapid and smooth interruption of capacitive and fault currents under all conditions

11.2 The circuit breaker shall be free from re-strikes under all operating conditions.

11.3 The circuit breaker offered shall be suitable for capacitor bank switching duties of capacitor bank ratings indicated in Annexure III of Section II.

11.4 Operating Mechanism

11.4.1 The circuit breaker should be suitable for remote control from the control room and in addition there should be provision for local electrical and manual operation of circuit breaker.

11.4.2. The circuit breakers should have mechanical "open/close" indicator in addition to the facilities for remote electrical indication.

11.4.3 The operating mechanism should of motor operated or pneumatically operated type. The mechanism should be trip free electrically and mechanically. All working parts in the mechanism should be of corrosion resistant material and all bearings which require greasing should be equipped with pressure grease fittings. A suitable anti pumping feature should be incorporated in the breaker.

11.4.4 The operating mechanism along with its accessories should be mounted in a weather proof cabinet with hinged doors and located near the breaker or accommodated in the steel framework of the breaker itself. The local control switch and the breaker position indicator should be provided in this cabinet.

11.4.5 The control circuit should be designed to operate on 220/110/50/24 – V d.c. and it should be possible to adopt it to work on any other required voltage by changing the closing and opening coils of the breaker. Closing coils should be designed to operate satisfactorily at any control voltage from 85% to 110% of the normal voltage. Tripping coils should be designed to operate satisfactorily at any control voltage from 70% to 110% of the normal voltage. However, circuit breaker when not carrying current should be capable of

operating satisfactorily when the control voltage at the terminals of trip coils is less than 50% of normal voltage.

11.4.6 A heater along with switch should be provided in the cubicle for connection to single phase 240 V AC supply to prevent moisture condensation

11.4.7 A local/remote switch should be provided in the operating mechanism of the circuit breaker to cut off the DC supply to trip or close coils from remote control when the switch is set to 'local' so that the breaker cannot be operated from remote control switch. But trip coils should be so connected that these receive a tripping command from the relays even after remote control is disconnected

11.4.8 Power supply for auxiliaries will be available at 240 V, 1 phase and 415 V, 3 phase, 50 cycles.

11.4.9 Necessary cable glands for the cable of the operating mechanism should be provided along with a large common gland plate.

11.5 Auxiliary switches

Adequate number of silver coated auxiliary switches (contacts) both of the normally open and normally closed types (along with 6 nos. and 6 NCs as spare) should be provided in each circuit breaker for use in the remote indication and control scheme of the circuit breaker and for providing safety inter-locking. There should be provision to add a few auxiliary switches at a later date, if required.

11.6 Interlocks

Provision should be made to enable suitable mechanical electrical interlocking for the opening or closing of the isolator.

11.7 Terminal connectors

Requisite number of suitable and matching terminal connectors shall also be supplied along with the breaker and accordingly, the prices may be quoted.

12.0 ISOLATOR AND ISOLATOR-CUM-EARTH SWITCH

12.1 The isolator shall be triple pole gang operated having horizontally rotating blades. The isolators shall be capable of withstanding the dynamic and thermic effects of rated short circuit current in the closed position. The earthing switches shall be capable of discharging trapped charges of the shunt capacitor banks.

12.2 The isolators and earth switch shall be manually/electrically operated. Isolators should be provided with ON and OFF indicators, arrangement for mechanical interlock and padlocking.

12.3 Isolators should be provided with auxiliary switches for their remote position indication on the control panel and electrical interlocking with circuit breaker. Four pairs of NO and NC contacts shall be provided.

13 CURRENT TRANSFORMERS

13.1 The current transformers shall be of the outdoor type single phase, 50Hz, oil immersed, self cooled type.

13.2 The core shall be of high grade, non ageing electrical silicon laminated steel of low hysteresis loss and

high permeability to ensure high accuracy at both normal and over current.

13.3 The current transformer shall conform to the latest edition of IS:2705. The bushing should conform to the latest edition of IS:2099 and 3347. The current transformer shall be complete in all respects including insulating oil, junction box, terminal connectors, fixing bolts and nuts and other accessories.

13.4 The current transformers shall be hermetically sealed to eliminate breathing and prevent air and moisture from entering the tank. These shall be provided with oil level gauge and pressure relieving device capable of relieving abnormal internal pressures.

13.5 Suitable and matching terminal connectors shall also be supplied along with the current transformers and accordingly, the prices may be quoted.

14.0 CONTROL AND RELAY PANEL

14.1 The control and relay panels shall conform in all respects to relevant Indian standards.

14.2 The control and relay panels shall be of floor mounted, indoor, free standing, cubicle type. The panel shall consist of fabricated sheet steel enclosures on the side, front, rear and top. The rear of the panels shall be in the form of lockable hinged flap door. The front and rear sheets shall be of folded construction for providing rigidity and strength without using any frame work or screwed or bolted sheets steel sections. The front of the panels which accommodates most of the mounting shall be fabricated with sheet steel of thickness not less than 3 mm. For the rest of the panels which carries no weight of the mountings, sheet steel of thickness not less than 2.5 mm should be used.

14.3 The panels shall be 2315 mm high, 750 mm wide and 610 mm deep with door lock and complete with wiring, earthing bar, fuses, links, vermin proof fittings, internal panel lighting arrangement, operated by a door switch, a space heater rated 100 watt, 230 V AC with a switch ,undrilled cable gland plate and 75x102 mm channel from plinth. The panels shall accommodate the following

1. Ammeter with selector switch
2. Circuit breaker control switch
3. Necessary relays and auxiliary relays
4. Necessary push buttons and switches necessary indicating lamps
5. Any other equipment considered necessary to make the panel complete in all respects.

14.4 All the relays should be accommodated suitably in the control panel complete with necessary indicating instruments, control switches, indicating lamps, wiring, fuses links etc.

14.5 The control and relay panels shall be delivered with all relays, instrument switches, indicating lamps etc. duly mounted.

14.6 The panels shall be equipped with necessary links and HRC type fuses of good quality which shall be mounted on sheet steel brackets. Each fuse shall be identified with the suitable engraved plastic label.

14.7 The internal wiring of the panels shall be carried out with PVC insulated multi-strand, flexible cables, of 650 V/1100 V grade. Both ends of wire shall have the numbered plastic ferrules for identification. Panels wiring shall be suitably bunched and clamped to prevent a neat appearance. All panel wiring should withstand 2 kV AC voltage for 1 min. between conductors and earth.

14.8 All panel wiring terminations (except for CT and VT) for connecting external apparatus circuit shall be

neatly terminated on ordinary terminal blocks. For CT and VT termination, links terminal blocks to be used shall have links for disconnection and plugging in facility for testing purposes. The terminal shall be suitably labeled to readily identify the outgoing/incoming wires. 20 percent terminal of each type shall be provided as spare in each panel for future use.

14.9 All the equipments including relays, indicating instrument etc. shall be flush mounted. All mountings shall be provided on the front side.

14.10 The outside surface of the panels shall be synthetic enamel painted in light grey as per shade No. 631 of IS:5. The inside surface shall be painted with white synthetic enamel paint.

14.11 Each relay, auxiliary relay, instrument, lamps, switches etc. should be identified , both inside and outside the panel with suitable engraved plastic labels

15.0 MIMIC DIAGRAM

15.1 Mimic diagram and symbols showing the exact representation of the system complete with symbols and colour strips to represent the buses, semaphore indicators etc. shall be provided in the front of the control panels. The control switches shall be mounted along with the mimic diagram.

15.2 Mimic diagram shall be made preferably of anodized aluminum of approved fast colour material which shall be screwed on to the panel and can be easily cleaned.

15.3 The colour scheme and size of mimic diagram shall be proposed by the tenderer and will be subject to approval of the purchaser.

15.4 Specific numbers shall be assigned to various isolators, earthing switches and circuit breakers on mimic diagram by the purchaser. The tenderer shall undertake to paint the same in suitable colour without any additional price. The exact numbering shall be intimated to the successful tenderer at a later date.

16. SEMAPHORE INDICATORS

16.1 Automatic semaphore indicators shall be provided for automatic indication in the mimic diagram of the position (open or close) of isolators with earthing switch. They shall be of two coil type and their operating voltage shall be from station DC supply. They shall also have the supply failure indication during which the disc comes to neutral position when both units of the indicator are de-energized. semaphore indicators shall be so mounted on the mimic diagram that the close position shall complete the continuity of the mimic. Their strips shall be of the same colour as of the associated mimic.

17.0 CONTROL SWITCHES

17.1 Control switches shall be of pistol grip type preferably with silver to silver contacts of adequate making, carrying and breaking current ratings and clearly marked to show operating position and shall be suitable for flush mounting with only switch front plate and operating handle projecting out. The connections shall be from the back. The contact assembly at the back of the switch shall be enclosed in dust proof removable covers.

17.2 The selection of operating handles for the different types of switches shall be as follows:

- a) Breaker control switches - Pistol grip black

b) Selector switches - Oval or knob, black

17.3 Circuit breaker control switches shall be 3 position spring return to neutral type. The control springs shall be strong and robust enough to prevent inadvertent operation due to light touch. Adequate number of spare contacts shall be provided on breaker control switch for control interlocking, annunciation. Instrument selection switches shall be of maintained contact (stay-out) type. Ammeter selector switches shall have make before break type contacts so as to prevent open circuiting of CT secondary when changing the position of the switch.

17.4 The contact rating of switches shall be as follows:

Description	Contract rating in Amps	
	240 V AC	220 V DC
a) Make and carry continuously	10	10
b) Make and carry 0.5 sec.	30	30
c) break		
i) Resistive load	7	3
ii) Inductive load with L/R= 40 m sec	7	0.2

18. INDICATING LAMPS

18.1 Indicating lamps shall be of miniature switchboard type suitable for panel mounting with rear terminal connections. Lamps shall be provided with series connected resistors preferably built in the lamp assembly to avoid short circuiting of control supply in the event of short circuiting of lamps. The supply for these lamps shall be from DC station battery unless stated otherwise. Lamps covers shall be of screwed type, unbreakable, and molded from heat resisting material. They shall be translucent to diffuse light unless otherwise stated, the lamp covers, shall be coloured as

- a. 'Red' for indicating close position of breakers
- b. 'Green' for indicating open position of breakers.
- c. 'Blue' for control supply monitoring
- d. 'White' and 'Amber' for miscellaneous indication.

18.2 Colour caps shall be screwed into the front of lamp body so that colour caps and lamps shall be replaceable from the front of the panel. Two sets of special tools, if required for replacing bulbs and covers shall also be included in the scope of supply. All colour covers shall be similar and interchangeable and all lamps be of same type and ratings. Lamps shall be furnished 20% in excess of the actual numbers used required and caps shall be furnished 10% excess of actual number for each colour.

18.3 The wattage and resistance of lamps shall be as follows:

- a. 220V, 5 to 10W, 4000 to 8000 ohms (series resistor)
- b. 110V, 5 to 10W, 1000 to 2000 ohms (series resistor)

The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis.

19.0 ANNUNCIATION SYSTEM

19.1 Alarm annunciation system shall be provided for control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective device. The annunciation shall be divided into the following two categories:

- i. Emergency annunciation
- ii. Warning annunciation

The annunciation equipment shall be suitable for operation on DC supply as specified in this specification.

19.2 EMERGENCY ANNUNCIATION

19.2.1 This annunciation is used to draw the attention of the operator when the circuit breaker is tripped automatically. Auxiliary contact for the audible annunciation shall be provided. The visual annunciation shall be by flickering of a respective facial window provided on the respective panel on which the control of the tripped breaker is located. The tripped breaker shall be identified by the flickering of the corresponding position indicating lamp.

19.3 WARNING ANNUNCIATION

19.3.1 This annunciation is used to draw the attention of the operator to the occurrence of an abnormal operating condition and then the tripping of the circuit breaker. Auxiliary contact for the audible annunciation shall be provided. The visual annunciation shall be by flickering of the respective facia window. Certain number of alarms under this category have to be time delayed with time delay adjustable between 2 to 10 seconds. Arrangements for this purpose shall be provided by supplier.

19.3.2 The visual annunciation shall be provided by annunciation facia flush mounted on the top row of the control panels. Necessary switching relays for the same shall be mounted inside the panels. The annunciator facia shall be provided with trans-lucent glass or plastic cover plates of white colour with inscriptions in black letters. The size of the facia window shall be 30 mm x 25mm and the size of the lettering shall not be less than 5 mm. Alarm inscriptions shall be engraved on each window in not more than three lines and shall be visible on when the facia light is on. The cover plates of the facia window shall be capable of easy removal to facilitate replacement of lamps. The transparency of covers and wattage of the lamps provided in the facia window shall be adequate to ensure clear visibility of the inscription from the location of the operator's table in the control room having high illumination intensity. Each annunciation window shall be provide with two lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The lamps circuit shall include series resistor of adequate rating. "Acknowledge" "Reset" and "Lamp Test" push buttons for the annunciators shall be provided. The sequence of operation of the annunciator shall be as follows:

Alarm condition	Fault Contact	Visual	Audible
		Annunciation	Annunciation
1. Normal	Open	off	off
2. Abnormal	Close	Flashing	On

3. Acknowledge a) Close Steady on Off
push button is pressed
- b) Open Steady on Off
4. Reset push a) Close on Off
button pressed
- b) open off off
- 5 Lamp test Open Steady on Off push button pressed.

19.3.3 In case of static annunciator schemes, special precautions shall be taken by the tenderer to ensure that spurious alarm conditions do not appear due to influence of external magnetic fields on the annunciator wiring and switching disturbances from the neighboring circuits within the panels.

19.3.4 Visual and audible annunciation for the failure of DC supply to the panel shall also be provided and this annunciation shall operate on a 240 volts AC supply with separate fuses. A separate voltage check relay (adjustable setting) for the failure of supply shall be provided and if the failure of supply exists for more than 2 to 3 sec. a facia shall light up and the bell shall sound. A separate push button shall provided for cancellation of this bell alone but the facia window shall remain steadily lighted till the supply the annunciation system is restored.

20.0 INDICATING INSTRUMENTS

20.1 Indicating instruments shall be flush mounted with anti-parallax white circular scales with black pointer and with black number and lettering. Knife edge pointers shall be preferred. Unless otherwise specified the size of all instruments shall be 125 mm x 125 mm and they shall have a circular 240 scale.

20.2 The dials shall be free from warping, fading and discolouring spring controlled instruments shall be provided on from with zero adjuster, capable of being safely handled while the instrument is in service. Instrument covers shall be of shadow proof design, utilizing all available light. They shall also have red marks on the dial corresponding to rated values of the associated primary equipment. The indicating instruments shall conform to IS: 1248 and shall have an accuracy class of 2.0 or better. The design of the scale shall be such that the resolution corresponding to 50% of the accuracy class index is possible.

21.0 AMMETERS

21.1 All ammeters shall be of moving iron type and provide direct reading triple 'range scale'. The scale value of AC ammeters shall be equal to 1 to 1.3 times the rated primary current of the current transformer feeding it. The rated current of the ammeter element shall be 1.0 Amp. Or 5 A. The ammeters shall withstand 120% of rated current continuously and 10 times the rated current for 0.5 sec. with out loss of accuracy.

22.0 TRIP CIRCUIT SUPERVISION RELAYS

22.1 The trip circuits shall be supervised by means of relays. The scheme shall continuously monitor the trip circuit before closing and after closing of the breaker. The scheme shall detect (i) failure of trip supply (ii) open circuit of trip circuit wiring and (iii) failure of mechanism to complete the tripping operation. The relays shall have necessary contacts to be connected to either the alarm bell or to the annunciator available in the control panel for audible and visual indication of the failure of trip circuit.

23.0 SERIES REACTOR

23.1 The series reactor of 0.2% of capacitor bank rating shall be provided for limiting the inrush current due to parallel switching of capacitor banks on the same bus.

23.2 The series reactors shall be of outdoor type, three phase, 50Hz, air cooled.

23.3 The series reactor would be connected towards neutral of the shunt capacitor.

23.4 The series reactors shall be complete in all respects including clamps, fixing bolts and nuts and other accessories and shall conform to the latest edition of IS:5553/IEC-259.

23.5 Requisite number of suitable and matching terminal connectors shall also be supplied along with the reactor and accordingly, the prices may be quoted.

24.0 FITTINGS AND ACCESSORIES

24.1 Any fittings or accessories which might not have been mentioned in the specification but which are usual or necessary in the equipment are to be provided by the contractor without extra cost. All equipments must be complete in all details whether mentioned in the specification or not.

25.0 TESTS

25.1 All equipment offered shall comply with type test stipulated in relevant IS/IEC. Test reports for all type tests shall be submitted along with the tender.

25.2 All equipment shall be subjected to routine and acceptance tests in accordance with relevant standards without any extra cost to the purchaser.

25.3 No equipment shall be dispatched until the test reports are duly approved by the purchaser.

25.4 The endurance test as per the procedure given below shall be carried out on one capacitor unit of each rating and size specified in section II or on a small unit of rating not exceeding 4.4 kV and 10 kVAR which is equivalent in all respects to the unit to be manufactured. In case, a small unit is used for testing, over load run test at SI. No. 6 Cl. 25.4.1 shall be repeated on complete unit also

25.4.1 ENDURANCE TESTING OF CAPACITOR UNIT

Aim of the test

Endurance test is a type test on power capacitors for checking the design and the manufacturing process of the capacitor and specifically to establish that the capacitor will withstand the service conditions with a high reliability.

Specification for endurance test on power capacitors

A summary for the test sequence for endurance testing of power capacitors for AC power system is as follows:

(U_N = Rated voltage of the capacitor unit)

1. Routine voltage test

The test unit shall be subjected to the routine voltage test between the terminals by applying $2.15 U_N$ a.c or $4.3 U_N$ d.c. for 10 sec. duration.

2. Conditioning of the capacitors before the test

The test unit shall be exposed to not less than $1.1 U_N$ a.c. at an ambient temperature of not less than $+ 10^\circ \text{C}$ for 16 to 24 hours.

3. Initial capacitance and loss measurement

The test unit shall be placed for at least 12 hours in unenergised state in a chamber with a forced air circulation having temperature selected from the range $+ 60^\circ \text{C}$ to $+75^\circ \text{C}$ with a permitted variation of $\pm 2^\circ \text{C}$. The unit at the same ambient temperature shall then be subjected to U_N . the capacitance and the losses shall be measured 4.5 to 5.5 minutes after the voltage application.

4. Transient over voltage test

The unit shall be place for at least 12 hours in the unenergised state in a chamber with forced air circulation having a temperature not exceeding the lower limit of the temperature category.

The test unit shall then be placed at an ambient temperature of $+ 15^\circ \text{C}$ to $+35^\circ \text{C}$ and exposing it to a voltage of $1.1 U_N$ a.c within 5 minutes after taking it out of the low temperature chamber. The test unit shall be exposed to an over voltage (AC + DC superimposed) of $2.25 U_N$ for a period of one second duration. The voltage $1.1 U_N$ is applied during five minutes followed by a new over voltage period. This sequence is repeated to 100 times a day. The daily cycles are performed UNTIL 1000 over voltage periods have been applied.

5. Capacitance and loss tangent measurement

Repetition of test at Sl. No. 3

6. Over load run test

Within one hour after the end of the over voltage test, the test unit shall be exposed to not less than $1.4 U_N$ a..c voltage for at least 500 hours. The test unit shall be place in a still air at an ambient temperature of $+ 15^\circ \text{C}$ to 60°C .

7. Capacitance and tangent delta measurement

Repetition of test at Sl. No. 3

8. Reduce routine voltage test

Repeat of test at Sl. No. 1 at 75% of the original test voltage.

9. Final capacitance and loss tangent

Repetition of test at Sl. No. 3

10. Acceptance criteria

The test unit is considered to have passed the endurance test successfully if no breakdown has occurred either in two test units out of two or two test units out of three. The capacitance measurements performed at

3,5,7, and 9 steps shall not differ less than an amount corresponding to either breakdown of an element or operation of an internal fuse. The variation of the dielectric loss angle evaluated by this test at 3, 5, 7, 8 and 9 steps shall not exceed beyond the limits specified in Cl. 14 of IS:2834-1986.

25.5 Purchaser also intends to have 'Capacitive current switching test' repeated on the circuit breaker. Tenderer shall quote his charges for the test.

25.6 The purchaser reserves the right of having at this own expense any other test of reasonable nature or any of the type test at his own cost at manufacturer's works or at any other place.

25.7 Four copies of test reports shall be supplied for approval. The reports shall indicate clearly the governing standard and the standard values specified for each test to facilitate checking of test reports.

26.0 SPARE PARTS

26.1 The tenderer shall quote separately for spares recommended by them for five years' operation of equipment covered by this specification. The purchaser will decide the actual quantity of spare parts to be ordered.

27.0 DEVIATIONS FROM SPECIFICATION

27.1 The deviations from specification shall be separately listed in the Schedule. In the absence of which it will be assumed that the provisions of the specification are complied with by the tenderer.

28.0 PERFORMANCE

28.1 The tenderer shall submit details of similar static shunt capacitor banks and the associated equipment supplied by them which are in operation for the last three years, in Schedule "Performance Schedule", along with certificates from their customers in support of the satisfactory manufacture and operation of the static shunt capacitor banks and associated equipment.

29.0 CAPITALISATION OF LOSSES

29.1 For comparison of various offers, equalization on account of differences in losses of capacitors and reactors in various offers shall be made at a rate of Rs..... Per kW. Capacitor bank losses should be given at 50° C and reactor losses at 75° C.

The successful tenderer shall also be penalized at the rate given above if during testing measured losses are found to be more than the guaranteed losses.

SECTION – II

SPECIFIC TECHNICAL REQUIREMENTS

1. SCOPE

1.1 This section of the specification covers project information, climatic conditions, system particulars, desired parameters and quantity of the shunt capacitor banks, associated switchgear and it is to be read together with Section-I which covers the Standard Technical Requirements.

2. PROJECT INFORMATION

2.1 Details of substations for which the equipment covered by this specification are required, are given in Annexure.....

2.2 The climatic conditions under which the equipment is required to Operate satisfactorily are given in Annexure I.

3. SYSTEM PARTICULARS

3.1 The particulars of the system in which the equipment shall be used are detailed in Annexure II.

4. EQUIPMENT PARAMETERS

4.1 The desired parameters of the shunt capacitor Banks and associated equipment are detailed in Annexure III.

5. MODE OF CONNECTION

5.1 Capacitor banks shall be connected as per the arrangement shown in Annexure IV(1), IV(2) and IV (3). In indoor installations, isolator shall not be provided and all control and protection equipment shall be accommodated in the indoor breaker panel, if so desired by the Purchaser. Series reactor shall be provided to limit the inrush current wherever two or more capacitor banks are connected in parallel. Lightning arresters shall also be provided if the existing lightning arresters provided elsewhere in the substation are not adequate to provide protection against lightning and switching surges.

ANNEXURE - I

CLIMATIC CONDITIONS

1 Maximum ambient temperature	50° C
2. Maximum daily average ambient temperature.	45° C
3 Maximum yearly average ambient temperature.	35° C
4 Maximum relative humidity	82%
5 Altitude	Not exceeding 1000M
6 Maximum Wind Load	195 Kg/ Cm ²
7 <u>Seismic level</u>	Horizontal acceleration 0.3g
8 Intensity of solar radiation	1KW/m ²

ANNEXURE-II

SYSTEM PARTICULARS

Highest system voltage	12kV / 36kV / 72.5kV
System frequency	50Hz
Number of phases	3
System earthing Effectively Earthed	
Short circuit leve	I 12.5 kA/ 16kA / 20 kA / 25 kA

Auxiliary power supply system	230V 1-f 415V 3-f
i) A.C.	110V / 220V
ii) D.C.	or any other voltage to match with utility practice

Note: The above power supplies are subject To the variations given below:

A.C. Supply-Voltage Variation	± 10%
Frequency	± 3%
D.C. Supply-Voltage	+10% -15%

EQUIPMENT PARAMETERS

Shunt Capacitor Banks

i) Type	Outdoor	Outdoor	Outdoor/Indoor
ii) Rated Voltage (kV rms)	66	33	11
iii) Capacitor Unit Rating (kVAr)	46	84	168
iv) Rated Voltage for capacitor Unit (kV)	11	11	7.3
v) Bank Rating (MVAR)	10,20	5,10	2,4
vi) Power frequency withstand voltage (kV rms)	140	70	28
vii) Impulse withstand voltage (kV peak)	325	170	75
viii) Type of connection As per Annexure	IV(1)	IV(2),	IV(3)
ix) Temperature category	50° C	50° C	50° C
x) Creepage distance	25mm/kV	25mm/kV	25mm/kV

Current Transformers

i) Type	Outdoor	Outdoor	Outdoor/Indoor
ii) Rated Voltage (kV rms)	72.5	36	12
iii) Rated primary current(A) for Bank Rating (MVAR)	250 125 20 10	250 125 10 5	300 150 4 2
iv) Rated secondary current (A) 1 or 5 Amp. As per requirement given in Annexure. Accuracy Class:			
v) Core 1 Core 2 Burden (VA)	5p 1	5p 1	5p 1
vi) Core 1 Core 2 Accuracy limit factor	15 15	15 15	15 15
vii) Instrument security factor Core 1 Core 2	Not less than 10 Not exceeding 5	Not less than 10 Not exceeding 5	Not less than 10 Not exceeding 5
viii) Short time current rating for 1 sec. (kA)	31.5	25	25
ix) Power Frequency withstand voltage (kV rms)	140	70	28
x) Lightning Impulse withstand voltage (kV Peak)	325	170	75
xi) Creepage distance	25mm/kV	25mm/kV	25mm/kV

Neutral CTs / RVTs.

Characteristics of protective core shall be determined by tenderer based on the protection requirement described in the specification. Detailed calculation in support of selected characteristics shall be supplied by tenderer. Metering core shall be of 1 Amp., accuracy class 1 and 10 VA. RVT should be capable of discharging the energy of the capacitor bank and the same should be supported by calculation.

Circuit Breakers

i)	Installation (Outdoor/Indoor)	Outdoor	Outdoor/Indoor	Outdoor/Indoor	
ii)	Type of Breaker	SF6	SF6/ Vaccuum	SF6/ Vaccuum	
iii)	Rated voltage (kV)		72.5	36	12
iv)	Number of poles		3	3	3
v)	Rated Normal Current (A)		1250	1250	1250
vi)	Power Frequency withstand voltage (kV rms)		140	70	28
vii)	1.2/50 microsecond lightning impulse withstand voltage (kV peak)		325	170	75
viii)	Rated Short circuit breaking current for 1 second (kA)		31.5	25	25
ix)	Rated peak withstand current	2.5 times the short time with-stand current	2.5 times the short time with-stand current	2.5 times the short time with-stand current	
x)	Rating of capacitor bank to be switched ON/OFF(MVAR)	10,20	5,10	2,4	
xi)	Operating sequence	-----0-3 min-CO-3 min.-CO-----			
xii)	Type of operating mechanism	Electrical or pneumatic.			
xiii)	Number of Trip coils		2	2	2
xiv)	Creepage Distance	25mm/kV	25mm/kV	25mm/kV	

Isolators

i)	Type of Isolators	Outdoor	Outdoor	Outdoor	
ii)	Rated voltage (kV)		72.5	36	12
iii)	Number of poles		3	3	3
iv)	Rated normal Current (A)		800	630	1250
v)	Power Frequency withstand voltage (kV rms)				
	to earth & between poles		140	70	28
	across the isolating distance		160	80	32
vi)	1.2/50 microsecond lightning impulse withstand voltage (kV peak)				
	to earth & between poles		325	170	70
	across the isolating distance		375	195	85
vii)	Rated shorttime withstand current		31.5	25	25

	current for 1 sec. (kA)			
viii)	Rated peak withstand current (kA)		78.75	62.5
ix)	Operating Mechanism		Manual/ Electrical	Manual
x)	Creepage distance		25mm/kV	25mm/kV

Lightning Arresters

		66kV	33 kV	11 kV
		System	System	System
i)	Rated voltage of system, (kV rms)	72.5	36	12
ii)	Type	-----Station class gapless type -----		
iii)	System earthing	Effectively earthed system		
iv)	Type of connection	-----Phase to ground-----		
v)	Rated voltage of arrester, kV (rms)	60	30	10
vi)	Continuous operating voltage, kV (rms)	48	24	8
vii)	Nominal discharge current kAP	10	10	10
viii)	Long duration discharge class	3	3/2	3/2
ix)	Prospective symmetrical fault current for pressure relief test kA (rms)	40	40	40
x)	Residual voltage for			
	a)Lighting impulse current (8/20 micro sec.)	195 kVP	100 kVP	35kvp
	b)Steep current impulse (1/20 micro sec) at nominal discharge current	220 kVP	110 kVP	40 kVP
xi)	Arrester housing			
	a) One minute power	140	70	28

frequency withstand voltage level, kV (rms)			
b) Lighting impulse withstand voltage (kVP)	325	170	75
c) Minimum total creepage distance (mm)	25 mm/kV (or) depending on site requirement----- -----		

CONTROL AND RELAY PANELS

Each panel shall be comprising of:

Quantity Item

- 1 Title plate
- 1 Set of mimic diagram.
- 1 Set of semaphore indicators showing 'ON' and 'OFF' position of isolators and suitable for voltage rating as specified.
- 1 Circuit breaker control switch.
- 4 Indicating lamps
- 1 Trip circuit supervision scheme as per clause 22.0 of section –I
- 1 Suitable scaled flush mounting ammeter with coil rating suitable to CT secondary as given in Annexure – .
- 1 Ammeter selector switch for reading phase currents.
- 1 Triple pole IDMT, non-directional combined over current and earth fault relays having two over current elements with 50-200% setting range and one earth fault element with 20-80% setting range of 1 or 5 Amp. as specified.
- 1 Over voltage protection relay with setting range 100-130% of 110 V (Phase-to-phase operation)
- 1 No volt protection relay with setting range of 50-90% of 110 V (Phase to Phase operation)
- 1 Time delay relay for avoiding closing of breaker with time delay of 0-6 minutes after opening operation.
- 1 Annunciation scheme as per clause 19.0 of Section-I.
- 1 Alarm scheme for D.C. failure as per clause 19.3.4 of Section-I.
- 1 Space heater and switch-board lighting.
- 1 Neutral unbalance ammeter suitable for N.C.T.
- 1 Neutral unbalance protection relays as specified.