TECHNICAL SPECIFICATION CONTENT

APPENDIX-1

SCOPE OF WORK

Scope of work covers the Supply, erection, testing and commissioning of 132/11 KV, 10 MVA, 01 no. additional Power Transformer at MRS, RWP, Bela PO- Arvind Nagar, Dist.-Saran (Bihar) with its all required accessories and design, manufacture, testing at works, packing and delivery at site, storage and handling, installation, testing and commissioning of 132/11 kV Main Receiving Station (MRS) including HT Cabling and in full compliance with the contract document. Although every required item of work may not be explicitly described in the specification, the contractor shall furnish all items necessary for the work without any exception. **The tenderer shall quote for the latest equipment such as numerical relays for protections and multifunction meters, instead of conventional equipment.**

1. Detailed design of 132/11 KV main receiving station works included in the technical specification.
2. Complete manufacture including the shop testing of the equipment.
3. Providing assembly and sub assembly drawings and components drawing of those components subject to wear and tear requiring, replacement, engineering data, instruction manual, catalogues, spare parts and special tools list etc.as required.
4. Packing and transporting from the manufacturers factory to the Rail Wheel Plant, Bela, Saran.
5. Unpacking, checking for damage/shortage, cleaning and erection of all the equipment.
6. Testing and commissioning of equipment including starting, trial operation and performance guarantee tests.
7. Warranty obligations.
8. Supply of spares, special tools for operation and maintenance.
9. Deputation of Engineering degree holder service engineer and staff to the RWP, Bela,Saran
10. Earthing of installation as per relevant Indian Standards Specification.
11. All other earthwork and masonry work required to be done with electrical works including foundation
12. Providing foundations to all electrical panels, including transformers.
13. The scope covers supplying of cables as indicated in specification and laying the cables in trenches, tunnels, ducts, columns and direct burial as per the trench layout drawing. The cables are to be terminated and connected at both ends using metal cable glands and copper/aluminum end terminals.
14. SCADA system should be synchronized with newly installed 132/11 KV power transformer
15. Installation and commissioning of 132/11KV transformer and its accessories should be compatible and synchronizing with existing system.
16. Contractors are advised to visit the existing power system before quoting the rate.

Approval from Inspectorate

Complete installation shall be in accordance with the requirements of Indian Electricity Rules and shall be to the satisfaction of **Electrical Inspector General (EIG) on Railway premises i.e. Chief Electrical Engineer, E C Railway, Hajipur** or any statutory body

having jurisdiction in this area. It shall be responsibility of the Contractor to get such approval, wherever necessary.

SYSTEM DATA

A. System voltage: 132 kV, 11 kV
B. System earthing: Solidly Earthed
C. Rated frequency: 50 Hz
D. Frequency variation: ± 3%
E. Voltage variation: ± 12.5% at 132 kV,
+ 6 and -9% at 11 kV

F. Three phase symmetrical short circuit level

a) At 132 kV: 7200 MVA, 31.5 kA
b) At 11 kV: 350 MVA, 31.5 kA

APPENDIX-2

132 KV SF-6 CIRCUIT BREAKERS

STANDARD:

The circuit Breakers shall comply with the requirements of latest issue of IEC 62271-100, IS 2561, IEC 56, IEC 60, IEC 71.

1 SCOPE:

This specification covers the manufacture, assembly, testing at manufacturer's works. Supply, delivery, testing and commissioning complete with all accessories and Current Transformers required for its satisfactory operation.

2 SCHEDULE OF REQUIREMENTS:

The circuit Breakers must be suitable for outdoor operation under climate conditions specified without any protection from sun and rain. The circuit breakers must be of the following specification and ratings:

Outdoor SF6 circuit breaker with control cubicle

- Confirms to IEC 62271-100
- Robust housing for protection against fire and hazardous conditions.
- The control cubicle must be as per specification.
- The breaking must be based on compression and self blast technique.
- It shall have operating mechanism complete with manual opening and closing push buttons, mechanical indicator for circuit breaker "opened and closed" and for springs "charged or discharged", and the indicators can be seen through the inspection window.
- The operating mechanism shall consist of the following.
    - Shunt opening release.
    - Shunt closing release.
    - Spring charging gear motor.
    - Lever for manual spring charging.
    - Locking circuit for insufficient gas pressure.
    - Electrical contacts signaling.
    - Anti-condensation heater.
    - The cabinet must be fitted with cable gland plate for control cables and with pad lockable front door.
    - Signaling lamps for breaker closed, opened, springs charged and insufficient gas pressure.
    - Selector switch for Local / Remote control.
    - Control switch for local ON/OFF electrical operation.
    - Auxiliary switch with 10 NO + 10 NC contacts.
    - Illumination lamp, which automatically switches on by means of a limit switch when the door is opened.
    - The mechanism shall be fitted with anti-pumping device to prevent re-closing by electrical or mechanical commands.

3 Technical details

Sl no.	Description.	Unit.	Rating.
1	Rated voltage	KV	145
2	Rated insulation voltage	KV	145

3	Withstand voltage at 50 Hz for one minute.	KV	275
4	Lighting impulse withstands voltage. Full wave 1.2 / 50micro secs.	KV	650
6	Rated breaking capacity.	KA	26
7	Duration of short circuit.	Secs.	3
8	Rated frequency.	Hz	50
9	Making capacity.	KA (peak).	100
10	Operating sequence		O-0.3s-CO-15s-CO
11	Opening time.	Ms	Max 45.
12	Dead time.	Ms	Max 300
13	Total breaking time.	Ms	Max 55-60
14	Rated reclosing time.	Ms	Max 300
15	Creep age distance to earth. -Normal. -Long	Mm	3040. 4015
16	First pole clear factor.		1.5
17	Operating temperatures.	Deg. C	+ 50
18	Presence of pollution.	IEC 815-table 1	Level III
19	Static force on terminal.	Longitudinal-N Transversal –N Vertical-N	Max 750 Max 500 Max 750
20	Shunt opening release normal voltage.	Volts DC	110
21	Shunt closing release normal voltage.	Volts DC	110
22	Spring charging geared motor normal voltage.	Volts AC	230,single phase.
23	Make.	HITACHI,Siemens,Crompton Greaves.	

Breakers must be furnished as a complete unit with all equipment in place and all internal wiring installed, terminated in the Mechanism housing and the equipment must be complete in all respects.

4. TECHNICAL PARTICULARS:

The Circuit Breakers must provide rapid and smooth interruption of current under all conditions completely suppressing all undesirable phenomena when under the most severe and persistent short circuit conditions or when interrupting small currents or leading or lagging reactive current.

The details of any device incorporated to limit or control the rate of rise of re-striking voltages across to circuit breaker contacts shall be stated.

The over voltages caused by the Circuit Breaker switching inductive or capacitive load shall not exceed 2.5 times the normal phase to neutral voltage.

5. CIRCUIT BREAKER MOUNTING AND HANDLING DETAILS

Each circuit breaker shall be supplied complete with the necessary lifting hooks, skid type base foundation bolts and other accessories complete.

Breaker must be suitable for mounting on steel structures.

All steel part, bolts and nuts etc. must be galvanized.

6. TEMPERATURE RISE

The maximum temperature rise of parts other than coils shall not exceed the following values when based on an ambient temperature of air having a peak value not exceeding 45 degree C.

a) For current carrying parts 50 degree C
b) For all other parts 50 degree C

These temperature rises shall not be exceeded when corrected for the difference between ambient temperatures at site and ambient specified above. The correction proposed shall be stated in the tender and shall be subject to approval of the Purchaser.

7. INSULATION OF THE CIRCUIT BREAKERS

The insulation to ground, the insulation between open contacts and the insulation between phases of the completely assembled circuit breaker must be capable of withstanding satisfactorily di-electric test voltages corresponding to basic insulation level specified i.e. 275 KV dry / 275 KV wet. The basic insulation level of the insulating porcelain shall be as specified and shall be suitable for installation in contaminated atmosphere. The porcelain used must be homogenous and free from cavities or other flaws. They shall be designed to have ample insulation, mechanical strength and rigidity for satisfactory operation under conditions specified. All porcelains of identical rating must be inter-changeable. The puncture strength of the porcelains shall be entirely free from radio disturbance when operating at a voltage up to 10% above rated voltage and must also be free from external and internal corona.

The insulation level of the porcelains shall be as given below:

Nominal System Voltage	Highest System Voltage	One minute dry with stand test (Power Frequency Voltage)	One minute wet with stand test(Power Frequency Voltage	Full Wave with stand (Impulse voltage)
KV	KV	KV	KV	KV Peak
132	145	275	275	650

8. OPERATING MECHANISM

The circuit breaker must be designed for remote control from the control room and in addition there shall be provision for manual or local electrical operation of circuit breaker during maintenance.

The Circuit Breakers must have a mechanical “Open /Closed “ indicator in addition to facilities for remote electrical control and indication through PLC control..

The operating mechanism must be of motor operated (230 V.A.C.) spring charging type. The mechanism must be trip free electrically and mechanically. All working parts in the mechanism must be of corrosion resistant material and all bearings, which require greasing shall be quipped, shall be removable without disturbing the other parts of the circuit breaker. The mechanism and breaker shall be such that the failure of any spring will not prevent tripping and will not cause tripping or closing.

The operating mechanism along with its accessories shall be mounted in a weatherproof cabinet with hinged doors located near the breaker. The local control switch and the

breaker position indicator shall be provided in this cabinet. The circuit breaker must also be provided with means for manual operation for maintenance purposes.
The control circuits must be designed to operate on 110 volts DC as indicated in the schedule. The closing and operating coils shall be designed to operate satisfactorily at any control voltage from 80% to 120% of the normal voltage. A heater shall be provided in the cabinet to prevent moisture condition.
Power supply for auxiliaries will be available at 415 volts, 3 ph. 50 Hz., 4-wire system of 230 V, single-phase system.
Necessary cable glands for the cables of the operating mechanism must be provided.
An indicator shall be provided to show the 'Open' and 'Close' positions of the breaker. It shall be properly located so that it is visible to a man standing on the ground with mechanism housing closed.
The tripping of the breaker must be performed by shunt trip coil/coils, so designed as to ensure satisfactory operation of the breaker when the voltage at the terminals of the shunt trip coil is any value from 80% to 120% of the rated voltage of the auxiliary supply. When the breaker is not carrying any current, it shall operate satisfactorily even when the shunt trip coil terminal voltage is not more than 50% of rated terminal voltage.

9. TERMINAL BOARDS

Terminal Boards for terminating the control wiring and of the secondary from instrument transformers shall be provided in the breaker mechanism housing. The secondary terminals (all taps of the CTs shall be wired unto these blocks by weather proof cables). The direct and alternating current terminals must be isolated from each other. Sufficient spare terminals shall be provided.

10. AUXILIARY SWITCHES

Adequate number of auxiliary switches (10NO+10NC contacts) both of the normally open and normally closed types must be provided in each circuit breaker for use in the remote indication and control scheme of the circuit breaker through PLC based scada system and for providing safety interlocking. There shall be provision to add more auxiliary switches at a later date, if required.

11. INTER LOCK

Provision shall be made to enable (mechanical or electrical) interlocking with the opening or closing of the isolator when the breaker is closed etc.

12. TESTS

Each circuit breaker must comply with the type tests and shall be subjected to the routine tests prescribed in IEC standards 62271-100, 62271-200 or latest.
Reports of all type tests are stipulated is IEC – 62271-100, 62271-200 or latest and the line charging current and transformer charging current interrupting tests shall be furnished along with the tender.
Routine tests as per IEC – 62271-100, 62271-200 or latest must be carried out on each breaker in the presence of Railways representative. All test report should be submitted and got approved by the Railway before the dispatch of the equipment.

13. GUARANTEED TECHNICAL PARTICULARS

Guarantee and technical particulars as called for in Appendix 1 shall be furnished along with the tender. Particulars, which are subject to guarantee, shall be clearly marked.

15. DRAWINGS

The drawings shall include but not be limited to the following: -

1) General outline showing front and side elevations plans of equipment with detailed dimensions, outline-shipping dimensions, net shipping weights etc.
2) Assembly and sub-assembly drawings of the breaker. All parts shall be numbered to enable Purchaser to order for spare parts, if necessary.
3) Detailed dimensions and assembly of auxiliaries.
4) Detailed drawings for operating mechanism.
5) Detailed drawings for current transformer.
6) Wiring and control diagrams (both schematic and wiring) with Control cable schedules.

APPENDIX-3

132KV CURRENT TRANSFORMERS

STANDARDS: The current transformers should conform to IS 2705 (Part I, II, III and IV) OR BS 3938 or IEC – 185

Te current transformers must be of single phase, 3 cores; self cooled type suitable for following service.

SPECIFICATION

The CTs shall be outdoor type, single-phase oil immersed, and self-cooled, independently mounted type. The CT rating shall be as specified under Bill of Material.

CT cores shall be of high-grade non-ageing electrical silicon laminated steel of low hysterisis loss and high permeability to ensure high accuracy at both normal and high currents.

CTs shall be properly sealed to eliminate breathing and prevent air and moisture from entering the tank. Oil level gauge and pressure relieving device shall be provided for all the CTs.

CTs shall have VA capacity, accuracy class, saturation limit factor of each core, insulation level etc, as specified under Bill of Material. Adequate winding sections shall be selected to withstand the specified thermal and dynamic stability currents.

CT core to be used for metering and instruments shall be of specified accuracy class, suitable for commercial and industrial metering. The saturation factor of this core shall be low enough not to cause any damage to measuring instruments in the event of maximum short circuit current.

CT core to be used for protective relaying purpose shall be of the specified accuracy class suitable for various protections indicated therein. The core shall be designed for a minimum saturation factor of 20 for the higher setting. The magnetization curve for these cores shall be furnished with the tender. For protection the class of CT shall be 5P 10 or as is specified in BOQ.

The secondary terminals must be brought out in weatherproof chamber on one side of CT for easy access. The secondary terminals must be provided with short circuit arrangements. Provisions shall be made for cable entry suitable for PVC-A-PVC control cables.

CTs shall be supplied filled with oil and properly sealed. The oil shall conform to the requirements laid out in IS: 335.

The insulator housing for the current transformers shall be made of wet process from electrical grade porcelain and free from all defects. Clearance and Creepage distances must be in conformity with the specified site conditions.

Temperature rise of the CT winding based on the maximum design ambient temperature of 45 deg. 'C' when carrying a primary current equal to the rated continuous current at a rated frequency and with rated burden should not exceed the appropriate values given below: -

a) Maximum temperature rise of oil at the top of the tank (measured by Thermometer): 40 deg. C.

b) Maximum temperature rise of windings (measured by resistance method): 50 deg. C.

The CTs must be suitable for pedestal mounting on concrete foundation plinths or for structure mounting with foundation bolts. The necessary galvanized bolts, flanges etc., for the base of the CT must be supplied.
Terminal connectors shall be suitable for the ACSR or AAAC conductors/IPS Al, tube, suitable terminals for earth connectors shall also be included.

Technical particulars for the CT shall be as specified under basic data.

Nominal system voltage	132 KV
Highest system voltage	145 KV
Frequency	50 Hz
Earthing of the system	Effective
Insulation Level	650 KV

I) CTs for Metering and Protection

Ratio	200 – 400/1-1-1-1A
Burden	100 VA
Accuracy	Class I Class 5 P10

APPENDIX-4

132 KV DISCONNECTING SWITCHES (ISOLATORS)

1 STANDARDS

The disconnecting switches shall be designed and constructed to conform to IEC 129 with the supporting insulators.

The disconnecting switches supplied shall be complete with all parts, which are necessary for their efficient operation. Such parts shall be deemed to be within the scope of supply whether mentioned in this specification or not. The switches shall be double break, triple pole, and center rotating type.

2 RATING AND GENERAL DATA

a) The rating and general data are given below for the guidance of the tenderer: -

TECHNICAL PARTICULARS FOR 1250 AMPS

SLNO	DESCRIPTION	UNIT	DATA
1	Applicable standard		IEC 129
2	Type		Double Break type
3	Local and remote both operations		**To be provided with Motor operated Mechanism**
4	Frequency	Hz	50
5	Rated voltage	kV	145
6	Rated current		
	a) Normal current	A	1250
	b) Short time for 1 sec	kA	25
7	Insulation level		
	a) Impulse withstand voltage	kV crest	650
	b) Power frequency withstand voltage (1 min, rms)	kV	275
8	Maximum current the switch can safely interrupt		
	a. Bus/line charging current	A	0.5
	b. Potential transformer magnetizing current	A	0.7
9	Clearance		
	a. Between live parts and ground	mm	1500 minimum
	b. Between fixed contact and blade in open position	mm	1810
10	Main contacts		
	-Material of contacts		HD HC Electrolytic copper, silver plated
	- Coating of contacts		Silver plated to 25 microns minimum.
	- Material of the contacts of the earthing switch		HD HC Electrolytic copper, silver plated

	- Coating of the contacts of the earthing switch		Silver Plated to 25 microns min
11	Material of terminals		Aluminum pad
12	Coating of terminals		Tin plated
13	Operating mechanism		Electrical & Manual
14	Local operating device.		To be provided.
15	Auxiliary contacts		
	a) Type.		Fixed
	b) Continuous current rating at 110V DC	A	10A
	c) Material		Copper
	d) Contacts		Silver plated.
	e) Number of NC. Contacts (minimum)	No.	8
	f) Number of NO. Contacts (minimum)	No.	8
16	No of operations switch can withstand without deterioration of contacts	Nos.	1000 operations minimum
17	Type of interlocks furnished:		Electrical & Mechanical
18	Disconnector and the earthing switches.		Mechanically interlocked to each other.
19	Auxiliary power supply		
	a) DS operating motor supply voltage	V	230 V AC, single phase.
	b) DS operating motor power	WT	0.5 HP
	c) Space heater and cubicle	V/ Phase	230V / 1ph
	d) Control circuit	V	110V DC
20	Insulator		
	b) Creep age distance in air	mm	3625
21	Enclosure protection		IP-55W
22	Thickness of sheet (minimum)	mm	2 mm – minimum
23	Earthing switch		
	a) Operating mechanism		Manual
	b) Type of interlocks furnished		Electrical & Mechanical
	c) Number of NC. Contacts (minimum)	No.	4
	d) Number of NO. Contacts (minimum)	No.	4

b) A reference to the single line diagrams will show that the disconnector is to be used for breaker isolation. Line connection and grounding. The switches will be called upon to close or interrupt the charging currents drawn by the Bus bars, breakers or similar equipment.

c) The tenderer shall indicate the maximum charging current that it can interrupt safely and the maximum current that it can make safely.

3. INSULATION LEVEL

The disconnecting switches shall have the following minimum insulation levels.

1.One-minute power frequency withstands voltage to earth and between poles - 275 KV

2. Impulse withstand voltage (1x50 or 1.5 x 40 micro sec-wave) to earth and between poles - 650KV

4. CLEARANCES

The clearance between line parts and grounded structure shall not be less than those specified in the relevant standard. The length of break in full open position shall be such that there is absolutely no possibility of arc over from the live parts to the de-energized parts on which any maintenance work may have to be done. The speed of opening or closing the switch shall be designed to ensure that the arcing during the operation is reduced to the minimum.

5.TYPE AND CONSTRUCTION

The design of the disconnecting switches shall be such that the switch can be changed to right or left hand control without excessive labor and with a minimum change of parts. The live parts shall be designed to eliminate sharp points, edges, other surfaces likely to produce corona and adequate shields shall be provided if required. Live metal parts shall be of non-rusting, non-corroding metal. Current carrying parts shall be non ferrous. Bolts, screws and pins shall be provided with lock washers, keys or other equivalent locking facilities and current carrying parts shall be made of copper alloy or equivalent materials. The switch shall not require lubrication of any part except at infrequent intervals.

The heights at which the disconnecting switches are to be provided are indicated in the layout drawing. Necessary lengths of operating rod as required shall be supplied.

6. OPERATING MECHANISM

a)The design of the operating mechanism shall be such that a minimum of energy is required for operation and one man shall be able to operate the switch without undue effort. The blades shall be in positive continuous control throughout the entire cycle of operation. The operating pipes and rods shall be sufficiently rigid to maintain positive control and when operated under tension or compression. They shall also be capable of withstanding all torsional and bending stresses due to operation of the disconnecting switch. It shall not be possible after final adjustment has been made for any part of the mechanism to be displaced at any point in the travel sufficiently to allow improper functioning of the switch when the switch is opened or closed at any speed. All holes in cranks, linkages, etc. having moving pins shall be drilled to accurate fit so as to maintain the minimum amount of slack and lost motion. The operating mechanism and its controls shall be so designed that under no circumstances the switchblades travel is interrupted before it reaches the fully closed or open position.

b) The operating **handles and the motor operating mechanism** shall be mounted on the base supporting structures or on separate supports at a height of 1.25 meters. from the ground level. The unsupported length of the operating rods shall not exceed 3 meters. Guide bearings shall be provided at suitable intervals. The contractor shall supply all brackets, angles or other members and accessories necessary for attaching the operating

mechanism to the switch supporting structure and the bearings for operating rod. Rustproof pins and bearings of the bronze bushing, ball or roller type shall be furnished. All ball and roller bearings shall be protected from weather by means of covers and grease retainers. Bearing pressure shall be kept low to ensure long life.

c) Provision shall be made for padlocking the mechanism of the disconnecting and ground switches in either the open or closed position.

d) An adequate flexible copper conductor shall be provided at the lower end of the vertical operating shaft for connection to the station ground bus.

e) The operating motors for electrically operated disconnecting switches shall be of the totally enclosed type suitable for 230 VAC. The H.P. of the motor and starting current shall be indicted.

f) Cable glands for the auxiliary wiring to the mechanism box shall be provided.

7. CONTACTS

The disconnecting switches shall be provided with high-pressure self-aligning adjustable contacts. The contacts shall be designed such that the contact pressure is released before any movement of the blades in the opening direction takes place and is applied after the closing travel is completed. There shall be sufficient wiping action of the contact to make them self-cleaning. The contacts shall be made of high-grade high conductivity heat resisting material.

The temperature rise of the contacts and other current carrying parts shall not be more than 45 degree C over an ambient air temperature of 45 degree C, while carrying the rated current continuously. The temperature rise due to the passage of the rated short circuit for a period of 3 seconds shall not cause any annealing or welding of the contacts.

8 SWITCH BLADES AND JAWS

The switchblade shall be copper. It shall be of one solid piece construction and shall be so assembled that no part of the blade can move relative to the other parts. The thickness and section of the blade shall be such that it retains its form and straightness under all conditions of operation including the flow of system fault current for a period of 3 seconds. It shall also be capable of withstanding all torsional and bending stresses due to operation of the switches. Wherever necessary the blades shall be counter balance by weights or springs. Fixed guides shall be provided so that proper seating of contacts will be obtained while closing, even when a blade is out of alignment of 2.5mm or less. Flexible copper conductors to prevent breaking due to repeated bending shall shunt all movable parts, which may be in the current path.

9 GROUNDING SWITCHES

One grounding blade per pole forming an integral part of the line disconnecting switch and group operated shall be supplied wherever called for. The grounding switch shall match the main switch in quality. A suitable flexible braid with a connector shall be provided on the hinge end of the grounding blade which shall be operated by a separate mechanism, but shall be mechanically interlocked with the disconnecting switch so that the grounding blades can be closed only when the disconnecting switch is open and vice versa. Alternatively, electrical interlock between the grounding switch and the isolator shall be offered.

10 TERMINALS

a) The disconnecting switches shall be provided with high conductivity connectors for use with conductors.

b) For bimetallic type of connectors, necessary steps shall be taken by the manufacturer to ensure that there is no adverse effect on the connectors and the connected equipment due to bimetallic action.

11 BASES

Each pole of the group-operating switch shall be provided with a galvanized steel base provided with holes for mounting bolts and designed for mounting on a steel structure. The bases shall be rigid and self-supporting and shall require no guying or cross bracing between phases other than the supporting structure. The necessary galvanized bolts for fixing the bases to the structure shall be supplied by the contractor.

12 AUXILIARY SWITCHES

At least eight single pole auxiliary switches, four for making contact "Circuit opening" and four at "Circuit closing" mounted in a weather proof, dust tight metal housing suitable for outdoor use and provided with necessary cable glands shall be provided. The auxiliary switch shall be mechanically coupled to the operating mechanism. Auxiliary switch shall be provided for the grounding blades also.

13 GRADING HORNS

Provision of adjustable grading horns for purposes of insulation co-ordination shall be indicated in the tender.

14 INTER LOCKS

The disconnecting switches will be electrically interlocked with the associated circuit breaker. For this purpose the auxiliary contact on the associated breaker shall be made use of. The control wiring of the electrical operating mechanism shall be so designed that when the circuit breaker is in the closed position, it shall not be possible to operate the disconnector switch either locally or by remote control from the control panel. The inter lock shall be foolproof in all respects. Complete details of the type of interlock offered shall be furnished in the tender.

15 INSULATORS

a) The tenderer shall state the type, number and make of insulators offered.

b) The porcelain used for the manufacture of insulators must be homogeneous, free from laminations and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture. The glazing of the porcelain shall be of uniform brown color, free from blisters, burns and other similar defects. Insulators of the same rating and type shall be interchangeable.

c) The porcelain and metal parts shall be assembled in such a manner and with such materials that the differential thermal expansion between the metal and porcelain parts, throughout the operating temperature range will not loosen the parts or create under internal stress which may effect the mechanical or electrical strength.

d) Each cap shall be of high-grade cast iron or malleable steel casting and each base muat be of high-grade malleable iron casting or steel forging. Caps and bases shall be machine faced and smoothly galvanized. The cap and base insulators shall be interchangeable with each other.

16 GALVANIZING.

All exposed ferrous parts of the switch assembly and base, all nuts, bolts and washers must be galvanized in accordance with I.S. 1367, 2629 – 2001 or any other equivalent standard.

17 FACTORY TESTS AND TEST REPORTS

All tests specified in relevant standards for disconnecting switches and all tests specified in relevant standards or any other equivalent standard for isolators shall be conducted and advance test certificates in duplicate to be handed over to the Railway immediately after the tests for approval. The equipment shall not be dispatched before obtaining the Railway's written approval for the test certificate.

18 TYPE TESTS

The tenderer shall furnish the certificates of type tests indicated below as evidence of the completeness of the disconnector with the requirements of the relevant clauses of applicable standards.

1. Mechanical endurance test.
2. Test of temperature rise.
3. Impulse voltage test.
4. Power frequency voltage to wet test.
5. Short time current test.

132KV LIGHTENING ARRESTORS

1 STANDARDS:

The lightning arrestors shall conform in all respects to IS 15086: 2002 with its latest amendments.

2 TECHNICAL PARTICULARS

The arrestors shall be of modern design of a type incorporating non-liner resistors and spark gaps in series and voltage grading resistors. The arrestors shall be designed to provide maximum possible protection against lightning and switching surges. Supporting insulators, terminal connectors, surge counters and other components shall be furnished with the arrestors.

3 SYSTEM VOLTAGE

The nominal and highest system voltages shall be as given below: -
Nominal system voltage 132 KV.
Highest system voltage 145 KV.

4 RATED ARRESTOR VOLTAGE

The rated arrestor voltage shall be at least 80% of the highest system voltage.
Highest system voltage 145 KV.
Minimum arrestor Rated Voltage 120 KV.

5 NOMINAL DISCHARGE CURRENT

The nominal discharge current of the station type lightening arrestors shall be 10 KA. The low current long duration withstands value of the arrestor shall be specified in the tender. However, this value shall not be less than 500 amps for 2000 microseconds for any arrestor.

6 MAXIMUM RESIDUAL VOLTAGE

Nominal system Voltage	132 KV
Arrestor Voltage Rating	132 KV
Max. Residual Voltage	355 KV

7 SPECIAL CONDITION

The lightning arrestors are to be used for protection against lightening and switching surges for transformers, Circuit breakers and other sub-station equipments. The lightening arrestors offered shall be suitable for outdoor installation. The insulating casing of the arrestor shall be made of wet process non-porous electrical porcelain.

8 IMPULSE WITHSTAND VOLTAGE OF EUIPMENT

The basic insulation level of transformers, circuit breakers and instrument transformers is as follows: -

275 KV rms and 650 KV peak.

9 INSULATION

The insulation shall be capable of withstanding continuously the normal voltage plus 10% with a frequency variation of plus or minus 3% and temperature and humidity condition specified elsewhere in this specification.

The flash over value at 50 HZ and impulse values of the outdoor bushing, insulators etc. should not be less than those given below:

Sl. No.	Nominal System Voltage	Outdoor wet or dry one minute withstand Power frequency	Impulse withstand Voltage (1/50 micro second wave RMS without arcing horns) at 80 degree F sea level and 80% relative humidity
1.	132 KV	275 KV	650 KV

10 TYPES OF MOUNTING

The lightening arrestors shall be suitable for pedestal grouting on steel lattice supports. The necessary flanges, foundation bolts or clamps nuts, etc. for the base of the lightning arrestors shall be supplied and these shall be galvanized. Insulating bases, if required, for mounting or arrestors with attachment of surge counters shall be included.

11 TERMINAL CONNECTORS

The arrestors shall be provided with line side terminal connectors both on line side and groundside. Suitable bimetallic type of connectors on the line side to receive AAAC conductors.

Two ground terminal connectors suitable on 25x3mm copper ground connection shall be provided. Physical data to be supplied for the arrestors. Technical and guaranteed particulars as required in Schedule . shall be furnished with the offer. Drawings showing dimension arrangements and clearance required shall also be furnished. Full performance details shall be supplied with the tender.

12 COMPLETENESS OF EQUIPMENT

The fittings and accessories which may not be specifically mentioned in the specification but which are usual or are necessary for the equipment shall be deemed to be included in the contract without extra charge.

13 MARKING

Each lighting arrestor shall be provided with a nameplate or plates legibly and indelibly marked with at least the following information:

a) Name of Trademark of the manufacturers and country of manufacture.
b) Name of the purchaser and reference to purchase order.
c) Type designation and or serial number.
d) Rated voltage.
e) Nominal discharge current.

The lightning arrestors may also be marked with the ISI certification mark.

14 TESTS

A) TYPE TESTS

The type tests and routine tests as indicated below shall be carried out as per IS 15086: 2002

a) Voltage withstand test of arrestor insulation.
b) Power frequency spark over tests.
c) 100 % 1.2/50 micro second impulse spark over test.
d) Front-or-wave impulse spark over test.
e) Residual voltage test.
f) Impulse current withstand tests.
g) Operating duty test.
h) Temperature cycle test on porcelain housing.
i) Foresight test on porcelain components.
j) Galvanizing test on metal parts.

B) ACCEPTANCE TESTS

a) Dry power frequency spark over test.
b) Hundred percent 1.2/50 micro second impulse spark over test.
c) Residual voltage test at the nominal discharge current.
d) Temperature cycle test on porcelain housing.
e) Porosity test on porcelain components.
f) Galvanizing test on metal parts.

C) ROUTINE TESTS

The following shall be the routine tests: -

Dry power frequency spark over test.

Triplicate copies of type test reports and sample test reports on prorated sections and complete arrestor assembly shall be supplied.

132 KV CONTROL AND RELAY PANELS

1 SCHEDULE OF REQUIREMENTS

The 132 KV Control and Relay Panel shall be cubical type and form a continuous board.

2 GENERAL

The panels must be self-supporting, floor mounted cubicle type made of sheet steel of thickness 2mm and light steel sections. The cubicle shall be inert, vermin and dust proof. Hinged doors with locking arrangements shall be provided to prevent unauthorized and inadvertent access to relays, meters, etc.

All control and supply cables shall be connected in a distribution trench under the cubicles. Necessary drawings showing the details of the trench opening in concrete floor, foundation bolts and other details shall be supplied by the successful tenderer.

3 PAINTING

The panel shall be powder coated in approved color.

4 WIRING

The wiring shall be single conductor and of tinned annealed copper wire, insulated for 1100 volts and shall be of grouped type, laid out in PVC channels and secured by means of binding ties or other standard means.

The wires shall run straight and shall be given right angle bends and in case of wires running from cubicle to cubicle they shall be properly screened.

The sizes of wiring in different circuits shall not be less than those specified below: -

5 Size

a) Metering and relay circuits connection to current transformers 4 sq.mm

b)Potential circuits for metering, relaying, indicating alarms, etc. 1.5 sq.mm

Terminal ends of all wires must be provided with properly numbered ferrules for circuit identification.

6 Color Code

Color of wire	Circuits where used	Color of Ferrule
Red	Red phase of instrument transformer circuits	Red
Yellow	Yellow phase of instrument transformer circuits	Yellow
Blue	Blue phase of instrument transformer circuits	Blue
Green	Neutral connection	Green
Black	A.C. 240/415 volts supply	Respective Phase Red, Yellow, Blue or Green
White	D.C. Circuits	Red for trip circuit, Yellow for Alarm circuit, Green for relay, Auxiliary and other Connections.

7 INDICATING LAMPS

Lamps covered by suitable colored translucent material shall be used to indicate the position of circuit breakers.

The lamps shall be of low voltage, switchboard type, suitable for replacement from the front of the panel. 15% of lamps used initially shall be supplied extra to serve as spares.

8 TEST BLOCKS

Test blocks with contacts rated for 10 amps, continuously and 150 amps for at least one second on 250 volts shall be provided for testing. They shall be of switchboard type and back connected. Devices for short-circuiting the terminals of the current transformers shall be provided. Suitable identification marks must be fixed near the test blocks for the purpose of identification of the circuits.

9 MIMIC DIAGRAMS

6mm wide mimic diagrams be provided on the top of the switchboard to represent the single line arrangement of the system. They shall be provided requisite Semaphore Indicators with red and green lamps for indicating switch position.

10 CONTROL SWITCHES

Circuit breaker control switches shall be pistol grip type having "ON and OFF" momentary operating positions and an automatic neutral return normal release position. The control spring shall be strong enough to prevent inadvertent operation due to light touch. Selector switches for ammeter shall short circuit the current transformer before it is broken and remove the short circuit after the ammeter is inserted in the circuit

11 SAFETY EARTHING

Earthing of juice free metallic part of the equipment on the switchboard shall be one with soft drawn single conductor, bare copper. The main earth connection shall not be less than 70 sq.mm and the tail connections shall not be less than 150 sq.mm.

12 FITTINGS

Each of the panel fronts shall be divided into four vertical sections, one section for the 132 KV side and the other sections for the 11 KV sides of the power transformers.

13 Annunciator panel

1. The annunciator panel shall have visual and audio indications for alarm and trip.
2. The annunciator shall be programmed for all the faults arising in the power distribution on 132KV and 11KV side of the main receiving station.
3. It shall have the capability of displaying all the faults arising in the system at a particular instant.
4. The annunciator shall be microprocessor based programmable type with test accept and reset functions.
5. The annunciator operating voltage shall be of 110 volts DC.
6. The visual display shall be in text form and the display size shall be such that the Shift in charge shall be able to clearly read the fault from a distance of 10 meters.
7. 20 % spare shall be made available for future additions.

The common section of the annunciator panel shall project the following annunciation: -

i) 132 KV main incoming SF-6 tripped on fault.

ii) 132 KV transformer control SF-6 tripped on fault separately for the breakers.

iii) Individual indication of transformer faults like bucholz gas, winding temperature trip, winding temperature alarm and low oil level alarm.

iv) 11 KV breaker trip

v) General A.C. failure

vi) D.C. failure, DC under voltage, DC earth leakage

14 INSTRUMENTS AND METERS

The indicating instruments shall be of switch board type, industrial grade 'A' as per IS 1248, back connected, flush mount square shaped with dust tight cases suitable for tropical climate with zero adjuster provided in front of the panel board. The indicating instruments shall conform to IS 13010, IS 13779.

The ammeters shall have direct reading scales of suitable ranges. The ammeter element shall be rated for 5 amps.

The voltmeter shall be provided with direct reading scales and shall have a maximum reading scales of 0-15 KV for the 11 KV side and 0-150 for the 132 KV side.

The Power and Energy meter shall be of 3 phase, 3 wire, and digital type as per clause 15(given below). The current and potential inputs shall be rated for 5 amps and 110 V respectively.

15 RELAYS

The relays shall be of numeric based and back connected and shall have test plugs for testing. The relay characteristics shall be programmable depending on the system requirement; reset shall be possible from the front of the relay case. The relay current inputs shall be rated for 5 amps. Potential inputs shall be rated for 110 volts. The relays shall conform to the provisions of IS: 3231 & IS: 8686 and latest amendments thereof.

Suitable terminal shorting devices for current circuits and fuses properly marked for potential circuits shall be provided to facilitate the relays and meters to be tested and calibrated. The insulation of all relays shall be tested for 2000 V.R.M.S.

A) RELAY FEATURES

- Numerical combined relay with three-phase fault poles with two independent transient free hi-set elements with 9 inputs and 7 outputs.
- Field selectable trip time characteristics.
- Time delay programmable output for over current as well as earth fault.
- Field selectable CT ratings.
- EEPROM to retain the program pickup values, characteristics, trip time settings and recorded parameters.
- Event recording (trip data of last 5 tripping with date and time stamping.).
- Diagnostics facility.
- The relay shall have RS 485 modbus communication port, which shall permit direct assess / transfer of data.
- It shall be possible to integrate the meter through RS 485 modbus with real time SCADA for power management system software installed in the server for easy access to real time data and information.
- Display to indicate parameter setting, current values etc.
- Auxiliary power supply range 24v to 110 volts AC/DC +/- 15%.

15 POWER AND ENERGY METER

This shall be multifunctional solid-state digital type numeric based to read the energy consumption. The meter shall be of CT operated type and suitable for 110V / 415V, 3 ph, 3 / 4 wire supply. The meter should have capability to integrate with automation system with **Ethernet communication port**. If separate CT is required, same has to be considered.

A) FEATURES OF POWER AND ENERGY METER

- Selectable function for measurement of
    - Energy (active, regenerative, reactive, and apparent).
    - Power (active, regenerative, reactive, and apparent).
    - Voltage.
    - Current.
    - Frequency.
    - Power factor.
- Facility for displaying three-phase current and voltage simultaneously and measurement items as assigned.
- Analog out put function for
    - Power (active, regenerative, reactive, and apparent).
    - Voltage, current, frequency and power factor (4 to 20mA DC).
- Measure average current and power within a specified period.
- Shall have the facility for measurement of maximum and minimum values of voltage and maximum and minimum value of current.
- Out put pulses proportional to the energy (one measurement item from active, regenerative, reactive, and apparent energy).
- Meter shall have 10 Base-T port and RS 485 modbus for direct access through Ethernet and modbus which shall permit the direct transfer of data.
- It shall be possible to integrate the meter through Ethernet and modbus with real time SCADA for power management system software installed in the centralized server for easy access to real time energy and power quality information.
- The meter shall have a class of accuracy of 0.2 or better.

APPENDIX-7

132/11kV POWER TRANSFORMERS

1 DESCRIPTION

10 MVA, 132/11 KV 3 PHASE, 50 CYCLES, OIL IMMERSED NATURAL COOLED TRANSFORMER WITH **ON LOAD TAP CHANGER** WITH SYNCHRONISED TAP CHANGING FACILITY AND REMOTE CONTROL SUITABLE FOR INSTALLING OUTDOORS AT THE MAIN RECEIVING STATION.

2 STANDARDS

The transformers shall confirm to the requirements of one of the following specifications or the latest modifications thereof:

a) ISS -2026 (part I)–1977 (reaffirmed 1996).
a) ISS -2026 (part II)–1977 (reaffirmed 1996).
b) ISS -2026 (part III)–1981 (reaffirmed 1991).
c) ISS -2026 (part IV)–1977 (reaffirmed 1991).
d) ISS -2026 (part V)–1994 (reaffirmed 1999).
e) Latest BSS Standards
f) ASA – C 57 MEMA and AIEE Rules
g) I.E.C. Publication No.76 of 1967

3 TECHNICAL SPECIFICATION FOR 10 MVA 132 / 11 KV ON LOAD TAP CHANGING POWER TRANSFORMER

Technical particulars of the transformer shall be as follows:

Particulars

1. Type: Outdoor
2. Number of windings: Two
3. System frequency: 50 CPS
4. Rating KVA:
   (i) HV 10,000 KVA (132 KV)
   (ii) LV 10,000 KVA (11 KV)
5. Voltage rating:
   (i) HV 132,000 V.
   (ii) LV 11,000 V.
6. Load taps Position in steps of 2 ½% each from + 5% to – 15% (refer clause 2.12.0) with remote tap changer control panel.
7. Winding connection for 3 phases.
   (i) HV winding Delta
   (ii) LV winding Star
8. Neutral point of all star point to be brought out through bushing for solid grounding.
9. Type of Insulation:

	(i) 132 KV	Fully
	(ii) 11 KV	Insulated
10. Type of cooling		ONAN
11. Impedance with IS tolerance		8.5 %
12. Insulating medium		Transformer oil
13. Vector grouping		Dy11 (as per IS).
14. Parallel operation		Suitable for parallel operation

4 TEMPERATURE RISE

The temperature rise shall not exceed the following values above the ambient temperature indicated while the transformer is delivering the full rated KVA. The ambient temperature for air is 45 degree C. The tenderer may also indicate the maximum output the transformer can deliver.

(i) Winding – Temperature rise of the windings for ONAN transformers as measured by the resistance method, over an ambient air temperature of 45 degree C shall not be more than 55 degree C.

(i) Oil – The temperature rise as measured by the thermometer in top oil shall not exceed 45 degree C above an ambient of 45 degree C.

5 EFFICIENCY:

(a) The transformer shall be so designed that the maximum efficiency occurs at about 80% full load and the efficiency load characteristic shall be as flat as possible between 80 and 100% rated capacity. The efficiency figures shall be subject to tolerance as per IS.

(b) The tank shall be fitted with a substantial under-carriage mounted on bi-directional wheels of the bogie type. The wheels shall have roller bearings. The gauge of the rollers both along its length and width shall be 5" – 6" (1676 mm).

(c) Guides shall be provided on the inner side of the tank to facilitate tanking and un-tanking of the core and coil assembly. The core assembly shall be such as to ensure a minimum clearance of 6" between the core and the tank bottom. The clearance between live parts and earth shall be such that the transformers can withstand the specified 50 cycles and impulse test voltages.

(d) The tank cover shall be bolted on the flanged rim of the tank with waterproof hot oil resistant and resilient gasket in between, for oil tightness. Surface where gaskets fit shall be machined. If the gasket is compressible, metallic stops shall be provided in the cover to facilitate unseating of the cover of the tank with the minimum damage to the gasket. Pockets and sharp corners where gas may collect without passing through to the Buchholz relay shall be avoided.

(e) Access and inspection holes blanked off with oil tight gasket sealed cover plates shall be provided for working on the connections of the leads of windings, the bottom terminals of bushings and other parts. Bushing turrets, covers of access holes, covers for

pockets of thermometers and other, devices shall be so designed as to prevent any leakage of rain water into the tank and the tank cover as a whole shall shed off all rain water.

(f)Each tank and its conservator shall after fabrication be fitted with the respective valves and pressure tested with transformer oil for a minimum duration of 24 hours to withstand a pressure equal to twice the stationary head of oil up to the surface level plus atmosphere pressure of 5.00 lb. Per sq. in. no valve shall drop and no weld shall sweat. The interior of the tanks and other oil filled chambers shall be cleaned thoroughly of all scales and painted with oil resisting enamel or varnish

6 LOSSES

The losses of the power transformer shall not be more than the following figures specified by Central board of Irrigation and Power, New Delhi.

Voltage	**Capacity**	**No load losses**	**Load loses**
132/11KV	10 MVA	12 KW Max.	65 KW Max.

No bonus shall be given for loss figure less than specified above. Offers with higher loss figures shall be rejected.

7 TANK AND TANK COVER

The tank must be constructed with welded boilerplates, suitably reinforced and made of one or more pieces as necessary. All joints shall be hot oil tight and no bulging shall occur either in service or during transport. The tank assemblies shall be sufficient rigid to withstand full vacuum against standard atmosphere pressure. External lugs for lifting the entire transformer while changing the position of bi-directional wheels and hauling holes in the under frame for haulage of the transformer shall also be provided.

8 CORE.

(a) The core shall be built up of the highest-grade non-ageing, grain oriented silicon steel laminations properly insulated to prevent eddy currents. The insulating materials shall not disintegrate due to core vibration, and also due to presence of moisture in a humid and saline atmosphere. Paper insulation will not be accepted. The maximum induction density (at rated voltage) in the core shall preferably be limited to such a value on the magnetization curve that the existing volt amperes required for 110 percent of the maximum induction density shall preferably not exceed about 200 percent of the volt amperes required for the maximum working induction density at full voltage.

(b)The core laminations forming the yokes shall be inter-leaved with those of the limb in the core type of transformer.

(c)The assembled core shall be secured by clamps on the limbs and the yoke so as to prevent any undue noise, or vibration and against mechanical displacement. If clamping bolts are arranged in two columns on a limb of the core due to its large width, necessary

measures shall be adopted to prevent the occurrence of a short path for the eddy currents, which may result from failure of insulation of any one of the bolts in each of the two columns. All clamping structure shall have adequate mechanical strength to withstand all mechanical stresses that are likely to arise during short circuits, lifting operations; transport etc. and no element in the clamping structure shall have any permanent deformation. The top core-clamping frame shall be provided with lifting eyes for the purpose of tanking and untanking of the entire core and coil assembly. The core shall be connected to the tank by a metal strip to drain off electrostatic potentials.

(d)Necessary cooling ducts for the efficient cooling of the core and to ensure free circulation of the oil shall be provided. The maximum hot spot temperature in the core shall be non-injuries to the insulation and materials of the core-clamping framework. The supporting framework of the core shall be so designed as to avoid the presence of pockets, which would prevent complete emptying of the tank through the drain valve. Each of the core bolts and parts of the core clamping frame work which are likely to form a closed circulation path shall be insulated from the core laminations and tested after completion of the core assembly to withstand a D.C. pressure of 2500 volts for a duration of one minute.

9 WINDINGS

(a) Each of the coils shall be wound with paper insulated continuous and smooth, tinned or enameled conductor made of electrolytic copper of more than 99.9 percent purity. Similar coils of a winding shall be connected by accessible joints, which shall be brazed or welded. There shall be no sharp bends in the connections or leads and no corona discharge shall result on the windings during all the specified factory insulation tests. Class 'A' insulation shall be used throughout. Paper insulation shall be new and free from punctures. Wood insulation shall be treated and seasoned.

(b) The arrangements of windings on the core shall be such that there is electrical and magnetic balance under all conditions of operation to ensure free circulation of oil and absence of hot spots. The high-tension windings shall be separated from the low voltage windings by suitable insulating barriers so placed as to form vertical oil ducts. The highest-grade sheet pressboard shall be used for the barriers and collars. One-piece pressboard flanged collars with the cylinders shall form insulating spools on the coils wound. The high and low tension windings on each leg shall be so assembled so as to admit their being placed on or removed from the core leg as complete units. Robust supports, wedges and spacers of hard insulation shall be fitted that they will neither move nor permit relative movement of any part of windings during normal service, or during terminal short circuit, nor mechanically injure the paper insulation.

All leads and connections shall be mechanically strong, heavily insulated, protected and rigidly clamped so that they withstand all short circuit stresses. The arrangement of the connections shall be such that the high voltage and low voltage connections do not cross one another. The winding connection for the HV side shall be 'Delta" and for the LV side "Star".

(c) The winding assembly shall be dried in vacuum, thoroughly shrunk to final dimensions and impregnated under vacuum with tested insulating oil. The insulation resistance measured immediately after impregnation and the temperature at which it is measured shall be reported for the purchaser's record. Easily accessible pressure adjusting devices shall be provided to compensate for any further shrinkage in service.

(d) The insulation levels of the windings shall satisfy the withstand tests specified in the following table. The impulse tests shall be conducted in accordance with the A.I.E./IS/ Standards, negative waves being used for the test.

INSULATION LEVELS FOR THE TRANSFORMER WINDINGS

Insulation Class of Windings	Power Frequency with stand Voltage KV (RMS)	Impulse test Voltage KV(Peak)
132 KV	275	650
11 KV	28	75

(e) The completely assembled transformer shall be dispatched to site after necessary test in the manufacturer's works. If required to limit the weight, the tank shall be filled with an inert gas like Nitrogen and a pressure gauge to be provided on each of the tanks. Necessary lifting lugs for the entire tank shall be provided.

10 TERMINAL ARRANGEMENTS

a) The transformer shall be capable of being moved on its own wheels from its permanent plinth to the repair bay on bi-directional wheels for any maintenance and repair works. The connections from the 132 KV, bushing shall be of aluminum tube. The terminal connections on the 11 KV side shall consist of disconnecting chambers and cable box with gland suitable for cross-linked PVC Aluminum cables of 400 Sq.mm 3 runs. By disconnecting the 132 KV aluminum tube and 11 KV disconnecting chambers, it should be possible for the transformer to be moved out for repairs. The location of the 132 KV and LV terminals and the location of the on load tap change gear, marshalling kiosk, etc. shall be so arranged that the supporting structures, connections, etc. Shall not interfere with one another. The terminal positions shall also be such that the bare tubular connections will have the required minimum clearances to component parts of the transformer itself such as oil conservator, piping etc. The details of the terminals on various voltage ratings are indicated below: -

i) 132 KV terminals of the transformer shall be of the oil filled condenser type.
ii) L.V. Terminals and its neutral bushings shall be solid porcelain type.

b) The bushing terminal fittings shall not only carry the full rated current of the transformer corresponding to the rated output but shall also carry 10% more than the rated output without the temperature rise of any part exceeding 25 degree C over an ambient of 45 degree C. The bushing shall be made of two one piece wet process brown glazed porcelain having high mechanical strength, stable insulation and high puncture value to ensure an external flashover before breakdown occurs due to high voltage. They shall be assembled together by clamping flanges. They shall operate satisfactorily in

heavy rain or in an atmosphere laden with sand or dust. They shall be free from corona and shall not cause radio interference. All porcelain surfaces in contact with gaskets shall be ground and machined to ensure oil tightness.

c) A non-breathing oil expansion chamber made of toughened amber glass to filter all light rays, which may cause the oil to sludge.

i) A magnetic type of gauge shall be provided to indicate the oil level.
i) Metallic ground shield
ii) Removable oil filling and oil drain plugs.
iii) Adjustable spark gap made of ½" round soft drawn copper rods for insulation co-ordination.

d) Terminal connectors.

i) The 132 KV bushing shall be provided with bimetallic type connector for vertical take off for aluminum tube. The connector shall be designed to prevent corrosion due to bimetallic action.

ii) The connection on 11 KV side shall be with disconnecting chamber suitable for 3 x 3 core x 400 mmsq, 11 KV, XLPE Aluminum cable.

iii) The L.V. neutral bushings shall be provided with suitable connections for connecting to strip type copper bus bars for ground connections.

e) All bushings shall be suitable for continuous operation at 10% above the nominal voltage of the bushings.

f) The windings side connection terminal of the bushings shall preferably be of the cable type suitable for brazing on the winding side and screwed on the cap side so that the bushing can be removed without opening the top cover of the transformer by sliding the lead down the central bushing tube. Alternatively, the tenderer may also offer for screwed type clamp connections.

g) The insulation requirements shall conform to IS 2099/1998 with latest amendments.

h) Bushing mounted current transformers on 132 KV side shall be as per IS standards.

11 COOLING EQUIPMENT FOR 10 MVA TRANSFORMER OIL IMMERSED NATURAL COOLING

Oil immersed natural cooled type of cooling shall be provided for these transformers.
The transformer shall be provided with detachable type radiator banks. Necessary cut-off valves between the radiator bank and the main tank of the transformer shall be provided both at the top and bottom.

12 ON LOAD TAPS AND TAP CHANGE GEAR WITH REMOTE CONTROL PANEL.

The transformers shall be provided with on load tap changing gear for varying the effective transformation ratio of the transformers without producing phase displacement. The variation shall take place in a number of steps specified elsewhere in the specifications. Each tap shall be designed for the full rated KA without exceeding the temperature rise and shall also be capable of withstanding continuously a voltage of 10% above the rated voltage of the tap. Full details of the type of gear offered, mechanical construction and control feature must be furnished along with the tender. The current diverting contacts shall be housed in separate oil changer not communicating with the main transformer tank. Contacts shall be easily accessible for inspection and replacement.

The supply must include remote controlled tap changer panel. Necessary tools and tackles required for the maintenance of the ON load tap changing gear shall be supplied without any extra cost.

The on load tap changer should have the facility of tap changing from one tap to an adjacent tap on load without interrupting the main circuit. The conventional tap changer should have the basic requirement.

1. Selector switch should not break current.
1. The main current should not be interrupted during tap changing.
2. Reduce oil deterioration by incorporating transfer resistors, so as to reduce arcing in the diverter switch and increase the life of contact.
4. No bouncing should take place at the diverter switch.
5. Switching mechanism should properly match the interruption characteristics and should ensure reliability of operation.
6. The diverter switch should not stop in between the tap position during tap changing cycle.
7. The diverter switch should have separate enclosure with breather if needed and the main transformer tank should not come in contact with the switch.
8. The service life of the tap changer shall be equal to the life of the transformer itself.

13 FITTINGS

a)All screw thread and nuts shall be cut to metric standard or other approved practice. All valves shall be of brass of standard test quality, leak proof and shall be able to withstand full vacuum inside the transformer tank.

b) The following fittings and accessories shall be provided for each of the transformers: -

1) Conservator with filling hole and cap.
2) Isolating valve of the conservator Flanged drain valve for the conservator.
3) Flanged drain valve for the conservator.
4) Magnetic oil gauge for the conservator with low and high oil level alarm contacts.
5) Silica gel breather with connecting pipe.
6) Pressure relief pipe with necessary air equalizer connection to the conservator.
7) Access holes with bolted covers for access to inner end of bushings on the transformer cover (manhole)
8) Cover lifting eyes.
9) Lifting eyes for core frame with windings.
10) Air release plug in the top cover and bushing turrets.

11) Upper filter valve 2", baffled to reduce serration of oil and flanged to seat 1 ½" BSP male threaded adopter for filter pipe connection..
12) Bottom filter valves 2" flanged to seat 1 ½" BSP male threaded adapter for filter pipe connection, so fitted as to drain off the oil completely.
13) Drain valve 4" flanged.
14) Three oil sampling valves one for the bottom oil, one for the middle oil and one for the top oil.
15) Lifting lugs or bollards for the whole transformer Jacking pad with hauling holes. The pad shall be suitable for jacking the transformer while changing the position of bi-directional wheels.
16) Transport lugs suitable for rail and road transport.
17) The designed position to be finalized in consultation with the purchaser.
18) Under carriage with flanged bi-directional bogie type wheels. The gauge shall be confirmed from the purchaser.
19) Tank earthing terminal two members to provide double earth connections as required in the Indian Electricity Rules.
20) Gas pressure testing valve with pressure gauge for testing the pressure of inert gas on receipt of transformer at site.
21) Buchholz relay double float type separate for each diverter chamber and transformer tank with one set of contacts for alarm and the other set for trip with annunciation facility. A testing pot cock shall also be provided. The contacts shall be wired up to the marshalling kiosk with weatherproof cable in metallic conduits.
22) Dial thermometer for oil and winding temperature indicator complete with two set of contacts, one for alarm and another for trip. 4-20ma out put for remote indication and control.
23) Pocket for inserting alcohol thermometer for oil temperature indication in each of the radiator circuits.
24) Weather proof and vermin proof terminal cabinet with hinged door and pad lock for marshalling terminal cabinet with hinged door and pad lock for marshalling terminal connections from protective and indicating devices.
25) Rating plate.
26) Diagram plate.
27) Any other accessories as needed.

14 RATING AND DIAGRAM PLATES

The following plates shall be fixed to the transformer tank at an average height approximate 5' – 9' above ground level:

a) A rating plate bearing the date specified in art.1 and 2 of IS 2026/1962 including the temperature rise of oil and windings, the BIL of the transformer insulation and terminals etc.
b) A diagram plate showing in an approved manner the internal connections and also the vector relationship to the several windings in accordance with IS 2026 or BS 171 and in addition a plan view of the transformer giving the correct physical relationship of the terminals. When links are provided for changing the transformer ratio, means shall be provided for clearly indicating the connections to be adopted for the several ratios.

c) A plate showing the location and function of all valves and air release cocks or plugs. This plate shall warn the operator to refer to the maintenance instructions before applying the vacuum treatments.

The above plates shall be of stainless steel or of other approved materials withstanding continuous outdoor service.

15 SUPPRESSION OF HARMONICS

The transformers shall be designed with particular attention to the suppression of harmonic voltages, especially the 3^{rd} and 5^{th} so as to eliminate wave form distortion and any possibility of high frequency disturbances, inductive effects or of circulating currents, between neutral point of different transformer station reaching such a magnitude as to cause interference with communication circuits.

16 INSULATION CO-ORDINATION

The contractor shall furnish (i) impulse flash over (ii) dry flash over characteristics for the bushing spark gaps set at different distances of separation. He shall also furnish the impulse volt-time characteristics of the transformer winding and bushing to enable the purchaser to obtain effective insulation co-ordination between the transformer, lightning arrestor and the rest of the station equipment.

17 PROTECTION

The following protection must be provided for the transformers: -
Detecting or actuation devices required which form part of the transformer construction shall be incorporated-
Buchholz Alarm and trip
Differential protection
Thermal Alarm and trip
Low and high oil level alarms for the conservators.

18 EARTHING

The transformer core and frame shall earthed to the tank by means of copper connections of adequate cross section which shall not be less than 0.1 sq.in in double earthing lugs shall be provided on each tank.

19 VIBRATION AND NOISE

All transformer and auxiliary plant shall operate without appreciable vibration and noise. The noise level of the transformer in db, under normal operating conditions shall be stated in the tender.

20 POWER SUPPLY TO AUXILIARIES.

A.C. supply to auxiliaries will be 3 phase, 4 wire, and 50 Hz. 415/240 +/- 10 percent volts. All motor, heaters illuminating lamps etc. shall be suitable for A.C.supply.

D.C. supply will be at 110 volts +/- 10 percent by station battery, the details are furnished elsewhere. All indicating lights, alarm and trip devices shall be suitable for the above D.C. supply.

21 INSULATION MEDIUM.
The insulation oil shall conform to the requirement of IS – 335 –2000 or the latest revision thereof.

The quantity of oil required for the transformers plus 10 percent extra shall be quoted separately in the price schedule. No extra shall be payable for these services.

22 PAINTING.
The surfaces to be painted shall be shot or sand blasted to remove all rust, scale, grease and other foreign matter. All steel surfaces on contact with insulating oil shall be given two coats of heat and oil resisting insulating varnish. All steel surface exposed to weather shall be given a priming coat of zinc chromate and two coats of light gray paint of shade 631 IS-5. All paints shall be suitable for subsequent application of approved paint.

All paints selected shall be suitable to withstand tropical heat and extremes of weather. The paint shall not scale off or crinkle or be removed by abrasion due to normal handling.

23 DRYING OUT AT WORKS AND SITE.
The transformers shall thoroughly dried under vacuum in the factory and sealed under positive pressure of dry inert gas or air for delivery. A pressure gauge shall be provided for each tank to determine the internal pressure on receipt at site, minimum outdoor work at site shall be ensured by the tenderer.

The contractor shall furnish detailed instructions for drying out the transformer using the type of equipment if drying at site becomes necessary.

24 GUARANTEE AND PENALTIES.
The guarantees to be furnished by the tenderer in respect of the efficiencies of the transformers shall be subjected to the following penalty.
If the efficiency at any of the above outputs falls short of the corresponding guaranteed figure by more than tolerance specified in IS 2026 the transformer shall be liable to be rejected by the Railway and the provisions under the relevant clause of the general conditions of contract shall immediately become applicable.

25 TESTS.
The following tests shall be carried out in order to determine whether the materials and performance comply with the specifications and to provide the necessary operating data.
a) Not less than 10 days' notice of all tests shall be given to the Engineer or his authorized representative in order that he may be represented if he desires.
b) Seven copies of all certified test report shall be furnished to the Railway. The advance copies shall be furnished by airmail for the Purchaser's scrutiny and the equipment shall not be dispatched without obtaining the Railway's written approval for the test reports.

A)STAGE TESTS.

The following tests shall be conducted during manufacture in addition to any other customary tests of the manufacturer: -

a) Vacuum withstands strength of tank.
b) Test for oil tightness.
c) Material test on core conductor and insulating materials.
d) Leakage tests for radiators.
e) All welds shall be tested to ensure that no weld would sweat.

B) ROUTINE TESTS.

After the completion of the manufacture, the following tests shall be conducted on each unit: -

a) Ratio test for all taps.
b) Check test for polarity, vector relationship and terminals markings.
c) No load test for losses and excitation current at 100 percent and 110 percent of the rated voltage.
d) Measurement of load losses at rated load current and calculation of the losses at 75 degree C.
e) Impedance voltage between windings at rates current and calculation of impedance at 75 degree C.
f) Resistance of windings, cold at test bed temperature and calculation of corresponding values at 75 degree C.
g) Insulation resistance between windings and windings to earth at 75 deg C
h) High Voltage Test.
   1. Applied voltage test the leakage current shall be recorded.
   2. Induced voltage test - the values of the exciting voltage, current and frequency shall be recorded in the test certificate.
   3. Calculation of regulation at unity P.F. and 0.8 P.F. lagging load.
   4) Determination of efficiency at full, three quarters half and quarter loads at unity P.F.
   5) Zero sequence impedance tests.

C) TYPE TESTS.

The tenderer shall submit with his tender the type test report for impulse test on a similar transformer and shall quote extra charges, if any, for carrying out the following type tests on the transformer of this rating.

D) TEMPERATURE RISE TEST.

Temperature rise shall not exceed the specified values with reference to the ambient temperature of 45 degree C for air.

E) IMPULSE TEST.

The tenderer shall state whether it is his practice to conduct impulse tests on each transformer as routine test. The extra charges if any for conducting impulse tests on the transformer shall also be indicated in the tender. Enlarged copies of the oscilograms of the impulse test shall be submitted.

F) TESTS ON ASSOCIATED EQUIPMENT.

Porcelain bushing, tap change gear, bucholz relays, motors, radiators and other associated equipment shall be tested according to standard practice. Certificates of compliance shall be furnished.

26 DRAWINGS FOR SHIPPING .

The following drawings shall be submitted in triplicate: -

a) A general outline and shipping dimensions, net and shipping weights, height of crane hook for lifting core and bushings etc.

b) Sectional views of bushings, heat exchangers, coolers etc.

27 CONTRACT DRAWINGS.

a) General outline showing plan, elevation and end view dimensions, dimensions of transformers, stripped for shipment, physical centerlines and position of center of gravity relative to them. Drawings to indicate height of crane hook for lifting bushings and untanking core, details of bushing top terminals, complete list of fittings and devices, net weights of core frames, windings tank, conservator, total quantity of oil, shipping weight, vacuum withstand strength of the transformer, rating particulars of transformer.

a) Diagram and rating plates per details in the specifications, temperature rise of oil and winding, high voltage test figures etc.

b) Electrical connections of windings, numbering of taps, tapping switches, terminal, vector group, polarity, terminal marking of C.Ts etc.

c) Control circuits and wiring diagram, schematic circuit diagram for paralleling interlock, wiring diagrams of control cabinets, signaling and indicating devices, current transformers, block diagrams showing interconnecting control cables schedules.

d) Schematic diagram, layout diagram, wiring diagrams, component layout of ON load tap changer remote control panel.

e) Drilling details and internal wiring of devices supplied loose for mounting on the purchaser's control board.

f) Shipping outline: Outline profile plan, elevation and view of transformer stripped for shipment, dimensions of projections referred to the physical center lines, the position of center of gravity. There shall be inset on the Railway clearance drawing.

g) Foundation drawings

i) Assembly of core and coils:

Details of winding connections, insulation spacers, barriers, and clearance core bolt insulation etc. that will help the purchaser to replace a set of windings in any future eventuality. The component parts shall be suitably numbered and the parts shipped shall have similarly numbered tags.

j) Bushing Assembly: Plan, elevation, Sectional view and details of joints seals, etc.

k) Radiator Assembly: Sectional view of radiator.

l) Detailed assembly drawings to enable the purchaser to do the core and coil. Separate numbers shall identify parts.

m) Dimensions drawings showing cooling passages on transformers and windings.

APPENDIX-8

12 KV, TRIPLE POLE, CENTER – POST – ROTATING, DOUBLE BREAK ISOLATOR

1.0 SCOPE

1.1 This specification covers design, manufacturing, assembly, testing before supply, inspection, packing and delivery at site, installation, site testing and commissioning and other basic requirements in respect of out door type 12 KV isolators with all the accessories equipment required for their satisfactory operation.

1.2 The isolator shall conform, in all respects to high standard of engineering, design and workmanship, It shall be guaranteed in a manner acceptable to the Owner who will interpret the meaning of drawings and specification and shall have power to reject any work or material, which, in his judgment is not in accordance therewith.

2.0 APPLICABLE STANDARD

2.1 The isolator shall conform to the latest revision of IS 9921. The post insulator shall confirm to IS 2544 and galvanizing to IS 2629.

2.2 Equipment meeting with the stipulations of equivalent of any other internationally recognized standards, which ensure equal or better quality than the standards listed in the end, shall also be acceptable. In such case the contractor should submit along with his offer, two copies of such standards in authentic English translation, if the language of the standard is other than English.

3.0 GENERAL TECHNICAL REQUIREMENTS

3.1 Type of Isolators:

The isolators shall be manually and motorised operated triple pole, centre-post rotating, gang operated, double break type. It shall be suitable to be mounted on horizontal or vertical arrangement.

3.2 Current Carrying Parts:

3.2.1 All current carrying parts shall be made of tinned electrolytic copper. The main contacts shall be silver plated, accurately machined and self-aligning type. The fixed contacts shall be spring loaded finger type to provide high contact pressure. The spring shall not creepy. The arcing contacts shall be made of phosphor bronze and shall have spring-assisted operation. The isolator shall have a spring

mechanism so as to ensure that speed of opening of contacts is independent of speed of manual operation.

3.2.2 Material of blades and contacts of earthing switch shall be the same as those of main switch moving blade and contacts respectively. Cross sectional area of earthing blades and contacts shall not be less than 50% of cross sectional area of main blades and contacts. Earthing blades shall have the same short time current rating (thermal & dynamic) as that of main switch.

3.2.3 All current carrying parts shall be designed to have smooth surfaces without any sharp points, edges and other corona producing surfaces.

3.2.4 The contact surface shall be wiped during closing and opening operations to remove any oxide deposition on the contacts.

3.3 CURRENT DENSITY

Current density to be adopted for all the parts of isolator and terminal connector shall not exceed the following limits:

Blade and other parts – Copper	1.6 A/sqmm
Terminal connectors – Aluminium	1.0 A/sqmm

3.4 INSULATORS

3.4.1 The Isolator shall be provided with 6 nos. of 24 KV post insulator per pole for 36 KV and 3 nos. of 24 KV post insulator per pole for 12 KV. There will be total of 18 such post insulators in one set of isolator for 36 KV and 9 such post insulators in one set of isolator for 12 KV. These insulators shall conform to latest amendment of IS: 2544 and IS: 5350 (Part –III)

3.4.2 Insulator shall be made of homogeneous and vitreous porcelain of high mechanical & 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 uniform, brown or dark brown colour with a smooth surface arranges to shed away rainwater. Porcelain and metal parts shall be assembled in such a way 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. Polycone insulators shall not be acceptable.

3.4.3 The insulator shall be provided with a completely galvanised steel base design for mounting on the support. The base and mounting arrangement of the insulator shall be such that the insulator shall be rigid and self-supporting and no guying or cross bracing between phases shall be necessary.

3.4.4 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.

3.4.5 All post insulator stacks except the central rotating stacks, shall be provided with arcing horns made of 10 mm GI rod.

3.4.6 The puncture voltage shall be greater than dry flash over voltage.

3.5 Terminal Connectors:

Six bimetallic bolted type terminal connectors shall be provided on the in-coming and out-going sides to directly receive conductors of 10-90 mm diameter without the use of lugs. The connectors shall be suitable for current ratings of 630 Amp in normal operation and 25 K Amp for 3 second. These connectors shall conform to all the test requirements of IS: 5561.

Terminal Pads shall be made out of electrolytic copper heavily silver plated (15 microns). The terminal pads shall be suitable for connection to 40x40 mm terminal connector.

3.6 Earthing:

3.6.1 The frame of each isolator shall be provided with a separate earthing terminal for each phase for connection to an earthing conductor having a clamping bolt of not less than 12 mm dia. The terminal shall be marked with 'EARTH' symbol.

3.6.2 Flexible copper braid 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 corrosion.

3.6.3 The frame of each disconnector and earthing switch shall be provided with two reliable earthing terminals for connecting to earth mat. The connection shall be such that it can carry specified short circuit current.

3.7 Clearances:

3.7.1 Phase clearance i.e. centre-to-centre distance between the insulators of adjacent phases in the assembled position shall be 1200 mm for 33 KV.

3.7.2 Centre to centre distance between adjacent poles of the same phases in the assembled position shall be 400 mm for 33 KV.

3.7.3 All part shall be interchangeable with the similar part of any other phase.

4.0 OPERATING MECHANISM.

A. MOTOERISE :- 11KV 2000 A double breake center rotating type isolator .Asper stander IS: 9921/IEC-60129, nos of poles 3,rated voltage 12 kv ,current 2000 A,galvanising IS 2629,control supply 110 V and auxlary supply 230 v AC. All Interlock are suitable as per site.

B. GANG OPERATED

4.1 The vertical operating rod shall comprise of 40 mm galvanized steel tube (medium class) as per IS: 1161. Length of the rod shall depend on the mounting position of the isolator. Operating handle shall be fixed to the support structures (apprx. 1 meter above the ground level.). The vertical tube shall be galvanized as per IS: 2544.

4.2 The rotating parts i.e. bell crank lever and fork etc. shall be either forged or made of mild steel (cast components are not permitted)

4.3 Manual operating mechanism gang operated through hand-operated lever shall b e provided for main switch. The isolator shall open when operating handle is pulled downwards and close when the handle is pulled upwards. Adjustable stops shall be provided to stop over turning. Besides counter balance springs shall be provided to prevent impact at the end of travel both in closed and open position. Double ball or roller bearing of best quality shall be provided for the rotating insulators stacks and single bearing for the operating mechanism.

4.4 The operating mechanism shall provide quick, simple and effective operation. The design shall be such that one person shall be able to operate the isolator without undue efforts. Earth switch shall close or open by rotation of lever through 90 degree. Earth switch and isolator operating mechanism should be such that it should not operate by gravity, wind, short circuit, seismic acceleration, vibration, shock, as accidental touching.

4.5 Mechanical interlocking between main switch and earth switch shall be provided. No operation of the main switch is possible as ong as earth switch is closed. Besides mechanical interlocking shall be provided so that the isolator cannot be operated when the associated circuit breaker is ON.

4.6 The isolator shall be provided with CLOSE/OPEN indicator.

4.6.1 Status of the isolator shall not show as 'CLOSED' till its main contacts are not properly closed.

4.6.2 Status of the isolator shall not show as 'OPEN' till its main contacts are not opened at least 80% of the isolating distance.

4.6.3 To avoid operation by the un-authorized person, the isolator shall have a pad lock arrangement both for 'CLOSED' and 'OPEN' position.

4.7 The operating handle shall be double earthed to ensure safety of personnel.

5.0 AUXILIARY SWITCH

5.1 The auxiliary cabinet shall be provided with hinged door along with padlocking arrangement. 15mm thick neoprene or better type of gaskets shall be provided to ensure degree of protection at least IP55 as per IS 13947.

5.2 Main switch operating mechanism shall be equipped with reliable auxiliary switch with 4 NO & 4 NC contacts exclusively interlocking and position indication scheme.

5.3 Auxiliary switches shall be actuated by a cam or similar arrangement directly mounted on the isolator shaft without any intermediate levers, linkages etc to ensure fool proof operation.

5.4 The auxiliary switch and auxiliary contacts shall be capable of carrying of 10 Amp current continuously.

5.5 Quick make and break (QMB) type auxiliary switch shall have snap action built in within the switch.

5.6 Terminal and Wiring

The cabinet shall be provided with 1100 volt grade stud type terminal. Auxiliary switch shall be wired up to the terminal block. There shall be at least 20% extra terminals. All wiring shall be carried out with 1100 V grade PVC insulated 2.5 sq. mm copper conductor as per IS: 1554.

A removable gland plate with double compression type brass cable glands shall be provided at the bottom for terminating all control cables.

6.0 MOUNTING & MOUNTING ACCESSORIES

6.1 Supporting Structures

The support structures also shall be fabricated out of galvanized lattice structure. The support structure shall be suitable for mounting of auxiliary switch cabinet and guides. It shall be designed to withstand short circuit forces, wind pressure, seismic forces etc. along with the operating forces, vibrations, shocks etc. at actual site conditions with adequate factor of safety.

7.0 PAINTING, GALVAN IZING AND CLIMATE PROOFING

7.1 All interiors and exteriors of enclosures, cabinets and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, grease and other foreign materials. After cleaning two coats of zinc oxide primer shall be given by suitable stoving and air drying etc. Colour of the final paint shall be epoxy light grey outside and white inside.

7.2 Paint inside the metallic housing shall be of anti-condensation type and the paint on outer surfaces shall be suitable for out door condition.

7.3 Hot dip Galvanisation with heavy coating shall be done after completion of the fabrication and should be capable of preventing corrosion in view of severe climatic conditions.

8.0 TESTING:

8.1 The contractor shall test the isolator as per IS: 9221. Immediately after finalization of the Programme of type/acceptance/routine testing, the Supplier/Contractor shall give three weeks advance intimation to the Owner, to enable him to depute his representative for witnessing the tests.

The equipment offered should be fully type tested as per relevant standards and contractor shall furnish a set of type test reports along with the offer.

In case these type tests are older than five years, all the type test as per relevant standard shall be carried out by the Contractor in presence of Owner's representative.

In order to make type test representative, all type tests must be carried out by erecting disconnector on its foundation and after fitting the actual operating mechanism of the disconnector and using normal insulators to be used in real case.

8.2 **Type Tests:**

1. Dielectric test (impulse and 1 minute wet power freq. withstand voltages)

2. Temperature rise test (for contacts & terminals)

3. Rated short time current & rated peak withstand current tests

4. Operation & mechanical endurance tests

5. Transformer off-load breaking capacity test

6. Line charging & breaking capacity test

8.3 **Routine Tests:**

1. Power freq. voltage dry test on isolator

2. Measurement of main contact resistance

3. Operating test

4. Power frequency voltage test on auxiliary circuit.

8.4 Additional Tests: To be conducted as per referred standards by the contractor

S.N.	Name of Test	Relevant Standard
1	Test on Insulator	IS 2544, IEC 168
2	Test on terminal connectors	IS 5561
3	Test on Galvanized components	IS 2623
4	Operation tests on operating mechanism & interlocks	IEC 129/IS 9921
5	Mechanical Endurance tests on auxiliary switches	

9.0 TECHNICAL PARAMETERS:

S.N	**Parameter**	**Unit**	**Requirements for (933 KV)**	**Requirements for (11 KV)**
1	Rated Freq.	Hz.	50	50
2	System Neutral Earthing		Solidly earthed	Solidly earthed
3	No. of phase (poles)	No.	3	3
4	Temp. rise	Deg.C	As per standards IS/IEC	As per standards IS/IEC
5	Safe duration of overload	Minutes		
	a) 150% of rated current		5	As per standards IS/IEC
	b) 120% of rated current		30	As per standards

				IS/IEC
6	Rated voltage	KV rms	36	12
7	Type of isolator (AB)		DBCR	DBCR
8	Rated normal current	Amps.	630	1250/800
9	Rated short time withstand current for 3 second	KA rms	25	25
10	Rated peak current	KA peak	63	63
11	Rated short circuit make current	KA peak	63	63
12	Derating factor		Unity	Unity
13	Basic Insulation Level			
	1) Lightning Impulse withstand voltage	KV peak		
	a) Pole to earth & between poles		170	75
	b) Across isolating distance		195	85
	2) Rated power freq. withstand voltage	KV rms		
	a) Pole to earth & between poles		70	28
	b) Across isolating distance		80	32
14	Min. Creepage distance (The protected Creepage distance shall not be less than 50% of total)	mm	900	300
15	Phase to phase spacing for installation	mm	1500	As per IE rule
16	Min. clearances	mm		
	a) Phase to earth		430	As per IE rule
	b) Between rotating post and fixed post on one phase		485	As per IE rule
17	Height of center line of terminal pad above ground level	mm	3885	As per IE rule
18	Special Requirements:			

	a) Earthing blades(EB) shall be capable to discharge the trapped charge of the line b) Isolator main switch(MS) 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 The isolator required is not with "Turn and twist mechanism". It must be rotating type.

APPENDIX-9

CONTROL & RELAY PANEL for 132 KV AND 11 KV

1.1 Simplex Panel

The Control and Relay Panel Boards shall consist of Simplex panel, vertical independent, floor mounted with equipment mounted on front and having wiring access from rear. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with built-in locking facility.

2.1 CONSTRUCTIONAL FEATURES

2.1.1 It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes be properly accommodated in the panels without congestion. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

2.1.2 Panels shall be completely sheet metal clad and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-4X in accordance with IS: 13947.

2.1.3 Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0 mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

2.4 All doors, removable covers and panels shall be gasketted all around with neoprene gaskets. Ventilating louvers to be if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

2.5 Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.

2.6 Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti vibration strips made of shock absorbing materials that shall be supplied by the contractor, shall be placed between panel and base frame.

2.7 Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly. The gland shall confirm to IS 12943.

3.0 MOUNTING

3.1 All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on from of panel shall be mounted flush. No equipment shall be mounted on the doors.

3.2 Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

3.3 Contractor shall carry out cut out, mounting and wiring of the items supplied by others, which are to be mounted in his panel in accordance with the corresponding equipment manufacture's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

3.4 The centre lines of switches, push buttons and indicating lamps shall be not less than 750 mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450 mm from the bottom of the panel.

3.5 The Centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.

4.0 PANEL INTERNAL WIRING

4.1 Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally.

4.2 All wiring shall be carried out with 1100V grade, single core, stranded FRLS tinned copper conductor wires with PVC insulation conforming to IS 1554. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

- All circuits except current transformer circuits and voltage transformer circuits meant for energy metering and AC & DC power circuit- one no 2.5 sq. mm. per lead.
- All current transformer circuits two nos. 2.5 sq.mm. per lead.
- Voltage transformer circuit (for energy meters): Two 2.5 sq.mm. per lead.
- AC/DC Power Circuit – One 4 sq.mm. per lead

4.3 All internal wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters and troughs shall be used for this purpose.

4.4 Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

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

disconnected from terminal blocks. All wires directly connected to trip circuit of breaker or device shall be distinguished by the addition of red colored unlettered ferrule.

4.6 Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near-the slots of holes meant for taking the inter-connecting wires.

4.7 Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.

5.0 TERMINAL BLOCKS

5.1 All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 1100 V grade and have 10 Amps continuous rating, moulded piece, complete with insulated barriers, stud type brass terminals, washers, nuts, lock nuts and identification strips. Markings on the terminal blocks shall be on marking strips and shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material. All Marking shall confirm to IS 11353.

5.2 Disconnecting type terminal blocks for voltage transformer secondary leads shall be provided. Current transformer secondary leads shall be provided with short circuiting and earthing facilities. These leads should have testing facilities.

5.3 At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

5.4 Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side

- All CT & PT circuits: minimum of two of 2.5mm Sq. Copper.
- AC/DC Power Supply Circuits: One of 4mm Sq. Copper.
- All other circuits: minimum of one of 2.5mm Sq. Copper.

5.5 There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

5.6 Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

5.7 All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. for external cables shall be included in the scope of supply.

6.0 PAINTING

6.1 All sheet steel work shall be phosphated in accordance with the IS: 6005 “Code of Practice for Phosphating Iron and Steel”.

6.2 Rust, scale, oil, grease, dirt and swarf shall be removed by 7 tank process.

6.3 After Phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

6.4 The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

6.5 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting. The final coat should present a hard glass finish.

6.6 A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.

6.7 In case the bidder proposes to follow any other established painting procedure like electrostatic painting or powder coating, the procedure shall be submitted for's review and approval.

7.0 MIMIC DIAGRAM

7.1 Colored mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.

7.2 Mimic diagram shall be made preferably of anodised aluminium or plastic of approved fast colour material, which shall be screwed on to the panel and can be easily cleaned. Painted overlaid mimic is also acceptable. The mimic bus shall be 2 mm thick. The width of the mimic bus shall be 10 mm for bus bars and 7 mm for other connections.

7.3 Mimic bus colour will be decided by the BSEB and shall be furnished to the successful Bidder during Engineering.

7.4 When semaphore indicators are used for equipment position they shall be so mounted in the mimic that the equipment close position shall complete the continuity of mimic.

7.5 Indicating lamp, one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition.

8.0 NAME PLATES AND MARKINGS

8.1 All equipment mounted on front and rear side as well as equipment mounted inside the panels shall be provided with individual name plates with equipment designation engraved. Also on the top of each panel on front as well as rear side, large and bold name plates shall be provided for circuit/feeder designation.

8.2 All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring.

8.3 Each instrument and meter shall be prominently marked with the quantity measured e.g. KVA, MW, etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

8.4 Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Nameplates shall be black with white engraving lettering.

8.5 All the panels shall be provided with nameplate mounted inside the panel bearing LOA No & Date, Name of the Substation & feeder and reference drawing number.

9.0 MISCELLANEOUS ACCESSORIES

9.1 **Plug Point:**

A 240V, Single phase 50Hz, 15 Amp AC socket with 15 Amps standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

9.2 **Interior Lighting:**

Each panel shall be provided with a 20 W fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.

9.3 **Switches and Fuses:**

Each panel shall be provided with necessary arrangements for receiving, distributing, protecting and isolating DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. MCBs shall confirm to IS: 13947. Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. However voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on moulded structure plug-in type fuse carriers fitted to bases as per IS 1300 bases. Fuse carrier base as well as MCBs shall have imprints of the fuse 'rating' and 'voltage'.

9.4 **Space Heater:**

Each panel shall be provided with a space heater rated for 240V, single phase, 50 Hz AC supply for the internal heating of the panel to prevent condensation of moisture. The heater shall be complete with thermostat controlled and a switch unit.

10.0 EARTHING

10.1 All panels shall be equipped with an earth bus securely fixed. The material and the sizes of the bus bar shall be at least 25 x 6 sq.mm perforated copper strip with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing suitable connectors for this purpose shall be provided. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

10.2 All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The colour code of earthing wires shall be green.

10.3 Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

10.4 VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

10.5 The earth bar shall be terminated into two earthling terminals of adequate size with nuts and washer for connecting to the station earthing system.

11.0 INDICATING INSTRUMENTS

All instruments and meters shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. Frequency meters shall be provided with individual transducers and these shall be calibrated along with transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site.

11.1.1 Unless otherwise specified, all electrical indicating instruments shall have circular 240 degree scale and with a dial of 96 mm x 96 mm. They shall be suitable for flush mounting.

11.1.2 Instruments dial shall be with white circular scale and black pointer and with black numerals and lettering. The dial shall be free from warping, fading, and discoloring. The dial shall also be free from parallax error.

11.1.3 Instruments shall conform to IS: 1248 and shall have accuracy class of 1.0 or better. The design of the scales shall be such as to have resolution suitable for the application. The marking of centre zero Watt/Var meters shall be IMPORT (on left) and EXPORT (on right) to indicate the direction of active/reactive power flow towards or away from the substation bus bars respectively.

11.1.4 Digital frequency meters shall be of class: 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than 25 mm (height).

11.2 TRANSDUCERS

11.2.1 Transducers (for use with Indicating Instruments) shall in general conform to IEC: 688-1

11.2.2 The energy meter capability shall be used for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.

11.2.3 Each panel shall consist of energy meter, protection schemes, indication and control etc. One 11 KV C&R panel shall be provided for each 11 KV outdoor type VCB for incomer and feeder.

11.2.4 Voltage signal (440 Volt ac L-L) for voltmeter, PF meter, frequency meter, KW meter etc to be provided in the C&R panel and shall be tapped from the respective PTs through a separate/independent copper cable.

11.3 ENERGY METER

Contractor shall provide Static TVM energy meter as per the technical specification covered in the chapter of technical specification of TVM energy meter

11.4 ANNUNCIATION SYSTEM

11.4.1 Alarm annunciation system shall be provided in the control board by means of visual and audible alarm. The annunciation equipment shall be suitable for operation on the voltages specified in this specification.

11.4.2 The visual annunciation shall be provided by annunciation facia windows mounted flush on the top of the control panels.

11.4.3 The annunciator facia shall be provided with translucent plastic window for alarm point with approximate size of 35mm x 50mm. The facia plates shall be engraved in black lettering with respective inscriptions. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.

11.4.4 Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure clear visibility of the inscriptions in the control room having high illumination intensity (350 Lux), from the location of the operator's desk.

11.4.5 All Trip facia shall have red colour and all Non-trip facia shall have white colour.

11.4.6 The annunciation system shall work in co-ordination with the existing annunciation system (hooter or bell) in the substation for R&M scheme. If the same is not provided, hooter shall be supplied for above purpose.

11.4.7 Sequence of operation of the annunciator shall be as follows:

Sl.N	Alarm condition	Fault contact	Visual Annunciation	Audible Annunciation (by Hooter)
1	Normal	Open	Off	OFF
2	Abnormal	Close	Flashing	ON
3	Accept push button pressed	Close Open	Steady on Steady on	OFF OFF
4	Reset push button is pressed	Close Open	On Off	OFF OFF
5	Lamp test Push button pressed	Open	Steady On	OFF
6	Alarm test	Open	Flashing	ON

11.4.8 Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 240 Volts AC supply. On failure of the DC to the annunciation system for more than 2 or 3 seconds (adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the DC supply to annunciation system is restored.

11.4.9 A separate voltage check relay shall be provided to monitor the failure of supply (240V AC). If the failure of supply exists for more than 2 to 3 seconds this relay shall initiate visual and audible annunciation. This annunciation shall operate on DC and buzzer shall sound.

11.4.10 The total number of windows shall be 16 and the matter for engraving shall be indicated to the contractor in due course.

11.5 SWITCHES

11.5.1 Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

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

Breaker control switches	:	Pistol grip, black
Selector switches	:	Oval or knob, black
Instrument switches	:	Round, knurled, black

11.5.3 The control switch of breaker shall be of spring return to neutral type. The switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively. It shall be necessary to press the switch before turning to close or command position.

11.5.4 Instrument selection switches shall be of maintained contact (stay put) type.

11.5.5 The contacts of all switches shall preferably open and close with snap action to minimize arcing. Contacts of switches shall be spring assisted and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts.

11.5.6 The contact rating of the switches shall be as follows:

Description	**Contact rating in Amps**
Continuous	30/110 V DC or 240 volts AC supply, 10 Amp
Make and carry	30/110 V DC or 240 volts AC supply, 30 Amp.
Break for Resistive load	30/110 V DC or 240 volts AC supply, 20 Amp.

11.6 INDICATING LAMPS

11.6.1 Indicating lamps shall be of multiple LED, panel mounting type with rear terminal connections. Lamps shall have translucent lamp covers to diffuse lights colored red, green, amber, clear white or blue as specified. The lamp cover shall be preferably of screwed type, unbreakable and moulded from heat resisting material.

11.6.2 Lamps and its parts shall be interchangeable and easily replaceable from the front of the panel.

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

11.7 SEMAPHORE INDICATORS

11.7.1 Position indicators of "SEMAPHORE" type shall be provided as part of the mimic diagrams on panels for indicating the position of circuit breakers, isolating/earthing switches etc. The indicator shall be suitable for semi-flush mounting with only the front disc projecting out and with terminal connection from the rear. Their strips shall be of the same colour as the associated mimic.

11.7.2 Position indicator shall be suitable for DC Voltage as specified. When the supervised object is in the closed position, the pointer of the indicator shall take up a position in line with the mimic bus bars, and at right angles to them when the object is in the open position. When the supply failure to the indicator occurs, the pointer shall take up an intermediate position to indicate the supply failure.

11.7.3 The rating of the indicator shall not exceed 2.5 W.

11.7.4 The position indicators shall withstand 120 percent of rated voltage on a continuous basis.

12.0 RELAYS

12.1 All relays shall conform to the requirements of IS: 3231 or IEC-60255 or other applicable standards. Relay shall be suitable for flush or semi-flush mounting on the front with connections from the rear. Relays could be either electromechanical or electronics.

12.2 All protective relays shall be in draw out type in modular cases with proper testing facilities in the form of blocks. Necessary test plugs shall be supplied loose and shall be included in Contractor's scope of supply.

12.3 AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 5 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80 percent and 110 percent of rated voltage. All relays shall have adequate thermal capacity for continuous operation.

12.4 The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays, timers, lockout relay etc. required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme. Contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections.

12.5 All protective relays, auxiliary relays and timers shall be provided with hand reset type contacts. They shall also be provided with hand reset type external operation indicators with suitable inscription to be informed in due course of time.

12.6 No control relay which shall trip the power circuit breaker when the relay is de-energised shall be employed in the circuits.

12.7 Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

12.9 All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals.

12.10 The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

12.11 Any alternative or additional protections or relays considered necessary for providing complete effective and reliable protection should also be offered separately. The acceptance of this alternative/additional equipment shall lie with the BSEB.

12.12 All relays shall have capability to withstand test voltage of 2 KV rms for one minute.

12.13 All relays and their drawings shall have phase indications as R-Red, Y-yellow, and B -blue.

12.14 PROTECTIONS:

A) Transformer protection panel:

I. Two over current (IDMT. Characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current) and one earth fault relay. Contractor may offer a composite unit also having these features as separate elements.

II. One auxiliary relay which shall receive inputs from all transformer protections and send command to trip coil of the circuit breaker through master trip relay.

III. One high speed master trip relay.

B) 11 KV Panels incoming and outgoing

I. Two over current (IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current) and one earth fault relay. The 33 KV lines are envisaged to operate in a synchronous ring having feed at multiple points.

II. There shall be high speed master trip hand reset lock out relay which shall receive inputs from above relay and send command to trip coil of the circuit breaker directly.

12.15 SUPERVISION RELAY

Following supervision relay shall be provided having adequate contacts for providing alarm.

a. Trip circuit supervision

b. DC supply supervision

c. AC supply supervision

13.0 TYPE TESTS

13.1 The following type tests shall be conducted on the Protective relays.

a) Insulation tests as per IEC 60255-5

b) High frequency disturbance test as per IEC 60255-4 (Appendix–E)-Class III (not applicable for electromechanical relays)

c) Fast transient test as per IEC 1000-4, Level III (not applicable for electromechanical relays)

d) Relay characteristics, performance and accuracy test as per IEC 60255

- Steady state Characteristics and operating time
- Dynamic

e) Tests for thermal and mechanical requirements as per IEC 60255-6

f) Tests for rated burden as per IEC 60255-6

g) Contact performance test as per IEC 60255-0-20

13.2 Steady state & Dynamic characteristics tests on the relays (current differential protection relays), as type test, shall be carried out based on general guide lines specified in CIGRE Committee 34 report on simulator/network analyser/PTL.

14.0 CONFIGURATION OF C&R PANELS (11KV)

Each panel shall consist of the following:

Sl.	Description of Relays	QUANTITY		
		TRANSFORMER PANEL	BUS COUPLER	FEEDER PANEL
1	Ammeter with selector switch	1		1
2	Wattmeter	1		1
3	Pistol grip CB control switch	1	1	1
4	Red indicating lamp for indicating close position of CB	1	1	1
5	Red indication lamp for indicating close position of Isolator	1 no for each Isolator	1 no for each Isolator	1 no for each Isolator
6	Red indicating lamp for indicating close position of Earth switch	1 no for each Earth switch	1 no for each Earth switch	1 no for each Earth switch
7	Green indicating lamp for indicating open position of CB	1	1	1
8	Green indicating lamp for indicating open position of Isolator	1 no for each Isolator	1 no for each Isolator	1 no for each Isolator
9	Green indicating lamp for indicating open position of Earth switch	1 no for each Earth switch	1 no for each Earth switch	1 no for each Earth switch
10	Yellow indicating lamp for auto trip	1	1	1
11	Blue indicating lamp for spring charging	1	1	1
12	Annunciation windows with associated annunciation relay	1	1	1
13	Push buttons for Alarm accept/Reset/Lamp test	1	1	1
14	Mimic to represent SLD with Seamaphore indication	1 LOT	1 LOT	1 LOT
15	Voltmeter with selector switch	1	-	-
16	Cut out mounting and wiring for WTI and selector switch	1 LOT	-	-
17	Energy meter TVM	-	-	1
18	Trip Circuit supervision relays	1	1	1
19	DC supply supervision relay	1	1	1
20	AC supply supervision relay	1	1	1
21	Flag relays, aux relays, timers trip	1 set	1 set	1 set

	relays etc as per scheme requirement			
22	Bus frequency meter (Digital)	1	-	-
23	Bus Healthy indication lamps	3	-	-
24	Auxiliary relay for Buchholz	1	-	-
25	2 O/C I E/F relay	1	-	1
26	Static, instantaneous 3 phase PT Fuse Failure Relays. Rated Voltage- 110 VAC	1	-	-
27	Master Trip Relays suitable for operation at 110 VDC with sufficient number and configuration of contacts.	1	1	1
28	Auxiliary Relays for Anti-pumping, Density switch, Contact multiplier etc. as may be required.	1 LOT	1 LOT	1 LOT
29	Power Factor meter (Digital)	1	-	-

Note:

1. For transformer feeders, all equipments of control panel shall be provided separately for HV and LV sides.
2. The above list of equipments mentioned for control panel is generally applicable unless it is defined elsewhere and in case of bay extension in existing substations, necessary equipments for matching the existing control panel shall be supplied.
3. Each line/HV side of transformer/LV side of transformer/TBC shall be considered as one feeder for above purpose.

APPENDIX-10

11KV VOLTAGE CLASS SURGE ARRESTORS

1.0 **SCOPE**

The specification covers the design, manufacture, shop & laboratory testing before dispatch, supply, delivery, erection and commissioning of 11 kV voltage station Surge Arrestors for installation on outdoor type 11 kV switchgear, transmission lines, transformers etc. 11 kV side of which is not enclosed in a cable box.

2.0 **STANDARDS**

The design, manufacture and performance of Surge Arrestors shall comply with IS:3070 Part-3 and other specific requirements stipulated in the specification. Unless otherwise specified, the equipment, material & processes shall conform to the latest amendments of the following:

IS:2071-1993 (Part-1)	Methods of High Voltage Testing General Definitions & Test Requirements.
IS:2071-1974 (Part-2)	Test procedures.
IS:2629-1985	Recommended Practice for hot dip galvanizing on Iron & Steel.
IS:2633-1986	Method for Testing uniformity of coating of zinc coated Articles.
IS:3070-1993 (Part-3)	Specification for surge arrestor for alternating current systems. Metal-Oxide lightening Arrestors without gaps.
IS:4759-1996	Specification for hot dip zinc coating on structural steel and other allied products.
IS:5621-1980	Hollow Insulators for use in Electrical Equipement.
IS:6745	Method for determination of mass of zinc coating on zinc coated iron and steel articles.
IEC 60099-4	Surge Arrestors.

The equipment complying with any other internationally accepted standards shall also be considered if it ensures performance equivalent to or superior to the Indian Standards.

3.0 **GENERAL REQUIREMENT**

3.1 The metal oxide gap less Surge Arrestor shall be suitable for protection of 11 kV side of power transformers, associated equipment and 11 kV lines from voltage surges resulting from natural disturbance like lightening as well as system disturbances including switching surges.

3.2 The surge arrestor shall draw negligible current at operating voltage and at the same time offer least resistance during the flow of surge current.

3.3 The surge arrestor shall consist of non-liner resistor elements placed in series and housed in electrical grade porcelain housing of specific Creepage distance of 300 mm. The protected creepage distance shall not be less than 50% of total creepage.

3.4 The assembly shall be hermetically sealed with suitable rubber gaskets with effective sealing system arrangement to prevent ingress of moisture.

3.5 The surge arrestor shall be provided with one line and two earth terminals of suitable size. The ground side terminal of surge arrestor shall be connected with 25x6 mm galvanized strip, one end connected to the surge arrestor and second end to a separate ground electrode. The bidder shall also recommend the procedure which shall be followed in providing the earthing/system to the Surge Arrestor.

3.6 The surge arrestor shall not operate under power frequency and temporary over voltage conditions but under surge conditions, the surge arrestor shall change over to the conducting mode.

3.7 The surge arrestor shall be suitable for circuit breaker performing O-0.3 min- CO-3 min-CO- duty in the system.

3.8 Surge arrestors shall have a suitable pressure relief system to avoid damage to the porcelain housing and providing path for flow of rated fault currents in the event of arrestor failure.

3.9 The reference current of the arrestor shall be high enough to eliminate the influence of grading and stray capacitance on the measured reference voltage.

3.10 The Surge Arrestor shall be thermally stable and the bidder shall furnish a copy of thermal stability test with the bid.

3.13 The arrestor shall be capable of handling terminal energy for high surges, external pollution and transient over voltage and have low losses at operating voltages.

3.14 The surge arrestor shall be provided with line and earth terminals of suitable size. The line side terminal shall be suitable for 100mm² (code name: Dog) Aluminum area, 6/4.72 mm Aluminum + 7/1.75 mm Steel SCA conductor.

4.0 **ARRESTOR HOUSING**

4.1 The arrestor housing shall be made up of porcelain housing and shall be homogenous, free from laminations, cavities and other flaws of imperfections that might affect the mechanical and dielectric quality. The housing shall be of uniform brown colour, free from blisters, burrs and other similar defects.
Arrestors shall be complete with terminal connectors and disconnectors.

4.2 The housing shall be so coordinated that external flashover shall not occur due to application of any impulse or switching surge voltage upto the maximum design value for arrestor. The arrestors shall not fail due to contamination. The 11 kV arrestors housing shall be designed for pressure relief class as given in Technical Parameters of the specification.

4.3 Sealed housings shall exhibit no measurable leakage.

5.0 **ARRESTOR MOUNTING**

The arrestors shall be suitable for mounting on 4 pole/2 pole structure used for pole/plinth mounted transformer and for incoming and outgoing lines.
The arrestor shall be capable of handling energy from 11 kV lines of length ranging from 1 km to 20 km.

6.0 **FITTINGS & ACCESSORIES**

6.1 The surge arrestor shall be complete provided with terminal connectors, disconnector.

6.2 The terminals shall be non-magnetic, corrosion proof, robust and of adequate size and shall be so located that incoming and outgoing connections are made with minimum possible bends. The top metal cap and base of surge arrestor shall be galvanized. The line terminal shall have a built in clamping device which can be adjusted for both horizontal and vertical take off. It should be suitable for ACSR conductor.

7.0 **TESTS**

7.1 Test on Surge Arrestors

The Surge Arrestors offered shall be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 3070 (Part-3)-1993. In addition, the suitability of the surge arrestors shall also be established for the followings.

(A) Acceptance tests:

i) Measurement of power frequency reference voltage of arrestor units.

ii) Lightning impulse residual voltage on arrestor units (IEC clause 6.3.2).

(B) Special acceptance tests:

i) Thermal stability test (IEC clause 7.2.2).

ii) Aging & Energy capability test on blocks (procedure to be mutually agreed).

iii) Watt loss test.

(C) Routine tests:

i) Measurement of reference voltage.

ii) Residual voltage test of arrestor unit.

iii) Sealing test

iv) Vertically check on completely assembled surge arrestors as a sample test on each lot.

7.2 The maximum residual voltages corresponding to nominal discharge current of 10 kA for steep current, impulse residual voltage test, lightning impulse protection level and switching impulse level shall generally conform to Annex-K of IEC-99-4.

7.3 The bidder shall furnish the copies of the type tests and the characteristics curves between the residual voltage and nominal discharge current of the offered surge arrestor and power frequency voltage v/s time characteristic of the surge arrestor subsequent to impulse energy consumption as per clause 6.6 of IS:3070 (Part-3) offered alongwith the bid.

7.4 The surge arrestor housing shall also be type tested and shall be subjected to routine and acceptance tests in accordance with IS: 5621.

7.5 Galvanization Test

All Ferrous parts exposed to atmospheric condition shall have passed the type tests and be subjected to routine and acceptance tests in accordance with IS: 2633 & IS 6745.

7.6 Test on Surge Arrestor Disconnectors

The test shall be performed on surge arrestors which are fitted with arrestor disconnector or on the disconnector assembly alone if its design is such as to be un-affected by the heating of adjacent parts of the arrestor in its normally installed portion in accordance with IS:3070 (Part-3).

8.0 NAME PLATE

8.1 The name plate attached to the arrestor shall carry the following information:

- Rated Voltage
- Continuous Operation Voltage
- Normal discharge current
- Pressure relief rated current
- Manufacturers Trade Mark
- Name of Sub-station
- Year of Manufacturer
- Name of the manufacture
- Name of Client-APDP
- Purchase Order Number along with date

9.0 **INSPECTION**

9.1 All tests and inspection shall be made at the manufacturer's works unless otherwise specifically agreed upon by the manufacturer and purchaser at the time of placement of purchase order. The manufacturer shall afford to the inspector representing the purchaser, all reasonable facilities, without charge to satisfy him that the material being furnished is in accordance with these specifications. The purchaser reserves the right to get any component/material being used by the manufacturer of the Surge Arrestor tested from any recognised test house.

9.2 The inspection by the purchaser or his authorized representative shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specification.

10.0 DRAWINGS AND INSTRUCTION MANUALS

Within 15 days of receipt of the order, the successful tenderer shall furnish to the purchaser, the following drawings and literature for approval:

(i) Outline dimensional drawings for Surge Arrestor and all accessories.
(ii) Assembly drawings and weights of main component parts.
(iii) Drawings of terminal clamps.
(iv) Arrangement of earthing lead.
(v) Minimum air clearance to be maintained of line components to ground.
(vi) Name plate.
(vii) Instructions manual.
(viii) Drawing showing details of pressure relief valve.
(ix) Volt –time characteristics of surge arrestors.
(x) Detailed dimensional drawing of porcelain housing/Silicon polymeric i.e. internal diameter, external diameter, thickness, height, profile, creepage distance, dry arcing distance etc.

11.0 **QUALITY ASSURANCE**

11.1 Quality Assurance Programme

a)As per relevant clause of General technical requirement.

11.2 Quality Assurance Document

The contractor shall be required to submit the quality assurance documents before dispatch of the equipment. The authorized representative reserves the carryout Quality Audit and Quality Surveillances of the System and procedures of the contractor/his vendor's quality management and control activities.

12.0 **TECHNICAL PARTICULARS**

12.1 The surge arrestors shall conform to the following standard technical requirements. The Insulation values shall be enhanced considering the altitude of operation & other atmospheric conditions.

System Parameters

i)	Nominal system voltage	11 kV
ii)	Highest system voltage	12 kV
iii)	System earthing	Effectively earthed system
iv)	Frequency (Hz)	50
v)	Lightning Impulse withstand Voltage (kVP)	75
vi)	Power frequency withstand Voltage (kV rms)	28
vii)	Arrestor duty	Station Class / Line class
	-- Connection to system	Phase to earth
	-- Type of equipment to be protected	Transformers & outgoing lines

12.2 Surge Arrestors

i)	Type	Gapless Metal oxide outdoor
ii)	Arrestor rating (kV rms)	9
iii)	Continuous Operating voltage (kV rms)	7.65
iv)	Standard Nominal Discharge Current Rating (kA) (8x20 micro impulse shape)	
	a) Station Class	10 KA
	b) Line Class	5 KA
v)	Degree of protection	IP 55
vi)	Steep current at 10 kA	45
vii)	Lightning Impulse at 10 kA	40
viii)	Energy capability corresponding to	
	a) Arrestor rating (kj/kV)	4.0
	b) COV (kj/kV)	4.9
ix)	Peak current for high current impulse operating duty of	
	a) arrestor classification 10 kA	100 KA
	b) arrestor classification 5 kA	65 KA

12.3 Insulator Housing

i)	Power frequency withstand test voltage (Wet) (kV rms)		28
ii)	Lightning impulse withstand/tests voltage (KVp)		75
12.4	Galvanisation		
i)	Fabricated Steel Articles		
	a) 5 mm thick cover	610 g/m²	
	b) Under 5 mm but not less than 2 mm thickness	460 g/m²	
ii)	Castings		
	Grey Iron, malleable iron		610 g/m²
iii)	Threaded works other than tubes & tube fittings		
	a) Under 10 mm dia	300 g/m²	
	b) 10 mm dia & above		270 g/m²

APPENDIX-11

11KV SWITCH BOARD

1. 11 KV Switch Board

Rated voltage – 12 KV.
Rated frequency – 50 Hz.
Phase - 3
Bus bar current – 1250 Amps.
Insulation levels – 28 KVrms, 75 KV peak.

The 11KV switchboard must be of metal clad, dead front totally enclosed, indoor type, compartmentalised construction forming a self-supporting continuous unit. The front portion of the board shall have individual compartments arranged for individual VCB to accommodate draw out type vacuum circuit breakers. Each compartment shall be provided in the front with properly interlocked access door. The back portion of the Board shall contain three phase sleeved insulated bus bars accommodated in a separate bus bar compartment as well as outgoing cable terminations, instrument transformers etc. housed in separate cable compartment. These two compartments shall be properly segregated so as to prevent accidental contact with the main bus while working on outgoing feeder connections. The cable compartment shall have ample space for terminating 3 runs of 3 core XLPE aluminium armoured cables with easy access from the rear bolted/hinged door. The cable entry arrangement within the cubicle shall be such that cable can be easily disconnected. The design of the breaker compartments shall be such as to provide interchange ability of same size vacuum circuit breakers.

The switchboard shall be designed and type tested to meet the requirements of IEC62271-200 & 60694 / IS: 3427.

All HV compartments must be individually tested for internal arc.

2 11KV circuit breakers

The operating mechanism shall be motorised spring charged.
Provision for manual charging
Open-close-open operation without recharging
Electrical anti pumping
Synchronisation and fast auto re-closure duty

The removable carriage shall be interchangeable between the incomers and outgoing breakers.

The vacuum circuit breaker shall be designed and type tested to the meet the requirements of IEC62271-100 / IS: 13118

Technical details of Vacuum Circuit Breakers.

Sr. no	Description.	Rating.
1	Rated voltage.	12 KV
2	Rated normal current at 40 deg C ambient.	1250 amps
3	Insulation levels	28 KV rms 75 KV peak
4	Breaking capacity	40 KA min.
5	Making capacity	100 KA peak.

6	Short time withstand current	40 KA min for 3 sec.
7	Opening time.	55 ms max.
8	Total breaking time.	70 ms max.
9	Making time.	75 ms max.
10	Operating sequence	O-3min – CO – 3min – CO/ O – 0.3sec – CO – 3min – CO.
11	Nominal closing coil voltage.	110 volts DC. +/- 10%
12	Nominal tripping coil voltage.	110 volts DC. +/- 10%
13	Nominal voltage of spring charge motor.	230 volts AC. +/- 10%
14	Mechanical life.	Not < 20000 operations.
15	Life at rated current.	Not < 20000 operations.

3 Fixed portion

1)Floor mounting gig set fabricated steel cubicle complete with supports for the gear, earthing connections, 3 surge diverter, CT with wiring and label.

2) 3 phase isolating spout assemblies complete with interlocking mechanism of opening and closing with a pair of automatic safety shutters.

3) Automatic connection and disconnection of main and auxiliary circuit to be made while rising and lowering or draw in or draw out the circuit breaker truck assembly.

4) CT having ratio of 800/5 for 1250 amps breaker having accuracy as per IS: 2705 part 1-IV, accuracy class – 1 for metering purpose and 5P10 for protection.

5) Potential transformer dry type 11KV / 110 volts as per IS: 3156, part 1-IV. The potential transformer should be draw out type or fixed type with PT chambers incorporating high voltage fuses and necessary draw out rails.

6) Cable box supplied without compound at rear side with gland suitable for aluminium conductor of 3 x 3 core 400 sqmm XLPE cable.

7) The breaker shall be provided with individual voltmeter with selector switch and individual ammeter with ammeter selector switch and power and energy meter.

8) The fixed and moving contact of the cubicle and truck shall be with adequate safety margin for avoiding heating of contacts.

9) Numeric based IDMT over current and earth fault relay flush mounted on the front panel.

4 Removable carriage portion:

1250 amps single break vacuum circuit breaker fitted with magnetic actuator or motorised spring charged and manual spring charge type operating mechanism. The breaker is mounted on a truck carriage complete with self-contained manually operated fully interlocked raising and lowering or draw in and draw out mechanism. The circuit breaker will not be possible to lower or draw out unless it is in the open position and the interlock lever is in the 'FREE' position. The carriage shall have:

Mechanical ON/OFF indicator with local/remote trip devices.

Auxiliary switch having 4 NO + 4 NC.

Shunt Trip coil.

Closing coil.

Spring charge mechanism or magnetic actuator.

One set of special tools and tackles for carrying out repairs / preventive maintenance shall be supplied along with switchgear.

5 11KV Main Bus bars

The switchgear shall have continuous three phases electrolytic copper bus bars silver-plated extending full length of switchboard. The bus bars shall be of adequate mechanical strength and of uniform cross section having continuous current rating OF 1250 AMPS. The size of the bus bar selected shall be capable of carrying the maximum continuous current OF 1250 Amps and short time withstanding current of 40KA for 3 seconds and peak current of 100 KA in the circuit. They shall be so arranged and supported that the permissible clearance is maintained under all service conditions including short circuits. The bus bars shall be arranged in such a way that they can be extended at the free ends without difficulty.

ABC is the three phases of AC circuit with anti clockwise vector rotation.

6 CABLE BOXES

These shall be mounted at the rear and should be designed for 11 KV cross-linked polythene cables. The cable boxes shall be mounted in the cubicle above the floor level.

Multicore terminal boxes for control wiring shall be provided at the rear and should have required number of terminal boards and glands.

7. 11 KV/ 110 V POTENTIAL TRANSFORMER.

This shall be of cast resin design. PT's shall be mounted on the circuit breaker truck itself.

Potential transformers provided for the panel shall conform in all respects to IS 3156 part II & III or latest. It shall be designed for dual purpose of metering and protection. The **class of accuracy shall be** 1 for internal metering and protection. Construction shall be matched to suit the 11KV switchgear panels. Rated burden on the PT's shall be 110 VA on the secondary. PT's shall be provided with primary and secondary fuses. The design of the PT shall be such that it is interchangeable between similar panels when necessary.

8 CURRENT TRANSFORMER.

Current transformers shall be of resin cast design provided for the panels and shall conform in all respects to IS 2705 part II & III or latest. It shall be designed for dual purpose and suitable for protection as well as metering. The **class of accuracy shall be** 1 for internal metering and protection. Construction shall be matched to suit the switchgear panels. Rated burden shall be 15 VA on the secondary.

Type test reports

Current transformers and potential transformers shall be subjected to the contractor's standard tests and to routine tests specified in standards. The routine tests shall include as minimum of the following:

i) **Current transformers**

At works

a) Insulation resistance test.
b) Power frequency high voltage test for 1 minute.
c) Continuous current carrying capacity test
d) Accuracy class test.
e) Tests to prove accuracy at rated burden.
f) Measurements of knee point voltage and secondary winding resistance.
g) Ratio test.
h) Verification of terminal marking polarity.
i) Physical inspection as per the approved drawings.

At site

a) Insulation resistance test.
b) Power frequency withstand test for one minute.
c) Ratio test.
d) Measurement of terminal marking and polarity.
e) Measurement of knee point voltage and secondary winding resistance.

ii) **Potential transformers**

At works

a) Insulation resistance test.
b) Power frequency HV test for one minute.
c) Tests to prove accuracy class at rated burden.
d) Verification of terminal markings and polarity.
e) Physical inspection as per approved drawing.
f) Ratio test.

At site

a) Insulation resistant test.
b) Power frequency H.V test for one minute.
c) Verification of terminal markings and polarity.
d) Ratio test.

9 PROTECTION AND RELAYS

Relays provided must be of numeric based. These will be operated in conjunction with 110 volts shunt trip relays. The relays shall be of draw out type; flush mounted and back connected. The adjusting devices shall be easily accessible. Operation of indicator reset shall be possible from the front of the relay case without removing the relay cover. They relay current input shall be rated for 5 amps, and potential input shall be rated for 110 volts. The relays shall conform to the provisions of IS: 3231 & IS: 8686 and latest amendments thereof.

Suitable terminal shorting devices for current circuits and fuses properly marked for potential circuits shall be provided to facilitate the relays and meters to be tested and calibrated.

The insulation of all the relays shall be tested for 2000 V RMS.

A) RELAY FEATURES

- Numerical combined relay with three-phase fault poles with two independent transient free hi-set elements with 9 inputs and 7 outputs.
- Field selectable trip time characteristics.
- Time delay programmable output for over current as well as earth fault.
- Field selectable CT ratings.
- EEPROM to retain the program pickup values, characteristics, trip time settings and recorded parameters.
- Event recording (trip data of last 5 tripping with date and time stamping.).
- Diagnostics facility.
- The relay shall have RS 485 modbus communication port, which shall permit direct assess / transfer of data.

- It shall be possible to integrate the meter through RS 485 modbus with real time SCADA for power management system software installed in the server for easy access to real time data and information.
- Display to indicate parameter setting, current values etc.
- Auxiliary power supply range 24v to 110 volts AC/DC +/- 15%.

10 INSTRUMENT PANELS

These shall be separate assemblies suitable for flush mounting type instruments and relays and mounted above the fixed portion of the circuit breaker cubicles.

11 INSTRUMENT AND METERS

The indicating instrument shall be of switchboard type, industrial grade 'A' as per IS 1248, back connected flush mounted square shaped with dust tight cases suitable for tropical climate with dust tight zero adjuster provided in front of the panel board. The power and energy meters shall be as per clause 6.19.0.

The ammeters must have direct reading scales of ranges specified elsewhere in this specification. The ammeter element shall be rated for 5 amps.

12 WIRING

The wiring shall be single conductor and of tinned annealed copper wire, insulated for 1100 volts and shall be of grouped type, laid out in flat formation and secured by means of cleats/PVC channels.

The wires shall run straight and shall be given right angle bends and in case of wires running from cubicle to cubicle they shall be properly screened.

The sizes of wiring in different circuits shall not be less than those specified below: -

A) WIRING SIZE

a) Metering and relay circuits connection to current transformers - 4 Sq.mm

b) Potential circuits for metering, relaying indicating alarms etc. - 2.5 sq.mm

Terminal ends of all wires must be provided with properly numbered ferrules for circuit identification

B) Color of wire Circuits where used Color of ferrule

Color of wire	**Circuits where used**	**Color of Ferrule**
Red	Red phase of instrument transformer circuits	Red
Yellow	Yellow phase of instrument transformer circuits	Yellow
Blue	Blue phase of instrument transformer circuits	Blue
Green	Neutral connection	Green
Black	A.C. 240/415 volts supply	Respective Phase Red, Yellow, Blue or Green
White	D.C. Circuits	Red for trip circuit, Yellow for Alarm circuit, Green for relay, Auxiliary and other Connections.

13 INDICATING LAMPS

Lamps covered by suitable colored translucent material shall be used to indicate the position of circuit breakers. The lamps shall be of low voltage, switchboard type,

suitable for replacement from the front of the panel. 15% of lamps used initially shall be supplied to serve as spares.

14 TEST BLOCKS

Test blocks with contacts rates for 10 amps. Continuously and 150 amps. for at least one second on 250 volts shall be provided for testing. They shall be of switchboard type and back connected. Devices for short circuiting the terminals of the current transformers shall be provided. Suitable identification marks shall be fixed near the test blocks for the purpose of identification of the circuits.

15 MIMIC DIAGRAMS

6mm wide mimic diagrams shall be provided on the top of the switchboard to represent the single line arrangement of the system. They shall be provided with red and green lamps for indicating switch position.

16 CONTROL SWITCHES

Circuit breaker control switches will be Pistol grip type having "ON and OFF" momentary operating positions and an automatic neutral return normal release position. The control springs shall be strong enough to prevent inadvertent operation due to light touch. Selector switches for ammeter shall short circuit the current transformer circuit the current transformer circuit before it is broken and remove the short circuit after the ammeter is inserted in the circuits.

17 SAFETY EARTHING

Earthing of juice free metallic parts of the equipment on the switchboard shall be done with soft drawn single conductor, bare copper. The main earth connections shall not be less than 70 sq.mm and the tail connections shall not be less than 150 sq.mm

18 PAINTING.

The panel shall be powder coated.

19 POWER AND ENERGY METER

This shall be multifunctional solid-state digital type numeric based with mechanical counter to read the energy consumption. The meter shall be of CT operated type and suitable for 110V / 415V, 3 ph, 4wire supply. The meter should have capability to integrate with automation system with RS-485 modbus, Ethernet communication port. If separate CT is required, same has to be considered.

A) FEATURES OF POWER AND ENERGY METER

- Selectable function for measurement of
  - Energy (active, regenerative, reactive, and apparent).
  - Power (active, regenerative, reactive, and apparent).
  - Voltage.
  - Current.
  - Frequency.
  - Power factor.
- Facility for displaying three-phase current and voltage simultaneously and measurement items as assigned.
- Analog out put function for
  - Power (active, regenerative, reactive, and apparent).
  - Voltage, current, frequency and power factor (4 to 20mA DC).
- Measure average current and power within a specified period.

- Shall have the facility for measurement of maximum and minimum values of voltage and maximum and minimum value of current.
- Out put pulses proportional to the energy (one measurement item from active, regenerative, reactive, and apparent energy).
- Meter shall have 10 Base-T and RS 485 modbus port for direct access through Ethernet and modbus, which shall permit the direct transfer of data.
- It shall be possible to integrate the meter through Ethernet and modbus with real time SCADA and power management system software installed in the centralized server for easy access to real time energy and power quality information.
- The meter shall have a class of accuracy of 0.2 or better.

20 Accessories Details Panel at MRS

35-panel factory assembled 11 KV, 40 kA flush front, metal enclosed switchgear with 3-phase air insulated sleeved continuously rated bus bars of 1250 amperes current carrying capacity with provision of extension on both ends. The switchgear units shall be draw-out type system with stationary and moving sections designed for interlock safe operation.

The panels shall be designed as follows:

A) TRANSFORMER INCOMER PANELS 3, 8, 13, 17

1. One set of CTs for combined metering and protection with dual accuracy.
2. One set CTs for differential protection
3. 3 phase Draw out PT having output of 110 VA and accuracy class 1.0 with primary and secondary fuses.

The following Instruments, meters and relays shall be provided: -

a) Indicating voltmeter scaled 0-15 KV with selector switch.
b) Indicating ammeter scaled 0-800 Amps with selector switch.
c) **Power and Energy meter with Ethernet communication port.**
d) Power Factor meter scaled 0.5 lead to .5 lag.
e) Triple pole IDMT numeric based combined over current and earth fault relay.
f) Differential Relay (numeric).

B) BUS COUPLER PANEL

1. CTS suitable for protection and metering
2. One indicating ammeter sealed 0-1250 amps with selector switch

C) OUTGOING FEEDER PANELS: One set CT's for Protection and metering.

1) One ammeter suitably scaled with selector switch.
2) Triple pole IDMT numeric based combined over current and earth fault relay.
3) Digital Energy meter with RS485 or Ethernet Port...

D) Outgoing feeder

1) One set CT's for Protection and metering.
2) One ammeter suitably scaled with selector switch.
3) Triple pole IDMT numeric based combined over current and earth fault relay.
4) **Power and Energy meter with Ethernet communication port.**
5) Power Factor meter scaled 0.5 lead to .5 lag.

E) P.F. CORRECTION FEEDERS:

These are the Feeders connected to 2238 + 2238 KVAr capacitor bank with series reactor.

a) Over voltage relay numeric based.
b) Under voltage relay numeric based.
c) Neutral voltage displacement relay numeric based.
d) Time delay relay numeric based.
e) Over current & earth fault relay numeric based.
f) Indicating Voltmeter scaled 0 – 15KV with selector switch.
g) Indicating ammeter scaled 0-800 Amps with selector switch.

F) INTERCONNECTING PANELS

a) Over current and earth fault relay numeric based.

Note: - The accessories list for 11 kV switchboard for unit substations is covered under the chapter of respective substations

APPENDIX-12

RECEIVING STATION STRUCTURES, FOUNDATIONS & FENCING

The tenderer shall design suitable supporting steel structures for terminating 132 KV incoming lines, formation of buses and supporting structures for circuit breakers, disconnecting switches, lighting arrestors, cable supports etc.

The steel structures shall be of latticed type fabricated out of rolled M.S. sections and hot dip galvanized. The connections shall be bolted type and the bolts shall be of approved quality and hot dip galvanized.

1 STANDARDS

The steel to be used shall conform to IS 2062 or latest. The bolts and nuts shall conform to IS: 1364 part I/1992.

The design of the structures shall be based on the following data: -

a) Maximum wind speed — 6.5 KMPH.
b) Factor of safety based on maximum load — 2.5
c) Factor of Safety against. Overturning — 2.5.
d) Slenderness ratio:-
   i) For leg members — Not to exceed 120
   ii)Other members having calculated stress — Not to exceed 200
   iii)For members having nominal stress — Not to exceed 250
e) Minimum thickness of Steel
   Main Members — 6mm
   Bracing — 6mm

The compressive stress formula as per applicable standards shall be used for calculating the strength of members and the value of tensile strength shall be 2600 Kg. Per Sq.cm

IS : 802 Shall be adopted for steel structure

IS : 875 Shall be adopted for building.

2 FOUNDATIONS

Excavation, concreting for foundations for transformers, CTs, PTs, lighting arrestors, circuit, breakers, towers, support insulators including materials and shuttering shall be paid with Civil Engg Schedules. The safe bearing capacity of the soil shall be assumed as detailed below.

RAFT FOUNDATIONS

FOUNDATION SYSTEM	Net allowable Bearing Capacity (T/Sq.m)	
	At 1.50m below EGL	At 3.00m below EGL
RAFT	8.00	12.00

ISOLATED FOOTING

FOUNDATION SYSTEM	Net allowable Bearing Capacity (T/Sq.m)	
	At 1.50m below EGL	At 3.00m below EGL
ISOLATED FOOTING (2 TO 3 M WIDTH)	8.00	10.00

RAFT FOUNDATION IN FILLED UP SOIL 1.50M BELOW FINISHED LEVEL.

FOUNDATION SYSTEM	Net allowable Bearing Capacity (T/Sq.m)
RAFT	8.00

The Design Data for the above with supporting calculations shall be submitted by the successful tenderer to the Railway for approval. It is confirmed that IS : 456-2000 Shall be applicable for RCC.

3 CABLE TRENCH

Cable trench for the Switch Yard shall be of brickwork with checkered plates for Trench Cover. The route and dimensions of trenches shall be designed to suit the requirements of Power/Control Cables.

APPENDIX-13

EARTHING AND LIGHTENING PROTECTION

1 SCOPE

Design, supply, fabrication, inspection, erection, testing and commissioning of plant system and safety earthing conforming to IS 3043, Indian Electricity Rules and regulations of CEI of Bihar state and Regulations of BSPTCL.

This section of the specification covers grounding of all equipments both in the 132 KV switchyard and those house indoors, running of ground wires, **formation of ground mats**, ground pits and providing Faraday caging and lightning conductors to the outdoor switch yard of the Main Receiving Station, as per IE Rules and relevant IS.

The earthing of the equipments shall be made by galvanized iron strip and also copper strips.

A) GENERAL

The plant power supply system shall have integrated earthing system. The principal requirements of earthing are as follows:

Resistance of earthing network of MRS shall not exceed 0.5 ohm under all operating conditions. While measuring earthing system resistance of MRS, earth electrodes provided at MRS alone shall remain connected in the system.

Each transformer neutral shall be connected to two independent earth electrodes through neutral grounding resistors. Lightning arrestors shall be connected to independent earth electrodes. These earthing electrodes shall be located as near to the equipment as possible and can be inter-connected to the earthing system.

Duplicate earthing shall be provided for all electrical equipment, metallic enclosures of mechanical equipment, which can becomes alive, metallic fencing at MRS.

Two separate, independent earth conductors shall be used for duplicate earthing and these conductors shall be terminated on the main earth conductor inter-connecting earth electrodes or earth ring formed in the premises.

Unit rates quoted for installation of all electrical equipment, structures etc., shall include supply and installation cost for providing duplicate earthing. The installation rate shall also include termination of earthing conductor at both ends, earth work/civil work whichever required.

To limit step and touch potential within permissible limits, ground mat shall be provided in the switch yard of MRS. The mat shall be laid at a depth of 70 cm from ground level. Design calculations for mat design shall be furnished for approval.

STANDARDS

1. IEEE – 80 / 1986.
2. IS: 3043.

B) The contractor shall study the complete system & soil resistivity report as submitted with this equipment and design a suitable earthing system and lightning protection, which shall conform to the above standards.

The following parameters shall be furnished.

INPUT DATA

SL.NO.	DESCRIPTION
1.	Max earth fault current.
2.	Duration of fault current for conductor sizing
3.	Duration of fault current for touch/step
4.	Grid material Cu/GI/Al.
5	Soil resistivity – 15 to 44 ohm-meter (Wenner and Schlumberger method with current electrode spacing from 1.8 meter to 80 meters.
6	Resistivity of surface crushed rock
7	Crushed rock layer thickness
8	Switchyard dimensions (B x L)
9	Area of switchyard
10	Spacing between parallel conductors (B x L)
11	No. Of parallel conductor in breadth wise
12	Depth of burial of earth grid conductor
13	Reference depth of earth grid conductor burial
14	Length of each rod electrode
15	Number of rod electrodes
16	Total length of rod electrodes
17	Switchyard buried grid conductor
18	External buried conductor
19	Total grid conductor
20	Buried conductor length
21	Correction factor for projected fault current
22	Decrement factor
23	Grid current division factor
24	Grid current
25	Total grid current IG per conductor length
26	Width conductor
27	Dia of earth electrode

OUTPUT DATA

1	Area of conductor without corrosion factor
2	Size of conductor without corrosion factor

3	Size of conductor including corrosion factor
4	Size of conductor selected
5	Maximum grid current
6	Diameter of half width of grid conductor
7	Reflection factor
8	Reduction factor
9	Correction factor for current irregularity
10	Addl. Correction factor for current irregularity
11	Correction factor for current depth of burial
12	Correction factor for mesh irregularity
13	Correction factor for grid geometry
14	Permissible touch potential
15	Permissible step potential
16	Attainable touch voltage
17	Attainable step voltage

CALCULATIONS FOR EARTH RESISTANCE.

1	Resistance of main grid.
2	Resistance of earth rod.
3	Resistance of Pipe electrodes.

Some of the major equipments to be earthed.

i) Each of the 132 KV lightning arrestor base ground terminals to the ground pit.
ii) Grounding of all bases of the 132 KV disconnecting switches
iii) Grounding of the 132 KV circuit breaker-marshalling kiosk.
iv) Independent ground of the 132 KV neutral bushing of each transformer and the Main Tanks and marshalling Kiosk of the transformers.
v) Grounding of the base of outdoor cable sealing ends.
vi) Grounding of 132 KV CTs and PTs of marshalling kiosks.
vii) Grounding of base of Bus Support Insulator stacks.
viii) Independent grounding of power cable racks at intervals of about 10 meters.
ix) Grounding of 11 KV switchgear cubicles shall include the following.
   a) Grounding of base indoor potheads.
   b) The 11 KV Switchgear Installation shall ensure grounding of all equipments inside the cubicle as per standard practice.
x) Grounding of transformer panel, annunciator panel, battery panel and low voltage distribution panel.
xi) Grounding of 3-core cable sealing ends on th -e 11 KV switchgear.
xii) Grounding of racks supporting the cables.
xiii) Separate earthing of perimeter fencing.

The offer should include-

1) Providing Faraday caging (Static Shield) for the 132 KV supporting structure of the switch yard as per standard practice using 7/10 SWG Galvanized wire as per IE rules.

2) For protection to the receiving station building against direct lightening strokes. This shall include providing suitable lightning finials and lightning conductors and earthing as per IE rules.

2 MATERIAL AND SIZE OF CONDUCTOR

A) SYSTEM EARTHING

The following minimum conductor size shall be considered for connecting transformer neutral to the grounding electrodes. The conductor shall be properly supported and clamped to withstand maximum forces.

Main power transformer neutral on 11 kV side shall be earthed through suitable size G.I. strip/copper flat.

B) SAFETY EARTHING

The following minimum sizes of conductor shall be considered for equipment earthing. The actual size of conductor and material of conductor shall be as per IS 3043, IER and stipulation of CEI of Bihar state. Installation rates quoted shall include actual size of conductor and material of conductor, as per stipulations of statutory authorities.

Minimum size of GI conductor to be considered for equipment earthing (thickness of galvanizing shall be 100 microns) are;

132 kV switchyard equipment:	500 sq.mm.
Main earths ring in MRS:	500 sq.mm
Earthing of Individual equipment:	300 sq.mm

3 EARTHING OF CABLE ARMOUR

Armour of power cable and control cable shall be connected to the earth bus at the switch board/panel ends. After cables have been terminated using HT sealing kit/cable glands, 50mm length of PVC overall sheath just before gland shall be removed and armour connected to earth bus using copper flexible. Jubilee clip shall be used for connections at cable end and bolted at the other end. Installation rate quoted for cables includes this work also.

4 EARTH CONNECTIONS/JOINTS

All earth connections/terminations shall ensure a permanent low resistance contact. Where combinations of GI and aluminum conductors are to be used, connection between them shall have bimetallic connectors and other necessary provisions to ensure low contact resistance at all conditions. Earth connections required to be removed for the purpose of testing/removal of equipment for measurement of resistance of individual earthing system/earth electrodes shall have bolted tinned connection. All joints of earth conductors shall be welded. All earth conductors shall have reliable and efficient electrical contact with general mass of earth. Earth conductors when laid across the road, shall be taken through GI pipe. All terminations of earth conductors at equipment,

sufficient length shall be left for easy movement of the equipment from its position for alignment.

5 EARTHING ELECTRODES

Contractor shall measure the soil resistivity at all locations of the main receiving station, in presence of engineer at no extra cost.

2.5m long, 100mm dia GI pipe electrode having its top at a depth of 0.8 m from ground level with associated GI funnel wire mesh, cement concrete pit, cast iron cover hinged to cast iron frame conforming to IS 3043-1987 shall be provided.

The arrangement of earth electrode/pit shall be as shown in IS 3043. Distance between earth pits shall not be less than 8m. All accessories required for the earth pit such as electrodes, charcoal, salt, clamps, clips, bolts/nuts/washers, GI pipes, GI funnel and also all masonry work of the pit including supply of necessary materials, bricks, cement, earth work shall come under the scope of the contractor. Main earth conductor interconnecting between earth electrodes and terminations shall also form part of the rate quoted for earth pit.

The electrodes shall be well packed with earth; charcoal and salt mix up to the level of connections. Masonry work of earth pit shall be carried out only after well ramming of riddled soil and complete setting of loose soil. As such electrodes shall be fixed in the ground before commencing of any other work of the installation and masonry work shall be taken up at the end only, after completion of other works in the installation. Earth pit shall be identified with numbers, as per approved earthing layout drawing.

Required number of earth electrodes, as per unit rates quoted shall be provided to achieve specified earth resistance. Any modification suggested by statutory authority on the work already done by the contractor, shall be done at no extra cost.

6 TESTING

The following tests/measurements shall be carried out after completion of earthing system and results shall be furnished to engineer/owner.

a) Earth resistance of each electrode.
b) Earth resistance of earthing system of MRS.
c) Earth resistance of total system.
d) Physical verification of earthing of each equipment as per IS 3043 and IER.
e) Earthing termination resistance for neutral earthing of each lightning arrestor.

All structures and buildings shall be provided with lightning protection as per IS: 2309-1989.

7 EQUIPMENT YARD: The equipment yard shall be laid with rounded gravel; the thickness of the layer shall be minimum 100mm. The size of gravel shall of 70mm to 150 mm.

CAPACITOR BANK AND SERIES REACTOR (11 KV)

1 INTRODUCTION

The capacitor banks are required for power factor correction when the Electric Arc furnaces are in operation.

The location of the capacitor banks has been indicated in the main receiving station yard layout. The capacitors shall be as per the schematic drawing conforming to the following standards.

2 STANDARDS

1. IS: 13925 (Part 1): 1998.
2. IS: 13925 (Part 1): 1998.

THREE BANKS OF (2238 + 2238 KVAr) 11KV, WITH SERIES REACTOR FOR POWER FACTOR CORRECTION AT MAIN RECEIVING STATION SUITABLE FOR OUDOOR DUTY, MOUNTED ON STEEL STRUCTURE OR CONCRETE PLINTH.

3 TECHNICAL PARTICULARS FOR CAPACITOR BANK

Sl. No.	Description	Unit	**Data**
1.	Applicable standard		**IS: 13925(Part 1) 1998**
2.	CAPACITOR UNIT		
(i)	Rated voltage	KV	**6.73**
(ii)	Maximum permissible continuous over-voltage as of percentage of rated voltage	KV	**IS: 13925(Part 1) 1998**
(iii)	Short time over voltage: • For 30 Minutes • For 1 Minute		**As per Table 2 of IS 13925 (Part 1): 1998**
(iv)	Manufacturing tolerance on Capacitance Value		**As Per IS: 13925(Part 1) 1998**
(v)	Type of Impregnant used		**Non PCB, Non toxic**
(vi)	Type of fuse used		**Internal**

(vii)	Temperature category as per IS		**50 deg C**
(viii)	Discharge resistor value	Ohm	**600 Seconds as per IS**
(ix)	**Discharge time for 50 Volts**		**Less than 600 seconds as per IS 13925 (Part I): 1998**
(x)	BUSHING		
	a. Number of bushings per unit & type		**2, Porcelain type**
	b. Rated voltage	KV	**12**
	c. Rated insulation level	KV_{rms}/KV_{peak}	**28/75**
	d. Total Creep age distance	mm	**300**
(xi)	Type of dielectric used		**All polypropylene**
(xii)	a. 10 Seconds test voltages	KV	**28 KV between shorted Terminal and Ground**
	b. Lightning impulse test voltage	KV_{peak}	**75**
(xiii)	a. Capacitor tank material		**CRCA 1.5 mm thick**
	b. Finish/paint details		**PU Painting, Poly Urethane**
	c. Type of welding		**TIG welding**
(xiv)	FUSES		
	a. Type (Internal/External)		**Internal**
	b. Number per element		**One**
(xv)	Losses under stabilized condition (after 40 hrs. of energisation)	Watts/KV AR	**Less than 0.2**

3. CAPACITOR BANK

(i)	Rated voltage	KV	**11**
(ii)	Maximum Continuous over voltage rating as a percentage of rated voltage		**As per IS 13925 (Part I): 1998**
(iv)	Manufacturing tolerance on nominal capacitances value	±%	**As per IS 13925 (Part I): 1998**
(v)	Variation of capacitance due to ambient temperature and load	±%	**As per IS 13925 (Part I): 1998**
(vi)	Variation of capacitance due to loss of units/elements: • At Alarm stage • At Trip stage	 (±)% (±)%	**As Per Unbalance Calculation**
(vii)	Connection symbol		**Star**
(ix)	Rated output	KVAr	**1800**
(x)	Power frequency withstand voltage	KV_{rms}	**28**
(xi)	Creepage distance	mm / KV	**25**
(xii)	Total guaranteed losses at rated voltage and frequency under stabilized conditions	Watts/ KVAr	**0.2**
(xiii)	Max. Residual voltage at de-energisation	Volts	**50 V or less as per IS**
(xiv)	Time taken in attaining the residual voltage	Seconds	**Less than 600 seconds after few hours of switching off the capacitor bank**
(xv)	Annual failure rate	%	**< 0.2%**

4 RESIDUAL VOLTAGE TRANSFORMER

Sl. No.	Description	Unit	Data
1.	Manufacture Name & Address		**ITC/ GYRO/ MEHRU/ Eqv.**
2.	Standard followed		**IS 3156 – 1992**

3.	Application		**Protection**
4.	Location		**Outdoor**
5.	System Specifications		
	• Voltage	KV	**11**
	• Frequency	Hz	**50**
6.	Ambient temperature		
	• Maximum temperature	Deg. C	**50**
	• Minimum temperature	Deg. C	**5**
7.	Type		**Oil Cooled**
8.	Rated Voltage	KV	**11**
9.	Ratio		**11KV/110V – 110V**
10.	Connection.		**Star/Star/open Delta.**
11.	Number of Cores		**Double Core, 5 limbs.**
12.	Accuracy Class		**Class 1 / 5P**
13.	VA Burden	VA	**50/50**
14.	Power Frequency Withstand Voltage	KV_{rms}	**28**
15.	Lightening Impulse Withstand Voltage	KV_{peak}	**75**
16.	Voltage factor		**1.2 cont. and 1.5 for 30 seconds.**
17.	Total Weight	Kgs.	**To be furnished**
18.	Overall Dimensions	mm*mm*mm	**To be furnished**

5 OIL COOLED SERIES REACTOR

Sl. No.	Description	Unit	Data
1.	Reference Standard		**IS 5553, Part 5**
2.	System Specification		
	• Voltage	KV	**11**
	• Frequency	Hz	**50**
	• Phase		**3**
3.	Rating.	KVAr	**108**
4.	Rated current	Amps	**94.5**
5.	Ambient Temperature		
	• Maximum Temperature	Deg C	**50**
	• Minimum Temperature	Deg C	**5**
6.	Type of Reactor		**Oil cooled**
7.	Purpose		**Current limiting**
8.	Location		**Outdoor**
9.	Mounting		**Suitable for Structure mounting**
10.	Type of cooling		**ONAN**
11.	Shielding		**Non shielded**
12.	Connection		**LINE SIDE**
13.	Maximum permissible continuous Current	Amps	**130 % of rated current**
14.	Class of Insulation		**A**
15.	Power frequency withstand voltage	KV rms	**28**
16	Impulse withstand voltage	KV peak	**75**
17	Terminal Arrangement		
	• Incoming		**Suitable for Bus bar**
	• Outgoing		**Suitable for Bus bar**
18	Winding material		**Copper**

19	Clearances • From phase to phase • From phase to earth • Magnetic clearances		**Should satisfy I.E. rules**
20	Creepage distance	mm/kV	**25**
21	Fittings (Standard)		**- Rating plate** **- Earthing terminals** **- Lifting arrangement** **- Base frame**

6 CAPACITOR UNITS.
The capacitor shall be built up of number of elements having a di-electric of polypropylene film between aluminum foils. Elements shall be assembled in a stack closely fitting into a steel container so that the quantity of free fluid is minimum. The container shall accommodate fluctuations in fluid volume due to variations in temperature. The containers shall be pretreated and painted to resist severe atmospheric conditions.

7 LOSSES.
The total losses in the capacitor unit including internal fuses and discharge resistors shall be less than 0.2W/KVAr under steady state conditions.

8 DI-ELECTRIC.
The di-electric shall be Polypropylenes film, which shall withstand transient over voltages at low temperatures and have long-term endurance at 1.4 times the nominal voltage.

9 IMPREGNATING FLUID.
The impregnating fluid shall have excellent electrical properties especially PD characteristics. It shall be low bioaccumulation tendency and rapid bio-degradation. It shall not produce poisonous gases.

10 DISCHARGE.
The capacitors shall have built in discharge resistors. The discharge resistors shall be capable of discharging the capacitor to 50 volts within five (5) minutes.

11 PROTECTION
Capacitors shall have internal element fuses so that only the fuse disconnects the faulty element.

12 RESIDUAL VOLTAGE TRANSFORMER

It shall be designed so that resistance and reactance drops are minimized. Best grads of cold rolled grain oriented electrical steels shall be used for operation at optimum level of magnetic induction.

13 INTERCONNECTIONS

The interconnections between disconnecting switch, series reactor and capacitor bank shall be done with aluminum bus tube rated for 800 amps.

APPENDIX-15

11 KV VACUME CIRCUIT BREAKERS (OUT DOOR TYPE)

Technical Specification for 11 kV, 1250A Outdoor Vacuum Circuit Breaker

1.0 Standards :-

i) The design, manufacture and performance of the Vacuum circuit breaker shall comply with all currently applicable statutes, regulations and safety codes.

Nothing in this specification shall be construed to relieve the bidder off his responsibilities.

ii) The Vacuum circuit breaker meeting with the stipulations of equivalent IEC,ANCI, CSA, DIN standards, which ensure equal or better quality than the standards listed below, shall also be acceptable. In such case the Bidder should submit along with his offer, two copies of such standards in authentic English translation, if the language of the standard is other than English. In case of dispute, the stipulations in the English translation, submitted by the Bidder, shall prevail. Further, in the event of conflict between the stipulations of standard adopted by the Bidder and the corresponding Indian Standard Specification, he stipulation of Indian Standard Specification shall prevail.

iii) Unless otherwise specified, the Vacuum circuit breaker offered shall conform to the latest applicable Indian, IEC, British, U.S.A. or International Standards and in particular, to the following:-

Sr. No.	Standards	Particulars
1.	IS 13118/ IEC 62271 -100-2001 amended up to date	High-voltage alternatingcurrent circuit- breakers
2.	IEC 694	Common clauses for switchgear
3.	IS 2099/IEC:815 IS 5621:1980	Porcelain Bushings.
4.	IS 2544	Porcelain Post Insulators
5.	IE C-2331	High Voltage porcelain bushings.
6.	IS 325 -	Specification for 1phase induction motor
7.	IS 12063/ 1987IEC: 529	**Degree of protection provided by enclosures of electrical equipment.**
8.	IS 5	Colour for ready mixed paints and enamels.
9.	IEC - 60 -	High voltage test techniques
10.	IS 5578 & IS:11353	Marking and arrangements for switchgears, bus bars , main and auxiliary wiring.
11.	IS 4794	Push button switches.

12. IEC - 71 Part-I & II - Insulation co-ordination, Terms, definitions, principles and rules
13. IEC 270- Partial discharge measurements.
14. IS 2629 - Recommended practice for hot dip galvanizing of iron and steel.
15. Indian Electricity Rules. 2005

2.0 System Particulars:-

2.1 Nominal System Voltage : 11 kV

2.2 Type : 12PV26

2.3 Corresponding Highest System Voltage: 12kV

2.4 Frequency : 50 Hz with ±3 % tolerance

2.5 Rated normal current : 1250 A

2.6 Number of Phase : 3 Phases

2.7 Neutral earthling : Solidly earthed.

2.8 Fault level (minimum) : 12.5 kA for 3 sec.

2.9 Motor voltge : 230 V AC

2.10 Coil Voltage : 110V DC

3.0 Service Conditions :-

A) The Vacuum circuit breaker to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

3.1	Maximum ambient temperature (Degree C)	50
3.2	Maximum temperature in shade (Degree C)	45
3.3	Minimum Temperature (Degree C)	3.5
3.4	Relative Humidity (percent)	10 to 95
3.5	Maximum Annual rain fall (mm)	1450
3.6	Maximum wind pressure (kg/sq.m)	150
3.7	Maximum altitude above mean sea level (Meter)	1000
3.8	Isoceranic level (days per year)	50
3.9	Seismic level (Horizontal Acceleration)	0.3 g

Moderately hot and humid tropical climate conductive to rust and fungus growth ….

B) The climatic conditions are prone to wide variations in ambient conditions and hence the Vacuum circuit breaker shall be of suitable design to work satisfactorily under these conditions.

4.0 Auxiliary Power Supply:

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

a) For A. C. Control & Protective devices, lighting fixtures, space heaters and motors:

A.C. supply 1 phase 2 wire, AC supply with one point grounded.

Voltage : 230 V±10%

Frequency : 50 Hz ±3%

b) For D.C. alarm, control and protective device:

D.C. supply 2 wire, DC source from batteries with midpoint grounded. The available DC supply voltage is 110 V DC.

Voltage : 110V, -15% to +10%.

5.0 Principal Technical Parameters :-

The Vacuum circuit breaker covered under this specification shall conform to specific parameters given below:

Sr. No.	Property	Requirement
1.	Rated voltage of the breaker (KV rms.)	
	Rated System Voltage Highest System voltage	11Kv, 12kV
2.	System frequency	50 HZ
3.	System Neutral grounding	Effectively earthed
4.	Continuous current rating (Amps)	For Incomer: 1250 Amps
5.	Installation	Outdoor
6.	Rated voltage of the breaker (KV rms.)	
	Rated System Voltage Highest System voltage	11kV, 12kV
7.	Type of breaker	Vacuum
8.	Mounting on hot dip galvanized steel support structure or on the operating mechanism box, as the case may be, to be supplied by the tenderer.	
9.	Number of Poles	3
10.	Type of operation mechanically and electrically.	
11.	a) Minimum Clearance between adjacent pole b) Minimum clearance between lowest live part to earth in mm c) Minimum clearance between upper live part (terminal) to lower live part in mm 280mm (minimum)370-280	
12.	Required clearance from the lowest live part of breaker to ground level	

13. Height of concrete plinth above ground level (mm) (To be provided by the Purchaser).
14. Minimum height of the lowest part of the support insulator from ground level (mm). 3100 mm
15. Operating mechanism Spring operated
16. Auto reclosing duty Rapid
17. Rated operating duty cycle. O-0.3 seconds-CO-3-minutes-CO
18. "First pole to clear" factor 1.5
19. Max. closing time (ms) <80 ms
20. Max. total break(Tripping) time at rated breaking capacity excluding relay time
21. 1.2/50 micro second impulse withstand voltage: 45-50 ms
i) to earth (kVp) 75
ii) Across open contacts: Impulse on one terminal, power 75 frequency voltage on opposite terminal (kVp)
22. One minute power frequency with-stand voltage (kV rms.) 28
23 Rated symmetrical short circuit breaking current (for 3 seconds) of outdoor circuit breaker in kA (rms) 12.5 kA
a) AC component (kA (rms)
b) percentage of DC component 12.5 kA
Corresponding to minimum opening time as per standard IEC-62271-100
24. Rated short circuit making current capacity (kAp) 62.5
25. Permissible limit of temperature rise. As per given in clause No. 11
26. Minimum creepage distance of insulator (mm) 300
27 Out of phase breaking capacity 100 % of rated breaking capacity

6.0 Specification for Operating Mechanism Housing and Breaker Cabinets:

i) The specification covers the requirements of control cabinets and associated equipment.

Cabinets shall preferably be of the free standing floor mounting type for HV CBs.

ii) Control cabinets shall be sheet steel enclosed and shall be dust, water and vermin proof. Sheet steel shall be at least 3.0 mm thick when control cabinets are intended for outdoor operation. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. Control cabinets shall be provided with double hinged door and padlocking arrangement. The door hinges shall be of union joint type to facilitate easy removal and the distance between hinges shall not exceed 350 mm. Door shall be

properly braced to prevent wobbling. It shall be painted white on the interior and Dark Admiralty Grey, 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 12063/1987. 15mm thick neoprene or better type of gaskets shall be provided to ensure degree of protection of at least IP55 as per IEC: 529. It shall have backwards slanting rain hood of 2 mm thick (14 SWG) sheet for protection against rain water. It shall be accommodate following items:

Sr. No.	Item	Quantity
1.	Mechanical ON & OFF knobs (TNC).	1 No.
2.	Electrical ON/OFF push buttons	1 No. each
3.	CB Mechanical ON/OFF indicator	1 No. each
4.	CB Electrical ON/OFF indicator	1 No. each
5.	Mechanical spring charged indicator.	1 No.
6.	Electrical spring charge indicator	1 No.
7.	Auxiliary A.C./D.C. supply indication	1 No. each
8.	Conveniently located manual emergency trip	1 No.
9.	Auxiliary switches as specified elsewhere in this Specification	1 Set.
10.	Control cable termination connector blocks with stud type brass terminals of min 4 mm dia.	1 Set.
11.	One power plug along with control switch (240V, 10A).	1 Set.
12.	Space heater along with ON/OFF switch and Thermostat.	1 Set.
13.	Cubical illumination lamp with switch.	1 Set.
14.	Mechanical Operation counter to register the number of breaker operations.	1 No.
15.	Local/Remote(For future requirement) switch	1 No.
16.	Trip circuit Healthy-1 indication	1 No.
17.	Trip circuit Helthy-2 indication	1 No.

iii) **Auxiliary Switches:**

a) 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.

b) 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.

c) Insulation level of auxiliary contacts shall be 1100 volts, 2.5 kV for 1 min.

d) All the electrical control equipments/switches, the operating point for manual spring charging handle etc. shall not be more than at a height of 1200 mm from ground level OR from a suitable platform which shall be provided by bidder on the structure at a height not more than 750 mm from ground level. 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.

e) The two steps platform structure with M S angle of size 40mm x 40mm x 6mm shall be

provided to breaker structure. The platform shall be such that the working space on the top platform shall not be less than 500 mm x 1000mm for second step top and

300mm X1000 for first step . The total height of the plat form shall be 750mm (400 mm

height for first step, and 350 mm for second step). The bidder shall specifically confirm that the offered breaker meets this requirement and furnish the G. A. Drawing showing the arrangement.

f) The circuit breaker shall be provided with motor operated spring charged closing.Spring charging motor shall be suitable for 230V, 50 Hz, single phase AC. Suitable rating starter shall be provided for Motor protection. Spring release coil for closing shall be suitable for 110V DC. Provision shall be available for charging the springs manually as well, and to close CB mechanically.

g) Tripping of the circuit breakers shall be through "Shunt trip" coils rated for 110V DC

operation. It shall be possible to trip the breaker manually in case of necessity.

h) 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.

i) Electrical anti-pumping device shall be provided for breaker.

j) Adequate quantity of cable glands of suitable size shall be provided.

k) 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.

l) Breaker Cabinet 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 230 V AC supply. In each panel, one 3-pin 10 Amp industrial type power plug along with control switch shall be provided for extending 230 V AC supply.

m) 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.

iv) **Circuit Breakers control switch:**

a) Switches should have finger touch proof terminals. For the convenience of maintenance, screw driver guide should be from top/bottom of the switch and not from the side. Terminal wire should be inserted from the side of the switch terminal.

b) Terminal screws must be captive to avoid misplace during maintenance.

c) Switch shall be with 48 mm x 48 mm escutcheon plate marked with Trip & Close.

d) Circuit Breakers control switch shall be Non- discrepancy type.

e) Trip-neutral-close, with pistol grip handle must be pushed in to spring return to either trip or close position from Neutral position for safety and not just turn to trip.

f) One contact to close in each position of Trip and Close. Contact not required in Neutral position. Contact rating shall be 10A at 110 V DC.

v) Equipments and devices shall be suitable for operation on specified auxiliary A.C. supply system.

vi) Push button shall be rated for not less than 10 Amps, 250 Volts A.C. or 10 Amp, 110 V D.C.

and shall be flush mounted on the cabinet door and provided with appropriate name plates. Red, green and amber indicating lamps shall be flush mounted and provided with series resistors to eliminate the possibility of short circuiting of control supply in the event of fusing of lamps.

vii) Breaker cabinet shall be provided with 230 V, 1-phase 50 Hz, 20 W Fluorescent lighting

fixture with on /off switch and a suitably rated 230 V, 1 phase, 5 amp, 3 pin socket for hand lamp.

viii) All AC control equipment shall be suitable for operation on 230V, 1 Phase two wire 50 Hz system, with one pole grounded.

ix) Items inside the cabinet made of organic material shall be coated with a fungus resistant varnish.

x) For protection of AC/DC aux. circuits, MCBs of suitable capacity & reputed make to be provided

7.0 Operating Mechanism & Associated Equipments:

i) The circuit breaker shall be designed for electrical local as well as remote control. In addition there shall be provision for local mechanical control.

ii) The operating mechanism shall be of spring charging type by electrical control undernormal operation. The mechanism shall be adequately designed for the specified tripping and reclosing duty. The entire operating mechanism control circuitry, spring charging motor etc., as required, shall be housed in an outdoor type, steel enclosure processed as per standard.

iii) All metal parts in the mechanism shall be of corrosion resistant material. All bearings

which require greasing shall be equipped with pressure grease fittings.

iv) The design of the operating mechanism shall be such that it shall be practically maintenance free. The guaranteed number of years in maintenance free operation, the number of possible full load and full rated short circuit current breaking operations without requiring any maintenance or

overhauling shall be clearly stated in the tender bid. As far as possible, the need for lubricating the operating mechanism shall be kept to the minimum and eliminated altogether, if possible.

v) The operating mechanism shall be anti-pumping and trip free There shall be no rebounds in the mechanism and it shall not require any critical adjustments at site. Operation of the power operated closing device, when the circuit breaker is already closed, shall not cause damage to the circuit breaker or endanger the operator. Provision shall be made for attaching an operation analyzer to facilitate testing of breaker at site.

vi) The technical requirement of spring type operating mechanism shall be as below.

vii) Spring Operating Mechanism:

a) The spring operating mechanism shall have adequate energy stored in the operating spring to close and latch the circuit breaker against the rated making current and also to provide required energy for the tripping mechanism in case the tripping energy is derived from the operating mechanism. The mechanism shall be capable of performing the rated operating duty cycle of O-0.3 Sec - CO - 3 min - CO. The spring charging motor shall not take more than 30 sec for fully charge the closing springs and provision shall be made for automatic charging of the closing springs as soon as they are discharged in a closing operation. For this, mechanism shall be such that charging of springs by motor does not interfere with the operation of the breaker.

b) The motor shall be adequately rated to carry out a minimum of 10 close and open

operations continuously. Also provision shall be made to protect the motor against overloads.

c) In case of failure of power supply of spring charging motor, the mechanism shall be capable of performing one sequence of 0 - 0.3 Sec - CO.

d) Mechanical interlocks shall be provided in operating mechanism to prevent discharging of closing springs when breaker is already in closed position. Provision shall also be made to prevent a closing operation to be carried out with the spring partially charged.

e) Facility shall be provided for manual charging of closing springs. The actuating force required for manually spring charging shall be less than 250N. In support of this requirement the bidder shall furnish test report for actual requirement of force based on actual measurement.

8.0 Galvanizing: All ferrous parts including nuts, bolts, plain and spring washers of size M 10 and above, support channels, structures, etc. shall be hot dip-galvanized to conform to latest version of IS 2629 or any other equivalent authoritative standard. All other fixing nuts, bolts, washers of size below M 10 shall be made out of stainless steel.

9.0 Earthing: The operating mechanism housing, support structures etc. shall be provided with two separate earthing terminals for bolted connection to 50 x 8 mm MS

flat to be provided by the purchaser for connection to station earth mat. The connecting point shall be marked with "earth" symbol No.86 of IEC publication 117-1 part 1.

10.0 Acceptance & Routine Tests:

a) All acceptance and routine tests as stipulated in relevant standards, amended up to date, shall be carried out by the supplier in the presence of purchaser's representative without any extra cost to the purchaser

(Note:- All measuring/testing equipments shall be of appropriate class of accuracy and shall have valid calibration certificates which shall be produced to the Inspecting Officer for verification.)

b) After finalization of the program of type/acceptance/routine testing, the supplier shall give three weeks advance intimation to the purchaser, to enable him to depute his representatives for witnessing the tests.

AAAC CONDUCTOR AND ALUMINUM BUS

STANDARDS

Standard 6201-T81 high strength aluminum conductors, conforming to ASTM Specification B-399, are concentric-lay-stranded, similar in construction and appearance to 1350 grade aluminum conductors.

The overhead conductor shall be of All Aluminum Alloy conductor of the following specification.

Sl No	Description.	Values.
1	Word code.	CANTON.
2	Size (KCM).	394.5
3	Number of strands.	19
4	Dia of individual wire.	3.660mm.
5	Dia of complete cable.	18.30mm
6	Cross section area.	199 sq.mm.
7	Resistance- DC at 20 deg.C	0.168/KM
8	Resistance- AC at 75 deg.C	0.2/KM
9	Current rating.	532 amps.
10	Size.	336.4
11	Rated strength.	6033 Kgs.

ALUMINUM BUS

The bus tubes for interconnecting the yard equipments shall be of electrolytic aluminum E91E-WP as per I.S. 5082-1969 rated for minimum 774 amps.
The bus tubes shall be of extruded tubular seamless bus pipe to convey electricity as per the physical and electrical properties detailed below.

Sl. No	Description.	Values.
1	Nominal size	25.4 mm.
2	Outside diameter of tube.	33.4 mm.
3	Wall thickness.	4.5466 mm.
4	Area in Sq.mm.	412.2572 Sq.mm.
5	DC resistance at 20 deg. C	24.060 microhms/ft.
6	Current rating (outdoor) at 30 deg C temperature raise over 40 deg. C ambient.	774 amps.

ACCESSORIES:

All connectors and hardware's shall be of approved quality and shall be of metric thread.

APPENDIX-17

POWER AND CONTROL CABLES AND TERMINATION.

1. Type of cable

A) EHT/High voltage XLPE Cable

- Confirm to IS: 7098 part-II.
- Construction details: Compacted circular aluminum conductor with conductor screening (extruded semi conducting layer) overall XLPE insulates using dry cured process followed by Insulation screen (extruded semi conducting layer followed by copper tape). The Cores laid up together suitable with filler material and insulated with PVC sheathed and armored with galvanized steel flat strip followed by extruded PVC outer sheath.
- Maximum conductor temperature for continuous operation – 90 deg. C.
- Maximum conductor temperature after end of short circuit. – 250 deg. C.
- Make: universal cables, RPG, Finolex, CCI, NICCO.

B) XLPE insulated General power distribution and control purpose cables

Power cables for LT power distribution, panel wiring and trolley cabling shall be of suitable rating, XLPE insulated, multi-strand, copper/aluminum conductor, armored cable of 1.1 KV grade. Confirm to IS-7098/Part I & II and IS: 8130/1984.
Insulation: Cross-linked polyethylene.
Inner sheath: Thermo plastic material compatible with thermal rating of insulation for control and Power distribution cables. Unvulcanised rubber for Trolley cabling.
Armour: Galvanized steel wires/Flat strips.
Outer sheath: PVC
Make: Universal cables, RPG, Finolex, CCI, NICCO.
Test certificates shall be produced with each drum.

2 Length

Cable shall be supplied and laid in single length as far as possible and joints should be avoided. No joints will be permitted when the clear run between terminations is less than 450 meters.

3 Loops

At each end of termination 5-meter loop shall be kept an allowance in form of ring. The log rings shall be formed circular and as recommended by the cable manufacturer.

4 End terminations and straight through joints.

All the end termination shall be by indoor type crimping methods shall be adopted. All cable entry glands shall be properly sealed to make the glands / holes vermin proof. Cable termination and straight through joint kit shall be of approved make and performance certificate from the recognized institution shall be submitted along with the supply.

5 laying of cables.
Laying of cables confirm to IS: 1255 2001 or latest in all respects, modern practice and IE rules etc. cables should be laid on cable racks. Additional supporting member to be provided as decided by the site engineer.

All the cables to be fixed to supporting member with 'U' clamps, bolts and nuts. The clamps and saddles shall be fabricated using minimum 23 x 3 mm GI flats.

Insulation resistance tests shall be repeated after laying and before jointing in the presence of the Engineer in charge.

A) BURIED CABLE
Outside the building where required the cables shall be buried 750mm deep along approved route and provided with sand cushioning and burnt brick protection. After inspection the trench shall be refilled with earth, and well rammed in stages to ring the surface in level with the original surface.

The cables shall be threaded through hume pipes of approved size at all road and rail line crossings and at all other service line crossings.

Approved type MS cable markers indicating the size length, origin and destination of cable shall be grouted in concrete along with route of the cable at intervals of 15 meters and at entry and exit of buildings.

B) LAYING IN DUCT:
Approved type MS cable identification tags indicating the size, the length, the origin and destination of the cable shall be provided on the cable at exit and entry of switch, switch boards. MSB boards, distribution boards etc. and at intervals of 15 meters along with length of the cable.

The duct will be provided by another agency with grouted brackets to facilitate laying of the cables.

The necessary drilling, welding, saddling etc, will be carried out under this contract.

The laying of the cables in ducts shall be carried out as directed by the engineer in charge using approved type of clamping arrangements with saddles made out of 24 x 3mm MS flats.

Care shall be taken to ensure that the cables do not cross one another.

C) LAYING ALONG BEAMS AND COLUMNS
Inserts only are provided by another agency for facilitating running of cables along beams and columns.

Fabricated framework shall be welded to the inserts over which the cable shall be run. The drawings according to which the framework has to be fabricated shall be got approved.

Saddles fabricated to suit the size of the cable shall be used to secure the cables.

The saddles shall be fabricated using 25 x 3mm MS flats.

The rates quoted for the cable shall include the supplying all the necessary materials, carrying out all necessary fabrication work etc.

6 LAYING OF CABLES INSIDE RCC TRENCHES

B) RCC TRENCHES

50 mm X 6 mm angle iron shall be welded or grouted at every 1-meter distance inside the RCC trenches and the cables shall be laid without crossings. Cables shall be clamped at each support. Spacing between the cables shall be maintained as per standards.

All supports and fabricated items shall be treated with rust preventive coating.

7 LAYING OF COMMUNICATION CABLES AND CONTROL CABLES

The communication cables, signal cables and control cables laid in trenches, tunnels, ducts etc shall be of separate covered slotted aluminum cable trays of minimum 300 mm X 100 mm x 2 mm size. The trays shall be fixed with GI bolts & nuts to the MS angle iron or 'U' channels.

Wherever supports are not there necessary angle iron supports shall be fabricated and fixed by welding or grouting.

Spacing between the communication cables and power cables shall be maintained as per standards or as per the manufacturers recommendation.

APPENDIX-18

APPLICABLE CODES AND STANDARDS

All applicable Indian and IEC codes, regulations and standards shall govern the work hereunder. In the event of the requirements of the specifications exceed the requirements of the corresponding codes, regulations or standards, the specification shall govern where there are more than one applicable codes or standards for any item, the most stringent will apply.

The latest edition of the applicable codes, regulations and standards will apply unless otherwise specified.

In the event of conflict between codes, regulations and standards referred to in this specification, the Railways decision is final and binding.

A. Transformers (Power and distribution)

1. IS 2026 Part-I 1977	Power Transformers Part-I General
Part-II 1977	Part-II Temperature rise
Part-III 1977	Part-III Insulation level and dielectric tests
Part-IV 1977	Part-IV Terminal markings, tappings and connections for Power transformers.
3.IS 3639 1966	Power transformer fittings and accessories.
4.IS 8478 1977	On load tap changer, application guide
5.IS 6600 1972	Guide for loading of oil immersed transformers.
6.IS 8468 1977	On load tap changers.
7.IS 10028 Part I 1985	Code of practice for transformer selection, installation and maintenance,
Part II 1981	Code of practice for transformer selection, installation and maintenance, -Installation
Part III 1981	Code of practice for transformer selection, installation and maintenance, -maintenance.
8. IS 335 1995	New insulating oils.
9. ANSI/IEE C 57, 12, 90-1980	Test code for liquid immersed distribution and power transformer

B. Current transformers

1. IS 2705 Part I 1992	Current transformers, general requirements.
Part II 1992	Measuring current transformers.
Part III 1992	Protective current transformers
Part IV 1992	Protective current transformers for special purpose application.
2. IS 1985 Part 28 1993	Electro technical vocabulary, instrument transformer

3. IS 2032 Part 22 1978	Graphical symbols used in electro technology, instrument transformers
4. IS 6949 1973	Summation current transformers.

C. **Voltage transformers**.

1. IS 3156 Part 1 1992	Part I General requirements.
Part 2 1992	Measuring voltage transformers.
Part 3 1992	Protective voltage transformers.
Part 4 1992	Capacitor voltage transformers.
2. IS 5142- 1969	Voltage auto transformers continuously variable.

D. Lightning arrestors

1. IS 3070 Part 3: 1993	Lightning arrestors for alternating current systems- Metal Oxide lightning arrestors without gaps.

E. Switchgear, Control gear and Isolators.

1. IS 9920 Part I: 2002	High Voltage Switches- rated for voltages above 1000 V and less than52 kV
Part II: 2001	High Voltage Switches- rated for voltages of 52 kV and above rating.
Part III: 1982	Design and construction. Alternating current switches for voltages above 1000 V
Part IV: 1985	Alternating current switches for voltages above 1000V Type Tests and Routine tests.
2. IS 9921 Part I: 1981	Alternating current Disconnectors (Isolators) and Earthing switches for voltages above 1000V. General and definitions
Part II: 1982	Rating
Part III: 1985	Design and Construction.
Part IV: 1985	Type Tests and Routine tests
Part V: 1985	Information to be given with vendors, Enquiries and Orders.
3. IS 13947: Part 2(Second Rev)	Circuit Breakers: Part 1&2 Requirements and tests: sec 1 Voltages not exceeding 1000 V A.C or 1200 V D.C
4. IS 13118 Part I	Circuit Breakers: General and definitions, Sec 2 for voltages above 1000 V AC (First Rev)
IS 13118 Part 2	Circuit Breakers: Rating, Sec 2 (First Rev) for voltages above 1000 V AC.
IS 13118 Part 3 (First Rev)	Circuit Breakers: Design and construction, Sec 2 for voltages above 1000 V AC.

IS 13118 Part 4(First Rev)	Circuit Breakers: Type tests and Routine tests: Sec 2 for Voltages above 1000 V AC.
IS 13118 Part 5(First Rev)	Circuit Breakers- Information to be given with enquiries, tenders and orders and rules of transport, erection and maintenance, Sec 2 for voltages above 1000 V AC
5. IS 8197 1976	Terminal markings for electrical measuring instruments.
6. IS 8623 Part 1 1993	Specification for low voltage Switchgear and control gear assemblies Part 1: Requirements for Type-tested and partially type tested assemblies.
Part 2 1993	Particular Requirements for Busbar Trunking systems (Busway)
Part 3 1993	Particular Requirements for Equipment where unskilled persons have access for their use.
7. IS 13947: Part I(First Rev)	General requirements for switchgear and control gear for voltages not exceeding 1000 V AC or 1200 V Dc
Part 2	Circuit breakers, AC: Requirements and tests, section 1 voltages not exceeding 1000 V AC or 1200 V DC.
IS 13947	Degree of protection provided by enclosure for low voltage switchgear and control gear.
8. IS 9385: Part I: 1979	High voltage fuses: Part 1 current limiting fuses.
9. IS 10118-1992 Part I	Code of practice for design, installation and maintenance of switchgear and control gear.
Part 1	General
Part 2	Selection
Part 3	Installation
Part 4	Maintenance.
9. IS 3427 1997	AC Metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV.
10. IS 9224: Part 2	HRC cartridge fuse links for voltage above 650 volts.
11. IS 9249 Part I, 1979	Safety requirements for indicating and recording electrical.
Part 2: 1982	measuring instruments and their accessories.

F. Relays

1. IS 3842 Part-I to Part-XII	Application guide for electrical relays for AC system
2. IS 3638 1966	Application guide for gas operated relays.
3. IS 3231 1986	Electrical relays for power system protection.

4. IS 3637 1966	Gas operated relays.
5. IS 4483 Part1:1968	Preferred panel cut-out dimensions for electrical relays.Part 1 Flush mounting IDMTL
6. IS 8686 1977	Static protection relays.

G. Power cables and conductors

1. IS 1554 Part I Part1:	PVC insulated (heavy duty) electric cables. For working voltages up to and including 1100V.
Part II 1988	For working voltages from 3.3 kV up to and including 11 kV.
2. IS 2121 Part1, 1981	Conductors and earth wire accessories for over head power lines.

H. Batteries

1. IS 6034 1992	Stationary batteries lead acid type with pasted positive Plates.
2. IS 1652 1991	Stationary cells and batteries lead acid type (with Positive plates).
3. IS 1651 1991	Stationary cells and batteries, lead acid type (with Tubular positive plates).
4. IS 6071 1986	Synthetic separators for lead acid batteries.

I. Insulators and accessories.

1. IS 731 1971	Specification for porcelain insulator for overhead Power lines with a nominal greater than 1000V.
2. IS 2486 1993	Part I General requirements and tests.
1982	Part II Dimensional requirements.
1974	Part III Locking devices.
1981	Part IV Tests for locking devices.

3. IS 2544 1973	Specification for porcelain post insulators for systems With nominal voltage greater than 1000V.
4. IS 3188 1980	Characteristics of string insulator units.
5. IS 2099 1986	Bushing for alternating voltages above 1000V.
6. IS 8603 Part 1 to	Dimensions for porcelain transformer bushings for use in Heavily polluted atmosphere 12 KV and 17.5KV.
Part 2: 2003	: 24 kV Bushings.
Part 3: 2003	36 kV Bushings.
7. IS 3347 Part I 1979	Dimensions for porcelain transformer bushings for use in Lightly polluted atmosphere.
8. IS 5621 1980	Hollow insulators for use in electrical equipment.
9. IS 2486 Part I to Part IV	Insulator fittings for overhead power lines with nominal voltage greater than 1000V.
10. IS 7935 1975	Insulator fittings for overhead power lines with nominal voltage up to and including 1000V.
11. IS 5300 1969	Porcelain guy strain insulators.
12. IS 9960 1981	Electrical grade castor oil for use as capacitor impregnate.
13. IS 6792 1992	Method for determination of electrical strength of insulating oils.
14. IS 9434 1992	Guide for sampling and analysis of free and dissolved Gases and oil from oil filled electrical equipment.
15. IS 1271 1985	Thermal evaluation and classification of electrical Insulation.

16. IS 6855 2003	Method of sampling for liquid dielectrics.
17. IS 6262 1971	Method of test for power factor and dielectric constant of electrical insulating liquids.

J. Electrical installation codes and practices.

1. IS 5613 Part I Section I & II	Design, installation and maintenance of overhead power. lines.
2. IS 8061 1976	Code of practice for design, installation and maintenance of service lines upto and including 650 V.
3. IS 3043 1987	Code of practice for earthing.
4. IS 9511 1980	Earthing knobs for neutral conductors.
5. IS 7689 1989	Guide for control of undesirable static electricity.
6 IS 7752 Part I 1975	Guide for improvement of power factor consumer's Installation: Part I Low and medium supply voltages.
7. IS 5578 1984	Guide for marking of insulated conductors.
8. IS 5216 Part I: 1982 Part II:	Recommendations on safety procedures and practices In electrical work- Part I: General Life saving techniques.
9. IS 13234	Guide for short circuit calculations.

K. Miscellaneous.

1. IS 2551 1982	Danger notice plates.
2. IS 5424 1969	Rubber mats for electrical purpose.
3. IS 4770 1991	Rubber gloves—Electrical purposes—specification.

4. IS 1255 1983	Code of practice for installation and maintenance of Power cables up to and including 33 kV rating.
5. IS 13925	Shunt capacitors for power systems (second revision)
6. IS 2721: 2003	Galvanized steel chain link fence fabric—specification.
7. IS 3722: Part 1:	1983 Letter symbols and signs used in electrical technology: Part1 General guidance on symbols and subscripts.
Part2: 1983	Reference table for symbols and subscripts.
8. IS 9676 1980	Reference ambient temperature for electrical equipment.
9. IS 8923 1978	Warning symbol for dangerous voltages.
10. IS 5 1994	Colours for ready mixed paints and enamels.
11. IS 1248	Indicating instruments.

MAKES OF EQUIPMENT/COMPONENTS

Following make of items are applicable, if make is not given in BOQ.

Sl.No.	Description	Makes
1	132 kV Disconnecting switch	S&S POWER,HITACHI, ELEKTROLITES, FARADAY, CG POWER
2	132 kV/11 kV Power transformers.	BHEL/HITACHI/CG POWER/SCHNEIDER/SIEMENS/
3	132 kV SF6 circuit breakers	CGL/SCHNEIDER/SIEMENS/HITACHI
4	132 kV lightning arrestors	OBLUM/ELPRO/JSI/CGPOWER/ ELEKTROLITES,HITACHI, LAMCO
5	11 kV Indoor switch board	ABB/CG POWER/SCHNEIDER/SIEMENS
6	D.C. Battery	HBL/EXIDE/AMAR RAJA/TATA
7	Battery Charger/DC Board	CALADYNE/HBL/AMAR RAJA/CHHABI
8	XLPE Cables (HT&LT)	POLYCAB/UNIVERSAL/ NICCO/CCI/TORRENT/HAVELLS
9	Relay & Control panel	GE/HITACHI/SIEMENS/ASHIDA
10	Capacitor Banks	ABB/UNISTAR/BHEL

COMPONENTS

Sl.No.	Description	Makes
1	Protection & Aux. Relays	SCHNEIDER/GE/MULTILIN/ABB/EASUN REYROLL/SIEMENS/L&T
2	HRC fuses	GE/SIEMENS/ABB/L&T
3	Selector switches/ Rotary switches	SIEMENS/KAYCEE/ALSTOM/L&T
4	LT contactors	SIEMENS/L&T/BCH/TELEMECHANIC/ SCHNEIDER
5	Meters/instruments.	AE/IMP/MECO/ENERCON/SATEC/SCHEIDER/ L&T
6	HT Heat shrinkable cable sealing kits	DENSONS/RAYCHEM/3M
7	Annunciators	MINILEC/TECHNIC/SECO
8	Indicating lamps/push buttons	SIEMENS/L&T/BCH/ABB/SCHNEIDER/ VAISHNO
9	Winding & oil tempr. Indicators	PERFECT CONTROLS/SCIENTIFIC CONTROLS/ PRECIMEASURE/PRADEEP
10	Breaker control switches & Semaphores.	GE/L&T/SELECT/KAYCEE
11	MCB & MCCB	SIEMENS/L&T./C&S/ SCHNEIDER/ABB
12	Terminal connectors	WAGO/ELMEX/CONNECTWEL
13	Power and energy meter.	YOKAGAWA/ L&T /SECURE/SCHNEIDER
14	Switch fuse units	ABB, Siemens, Schneider, L&T.

15	Clamps and Connectors	These are to be sourced from regular approved sources of M/s Powergrid and CORE (central organization for Railway Electrification) Allahabad. Trial sources shall not be permitted. The sources are listed on their website. www.powergridindia.com. and www.core.railnet.gov.in
16	Insulators	BHEL/Birla.NGK/ WSI
17	HT and LT BUS DUCTS	There are to be sourced from regular approved sources of M/s Powergrid and CORE (central organization for Railway Electrification) Allahabad. Trial sources shall not be permitted. The sources are listed on their website. www.powergridindia.com. and www.core.railnet.gov.in
18	GI structures	There are to be sourced from regular approved sources of M/s Powergrid and CORE (central organization for Railway Electrification) Allahabad. Trial sources shall not be permitted.
19	40 mm Dia MS Rod	TATA STEEL, JINDAL, SAIL
20	UPS	AUTOMETER, APC, NUMERIC, LUMINOUS
21	Capacitor	EPCOS/Meher/UNISTAR/ABB
22	CT/PT 11 kV	KAPPA/PLASTOFAB/NPP