

7.3.0 TECHNICAL SPECIFICATIONS FOR 33/11 KV SUBSTATION EQUIPMENT

7.3.1 Scope

This clause describes the General Technical Requirements for the new 33 KV Circuit Breaker with PCM and 11KV AIS Switchgear and general switchyard equipment, and shall be read in conjunction with the Project Requirements, Schedules and Drawings in the specification.

The Contractor shall demonstrate that the switchgear has been designed, built and installed in accordance with the relevant international standards and the specification as specified in the tender documents. It shall also operate and perform on a site in accordance with the requirements of the specification and in the environment defined herein.

The design shall be proven by the submission at the time of Tender of test certificates covering all specified tests deemed to be pertinent to the plant and to the conditions in which it will operate or, if such test certificates cannot be supplied or are deemed unacceptable by the Engineer, type tests which will be subject to the conditions of this Contract shall be carried out at no extra cost to the Employer.

The requirement for switchgear spares, tools and appliances, including test, maintenance and handling equipment shall be as stated in the tender document.

7.3.2 REFERENCES

7.3.2.1 British Standards

BS	159	Specifications for HV bus bars and bus bar connections
BS	1977	Specifications for high conductivity copper tubes for electrical purposes
BS	2898	Specifications for wrought aluminium for electrical purposes. Strip with drawn or rolled edges.
BS	3938	Specification for current transformers.
BS	5253	Specifications for AC disconnectors and earthing switches.
BS	6651	Lightning Protection
BS	7354	Code of practice for design of HV open terminal stations.

7.3.2.2 IEC Standards

1.	IEC 62271	HV Switchgear and Controlgear.
2.	IEC 60376	Specification and acceptance of new sulphur hexafluoride
3.	IEC 60480	Guide to checking of sulphur hexafluoride taken from electrical equipment.
4.	IEC 60060	High Voltage test techniques.
5.	IEC 60071	Insulation Co-ordination
6.	IEC 60099-5	Surge arresters Part 5: Selection and application recommendation
7.	IEC 60129	AC disconnectors (isolators) and earthing switches
8.	IEC 61869-1&2	Current transformers.
9.	IEC 61869-1&3	Voltage transformers.
10.	IEC 60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V.
11.	IEC 61850	Communication network and system in substation
12.	IEC 60529	Degrees of protection provided by Enclosure (IP code)
13.	IEC 60255	Electrical relays
14.	IEC 62271-1	High voltage switchgear and control gear: common specification
15.	IEC 62271-100	High voltage switchgear and control gear: Part 100: Alternating current circuit breakers
16.	IEC 62271-102	High voltage switchgear and control gear: Part 102: Alternating current disconnector and earthing switch

7.3.3 33 KV VACUUM CIRCUIT BREAKER

1.	Installation	:	Outdoor Sub-station.
2.	Type	:	Vacuum Circuit Breakers
3.	Number of Phase	:	3 (Three)
4.	Operation	:	Single Break in Service/ Pole
5.	Nominal Voltage	:	33 KV
6.	Maximum Operating Voltage	:	36 KV
7.	Frequency	:	50 Hz
8.	Rated Current for	:	1600A/2500A
9.	Symmetrical Breaking Capacity	:	1800 MVA
10.	Asymmetry	:	50%
11.	Short Time Current Duration	:	40 kA (3 Sec.) for 2500 A , 31.5 kA(3 Sec.) for 1600 A
12.	Making Current (Peak) KA	:	102KA for 2500 A /80KA for 1600 A
13.	Opening Time (Maximum)	:	0.05 Sec.
14.	Breaking Time	:	<3 Cycle
15.	Capacity of Vacuum Interrupter at rated short circuit current switching	:	≥50 nos. of operations
16.	Basic Insulation Level (1.2/50 Micro Second Wave)	:	170kVp
17.	Power Frequency Test Voltage (Dry)	:	70 KV at 50 Hz, 1 Min.
18.	Rated Operating Sequence	:	O - 0.3 Sec - CO - 3 min - CO
19.	Standard	:	Design, Manufacture, Testing, Installation and Performance shall be in accordance with the latest edition of IEC-60056 & IEC-62271-100
20.	FEATURES <ul style="list-style-type: none"> - Circuit Breaker terminal connectors shall be suitable for ACSR Merlin, Gros Beak (636MCM). - Grading terminal connector. - All current carrying parts shall be made of copper including top & bottom pad/terminals. - Externally visible circuit breaker position indicator. - Electrically remote controlled operating mechanism. - Shall be capable of the interrupting duties produced by the switching of transformer magnetizing current and the switching of line charging current. Tests certificate demonstrating this ability of the circuit breakers shall be submitted with the offer. - Circuit Breaker closing mechanism shall be 230 volt AC motor wound spring-operated type such that the closing speed is independent of the operator. Spring charging motor shall be AC driven Universal motor. Rectifier in motor circuit is not acceptable. - Shall have two tripping coils and one closing coil. Trip coil and close coil shall have freewheeling diode installed. - Hand closing and tripping shall be done through manual levers. - Trip free mechanism as specified in IEC 60056-1 i.e. tripping is independent. - Local "Close" and "Trip" controller. - VCB should be re-strike free. - VCB should be trip free. - Operation Counter. - Supporting Steel Structure. 		

- Bushing Insulator as Specified in latest version IEC-60137.
 - Weather proof sheet steel control kiosk, with hinged door on three sides and necessary multi-core cable glands. Controls from this position will normally be used under maintenance and emergency conditions only. AC 230V lighting system inside the door of control kiosk shall be provided.
 - ARC suppression type contacts.
 - Manually operating devices for slow closing for inspection and maintenance. It shall not be possible to slow close a breaker when in normal services.
 - Earthing pad with provision for earth leads.
 - Standard sundries like anti-condensation heaters, MCBS wiring board etc.
- Facilities to be incorporate for tripping and lockout of the breaker in the event Vacuum failure falling below stipulated value.
- Rating plate and diagram plate shall be made of stainless steel and have engraved letters filled with black enamel paint with clear visibility.
 - Evidence of prototype tests together with test certificate from an internationally reputed/accredited institution covering the equipment shall be furnished with the offer. The test duty shall be as per the requirements of IEC-60056. Laminated control & protection drawing set shall be fitted/supplied inside the control box/kiosk.
 - Motor-driven, spring charged
 - Automatically charged after each closing operation
 - O-C-O operation without recharging
 - Mechanical / electrical interlocking, anti-pumping
 - Provision for manual charging
 - Manual closing and tripping arrangement
 - Mechanical ON-OFF, operation counter and spring-charged indication
 - All necessary positive interlocks installed, as per IEC guidelines.
 - Marking and data to be shown on the Nameplate will be as per approval.

7.3.3.1 INFORMATION REQUIRED for Outdoor type VCB

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information/ Documents have to be submitted:-

- a) The Bidder/ Manufacturer shall submit with the bid the testing procedure & list of testing/ measuring equipment, meters etc. along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.
- b) Construction, Installation, Operation & Maintenance Manual.
- c) Outline, Dimensional, Cross-sectional & General arrangement drawings of offered type equipment with mounting structure arrangement.

Manufacturer's printed catalogue describing specification and technical data of the offered type equipment.

7.3.3.2 TEST CERTIFICATES:

The following test certificates along with test results for offered similar or higher Ampere rating **VCB** for same voltage class from any short-circuit testing liaison (STL) Member [http://www.stl-liaison.org/web/03_Members.php] Testing Organization or Laboratory as per relevant IEC standard. The type test report along with results shall include at least the following tests:

- a) Lightning Impulse Voltage withstand tests
- b) Power Frequency Withstand Tests
- c) Temperature Rise tests.
- d) Measurement of Resistance of the main circuit.

- e) Short-time withstand current and peak withstand current tests.
- f) Mechanical Endurance tests
- g) Short Circuit performance tests.
- h) Out of phase making & breaking tests
- i) IP55 tests

7.3.3.3 Special TEST CERTIFICATES:

The following test certificates along with test results for offered similar or higher Ampere rating **VCB** for same voltage class from independent Testing Organization or Laboratory as per relevant IEC standard.

- a) Dielectric tests
- b) Short-circuit current making & breaking tests
- c) Mechanical operation test at ambient temperature
- d) Additional tests on auxiliary and control circuits
- e) Tightness test
- f) EMC test

7.3.3.4 TESTS AT MANUFACTURERS WORKS FOR OUTDOOR TYPE VCB

General

Functional electrical, material, mechanical and hydraulic tests shall be carried out at manufacturers' premises. The extent and method of recording the results shall be agreed by the Purchaser in ample time to enable the tests to be satisfactorily witnessed or to make any changes to the proposed program of tests.

MATERIAL TESTS

The supplier shall provide test pieces free of charge as required to enable the quality of the material to be determined at the supplier's expense. Purchaser may at its own discretion and by specific arrangement accept certified particulars of tests carried out in the absence of his authorized representative.

TYPE TEST

Type tests are required to prove the general design of the offered equipments/ materials. The Tenderer shall submit the type test reports of the offered equipments/ materials from as per relevant clause.

ROUTINE TESTS

All equipments/ materials shall be subjected to routine tests as per latest version of relevant IEC/ BS or equivalent international standards as mentioned in the contract at the manufacturers works and shall include, but not be limited to, an operational test.

7.3.4 33KV PCM PANEL

7.3.4.1 General

The panels shall be vermin and dust proof free standing type completely metal enclosed by sheet steel (minimum 1.62 mm thick) with necessary reinforcement color gray with appropriate spray painting. The approximate dimension of the PCM panel shall be 2100 mm (Height) x 900 mm (Width) x 700 mm (Depth) while viewed from the front side, suitable for opening at the back by hinged door with locking arrangement. The panels shall be neatly and completely wired before shipment.

The work relating to protection, control and panels for 33/11KV Sub-stations shall comprise of development of elementary diagram, design, manufacture, test and supply of pre-wired control panels to be installed in the sub-station control room. The protection, control and panels are to be pre-wired with relays and meters in position. The elementary primary diagram shall be produced giving a clear representation of each protection, control and metering function. The standard design, drawing, manufacturing, testing & performance shall be in accordance to the IEC-298 standards.

7.3.4.1 A 33 kV Protection, Control, Metering and Relay Panel For Power Transformer, each Panel comprising:

1.	Indicating analogue Ampere meter flush mounting with dual scales options, 0-300/600A for connecting to current transformer ratio 300-600/5-5-5A for 5/6.67 MVA, 10/13.33MVA , 16/20 MVA Power Transformer.	3 (three) nos.
2.	Indicating analogue voltmeter with seven position selector switch flush mounting with scales 0-40 KV for connection to potential transformer ratio $(33/\sqrt{3})/(0.11/\sqrt{3})/(0.11/\sqrt{3})$ KV, (50 Hz).	1 (one) set
3.	a) Numerical Programmable Multifunctional type MFM Meter It shall be capable of measuring and displaying MW, MVAR, PF, V, I, f, ϕ etc. distinguishing import and export operation.	1 (one) no.
	b) 3 phase, 4 wire, 3 element solid state, indoor type, multi tariff programmable KWh meter of class of accuracy 0.2S with the features for measuring the parameters viz. phase voltages, phase currents, system frequency, per phase & total KW with demand, KVAR, Power factor etc.	1 (one) no.
4.	Numerical programmable type Three Phase combined Over Current and Earth fault protection relay of 5 Amps, 50 Hz, 110V dc, 3 second operating time ratings having 3 (Three) over current units and one earth fault with current setting range of the O/C & E/F relay shall be from 0.1*In to 40*In (where In is relay nominal current) for both overcurrent and earth fault element. All O/C & E/F relays shall have both IDMT & DT (51) and Instantaneous (50) function along with IEC NI, VI, EI, LTI etc. curve setting capability with all other necessary protection & monitoring functions. The relays are housed in a horizontal, flush mounting draw-out case (tropicalized) with self-reset trip relay (relaying 02 nos. NO contacts as spares) (Not to be included in Differential Relay). The numerical programmable relay shall have IEC 61850 communication protocol suitable for SAS implementation. Necessary Binary I/O module along with the relay (alternately separate BCU will also be accepted) shall be provided for SAS/SCADA operation.	1 (one) set

5.	Numerical programmable type Differential relay with REF inbuilt feature for 33/11KV, 5/6.67 MVA, 10/13.33MVA, 16/20 MVA Power Transformer. Scheme of REF protection (High/Low impedance) shall be mentioned clearly. The relay(s) are housed in a horizontal, flush mounting draw-out case (tropicalized) with hand & electrical reset trip relay (having 02 nos. NO contacts as spares). Differential relay shall have user defined 3 nos. curves for differential and REF protection with second and fifth harmonic blocking features. The numerical programmable relay shall have IEC 61850 communication protocol suitable for SAS implementation.	1 (one) set
6.	Separate Auxiliary Flag Relays for Device/Self Protection of Power Transformer to be provided. The following Auxiliary Flag Relays shall be available - OTA, OTT, WTA, WTT, MAIN BA, MAIN BT, OLTC Surge Alarm, OLTC Surge Trip , PRD for main tank & OLTC, Oil level low/high for main tank & OLTC etc. All the mentioned Alarm signals shall be incorporated in SAS.	1 (one) set
7.	OLTC Tap position indicator & Lower/Raise push-button switches with blinking feature along with AVR relay etc. AVR relay shall have IEC-61850 communication protocol for SAS. The panel shall be equipped with Oil & winding temperature indication meter, auto/manual selection switch for tap lower/rise operation and master/follower control function for facilitate parallel operation of transformers and appropriate data communication port have to be provided. Also it shall have local/remote selector switch, fan start & stop controlling push button/electrical switch with manual/auto operation mode selection. Indication LED for fan running (Red), fan stop (Green), OLTC in progress (Yellow) etc. shall be provided. Annunciation for OLTC out of step, OLTC faulty/motor tripped, OLTC max./min. position etc. along with other transformer's self-protection alarm & trip signals shall be provided. Annunciator shall have 30 or more window for facilitate all the alarm & trip signals mentioned with built in buzzer/hooter and accept, reset & test push button/electrical switch. . These facilities can also be provided in separate panel (RTCC).	1 (one) set
8.	All necessary switches (Local and remote selector switch, TNC switch, etc.), CT terminal blocks with inbuilt isolating, shorting & jacking facility for test purpose, PT terminal blocks with inbuilt isolating & jacking facility for test purpose, signaling set lamps, trip circuit supervision relay for each trip circuit coil, PT supervision relay, auxiliary relay, MCB, fuse and provision for lighting etc. terminal blocks, mimic diagram with circuit breaker control indicating switches and isolating position indicating switches, indicating lamps shall be provided to indicate "Spring Charge"/ readiness for closing and healthy trip circuit indicating readiness for tripping. The mimic and positions of circuit breaker control cum position indicating switch and isolator position indicating switch arrangement in the panel. Mimic diagram shall contain LED based Semaphore Indicator for Isolator/Breaker/Earth switch position. The annunciator shall have 30 or more windows for facilitate transformer related all the alarm & trip signals and OLTC related alarm and indication signals and have built in buzzer and AC/DC fail relay.	1 (one) set
9.	70 W, 230 V AC, Single Phase heater with thermostat and a visible light indicator which indicate the "ON"- "OFF" position of the heater	1 (one) set
10.	Master Trip relays (02 Nos,)	1 (One) set

7.3.4.1 B 33 KV PROTECTION, CONTROL, METERING AND RELAY PANEL FOR LINE FEEDER (INCOMING /OUTGOING), each comprising:

1.	Indicating analogue Ampere meter flush mounting with dual scales option (0-400A/800A) for connecting to the current transformer ratio 400-800/5-5A for Line Feeder.	3 (three) nos.
2.	Indicating analogue voltmeter with six position selector switch flush mounting with scales 0-40 KV for connection to potential transformer ratio $(33/\sqrt{3})/(0.11/\sqrt{3})/(0.11/\sqrt{3})$ KV, (50 Hz).	1 (one) set
3.	a) Numerical Programmable Multifunctional type MFM Meter It shall be capable of measuring and displaying MW, MVAR, PF, V, I, f, ϕ etc. distinguishing import and export operation.	1 (one) no.
	b) 3 phase, 4 wire, 3 element solid state, indoor type, multi tariff programmable KWh meter of class of accuracy 0.2s with the features for measuring the parameters viz. phase voltages, phase currents, system frequency, per phase & total KW with demand, KVAR, Power factor etc.	1 (one) no.
4.	Numerical programmable type Three Phase combined Over Current and Earth fault protection relay with directional feature of 5 Amps, 50 Hz, 110V dc, 3 second operating time ratings having 03 (Three) over current units and 01(one) earth fault with current setting of 50 to 200% and one earth fault unit with current setting range of the O/C & E/F relays shall be from $0.1 \cdot I_n$ to $40 \cdot I_n$ (where I_n is relay nominal current) for both overcurrent and earth fault element. All O/C & E/F relays shall have both IDMT & DT (51) and Instantaneous (50) function along with IEC NI, VI, EI, LTI etc. curve setting capability with all other necessary protection & monitoring functions. The relays are housed in a horizontal, flush mounting draw-out case (tropicalized) with self-reset trip relay (relaying 02 nos. NO contacts as spares). The numerical programmable relay shall have IEC 61850 communication protocol suitable for SAS implementation. Necessary Binary I/O module along with the relay (alternately separate BCU will also be accepted) shall be provided for SAS/SCADA operation. All the numerical relays of 33kV Incomer & Outgoing Panel shall have built in synchrocheck (25) function.	1 (one) set
5.	All necessary switches (Local and remote selector switch, TNC switch, etc.), CT terminal blocks with inbuilt isolating, shorting & jacking facility for test purpose, PT terminal blocks with inbuilt isolating & jacking facility for test purpose, signaling set lamps, trip circuit supervision relay for each trip coil, PT supervision relay, auxiliary relay, MCB, fuse and provision for lighting etc. terminal blocks, mimic diagram with circuit breaker control indicating switches and isolating position indicating switches, indicating lamps shall be provided to indicate "Spring Charge"/ readiness for closing and healthy trip circuit indicating readiness for tripping. The mimic and positions of circuit breaker control cum position indicating switch and isolator position indicating switch arrangement in the panel. Mimic diagram shall contain LED based Semaphore Indicator for Isolator/Breaker/Earth switch position. The Annunciator shall have at least 14 windows and have built in buzzer and AC/DC fail relay.	1 (one) set
6.	70 W, 230 V AC, Single Phase heater with thermostat and a visible light indicator which indicate the "ON"- "OFF" position of the heater	1 (one) set
7.	Master Trip relay (01 Nos.)	1 (One) set









7.3.4.1 C FOR 33 KV PANEL FEATURES:

Each PCM panel shall be equipped with the following:

- a.) Instruments and Relays described elsewhere. All the relays shall be IEC 61850 protocol type for automation network of the 33/11kV Sub-station. In addition, numerical relay shall have sufficient contacts and shall be configured for SAS operation. Intermediate auxiliary relay with sufficient spare contacts shall be used for controlling CB or any other switching devices through numerical relay in case of SAS operation.
- b.) Status indicating discrepancy, Control switches for 33 kV Circuit Breaker with safety arrangements.
- c.) Illuminated Circuit Breaker and Isolator position indicators.
- d.) Signaling relays (annunciator, compact type) to yield audiovisual signals on faults and have reset feature.
- e.) The inside of the panel will have all auxiliary relays to sense the operation of gas relays, over temperature, over current, differential relay operation failure of auxiliary voltage (DC & AC) etc. and to transmit for tripping and fault signaling.
- f.) All inside equipment described and required shall be neatly arranged inside the panel.
- g.) Thermostat control heater with status indicating illumination lamp (LED) shall be provided.
- h.) The terminal blocks for connecting the incoming multi-core cables shall be placed at the bottom part and necessary glands/ opening shall be provided for the entry of the outside cables.
- i.) Sufficient-working spaces shall be provided inside the panel between instruments and wiring for easy approach.
- j.) All AC, DC auxiliary power circuits and PT secondary circuits entering the control panel shall be provided with MCCB. Separate MCBs shall be provided for DC supply to Power, Control and Alarm & Indication circuits.
- k.) Provision to hang danger/ caution board.
- l.) The PCM panel shall be SCADA/SAS compatible and hence all intelligent devices, digital energy meters etc. shall comply IEC61850. All physical connections for control, measurement and status indication shall be made SAS ready.
- m.) Sufficient spare terminals (at least 10%) in each terminal block.
- n.) Stabilizing resistance and Metrocil of appropriate value by calculation for the for the high impedance REF scheme in the PCM panel.
- o.) There must be two trip coils, both trip coils shall be energized by separate contacts of trip relay for protection tripping. However, for manual tripping, only one trip coil can be engaged only.
- p.) All CT Terminal blocks shall have shorting, isolating and jacking (test barrel) facility while PT terminal blocks shall have isolating and jacking (test barrel) facility.
- q.) Circuit Breaker control indicating switches and isolating position indicating lamps to indicate spring Charge/ Readiness for closing and healthy trip circuit indicating readiness for tripping.
- r.) Signaling /indicating lamps shall be LED type only.
- s.) Auxiliary relays, trip relays with spare contacts, fuses.
- t.) All necessary switches etc. Local/remote switches should have atleast 4NO+4NC contact
- u.) Provision for lighting etc.
- v.) 70W, 230V AC, 1-phase heater with thermostat and control switch and a visible light indicator which indicate the "ON"- "OFF" position of the heater. Master trip auxiliary relay coil rating shall be 110Volt DC.
- w.) Mimic diagram along with semaphore for CB, DS and ES. Mimic diagram shall contain LED based Semaphore Indicator instead of moving Semaphore indicator. The color and size of the mimic shall be as described below:

33 KV	GREEN	½" X 1/8"
11 KV	BLACK	½" X 1/8"

- x.) Ferrule marking and color coding for all type of wiring shall be as follows:
1. **Ferrule marking:** Ferrule marking shall be done by white flexible rubber/ PVC tube with permanent black ink printing on top, fitted with cable, double point addressing (source-destination)
 - i. "A"- for differential protection circuit
 - ii. "C"- for O/C & E/F protection circuit
 - iii. "D"- for metering circuit
 - iv. "E"- for PT circuit
 - v. "L"- for Alarm & Indication circuit
 - vi. "S"- for fault recorder
 2. **Color coding:**
 - i. "Black"- for phases of AC supply
 - ii. "White"- for neutral of AC supply
 - iii. "Grey"- for control circuit
 - iv. "Brown & Grey"- for (+) and (-) DC supply respectively
 - v. "Red, Yellow, Blue, Black"- for CT and PT circuit
 - vi. "Yellow with green strip"- for earthing
- y.) Detailed schematic diagram of control circuit of PCM inside panel.
- z.) Separate relay shall be used for over current, Earth fault protection and differential protection.
- aa.) Annunciator shall have at least 14 nos. window for 33kV Incoming, Outgoing, Auxiliary Transformer & Bus Coupler panel and 30 nos. windows for 33kV Transformer panel
- bb.) Necessary communication cable and software shall be supplied.
- cc) Inter tripping arrangement for 11 kV incomer (from 33 kV transformer feeder tripping) and for 33 kV transformer feeder (from directional tripping of 11 kV incomer or Stand by E/F tripping) shall be provided. All type of tripping shall be done through Master Trip relay.
- dd) Supply RTCC Panel with AVR relay and tap changing control switch along with necessary indication system (Tap position, temperature etc.).
- ee) Following LED Indicators including Lamp test facility shall be provided in the panel:

							
DC	DS close	DS open	CB	Spring	CB	ES close	ES open
Availabl	indicatio	indicatio	Clos	Charge	Ope	indicatio	indicatio
e	n	n	e	d	n	n	n

Besides the provisions of control, signal, protection and metering described, any other provisions to suit with the requirement of associated equipment of the concern feeder shall be provided. All meters and relays shall be flush mounting. There shall be panel-grounding terminal.

The bidder shall quote the particulars of various protective relays, meters, Auxiliary relays signaling relays, discrepancy control and position indicating switches etc. of the control panel, mentioning the names of the manufacturers.

7.3.4.1 D Alarms

The following alarm provision shall be made:

1. 33 KV TRANSFORMER FEEDER (30 or more window Annunciator)

Main DC Fail	AC Fail	Main Relay-1 Faulty	Main Relay-2 Faulty	TCS-1 Unhealthy	TCS-2 Unhealthy
PT Failure	OTI High Alarm	OTI High Trip	WTI High Alarm	WTI High Trip	PRD Trip
MT Buchholtz Alarm	MT Buchholtz Trip	OLTC Surge Trip	O/C Trip	E/F Trip	87T Trip
87N/64 Trip	11 kV Inter trip	Main tank oil level high/low	Lockout operated pare	Trip relay-2 operated	OLTC out of step
OLTC faulty/motor tripped	OLTC in max. position	OLTC in min. position	Spring Charge Fail	OLTC BZ Alarm	SCADA/ Remote Trip

2. 33 kV Incoming/Outgoing/Bus Coupler/Auxiliary Transformer Feeder (at least 14 window Annunciator)

Main DC Fail	AC Fail	Main Relay Faulty	PT Failure
TCS-1 Unhealthy	TCS-2 Unhealthy	O/C Trip	E/F Trip
67 Trip	67N Trip	Trip relay operated	Spare
Spring Charge Fail	SCADA/ Remote Trip	OV/UV Trip(Only for IN/OUT Panel)	Spare

7.3.10 E TESTS

Complete tests shall be made at the manufacturer's factory in accordance with the latest relevant IEC 62271-200:2003 standards. Among others, at least the following test shall be included:

- a) Wiring Check
- b) Functional check
- c) Di-electric Test
- d) Verification of protection

Test plugs shall be supplied. Test results of instruments and relays are to be provided along with the bid.

7.3.4.1 F Construction Details

Each panel shall be fabricated from steel sheet (minimum 1.62 mm thick) with necessary steel member reinforcement to make the structure self supporting. All joints are to be welded and ground to be made smooth.

Mounting brackets required shall be arranged inside the panel for mounting and fixing auxiliary devices and terminal blocks.

Instruments meters control switches and protective relays shall be mounted on the front panel only. Panel output mounting studs and support brackets shall be accurately located.

Finished panel surface shall be free of waves and other imperfections exterior panel surfaces shall be sand blasted, ground smooth, filled, panel and finished with gray enamel. Interior surface shall be sand blasted, primed and finished with glass white enamel.

The panel shall be designed to have bottom closed and with an adequate number of 50 mm knock outs provided to facilitate entry of control wires and cables. The back end closure of the panel shall be equipped with hinged formed door. The door shall be rigid and shall be equipped with three point latches.

The supplier shall furnish internal panel wiring and circuit protection. The supplier shall provide one 70W, 240, AC strip heater in the panel. The heater shall have a separate switch. Engraved name plate shall be provided at the top of the front enclosure.

7.3.4.1 G PANEL WIRING

The supplier shall provide internal wiring and connections, in accordance with the requirements of the following paragraph.

All wiring used within the panel shall conform to the requirements of these specifications and shall be installed and tested at the factory. All wiring shall be neatly and carefully installed in wiring gutters of raceway wiring raceway shall be plastic wiring duct with covers. Instrument wiring on the panel shall be numbered sequentially from the sources to the panel instrument and the number of the source equipment shall be used as a prefix for the individual wire numbers, wiring shall be terminated at terminal blocks plainly lettered or marked in accordance with the manufacturer's connection diagrams.

Sufficient clearance shall be provided for all the leads. All the leads for external circuit wiring shall be connected to grounded terminal blocks located for convenient connection of external circuits.

Splices will not be permitted in panel wiring.

All the terminal block connections shall be made with ring type lugs. Pre-insulated ring type terminals with crimp guide or per-insulated slotted spring spade terminals shall be provided on devices equipped with individual fitted covers.

Arrangement of circuits on terminal block shall be such that all the connections for one circuit, plus any spare conductors, shall have terminal blocks adjacent to the split and shall be provided with wiring required to interconnect the split unit.

The size of the wiring used in the panel shall be conform to the following requirements:

- a.) Ampere meter and current transformer circuit: 6 Sq.mm (RYB color code shall be used)
- b.) All other wiring: 2.5 Sq.mm.

Closing circuit of the PCM panel shall have Interlocking mechanism with DS/ES switch. DC/AC supply of the 33 kV breaker panel shall be supervised through corresponding PCM panel. Single point grounding of the neutral of CT/PT circuits shall be ensured. It is always recommended that the neutral of CT/PT is grounded at the CT/PT junction box end. Ferrule marking and color coding shall be as per clause “7.1.4.1 C 33 kV PCM Panel Features”

7.3.4.1 H POWER SUPPLY DISCONNECT

Each panel mounted devices requiring AC or DC supply, shall have disconnecting devices from the power supply in the tripped or open condition.

The MCBs used in DC control circuit shall have a voltage rating 125 VDC and sufficient current rating as per use. The tumbler switch in the heater shall have the same rating.

Each S/S will be equipped generally with the following :

3 (Three) phase MCCB for incoming from Auxiliary transformers	- 1 (one) no.
MCCB for incoming DC for battery	- 1 (one) no.
MCCB for AC outgoing	- 10 (ten) nos.
MCCB for DC outgoing	- 10 (ten) nos.

The fuses shall be modular type with Bakelite frame and reinforced retaining clips.

7.3.4.1 I INDICATING LIGHTS

Indicating lights of LED type shall be have transparent glass lenses and appropriately sized resistor. CB spring charged indication- Blue, Panel DC available indication- White, CB close indication- Red, CB open indication- Green, DS close indication- Red, DS open indication Green, ES close indication- Red"ES open indication- Green. It is recommended to install the CB, DS & ES Open/close indicating LED lamps/semaphore in the mimic bus.

7.3.4.1 J TERMINAL BLOCKS

Terminal blocks shall provided with white marking strips, circuit designation by the supplier shall be inscribed on the marking strip with black print, terminals in a quantity of not less than 25 percent of the interconnected terminals in excess shall be provided on each terminal block for circuit modifications and for termination of all conductors in multi-conductor cable.

All CT Terminal blocks shall have shorting, isolating and jacking (test barrel) facility while PT terminal blocks shall have isolating and jacking (test barrel) facility.

CT, PT, Control, Alarm etc. wiring shall be separately grouped or segregated.

All physical connections for control, measurement and status indication shall be made SAS ready hence Terminal Blocks shall be kept reserved if necessary.

Terminal block shall be grouped in each panel for easy accessibility unrestricted by interference from structural members and instruments. Sufficient spaces shall be provided on each side of each terminal block to allow an orderly arrangement of all the lead to be terminated on the block.

7.3.4.1 K INSTRUMENTS AND DEVICES

Indicating instruments shall be semi flush panel type with 1% percent accuracy class except for energy meters which shall be of 0.2. They shall be approximately 100 mm square with black 240 degree scales on a white back ground.

All AC instruments shall be designed for operation on 5A current transformers secondary and 110V (50 Hz) potential transformer secondary.

7.3.4.1 L TRIP RELAYS

Following shall be the main features of a high speed tripping relays:

All tripping relays shall be of the heavy duty type suitable for panel mounting and shall have operating coils which are rated sufficiently to operate in conjunction with series flag relays. If

necessary, normally closed contacts in series with the relay operating coil, shall be delayed for a period which will allow series flag relays to operate satisfactorily. All other tripping contacts should be instantaneous i.e. no intentional time delay. The operating time shall not exceed 10 milliseconds at rated voltage. The operating range of the relay shall be from 70% to 120% of rated voltage. Electrical reset facilities shall be available for operation, from remote and supervisory controls. High speed tripping relays shall prevent closing of the associated circuit breakers until reset. Wherever the tripping relay contacts need to break the d.c. current, sufficiently rated magnetic blow out contacts or such approved means shall be used.

Trip Relay shall be of following types:

- a. Self-reset type for O/C, E/F protection relay
- b. Hand & Electrical reset type for Differential, REF and Transformer Self-protection
- c. Operating Coil Voltage: 110 V DC (No series resistor allowed)
- d. Shall have in built freewheeling diode.

7.3.4.1 M SUPERVISION RELAYS

7.3.4.1 M.1 Trip Circuit and Protection Supply Supervision

The trip circuit supervision function shall be a separate relay and independent of control and protection unit provided in the switchgear. Trip circuit supervision relays shall be provided to monitor each of the trip circuits of all 33kV circuit breakers and each relay shall have sufficient contacts for visual/audible alarm and indication purposes. The trip circuit supervision scheme shall provide continuous supervision of the trip circuits of the circuit breaker in either the open or closed position and independent of local or remote selection at the local operating position. Relay elements shall be delayed on drop-off to prevent false alarms during faults on dc wiring on adjacent circuits, or due to operation of a trip relay contact. Series resistances shall be provided in trip supervision circuits to prevent mal tripping a circuit breaker if a relay element is short circuited. Relay alarm elements shall be equipped with hand resetting flag indicators.

Trip circuit supervision relay (TCSR) shall supervise not only the trip coil but also the whole trip circuit during both breaker open and close position (pre-close & post-close). Both trip circuits shall be supervised by separate TCS relay. TCS function of main relay shall be avoided for supervision.

All the TCS relay shall have at least 3NO+3NC contact for Indication, Annunciation & SAS Integration. 2 NO contact shall be used for CB closing circuit interlock & closing readiness indication (if used) and 2 NC contact shall be used for TCS faulty Annunciation & SAS integration.

7.3.4.1 M.2 D.C. Supply Supervision

All the DC Supply MCB (Main supply, Control supply, Device supply, Indication supply, Annunciation supply etc.) shall have at least 2NO+2NC contact for & there shall be 1 (one) 110V D.C. operated no-volt auxiliary relay (self-reset type) installed across panel's main DC supply entry point at terminal block with inscription "Main D.C. Supply Supervision relay" and shall have at least 2NO+2NC contact for Indication, Annunciation & SAS integration. These supervision relays are to be independent of alarms from the trip circuit supervision scheme so that the operator can clearly differentiate via the available alarms between loss of supply due to a blown fuse / tripped MCB and failure of a trip circuit's supervision /faulty supervision wiring. 1 NO contact of the Main DC supply supervision relay & DC supply MCBs shall be used for DC supply healthy indication (if used) and 2 NC contact shall be used for DC supply faulty Annunciation & SAS integration

DC supply supervision of the annunciation circuit shall be performed by the built in AC/DC fail relay of the Annunciator. Hence, the Annunciator shall be powered by dual source (with internal/external AC/DC changeover switch).

7.3.4.1 M.3 PT Supply Supervision

Each PT supply secondary circuit shall be supervised by individual 110V A.C. operated no-volt auxiliary relay (self-reset type) installed across panel's main PT supply entry point at terminal block with inscription "Measuring/Protection P.T. Supply Supervision relay" with at least 2NO+2NC contact for Indication, Annunciation & SAS integration. 1 NO contact of the PT supply supervision relay & PT secondary supply MCBs shall be used for PT supply healthy indication (if used) and 2 NC contact shall be used for PT supply faulty Annunciation & SAS integration.

7.3.4.1 M.4 A.C. Supply Supervision

There shall be 1 (one) 240V A.C. operated no-volt auxiliary relay (self-reset type) installed across panel's main AC supply entry point at terminal block with inscription "Main A.C. Supply Supervision relay" and shall have at least 2NO+2NC contact for Indication, Annunciation & SAS integration.

All the AC Supply MCBs (Main supply, Spring charge motor supply, TPS motor supply, lighting & heating supply etc.) shall have at least 2NO+2NC contact for Indication, Annunciation & SAS integration. 1 NO contact of the Main AC supply supervision relay & AC supply MCBs shall be used for AC supply healthy indication (if used) and 2 NC contact shall be used for AC supply faulty Annunciation & SAS integration.

7.3.4.1 N SPECIFICATION OF 110V, 3 x 5(6) A, 3-PHASE, 4-WIRE, 3-ELEMENT, INDOOR TYPE MULTI-TARIFF PROGRAMMABLE METER WITH ASSOCIATED INSTRUMENT TRANSFORMERS ENCLOSED IN METERING PANEL.

7.3.4.1.N. A GENERAL

The meters are required for the purpose of energy metering of medium/high/extra-high voltage consumer metering at 132 kV or 33 kV or 11kV level. KWh is the unit for the purpose.

System voltage	Nominal service voltage 110V (PT Secondary), 3 phase 4wire, solidly grounded neutral at source, maximum system voltage 120V line to line.
System frequency	50 Hz

7.3.4.1.N. B SPECIFICATION OF 110V 3 x 5(6)A, 3-PHASE, 4-WIRE 3-ELEMENT, INDOOR TYPE MULTI TARIFF PROGRAMMABLE DIGITAL ENERGY METER

The consumer meters are required for the purpose of energy metering of low voltage consumer who purchases power at 11 kV/33 kV line through PT & CT. kWh is the unit for revenue purpose.

System voltage	: Nominal service voltage 110V, 3 phase 4 wire, solidly grounded neutral at source, maximum system voltage 120V line to line.
System frequency	: 50 Hz
Standard	: The Energy Meter should be designed, manufactured and tested in accordance with IEC 62052-11, 62053-22 and 62053-23 or ANSI C 12.16, 12.10 (latest publication) or specified in this specification
Installation Type	: Indoor Type : Solid state.
Application	: Registration of KWh (Peak & off-peak), Total KVarh(Q1+Q4), KW on 3- phase, 4-wire supply for balanced & unbalanced load (unidirectional). Peak 17.00-23.00. hrs and off peak 23.00-17.00 hrs (programmable) Bangladesh standard time. The software for Time of Use (TOU) shall be so developed to accommodate future tariff and can be customized, if the purchaser changes the tariff. The software shall be compatible with Windows operating system.
Connection	: 3-phase 4-wire, solidly grounded neutral.
Nos. of element	: 3 (Three)
Rated current	: Basic current 5 amps and maximum current ≥ 6 amps.
Multiplication factor	: The following shall be inscribe on the mater. Dial reading X CT ratio X PT ratio = Actual reading in KWh.
Register	: Solid state LCD display type register. The display shall be programmable, automatic and include: <ul style="list-style-type: none">• Meter ID• Time & date• Cumulative KWh (Peak & off-peak)• Cumulative Total KVarh (Q1+Q4)• Maximum demand (KW) with time & date• Cumulative Maximum demand (kW) for billing month. Maximum demand (MD) in kW shall be registered using the technique of cumulating on integration period controlled by built-in process and the MD shall be continuously recorded and the highest shall be indicated. The highest MD shall be added to the cumulative store, which shall be automatically initiated after an interval of one month / one billing period by means of built-in timing device.

- Integration period: 30 (thirty) minutes.
- Number of MD reset (Automatic & manually).
- Average PF for billing period.

Instantaneous:

- Phase voltage with indication
- Phase amps with direction.
- Power factor (average).
- Demand (KW)
- Voltage phase angle (each phase) | or P.F. Angle (each phase)
- Current phase angle (each phase)
- Tampering indication in the register.

Memory storage	<p>: The meter shall have sufficient capacity (minimum 400 KB) to store the following readings and data in non-volatile memory even in case of power failure.</p> <ul style="list-style-type: none"> • Equipment identification codes, security codes and access codes. • Number of power interruption with date & time (minimum 100 events). • Latest power failure time & date • Date & time of meter tampering. (Voltage & Current missing, demand reset, time change). • Event logs • Current & Previous registered in month KWh (Peak & off-peak), Total KVarh (Q1+Q4) • Current & Previous month registered with maximum KW demand since last MD reset with time and date of its occurrence. <p>The meter must have sufficient capacity to store data at 30 (thirty) minutes interval for at least 180 (one hundred eighty) days.</p> <ul style="list-style-type: none"> • Load Profile data [kWh, KVarh (Q1+Q4)] • Phase voltage or Vh • Phase amps or Ah
Accuracy class	<p>: Accuracy class is 0.2s (point two s) for active energy (KWh) & 0.5s for reactive energy (Kvarh)</p>
Number of digit	<p>Minimum 5 (Five) integer with 3 (three) decimal (Total 8 digit).</p>
Type of Display	<p>Solid-state LCD display.</p>
Time switch	<p>: The time switch shall be built-in type and shall be designed to perform a present cycle of operation. Time switch shall reset MDI at the end of every month (billing period) automatically. In the event of failure of power supply and battery, at the same time set memory shall not be lost i.e. the set program shall be recorded in non-volatile memory. The maximum error shall be kept within ± 1 (one) second per day. Time error adjustment facility shall be provided.</p>
Battery reserve	<p>: Each time switch must be provided with lithium battery which allow the switch to function for a period of not less than 10 (ten) years. The guaranteed life of the battery should not be less than 10 (ten) years and shall have provision for easy replacement. The shelf life of the battery should be minimum 15 (fifteen) years or more.</p>
Construction	<p>: The meter shall be completely self-contained round socket or enclosure type. The meter cover shall be made of polycarbonate/acrylic /phenolic /resin and socket cover shall be made of metal polycarbonate/ acrylic /phenolic /resin. The meter cover and socket /enclosure shall be provided with security sealing provisions to prevent unauthorized access to the internal meter works and socket /enclosure sealing shall be designed to accommodate both padlock and wire type seal.</p>

IEC meters shall be minimum IP51. The ANSI Standard meter shall be effectively sealed to prevent entrance of rain and dust into its internal parts. The meter shall pass Rain test described in underwriter's laboratory standard UL-50 (USA) for type 3 enclosures. A general purpose finish of class 1 as specified in section 7 of ANSI C12.10 shall be provided for the meter and it shall meet the requirement of weather simulation test (Sec. 7.2.1 of ANSI C12.10) and salt spray test (ASTM B117). It shall be designed to operate continuously for the normal life of the meter in unsheltered outdoor tropical location exposed to the elements without corrosion or other damage to parts to adversely affect meter accuracy or reliability.

Enclosure for IEC
Standard Meter

The meter shall be surface mounted in PCM panel with necessary wiring. The enclosure box should be made either of high quality flame retardant ABS Resin of minimum 3 mm thickness or of galvanized sheet steel of minimum 1.22 mm (18 SWG) thickness or of auto extinguishable, shockproof and UV resistant, hot molded glass reinforced polyester of minimum 3 mm thickness. The box shall have hinged front door with one toughened glass window or transparent UV resistant Polly carbonate to enable easy reading of meter. The metering box shall be weather proof, dust proof, rodent and insect proof in accordance with enclosure classification IP54. Service cable entry and exit will be sides of the box and 40 (forty) mm diameter hole with black PVC conic cable gland shall be provided for side entry & exit for this purpose. All material parts shall have anti-corrosive protection.

All materials shall be designed, manufactured and tested as per IEC or equivalent International standards except as mentioned. The front door shall be removable and provision must be made for sealing in the closed position.

Socket

- : Meter sockets shall be suitable for installation of offered type meter. Meter sockets shall be 3-phase, 4-wire wye, 600 volt class, made from 16 gauge sheet metal. Meter sockets shall be similar except as described below. Meter sockets shall approximately 14" (35.6 cm) H×9"(22.9cm) W×4" (10.2 cm) D and rectangular in shape. Sockets shall be the same size as 1-phase sockets and terminal blocks shall be interchangeable. Sockets shall be ring less type, sealing latch to be stainless steel and have adequate means for socket grounding. Meter socket shall have a 2"(5 cm) Diameter top opening complete with a 1- ¼" (3.2 cm) hub. Meter socket shall have 4 knockouts with a range up to 2"(5 cm) Diameter, one on the back, one in the bottom and one in each side. Meter socket shall comply with ANSI C 12.6, 12.10

The Socket shall have written permanently (not in paper printed) "connection diagram" distinctly marked in addition to all standard data.

Terminal

- : Socket connected type/ Non-symmetrical, bottom entry, front connection, and connection type with extended terminal cover: Minimum 10 Terminals to accommodate up to 06 sq. mm size of cable. The terminal cover for the offered energy meter shall be

extended type, and which can be sealed independently. There shall be free space between bottom of the terminal and the bottom of the terminal cover.

Connection	:	3-phase, 4-wire solidly grounded neutral.
Service life of meter	:	Shall be minimum 15 (fifteen) years.
Visual indication of operation	:	Pulse indicator on the front of meter as per meter constant.
Special condition	:	a) The factory calibration conforms to relevant IEC or equivalent international standard. LCD display shall be shown consecutively and continuously one after another. The display shall be automated i.e. no external means shall be required to see the display. Each display shall last for at least 5 (five) sec. b) Meter Electronic Circuit biasing voltage shall have to be ensured from each phase to phase and each phase to neutral and minimum basing voltage 40V.
Meter Sealing	:	The Energy meter body will be hermetically sealed or ultrasonically welded to avoid unauthorized opening of meter cover.
Communication port	:	The meter must be provided with a suitable communication port to allow down loading of desired information stored in the meter to a PC via hand held data logger as per IEC 1107 or equivalent standard.
Remote Communication	:	The meter shall be equipped with external GSM-GPRS Modem, which will be able to interface with RS232, RS485 for data communication with the central server from meters, having all accessories like power supply adapter, necessary connecting cables, antenna with minimum 2.5 meter extension cable, connectors, enclosure box with fixing materials etc. The modem shall be compatible with existing AMR system of BPDB.

7.3.4.1.N.C TAMPER AND FRAUD PROTECTION FEATURE:

The meter shall have the following features to prevent/detect tamper and fraud:

- **Phase Sequence Reversal:** The meter should work accurately irrespective of phase sequence of supply.
- **Missing Potentials:** The meter shall be capable of detection occurrence of missing potential of one phase or two phase(s), which can happen due to intentional/accidental disconnection of potential link(s).
- **Terminal cover** must have micro-switch provision to monitor unauthorized opening. Opening of terminal cover shall trigger an event to be recorded in the event log memory.
- **Software Access:** Software access for configuration and setting of the meters.
-

7.3.4.1.N.D TECHNICAL FEATURE

- The body cover and socket / enclosure shall be provided security sealing provisions to prevent unauthorized access to the internal meter works.
- The meter shall be provided with connection diagram.
- The data access should be protected by minimum 3(three) steps software password in meter.
- The meter shall have provision of phase to phase and each phase to neutral biasing.
- The meter shall have minimum biasing voltage of 40V.
- The meter and socket/enclosure shall have provision of earthing.

- Meter must operate and accurately register demand and energy when service voltage is applied across any two of the three input terminals or when service voltage is applied from any input terminal to neutral. Meter will continue to operate even the neutral is missing.
- The meter and socket/ enclosure must be the same country of origin other wise the bid will be rejected.
- The registration of KWh (Peak & off-peak) on 3-phase, 4-wire supply for balanced & unbalanced load will be unidirectional. i.e. if one, two or three phase supply is/are reversed, it will take the absolute (kWh-del) + absolute (kWh-rev) and will add them together as total 3-phase KWh.
- The meter shall be equipped with remote GSM & PSTN communication option.
- It has to be ensured that the meter complies IEC61850 for SAS operation. If required, internal/external module as protocol converter can be used for the compatibility with IEC61850
- The meter shall have permanently print nameplate distinctly marked with the following in addition to all standard data:
 1. The word “BPDB” and insignia of BPDB.
 2. Voltage and current rating.
 3. Frequency.
 4. Number of element, number of wire and multiplication factor.
 5. Accuracy class.
 6. Year of manufacture.
 7. Serial number.
 8. Name of manufacturer.
 9. Meter constant.

7.3.4.1. N. E Display of measured values/ Meter Display

- The Sequence of LCD display should be user programmable.
- The contrast setting of LCD display should be visible in different lighting environment and distinctly visible in broad daylight.
- The meter should be of displaying time and date, the direction of energy i.e. as import/export or +/-, active tariff and internal fault indicators.
- There should be up to three groups of display to priorities the display. Each showing a programmable function group.

7.3.4.1.N. F Meter Parameterisation Software

- The parameterisation software must run on Windows operating environment.
- The software must be protected by software keys to control duplication and installation.
- The software should have a customizable printing feature by task list.
- The meter must be able to display or record meter ID, Program, Programmer ID, C. T. ratio, V. T. ratio, Total (KWh, KVarh, KVAh, KW, KVar, KVA, P.F); per phase (voltage, current, KW, KVar, KVA, P.F, phase voltage angle, phase current angle); Load profile having minimum 8(eight) Channels data stored in different interval for 90 days.
- Tamper feature: The meter must have Errors & Warnings codes, History log and Event log(minimum 400events) to record date & time of all power outages, demand resets, time change.
- In addition, each software key must bear a unique user ID and that is not transferable to another PC that has different user ID.
- The Meter should be able to display the phasor diagram.
- The software for Time of Use (TOU) shall be compatible to accommodate future tariff and can be customized, if the purchaser changes the tariff .The software shall be compatible with Windows operating system.

- The Meter must be provided with meter passwords to secure communication between meter software and meter having minimum 3(three) access levels.
- The AMR Software have to be compatible with BPDB's existing AMR System. The Tenderer have to develop the total AMR System with exiting and supplied AMR Solution. In this case the tenderer have to provide their meter protocols so that all exiting meters and supplied meters data will be downloaded and managed in a single AMR System.

7.3.4.1.N. G EXTERNAL MODEM WITH ACCESSORIES

GSM/GPRS modem with RS-232/RS-485 ports, meter interfaced power supply, connection cables, antenna with minimum 2.5 meters cable, mounting facilities, enclosure (if necessary). The modems will be capable of GSM and GPRS connectivity simultaneously. For GSM configuration the AT command will be available and for GPRS communication the APN, reset time, username, password, port number, etc. are configurable. The modem will have the following specification.

Interruption (< 1 ms), RS-232 (at least 1), GPRS class 10, operating band 900/1800, auto reset capability (with phone call, SMS). The modem will be robust, durable and compatible with the employers existing service condition.

7.3.4.1.N. H Manufacturer

All the energy meter shall be supplied from any of the following Country: -

- a) European Country.
- b) North American Country.
- c) Japan
- d) Australia

The tenderer should submit authentic document with the tender against the country and location of the offered Electric Energy Meter Manufacturing plant which will be verified during tender evaluation.

Note: Related software & accessories if required for Energymeters is within the scope of supply.

7.3.4.1.O PROTECTIVE RELAYS

All Protective relays shall be numerical programmable type and shall comply relevant IEC or equivalent international standard. Contract arrangement of the relays should conform to the requirements of the diagram. All the relays shall be IEC 61850 protocol type for automation network of the 33/11kV Sub-station.

All the protective relays shall be supplied from any of following manufacturers:

ABB (Switzerland/Finland/Sweden)/
Siemens (Germany/ Switzerland)/
Alstom (France/UK)/
Schneider (france/UK)/
NR, China/
SEL, USA.

Note: Related software & accessories if required for Relays is within the scope of supply.

7.3.4.1.P. AUXILIARY RELAY

Auxiliary relays with sufficient contact shall be used for transformer self-protection (OTA, OTT, WTA, WTT, BA, BT, OLTC Surge, PRD for main tank. etc.). Apart from these relays, each 33 kV PCM Cubicle shall be provided with 1 (one) set separate Auxiliary and signaling relay and wiring with fuses. This relay shall be used for control & monitoring of CB, DS and ES through numerical relay/BCU in case of SAS operation.

7.3.4.1.Q. ANNUNCIATOR

Each PCM panel shall be equipped with 1 (one) set Annunciator with sufficient windows (LED type with blinking facility) to display the alarms as per requirement. Annunciator shall have built in buzzer and AC/DC fail relay and shall be powered by dual source (with internal/external AC/DC changeover switch). Buttons for Accept, Mute, Test, Reset etc. shall be provided in the Annunciator.

7.3.4.1.R. INDICATING AMMETERS

Each 33 KV PCM Cubicle will be provided with 3 Ammeters (1 for each phase), analogue type.

7.3.4.1.S. INDICATING VOLTMETERS

1 (one) voltmeter with a multi-selector switch (phase to phase, phase to neutral, off) shall be installed on 33 KV transformer panel.

7.3.4.1.T. MIMIC BUS

LED based Semaphore Indicator showing the position (open/close) of Circuit Breaker, Isolator and Earth Switch shall be inserted within the mimic bus.

Mimic bus material shall be brass, bronze or copper with enamel finished or anodized aluminum or plastic. The mimic bus and included symbols shall be shaped, colored and located as international standard. Light indicator showing position (opening/closing) of circuit breaker shall be installed.

The mimic bus shall be attached to the panel by mechanical devices, not with adhesive. Attachment shall be closely spaced to hold all parts of the mimic bus firmly to the panel face.

Mimic bus shall be provided with the following dimensions and color code:

<u>Voltage</u>	<u>Bus Color</u>	<u>Thick</u>	<u>Dimension (mm)</u>
33 KV	Green	3	12

Note : One set of relay testing plug shall be supplied with protection, metering and control panel which will be included in the quoted price. Each cubicle shall be complete according to the specification, features and bill of materials but not limited to these items; the cubicles should be complete in all respects, to make it operational. 33kV bus name (1,2,3,4.....) shall be indicated with visible permanent sticker in the 33kV mimic bus

7.3.4.1. U AVR Relay

Remote Tap Changer Cubicle (RTCC) Panel shall be equipped with AVR relay for automatic OLTC operation. It shall have provisions of auto/manual tap lower/rise operation and master/follower control function to facilitate parallel operation of transformers and appropriate data communication port have to be provided. AVR relay shall have IEC 61850-communication protocol for SAS.

7.3.4.1.U INFORMATION REQUIRED

The Tenderer/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information/Documents has to be submitted along with the tender:-

- (a) Manufacturer's drawing showing Outline dimension & General arrangement drawings of offered type equipment.
- (b) Manufacturer's Printed Catalogue describing specification and technical data of the offered type equipment.
- (c) The Tenderer/Manufacturer shall submit with the bid the testing procedure & list of testing/measuring equipment, meters etc. used for Factory test witness.
- (d) Construction, Installation, Operation & Maintenance Manual.
- (e) Manufacturer's valid ISO Certificate.

7.3.4.1. V TESTS AT MANUFACTURERS WORKS FOR PCM PANEL

General

Functional electrical, material, mechanical and hydraulic tests shall be carried out at manufacturers' premises. The extent and method of recording the results shall be agreed by the Purchaser in ample time to enable the tests to be satisfactorily witnessed or to make any changes to the proposed program of tests.

MATERIAL TESTS

The supplier shall provide test pieces free of charge as required to enable the quality of the material to be determined at the supplier's expense. Purchaser may at its own discretion and by specific arrangement accept certified particulars of tests carried out in the absence of his authorized representative.

TYPE TEST

Type tests are required to prove the general design of the offered equipments/ materials. The Tenderer shall submit the type test reports of the offered equipments/ materials from as per relevant clause.

ROUTINE TESTS

All equipments/ materials shall be subjected to routine tests as per latest version of relevant IEC/ BS or equivalent international standards as mentioned in the contract at the manufacturers works and shall include, but not be limited to, an operational test.

7.3.5 TECHNICAL SPECIFICATIONS & REQUIREMENTS OF 11KV VACUUM CIRCUIT BREAKERS WITH PROTECTION, CONTROL & METERING CUBICLES: (Not Applicable)

7.3.6 TECHNICAL SPECIFICATION OF 33KV ISOLATOR WITH EARTH BLADE

7.3.6.1 General Specification:

1.	Installation	Outdoor Sub-station
2.	Type	Air
3.	Construction	Open
4.	Operation	Gang
5.	Operating Mechanism	Manual
6.	Mounting Position	Vertical on Supporting Structure
7.	Number of Pole	3 (Three)
8.	Frequency	50 Hz
9.	System Nominal Voltage	33 kV
10.	System Maximum Voltage	36 kV
11.	Basic Insulation Level	170 kV
12.	Rated Normal Current	1600/2500 A
13.	Rated Short Time Withstand Current	31.5 kA (3 Sec.) for 2500 A , 31.5 kA(3 Sec.) for 1600 A
14.	Rated Power frequency withstand voltage (kVrms), 1 min	70 kV
15.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.

A. Features

- 1) The isolators shall be single break Pattern [Vertical break or Horizontal break (centre break)] off-load type with manual operating mechanism for the earth blade. There shall be interlocking arrangement with the breaker to ensure that the Isolator can only be operated with breaker in “OFF” position. Necessary controls, accessories and auxiliary operating mechanism for manual operation shall be provided in water proof outdoor boxes.
- 2) The earthing device shall be gang operated & integral with the switch. The unit shall be complete with channel type mounting base, insulators, and phases coupling tube for gang operation and adjustable operating rod with insulating link and intermediate guide for operating rod.
- 3) Auxiliary switch operated by the phase coupling tube shall be provided to control circuits for operating devices like indicators/alarms & interlocking with 10% spare contacts.
- 4) Terminal connectors shall be suitable for ACSR Dog/Merlin/ Gross Beak/ HAWK conductor as required.
- 5) Earthing steel pads shall be provided with provision of earth leads.
- 6) Cable glands for multi-core control/ power cables as required.
- 7) There shall be provisions for pad locking in “ON” & “OFF” position.
- 8) Provision of key interlocking.

- 9) Mechanical interlocking between earthing device & the switch shall be provided.
- 10) All accessories, nuts, bolts etc. required for mounting the isolator on structure as required.
- 11) All ferrous parts shall be hot dip galvanized after completion of machining. Galvanizing shall be in accordance with BS-729 and ASTM A90.
- 12) All control devices shall be suitable for operation from 110 Volts DC available in the control room.
- 13) Operating mechanism shall be fully tropicalized and housed in waterproof housing.
- 14) Complete supporting steel structure.
- 15) Isolator and earthing devices shall be accordance with IEC-129. They shall be complete with supporting steelwork and installed to permit maintenance of any section of the sub-station plat when the remainder is alive and shall be so located that the minimum safety clearances are always maintained.
- 16) The air gap between terminals of the same pole with the isolator open shall be of a length to withstand a minimum impulse voltage wave of 115 percent of the specified impulse insulation rating to earth.
- 17) Isolating switches shall be designed for live operation and isolators shall be hands operated. Where used for feeders they shall be capable of switching transformer magnetizing currents main contacts shall be of the high-pressure line type and acing contacts.
- 18) All feeder isolators shall be fitted with approved three phase link earthing devices, mechanically, coupled or interlocked with the main isolator so that the earthing device and main isolator can not be closed at the same time.
- 19) Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be un-effected by the climatic conditions at site. Mechanism shall be as simple as possible and comprise a minimum of bearing and wearing parts. Approved grease lubricating devices shall be fitted to all principal bearings. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729 and ASTM A90.

B. Blades:

All metal parts shall be of non rusting and non corroding material. All current carrying parts shall be made from high conductivity electrolytic copper. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper alloy. The bolts or pins used in current carrying parts shall be made of non corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast steel. No grey iron shall be used in the manufacture of any part of the isolator. The live parts shall be designed to eliminate sharp

joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals i.e. after every 1000 operations or after 5 years whichever is earlier.

C. Base:

Each isolator shall be provided with a complete galvanized steel base provided with holes and designed for mounting on a supporting structure.

D. Supporting Structure

All isolators and earthing switches shall be rigidly mounted in an upright position on their own supporting structures. Details of the supporting structures shall be furnished by the successful tenderer. The isolators should have requisite fixing details ready for mounting them on switch structures.

E. Test Certificates:

The following test certificate along with test results for offered type Isolator confirming to the tender document shall be submitted with the offer from internationally reputed Independent testing laboratory or reputed & renowned testing laboratory as per relevant IEC Standard, otherwise the bid will be rejected.

- a) Short time & peak withstand current.
- b) Resistance measurement of the main circuit.
- c) Temperature rise.
- d) Lightning Impulse Voltage withstand.
- e) Dielectric test
- f) Operating and mechanical endurance test
- g) verification of the protection
- h) Operation at the temperature limits

F. Information Required

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of all type of **33 kV Isolators**.
- b) Outline and General Arrangement drawings.
- c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.3.7 TECHNICAL SPECIFICATION OF 33KV ISOLATOR WITHOUT EARTH BLADE

7.3.7.1 General Specification:

1.	Installation	Outdoor Sub-station
2.	Type	Air
3.	Construction	Open
4.	Operation	Gang
5.	Operating Mechanism	Manual
6.	Mounting Position	Vertical on Supporting Structure
7.	Number of Pole	3 (Three)
8.	Frequency	50 Hz
9.	System Nominal Voltage	33 kV
10.	System Maximum Voltage	36 kV
11.	Basic Insulation Level	170 kV
12.	Rated Normal Current	1600/2500 A
13.	Rated Short Time Withstand Current	31.5 kA (3 Sec.) for 2500 A , 31.5 kA(3 Sec.) for 1600 A
14.	Rated Power frequency withstand voltage (kVrms), 1 min	70 kV
15.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.

A. Features

- 1) The isolators shall be single break Pattern [Vertical break or Horizontal break (centre break)] off-load type with manual operating mechanism for the earth blade. There shall be interlocking arrangement with the breaker to ensure that the Isolator can only be operated with breaker in “OFF” position. Necessary controls, accessories and auxiliary operating mechanism for manual operation shall be provided in water proof outdoor boxes.
- 2) The earthing device shall be gang operated & integral with the switch. The unit shall be complete with channel type mounting base, insulators, and phases coupling tube for gang operation and adjustable operating rod with insulating link and intermediate guide for operating rod.
- 3) Auxiliary switch operated by the phase coupling tube shall be provided to control circuits for operating devices like indicators/alarms & interlocking with 10% spare contacts.
- 4) Terminal connectors shall be suitable for ACSR Dog/Merlin/ Gross Beak/ HAWK conductor as required.
- 5) Earthing steel pads shall be provided with provision of earth leads.
- 6) Cable glands for multi-core control/ power cables as required.
- 7) There shall be provisions for pad locking in “ON” & “OFF” position.
- 8) Provision of key interlocking.
- 9) Mechanical interlocking between earthing device & the switch shall be provided.

- 10) All accessories, nuts, bolts etc. required for mounting the isolator on structure as required.
- 11) All ferrous parts shall be hot dip galvanized after completion of machining. Galvanizing shall be in accordance with BS-729 and ASTM A90.
- 12) All control devices shall be suitable for operation from 110 Volts DC available in the control room.
- 13) Operating mechanism shall be fully tropicalized and housed in waterproof housing.
- 14) Complete supporting steel structure.
- 15) Isolator and earthing devices shall be in accordance with IEC-129. They shall be complete with supporting steelwork and installed to permit maintenance of any section of the sub-station plant when the remainder is alive and shall be so located that the minimum safety clearances are always maintained.
- 16) The air gap between terminals of the same pole with the isolator open shall be of a length to withstand a minimum impulse voltage wave of 115 percent of the specified impulse insulation rating to earth.
- 17) Isolating switches shall be designed for live operation and isolators shall be hands operated. Where used for feeders they shall be capable of switching transformer magnetizing currents main contacts shall be of the high-pressure line type and arcing contacts.
- 18) All feeder isolators shall be fitted with approved three phase link earthing devices, mechanically, coupled or interlocked with the main isolator so that the earthing device and main isolator can not be closed at the same time.
- 19) Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be unaffected by the climatic conditions at site. Mechanism shall be as simple as possible and comprise a minimum of bearing and wearing parts. Approved grease lubricating devices shall be fitted to all principal bearings. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729 and ASTM A90.

B. Blades:

All metal parts shall be of non rusting and non corroding material. All current carrying parts shall be made from high conductivity electrolytic copper. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper alloy. The bolts or pins used in current carrying parts shall be made of non corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast steel. No grey iron shall be used in the manufacture of any part of the isolator. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit

forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals i.e. after every 1000 operations or after 5 years whichever is earlier.

C. Base:

Each isolator shall be provided with a complete galvanized steel base provided with holes and designed for mounting on a supporting structure.

D. Supporting Structure

All isolators and earthing switches shall be rigidly mounted in an upright position on their own supporting structures. Details of the supporting structures shall be furnished by the successful tenderer. The isolators should have requisite fixing details ready for mounting them on switch structures.

E. Test Certificates:

The following test certificate along with test results for offered type Isolator confirming to the tender document shall be submitted with the offer from internationally reputed Independent testing laboratory or reputed & renowned testing laboratory as per relevant IEC Standard, otherwise the bid will be rejected.

- i) Short time & peak withstand current.
- j) Resistance measurement of the main circuit.
- k) Temperature rise.
- l) Lightning Impulse Voltage withstand.
- m) Dielectric test
- n) Operating and mechanical endurance test
- o) verification of the protection
- p) Operation at the temperature limits

F. Information Required

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of all type of **33 kV Isolators**.
- b) Outline and General Arrangement drawings.
- c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.3.8 TECHNICAL SPECIFICATION OF 33 KV OFF-LOAD FUSED ISOLATOR FOR AUXILIARY TRANSFORMER AND BUS PT.

A. General :

1.	Installation	Outdoor
2.	Type	Air
3.	Construction	Open
4.	Operation	Gang
5.	Purpose	For auxiliary Transformer / Bus PT
6.	Operating Mechanism	Manual
7.	Base Mounting Position	Vertical
8.	Number of Pole	3 (Three)
9.	Frequency	50Hz
10.	System Nominal Voltage	33 kV
11.	System Maximum Voltage	36 kV
12.	Continuous Current	400 A
13.	Fuse Rating	5A
14.	Fuse Type	HRC Cartridge
15.	Rated Short Time Withstand Current	31.5KA 3 Sec.
16.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.
17.	<p>Features</p> <ul style="list-style-type: none"> - Single Break Pattern [Vertical break). - Channel type mounting base, insulator & phase coupling tube for gang operation and adjustable operating rod with insulating link and intermediate guide for operating rod. - Terminal connectors shall be suitable for ACSR Merlin/ Grosbeak/ HAWK conductor as required. - Glands for multi-core control cables. - Provision for pad locking in “ON” & “OFF” position. - Galvanized Nuts, bolts & all accessories shall be required for mounting the isolator on structure. - All ferrous parts shall be hot dipped galvanized after completion of machining. Galvanizing shall be in accordance with BS-729 and ASTM A90. - 2 sets of spare fuse links (6 Nos.) shall be supplied with each set of isolator. - All steel supporting structures for mounting on the structures. - For enclosed fuses a positive mechanical indication shall be provided to indicate a blown fuse. - The design shall provide reasonable protection against accidental earthing by animals or birds. - All the movable current carrying contacts shall be silver plated. - Arcing horn if the unit is combined. - Disconnecting blade has continuous current rating as specified. 	

- Isolating devices shall be accordance with IEC-129. They shall be complete with supporting steel work and installed to maintenance of any section of the sub-station plant when the remainder is alive and shall be so located that the minimum safety clearances are always maintained.
- The air gap between terminals of the same pole with the isolator open shall be of a length to withstand a minimum impulse voltage wave of 115 percent of the specified impulse insulation rating to earth.
- Isolating switches shall be designed for live operation and isolators shall be hands operated. Where used for feeders they shall be capable of switching transformer-magnetizing currents. Main contacts shall be of the high-pressure line type and arcing contacts, if provided, shall be to the Engineer's approval.
- Service conditions require that isolating switches shall remain alive and in continuous service for periods of up to 2 years in the climatic conditions specified without operation or maintenance. These contacts shall carry their rated load and short circuit currents without over heating or welding and at the end of the two years period the maximum torque required at the operating handle to open 3-phase isolator shall not exceed 350 NM.
- All feeder isolators shall be fitted with approved three phase link earthing devices, mechanically, coupled or interlocked with the main isolator so that the earthing device and main isolator con not be closed at the same time.
- Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be un-effected by the climatic conditions at site. Mechanism shall be as simple as possible and comprise a minimum of bearing and wearing parts. Approved grease lubricating
- devices shall be fitted to all principal bearings. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729 and ASTM A90.
- At least two pairs of auxiliary contacts for each isolator shall be provided.

7.3.9 TECHNICAL SPECIFICATION OF 33 KV OFF-LOAD ISOLATOR WITHOUT EARTH BLADE.

7.3.9.1 General

1.	Installation	Outdoor
2.	Type	Air
3.	Construction	Open
4.	Operation	Gang
5.	Operating Mechanism	Manual
6.	Mounting Position	Vertical for Bus Isolator & Horizontal for Bus Coupler on supporting structure
7.	Number of Pole	3 (Three)
8.	Frequency	50 Hz
9.	System Nominal Voltage	33 kV
10.	System Maximum Voltage	36 kV
11.	Basic Insulation Level	170 kV
12.	Rated continuous Current	1600/2500 A
13.	Rated Short Time Withstand Current	31.5 kA (3 Sec.) for 2500 A , 31.5 kA(3 Sec.) for 1600 A
14.	Rated power frequency withstand voltage, kV (rms) 1 minute	70KV
15.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.

A. Features

- 1) The isolators shall be single break Pattern [Vertical break or Horizontal break (centre break)] off-load type with manual operating mechanism for the earth blade. There shall be interlocking arrangement with the breaker to ensure that the Isolator can only be operated with breaker in “OFF” position. Necessary controls, accessories and auxiliary operating mechanism for manual operation shall be provided in water proof outdoor boxes.
- 2) The earthing device shall be gang operated & integral with the switch. The unit shall be complete with channel type mounting base, insulators, and phases coupling tube for gang operation and adjustable operating rod with insulating link and intermediate guide for operating rod.
- 3) Auxiliary switch operated by the phase coupling tube shall be provided to control circuits for operating devices like indicators/alarms & interlocking with 10% spare contacts.
- 4) Terminal connectors shall be suitable for ACSR Dog/Merlin/ Gross Beak/ HAWK conductor as required.
- 5) Earthing steel pads shall be provided with provision of earth leads.
- 6) Cable glands for multi-core control/ power cables as required.
- 7) There shall be provisions for pad locking in “ON” & “OFF” position.

- 8) Provision of key interlocking.
- 9) Mechanical interlocking between earthing device & the switch shall be provided.
- 10) All accessories, nuts, bolts etc. required for mounting the isolator on structure as required.
- 11) All ferrous parts shall be hot dip galvanized after completion of machining. Galvanizing shall be in accordance with BS-729 and ASTM A90.
- 12) All control devices shall be suitable for operation from 110 Volts DC available in the control room.
- 13) Operating mechanism shall be fully tropicalized and housed in waterproof housing.
- 14) Complete supporting steel structure.
- 15) Isolator and earthing devices shall be accordance with IEC-129. They shall be complete with supporting steelwork and installed to permit maintenance of any section of the sub-station plat when the remainder is alive and shall be so located that the minimum safety clearances are always maintained.
- 16) The air gap between terminals of the same pole with the isolator open shall be of a length to withstand a minimum impulse voltage wave of 115 percent of the specified impulse insulation rating to earth.
- 17) Isolating switches shall be designed for live operation and isolators shall be hands operated. Where used for feeders they shall be capable of switching transformer magnetizing currents main contacts shall be of the high-pressure line type and acing contacts.
- 18) All feeder isolators shall be fitted with approved three phase link earthing devices, mechanically, coupled or interlocked with the main isolator so that the earthing device and main isolator can not be closed at the same time.
- 19) Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be un-effected by the climatic conditions at site. Mechanism shall be as simple as possible and comprise a minimum of bearing and wearing parts. Approved grease lubricating devices shall be fitted to all principal bearings. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729 and ASTM A90.

B. Blades:

All metal parts shall be of non rusting and non corroding material. All current carrying parts shall be made from high conductivity electrolytic copper. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper alloy. The bolts or pins used in current carrying parts shall be made of non corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast steel. No grey iron shall be used in the

manufacture of any part of the isolator. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals i.e. after every 1000 operations or after 5 years whichever is earlier.

C. Base:

Each isolator shall be provided with a complete galvanized steel base provided with holes and designed for mounting on a supporting structure.

D. Supporting Structure

All isolators and earthing switches shall be rigidly mounted in an upright position on their own supporting structures. Details of the supporting structures shall be furnished by the successful tenderer. The isolators should have requisite fixing details ready for mounting them on switch structures.

E. Test Certificates:

The following test certificate along with test results for offered type Isolator confirming to the tender document shall be submitted with the offer from internationally reputed Independent testing laboratory or reputed & renowned testing laboratory as per relevant IEC Standard, otherwise the bid will be rejected.

- q) Short time & peak withstand current.
- r) Resistance measurement of the main circuit.
- s) Temperature rise.
- t) Lightning Impulse Voltage withstand.
- u) Dielectric test
- v) Operating and mechanical endurance test
- w) verification of the protection
- x) Operation at the temperature limits

F. Information Required

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of all type of **33 kV Isolators**.
- b) Outline and General Arrangement drawings.
- c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.3.10 33KV CURRENT TRANSFORMER

A. GENERAL TECHNICAL PARTICULARS:

1.	Application	Metering and Protection
2.	Installation	Outdoor.
3.	Construction	Sealed Tank
4.	Insulation	Oil
5.	Number of Phase	Single
6.	Rated Frequency	50 Hz
7.	Mounting	On Supporting Structure
8.	System Primary Rated Voltage	33 kV Phase to Phase
9.	Maximum System Voltage	36kV Phase to Phase
10.	System Earthing	Effectively earthed
11.	Basic Insulation Level (1.2/50 μ sec.)	170 kV
12.	Power Frequency Withstand Voltage (1 min. 50 Hz).	70 kV
13.	33 kV Line Feeder Ratio:	600-1200/5-5A 1200-2400/5-5A
	Transformer Feeder Ratio:	300-600/5-5-5A (Not Applicable)
14.	Primary	Single Winding
15.	Secondary	Double Winding
16.	Accuracy Class	0.2S for Measurement, 5P20 for Protection.
17.	Burden	30VA
18.	Short Time Current Rating	40 kA for 1200-2400/5-5A, 31.5 kA for 3 Sec.
19.	Extended Current Rating	120% of Rated Current
20.	Over Current Rating	< 10 A
21.	Creepage Distance	25 mm/ KV (minimum)
22.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC 61869-1 & IEC 61869-2 standards.

B. FEATURES & ACCESSORIES:

- a) Current transformer shall have porcelain outdoor type bushing.
- b) Terminal connectors provided, shall be suitable for ACSR Merlin/ Grosbeak/ Hawk conductor as required.
- c) The equipment must be tropicalized and suitable for the outdoor location.
- d) Galvanized nuts, bolts and all accessories required for mounting on structure.
- e) All ferrous parts shall be hot-dip galvanized after completion of machining. Galvanizing shall be in accordance with BS-729.
- f) Each terminal shall have cadmium-plated nuts and bolts.
- g) Sealing/locking arrangement for the secondary terminal box shall be provided.
- h) Diagram plate and rating nameplate shall be provided. Rating plate and diagram plate shall be made of stainless steel and have engraved letters filled with blank enamel paint mentioning manufacturer's name, client name, year of manufacturing, contract no & model no, rating, etc.
- i) Supporting clamps, all accessories shall be provided with the CT's for installation on supporting gantry structure for line feeders CT's.

C. INFORMATION REQUIRED

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of **33KV Current Transformer**.
- b) Outline and General Arrangement drawings.
- c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.3. 11 TECHNICAL SPECIFICATION OF SINGLE PHASE 33KV POTENTIAL TRANSFORMER

A GENERAL TECHNICAL PARTICULARS:

1.	Application	Metering and Protection
2.	Installation	Outdoor
3.	Insulation	Oil
4.	Type	Voltage Induction
5.	Construction	Oil Tank
6.	Number of Phase	Singe Phase (1Set=3Nos)
7.	Frequency	50 Hz
8.	Mounting Mounted	Supporting on Gantry Structure Mounted
9.	System Primary Rated Voltage	33 kV (Phase to Phase)
10.	System Primary Maximum Voltage	36 kV (Phase to Phase)
11.	System Earthlings	Effectively earthed
12.	Basic Insulation (Impulse withstand Voltage)	170 kV
13.	Power Frequency Withstand Voltage	70 kV
14.	The neutral end of primary winding, for direct connection to ground	Insulated to withstand the 10 kV low frequency test.
15.	Type of Secondary Winding	Double Winding
16.	Transformation Ratio	$(33/\sqrt{3}) / (0.11/\sqrt{3}) / (0.11/\sqrt{3})$ kV
17.	Creepage Distance	25 mm/ kV (minimum)
18.	Rated Secondary Burden	30 VA
19.	Voltage limit factor	1.2 continuous
20.	Class of Accuracy	0.2 for metering and 3P for protection.
21.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC IEC 61869-1 & IEC 61869-3.

B FEATURES & ACCESSORIES:

- a) Potential transformer shall have porcelain outdoor type bushing.
- b) Terminal connectors provided, shall be suitable for ACSR Merlin/ Grosbeak/ Hawk conductor as required.
- c) The equipment must be tropicalized and suitable for the outdoor location.
- d) Galvanized nuts, bolts and all accessories required for mounting on structure shall be provided.
- e) All ferrous parts shall be hot dip galvanized after completion of machining, galvanizing shall be in accordance whether BS-729.
- f) Each terminal shall have cadmium-plated nuts and bolts.
- g) Each Voltage transformer is to be protected by high voltage fuse of the high rupturing capacity cartridge type. All fuses are to be clearly identified and easily accessible.
- h) Diagram plate and rating nameplate shall be provided. Rating plate and diagram plate shall

be made of stainless steel and have engraved letters filled with blank enamel paint mentioning manufacturer's name, client name, year of manufacturing, contract no & model no, rating, etc.

- i) Sealing/locking arrangement for the secondary terminal box shall be provided.

C INFORMATION REQUIRED

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of **33KV Potential Transformer**.
- b) Outline and General Arrangement drawings.
- c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc., along with valid Calibration Certificate(s) from competent authority used in manufacturer's laboratory for performing Routine Test as per IEC standard.

7.3.12 33 KV SINGLE PHASE LIGHTNING ARRESTER

1.1 SCOPE

This specification covers the general requirements of the design, manufacture, testing and inspection requirement of 33kV Outdoor Type Single Phase, Metal Oxide (ZnO), Gapless Lightning Arrester and accessories as specified.

1.2 GENERAL :

Lightning arresters shall protect substation and pole-mounted equipment from voltage impulses or surges resulting from lightning strokes, system faults, circuit switching, load rejection or other events. The arresters shall limit such over-voltages to voltage levels below equipment BIL ratings. The country of origin and place of manufacturer shall be same.

1.3 STANDARDS

Performance, Design & Testing of Outdoor Type Single Phase Metal Oxide (ZnO) Gapless Lightning Arrester shall conform to the latest edition of the IEC-60099-4 or equivalent international Standards unless otherwise specified herein.

1.4 SERVICE CONDITIONS

a. Altitude	:	1000 meters above the sea level
b. Maximum ambient temperature	:	48° C
c. Minimum ambient temperature	:	3°C
d. Relative Humidity	:	50-100%
e. Average annual rainfall	:	3454 mm
f. No. of annual rainy days	:	80-120 days
g. Isokeraunic level	:	80-120 days/year
h. Pollution of ambient air	:	dust, salt, chemicals

1.5 SYSTEM PARTICULARS

SL. NO.	SYSTEM CHARACTERISTICS	VOLTAGE LEVEL
1.	Nominal System Voltage, KV (Voltage Class)	33
3.	Maximum System Voltage, KV	36
4.	System Frequency, Hz	50
5.	Type of System Grounding	Solidly earthed system
6.	Rated Fault Level (3-Phase Symmetrical), kA 1 sec.	31.5
7.	Lightning Impulse Withstand Level(LIWL), kV	170

1.6 TECHNICAL REQUIREMENTS

Lightning arrester shall have the following characteristics:

1	Application	Distribution Transformer/ Overhead Line/ Power Cable Line/ Power Transformer of heavy duty class.
2	Type of Arrester	Station Class, Metal Oxide (ZnO), Gapless
3	Construction	Single Unit, gapless hermetically sealed in with non-linear characteristics with high energy capacity, all enclosed in housing.
4	Installation	Outdoor
5	Mounting	Pole Mounted steel bracket/Gantry mounted
6	Rated Arrester Voltage (rms, Ur)	36kV
7	Continuous Operating Voltage (COV, Uc)	22- 27.5 kV
8	Number of Phase	1
9	Nominal Discharge Current (kAp) of 8/20 micro second wave	10 kA
10.1	Type of Lightning Arrester housing	Porcelain
10.2	Power Frequency withstands voltage of Lightning Arrester Housing, Dry & Wet.	≥ 70 kV (Dry & wet)
10.3	Impulse Withstand Voltage of Lightning Arrester Housing.	≥ 170 kV (peak)
11	Lightning Impulse Residual Voltage (8/20 micro-second wave)	80 or better
12	Steep Current Impulse Residual Voltage at 10kA for 1 micro-second front time.	85 or better
13	High Current Impulse Withstand Value (4/10 micro-second)	100 or better
14	Minimum Energy Discharge capability (kJ/kVr) at rated voltage.	5
15	Line Discharge Class	3
16	Creepage distance (minimum)	31 mm/ kV
17	Partial Discharge (pico-coulomb) when energized at 1.05 times its continuous operating voltage.	Not exceeding 10 pC

1.7 BASIC FEATURES

1.7.1 CONSTRUCTION:

Lightning arresters shall be gapless type described briefly as follows:

- a. Gap less Arresters shall have elements of zinc oxide to perform both the surge discharge and power frequency reseal functions. ZnO arrester shall have excellent thermal stability for high energy surges, external pollution & temporary over voltage. Zinc oxide elements block RMS value should be minimum 3kV.

1.7.2 INSULATORS

The housing insulator of Lightning Arrester shall be wet process porcelain. The insulator sheds shall be designed to minimize the trapping of contamination and shall have a high Creepage distance (minimum 31mm/kV) and a high dielectric strength, as specified in article 1.6 above. Also, the minimum aerial distance between contact terminal to ground shall be 25 inch (635mm) for 33kV.

1.7.3 CONNECTORS

The Line lead and earthing terminal with clamps shall be provided, suitable to accommodate AAC/ ACSR/ Copper Conductor of diameter from 10.0mm to 15 mm. - The necessary connecting wire (5meter for each LA) for the connection of each Lightning arrester to surge counter shall also be included in the scope of supply.

1.7.4 NAMEPLATE

Information required for identification must be embossed on a stainless steel nameplate firmly fixed to the arrester and shall include:

- a. Arrester classification
- b. Manufacturers identification or symbol
- c. Arrester model and identification number
- d. Arrester voltage rating
- e. Year of manufacture
- f. Contract Number.

1.7.5 SURGE COUNTER

Tenderer shall supply surge counter/Monitor for each phase of the surge arrester. It shall be integrated into the arrester ground connection and counts the surge arrester responses that have occurred. Surge counter with leakage current meter shall also offer monitoring of arrester leakage current. The surge counter shall be analog or digital type. Surge arrester shall have suitable earth terminal to connect surge counter with insulated cable. Surge counter shall be of at least 4 digit.

1.7.6 MOUNTING

For pole mounted Mounting steel bracket and fixing bolts, nut, washer, Standard clam etc. shall be provided with the arrester for steel cross-arm. The mounting steel bracket & necessary fittings shall be hot dip galvanized as per BS-729.

For structure mounted surge arrester, arrester shall be supplied with insulating base.

1.7.7 FINISH

All exposed steel or iron parts of the arrester except threaded parts smaller than 3 inch in diameter, shall be hot-dip galvanized in accordance with ASTM A153.

1.8 TESTS:

1.8.1 TYPE TEST CERTIFICATES:

Tenderer's shall include in their offer the following type tests report as prescribed in IEC60099-4 for offered type Lightning Arrester of same voltage class:

- i. Insulation withstand test on the arrester housing.
- ii. Residual voltage test.
 - a. Step current impulse residual voltage test.
 - b. Lightning impulse residual voltage test.
 - c. Switching impulse residual voltage test.
- iii. Long duration current impulse withstand test.

- iv. Operation duty test.
 - a. High-current impulse operating duty test.
 - b. Switching surge operating duty test.
- v. Short-circuit test.
- vi. Internal partial discharge test.
- vii. Bending moment test.
- viii. Environmental test.
- ix. Seal leak rate test.
- x. Radio interference voltage (RIV) test.

1.8.2 ROUTINE TEST:

Manufacturer shall have all routine test facilities for arrester at their own manufacturing premises. The following routine tests shall be carried out on all the arresters as per IEC 60099-4 and the test reports shall be made available for the observation at the time of inspection.

- i. Residual voltage test.
- ii. Internal partial discharge test.
- iii. Reference voltage test.
- iv. Leak test.

1.8.3 SPECIAL TEST:

Following special tests shall be performed during Pre-Shipment Inspection & Post-Landing Inspection (if necessary).

- a. Insulation resistance test :
Insulation test result shall be more than 1GΩ.
- b. Seal Test:
The randomly selected samples as specified shall be sunk in the 1 (one) meter deep water tank for minimum 4 (four) hours. After removing samples from the water tank, the insulation resistance test shall have to perform again. The insulation resistance test result shall not vary more than 10% before and after seal test. After completing this test the MCOV shall be applied on Arrester at least five times. In each time the result shall be satisfactory as per specification.

1.9 DOCUMENTATION:

The following documents must be submitted along with the tender, without which the tender shall be considered as non-responsive.

- 1.9.1** Filled up Guaranteed Technical Particular (GTP) of the offered equipments.
- 1.9.2** Manufacturer's Production capacity as mentioned in Tender Data Sheet (TDS) of tender document.
- 1.9.3** Outline drawings and internal construction of offered equipment (including surge counter) considering the conceptual arrangement and nomenclature of a 33kV Lightning Arrester.
- 1.9.3.a** At least 02(two) nos. of Manufacturer's Supply Experience for similar type Lightning Arrester of same voltage class within the last 5 (Five) years; years counting backward from the date of publication of Invitation for Tender (IFT) in the newspaper. The Supply Experience covering at least 25% of the Tendered quantity in a single Contract will be considered only.

Manufacturer's supply experience (supported by copy of Contract Agreement and Certificate from purchaser) shall be furnished in the following format:

Sl. No.	Name, Address, Phone No. E-mail & Fax No. of the Purchaser	Contract No. & Date	Contract Value	Description of material with Quantity	Date of completion of supply
1.					
2.					

1.9.3.b At least 02 (Two) nos. of Manufacturer's Satisfactory Performance Certificates (supported by the supply record) from Electricity Utility as End User depicting that similar type Lightning Arrester of same voltage class has been supplied within last 10 (ten) years; years counting backward from the date of publication of IFT in the newspaper and has been in satisfactorily service for at least 02 (two) year. The Satisfactory Performance Certificate(s) shall be in End User's official pad in English and shall contain End User's full mailing address, e-mail address, website address, fax/telephone number for the convenience of authentication.

1.9.3.c The following provision will be applicable for purchasing less or equal to 5000 (five thousand) nos. of Lightning Arrester from new local manufacturers: **Not Applicable**

- i. At least 02(two) nos. of Manufacturer's Supply Experience for similar type Lightning Arrester of same voltage class within the last5 (Five) years; years counting backward from the date of publication of Invitation for Tender (IFT) in the newspaper. The Supply Experience covering at least 5% of the Tendered quantity in a single Contract will be considered only.

Manufacturer's supply experience (supported by copy of Contract Agreement/ Work Order /Certificate from purchaser) shall be furnished in the following format:

Sl. No.	Name, Address, Phone No. E-mail & Fax No. of the Purchaser	Contract No. & Date	Contract Value	Description of material with Quantity	Date of completion of supply
1.					
2.					

- ii. At least 02 (Two) nos. of Manufacturer's Satisfactory Performance Certificates (supported by the supply record) from public/private organization as End User depicting that similar type Lightning Arrester of same voltage class has been supplied within last 05 (five) years; years counting backward from the date of publication of IFT in the newspaper and has been in satisfactorily service for at least 01 (one) year. The Satisfactory Performance Certificate(s) shall be in End User's official pad and shall contain End User's full mailing address, e-mail address, website address, fax/telephone number for the convenience of authentication.

iii. The New Manufacturer shall submit the following document with the Tender document:

- a) Location of the Factory & layout plan.
- b) List of Capital Machineries (Related to manufacturer of the Tendered goods).
- c) Factory Project Profile
- d) Production Line description.
- e) List of Key Personnel (with Bio-data).
- f) Source of raw materials.
- g) Sample of offered item.
- h) Testing facilities & calibration certificates of testing equipments.

- iv. New Local Manufacturer's factory/manufacturing plant shall be visited & inspected by the Tender Evaluation Committee (TEC) and/or TEC nominated members, to assess the New Manufacturer's production capability and will submit a report regarding Technical and Financial aspect in comparison to the information and document furnished by Tenderer. If the assessment

report is not satisfactory, the related tender proposal of the tenderer will be considered as Non-Responsive.

All costs regarding visiting & inspection shall be borne by the New Manufacturer.

Factory shall be inspected by Tender Evaluation Committee (TEC) and/or TEC nominated members as per following guide lines:

1. Location of the Factory & layout plan.
2. List of Capital Machineries (Related to manufacturer of the Tendered goods)
3. Factory Project Profile
4. Production Capacity (Yearly)
5. Production Line description.
6. List of Key Personnel (with Bio-data)
7. Testing Facilities as per IEC60099-4 or latest revision there on.
8. Source of raw materials.
9. Provide sample of the Tendered product manufactured in the Factory for testing during factory Inspection.
10. Testing of offered type Lightning Arrester and ZnO shall be witnessed at manufacturer's testing laboratory.

All other clauses of the specification and Guaranteed Technical Particulars (GTP) except Supply record & Performance Certificate (Clause no. 1.9.4.a&1.9.4.b) shall be applicable for tender Submission and Evaluation.

- 1.9.4** Type test report as per clause no. 1.8.1 for offered type Lightning Arrester of same voltage class as per IEC 60099-4. All Type Test shall be done from any of the following independent testing laboratories:

- | | |
|----------------------------|------------------------|
| I. CESI, Italy | VII. SATS, Norway |
| II. ESEF ASEFA, France | VIII. STLNA, USA |
| III. JSTC Japan | IX. VEIKI, Hungary |
| IV. KEMA, The Netherlands | X. ZKU, Czech Republic |
| V. PEHLA, Germany | XI. UL, USA |
| VI. TUV Rheinland, Germany | |

1.10 Packing:

The complete Machines are to be export-packed and properly protected for shipment, rough transportation and storage. Specific care shall be taken for protection in store and reference is made to the climatic condition prevailing in Bangladesh. The packing used for equipment shall be 100% waterproof.

The supplier shall be responsible for damages due to inadequate packing. A packing list showing the contents of each packing shall be enclosed in a waterproof envelope secured to the outside of the packing case. A copy of the packing list shall also be enclosed inside the package.

All packages imported are liable to be opened for Customs examination and packing shall therefore be designed to facilitate opening and re-packing thereafter.

A red band (20 cm. wide) shall be painted all around each package. Each package shall have the following information printed on it in bold letters:

- Name of supplier.
- Port of Loading.
- Port of destination.
- Name of Consignee.
- Contract Number.
- Brief description of Stores.
- Number of Packages.
- Gross and net weight.
- Measurements.

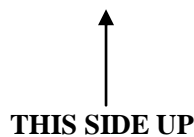
In addition, each package shall be clearly marked or stencilled in red on two sides, the shipping mark, "Name of Utility, Bangladesh" inscribed within a triangle mark as shown below:

The Shipping Mark

**UTILITY'S LOGO
BANGLADESH**

On the other two sides arrow marking with the wording "THIS SIDE UP" and "FRAGILE" shall be clearly marked or stencilled to indicate the face of the package to be kept upward.

FRAGILE



1.11 PRE-SHIPMENT INSPECTION

The Purchaser shall appoint a team consisting Engineers and they shall be entitled at all reasonable time during manufacture and/or pre-shipment to inspect and witness the Quality Assurance Test (QAT) of the offered item to confirm quality of the equipments to the specification at the manufacturers' premises. Manufacturer shall have all routine test facilities at their own manufacturing premises.

The contractor shall, after consulting the Purchaser, give the Purchaser reasonable notice in writing of the date and place at which any material or equipment will be ready for testing as provided in the contract and if the Purchaser does not attend at the place so named on date, which the supplier has stated in his notice, the Supplier may proceed with the tests, which shall be deemed to have been made in the Purchaser's presence, and shall forthwith forward to the Purchaser duly certified copies of Test Readings.

Inspection Team will witness the following test on random sampling basis (sample selected by the Inspection Team) during factory test in manufacturer's factory premises.

In case of purchasing more than 30,000 (Thirty Thousands) arresters, the Manufacturer shall have to perform tests described in section 1.8.2 on 15 nos. randomly selected samples. In case of purchasing less than 30,000 (Thirty Thousands) arresters, the Manufacturer shall have to perform tests described in section 1.8.2 and 1.8.3 on 10 nos. randomly selected samples.

The tests, as agreed upon by the Purchaser and the Supplier, shall be carried out as per relevant IEC/BS Standard or equivalent.

As and when the Purchaser is satisfied that any materials/equipment shall have passed the relevant tests, the Purchaser shall notify the Contractor in writing to the effect.

Should any inspected/tested goods fail to conform to the specification, the Purchaser shall have the right to reject any of the items or complete batch if necessary. In that case the Supplier shall have to replace the goods without any financial involvement to the Purchaser.

Nothing in this clause shall in any way release the Supplier from any warranty or other obligations under the contract.

1.12 POST-LANDING INSPECTION AND TESTING

The inspection team constituted by BPDB shall perform post-landing inspection in presence of supplier's representative after the delivery of the item at the designated store of BPDB.

The supplier shall arrange the program of such inspection. Any defect or damage have been found at post-landing inspection, the defective or damaged item to be repaired/ replaced by the supplier at his own cost.

The purchaser's right to inspect, test (where necessary) and reject the items after delivery at the designated store of BPDB shall in no way be limited or waived by reason of the goods having previously been inspected, tested and passed by the purchaser prior to the good's delivery.

The PLI Committee in its report shall mention the quantity of goods. The post landing inspection of goods shall generally cover the following, but not limited to:

- (i) Visual inspection of goods;
- (ii) Conformance with approved drawings with respect to dimensions and type.
- (iii) If necessary the inspection team may select randomly 5 to 10 nos. of Arresters from each lot and carryout the test(s) in following manner:
 - a. Routine test which will confirm clause no 1.8.2 (Tests which are available in Bangladesh)
 - b. Special test in accordance with clause no 1.8.3.
 - c. The selected samples will be sent to BUET/RUET/CUET/KUET to carry out the above tests. All costs of testing of samples including carrying, loading, un-loading etc. will be borne by the supplier.

If the tests of lightning arrester(s) are not satisfactory then the inspection team will randomly select double of the earlier sample size and carryout the test as per above from the same laboratory. If the test of any one of the sample fails, the batch under this inspection will be rejected and the delivered quantity will be taken back from the store by the supplier at his cost.

7.3.13 11KV SINGLE PHASE LIGHTNING ARRESTER

1.13 SCOPE

This specification covers the general requirements of the design, manufacture, testing and inspection requirement of 11kV Outdoor Type Single Phase, Metal Oxide (ZnO), Gapless Lightning Arrester and accessories as specified.

1.14 GENERAL :

Lightning arresters shall protect substation and pole-mounted equipment from voltage impulses or surges resulting from lightning strokes, system faults, circuit switching, load rejection or other events. The arresters shall limit such over-voltages to voltage levels below equipment BIL ratings. The country of origin and place of manufacturer shall be same.

1.15 STANDARDS

Performance, Design & Testing of Outdoor Type Single Phase Metal Oxide (ZnO) Gapless Lightning Arrester shall conform to the latest edition of the IEC-60099-4 or equivalent international Standards unless otherwise specified herein.

1.16 SERVICE CONDITIONS

- | | | |
|--------------------------------|---|---------------------------------|
| a. Altitude | : | 1000 meters above the sea level |
| b. Maximum ambient temperature | : | 48° C |
| c. Minimum ambient temperature | : | 3° C |
| d. Relative Humidity | : | 50-100% |
| e. Average annual rainfall | : | 3454 mm |
| f. No. of annual rainy days | : | 80-120 days |
| g. Isokeraunic level | : | 80-120 days/year |
| h. Pollution of ambient air | : | dust, salt, chemicals |

1.17 SYSTEM PARTICULARS

SL. NO.	SYSTEM CHARACTERISTICS	VOLTAGE LEVEL
1.	Nominal System Voltage, KV (Voltage Class)	11
3.	Maximum System Voltage, KV	12
4.	System Frequency, Hz	50
5.	Type of System Grounding	Solidly earthed system
6.	Rated Fault Level (3-Phase Symmetrical), kA 1 sec.	25
7.	Lightning Impulse Withstand Level(LIWL), kV	75

1.18 TECHNICAL REQUIREMENTS

Lightning arrester shall have the following characteristics:

1	Application	Distribution Transformer/ Overhead Line/ Power Cable Line/ Power Transformer of heavy duty class.
2	Type of Arrester	Station Class, Metal Oxide (ZnO), Gapless
3	Construction	Single Unit, gapless hermetically sealed in with non-linear characteristics with high energy capacity, all enclosed in housing.
4	Installation	Outdoor
5	Mounting	Pole Mounted steel bracket
6	Rated Arrester Voltage (rms, Ur)	9kV
7	Continuous Operating Voltage (COV, Uc)	8- 10 kV
8	Number of Phase	1
9	Nominal Discharge Current (kAp) of 8/20	5 kA

	micro second wave	
10.1	Type of Lightning Arrester housing	Porcelain
10.2	Core Technology	Open Cage Polymeric
10.3	Power Frequency withstands voltage of Lightning Arrester Housing, Dry & Wet.	≥ 35 kV (Dry) & 30 kV (Wet)
10.4	Impulse Withstand Voltage of Lightning Arrester Housing.	≥75 kV (peak)
11	Lightning Impulse Residual Voltage (8/20 micro-second wave)	35 kV (peak)
12	High Current Impulse Withstand Value (4/10 micro-second)	65kV (peak)
13	Creepage distance (minimum)	25 mm/ kV
14	Partial Discharge (pico-coulomb) when energized at 1.05 times its continuous operating voltage.	Not exceeding 10 pC

1.19 BASIC FEATURES

1.19.1 CONSTRUCTION:

Lightning arresters shall be gapless type described briefly as follows:

- a. Gap less Arresters shall have elements of zinc oxide to perform both the surge discharge and power frequency reseal functions. ZnO arrester shall have excellent thermal stability for high energy surges, external pollution & temporary over voltage.

1.19.2 INSULATORS

The housing insulator of Lightning Arrester shall be wet process porcelain/polymer (Hydrophobic silicon).The insulator sheds shall be designed to minimize the trapping of contamination and shall have a high Creepage distance (minimum 25mm/kV) and a high dielectric strength, as specified in article 1.6 above. Also, the minimum aerial distance between contactterminal to ground shall be 10 inch (254mm) for 11kV.

1.19.3 CONNECTORS

The Line lead and earthing terminal with clamps shall be provided, suitable to accommodate AAC/ ACSR/ Copper Conductor of diameter from 10.0mm to 15 mm.

1.19.4 NAMEPLATE

Information required for identification must be embossed on a stainless steel nameplate firmly fixed to the arrester and shall include:

- a. Arrester classification
- b. Manufacturers identification or symbol
- c. Arrester model and identification number
- d. Arrester voltage rating
- e. Year of manufacture
- f. Contract Number.

1.19.5 MOUNTING

For pole mounted Mounting steel bracket and fixing bolts, nut, washer, Standard clam etc. shall be provided with the arrester for steel cross-arm. The mounting steel bracket & necessary fittings shall be hot dip galvanized as per BS-729.

For structure mounted surge arrester, arrester shall be supplied with insulating base.

1.19.6 FINISH

All exposed steel or iron parts of the arrester except threaded parts smaller than 3 inch in diameter, shall be hot-dip galvanized in accordance with ASTM A153.

1.20 TESTS:

1.20.1 TYPE TEST CERTIFICATES:

Tenderer's shall include in their offer the following type tests report as prescribed in IEC60099-4 for offered type Lightning Arrester of same voltage class:

- i. Insulation withstand test on the arrester housing.
- ii. Residual voltage test.
 - a. Step current impulse residual voltage test.
 - b. Lightning impulse residual voltage test.
 - c. Switching impulse residual voltage test.
- iii. Long duration current impulse withstand test.
- iv. Operation duty test.
 - a. High-current impulse operating duty test.
 - b. Switching surge operating duty test.
- v. Short-circuit test.
- vi. Internal partial discharge test.
- vii. Bending moment test.
- viii. Environmental test.
- ix. Seal leak rate test.
- x. Radio interference voltage (RIV) test.

1.20.2 ROUTINE TEST:

Manufacturer shall have all routine test facilities for arrester at their own manufacturers' premises. The following routine tests shall be carried out on all the arresters as per IEC 60099-4 and the test reports shall be made available for the observation at the time of inspection.

- i. Residual voltage test.
- ii. Internal partial discharge test.
- iii. Reference voltage test.
- iv. Leak test.

1.20.3 SPECIAL TEST:

Following special tests shall be performed during Pre-Shipment Inspection & Post-Landing Inspection(if necessary).

- a. Insulation resistance test :
Insulation test result shall be more than $1G\Omega$.
- b. Seal Test:
The randomly selected samples as specified shall be sunk in the 1 (one) meter deep water tank for minimum 4 (four) hours. After removing samples from the water tank, the insulation resistance test shall have to perform again. The insulation resistance test result shall not vary more than 10% before and after seal test. After completing this test the MCOV shall be applied on Arrester at least five times. In each time the result shall be satisfactory as per specification.

1.21 DOCUMENTATION:

The following documents must be submitted along with the tender, without which the tender shall be considered as non-responsive.

1.21.1 Filled up Guaranteed Technical Particular (GTP) of the offered equipment.

1.21.2 Manufacturer's Production capacity as mentioned in Tender Data Sheet (TDS) of tender document.

1.21.3 Outline drawings and internal construction of offered equipment (including surge counter) considering the conceptual arrangement and nomenclature of a 11kV Lightning Arrester.

1.21.3.a At least 02(two) nos. of Manufacturer's Supply Experience for similar type Lightning Arrester of same voltage class within the last 5 (Five) years; years counting backward from the date of publication of Invitation for Tender (IFT) in the newspaper. The Supply Experience covering at least 25% of the Tendered quantity in a single Contract will be considered only.

Manufacturer's supply experience (supported by copy of Contract Agreement and Certificate from purchaser) shall be furnished in the following format:

Sl. No.	Name, Address, Phone No. E-mail & Fax No. of the Purchaser	Contract No. & Date	Contract Value	Description of material with Quantity	Date of completion of supply
1.					
2.					

1.21.3.b At least 02 (Two) nos. of Manufacturer's Satisfactory Performance Certificates (supported by the supply record) from Electricity Utility as End User depicting that similar type Lightning Arrester of same voltage class has been supplied within last 10 (ten) years; years counting backward from the date of publication of IFT in the newspaper and has been in satisfactorily service for at least 02 (two) year. The Satisfactory Performance Certificate(s) shall be in End User's official pad in English and shall contain End User's full mailing address, e-mail address, website address, fax/telephone number for the convenience of authentication.

1.21.3.c The following provision will be applicable for purchasing less or equal to 5000 (five thousand) nos. of Lightning Arrester from new local manufacturers:

- i. At least 02(two) nos. of Manufacturer's Supply Experience for similar type Lightning Arrester of same voltage class within the last 5 (Five) years; years counting backward from the date of publication of Invitation for Tender (IFT) in the newspaper. The Supply Experience covering at least 5% of the Tendered quantity in a single Contract will be considered only.

Manufacturer's supply experience (supported by copy of Contract Agreement/ Work Order /Certificate from purchaser) shall be furnished in the following format:

Sl. No.	Name, Address, Phone No. E-mail & Fax No. of the Purchaser	Contract No. & Date	Contract Value	Description of material with Quantity	Date of completion of supply
1.					
2.					

- ii. At least 02 (Two) nos. of Manufacturer's Satisfactory Performance Certificates (supported by the supply record) from public/private organization as End User depicting that similar type Lightning Arrester of same voltage class has been supplied within last 05 (five) years; years counting backward from the date of publication of IFT in the newspaper and has been in satisfactorily service for at least 01 (one) year. The Satisfactory Performance Certificate(s) shall be in End User's official pad and shall contain End User's full mailing address, e-mail address, website address, fax/telephone number for the convenience of authentication.
- iii. The New Manufacturer shall submit the following document with the Tender document:
 - i) Location of the Factory & layout plan.
 - j) List of Capital Machineries (Related to manufacturer of the Tendered goods).
 - k) Factory Project Profile
 - l) Production Line description.
 - m) List of Key Personnel (with Bio-data).
 - n) Source of raw materials.
 - o) Sample of offered item.
 - p) Testing facilities & calibration certificates of testing equipments.
- iv. New Local Manufacturer's factory/manufacturing plant shall be visited & inspected by the Tender Evaluation Committee (TEC) and/or TEC nominated members, to assess the New Manufacturer's production capability and will submit a report regarding Technical and Financial aspect in comparison to the information and document furnished by Tenderer. If the assessment report is not satisfactory, the related tender proposal of the tenderer will be considered as Non-Responsive.

All costs regarding visiting & inspection shall be borne by the New Manufacturer.

Factory shall be inspected by Tender Evaluation Committee (TEC) and/or TEC nominated members as per following guide lines:

1. Location of the Factory & layout plan.
2. List of Capital Machineries (Related to manufacturer of the Tendered goods)
3. Factory Project Profile
4. Production Capacity (Yearly)
5. Production Line description.
6. List of Key Personnel (with Bio-data)
7. Testing Facilities as per IEC60099-4 or latest revision there on.
8. Source of raw materials.
9. Provide sample of the Tendered product manufactured in the Factory for testing during factory Inspection.
10. Testing of offered type Lightning Arrester and ZnO shall be witnessed at manufacturer's testing laboratory.

All other clauses of the specification and Guaranteed Technical Particulars (GTP) except Supply record & Performance Certificate (Clause no. 1.9.4.a & 1.9.4.b) shall be applicable for tender Submission and Evaluation.

1.21.4 Type test report as per clause no. 1.8.1 for offered type Lightning Arrester of same voltage class as per IEC 60099-4. All Type Test shall be done from any of the following independent testing laboratories:

- | | |
|----------------------------|------------------------|
| I. CESI, Italy | IX. VEIKI, Hungary |
| II. ESEF ASEFA, France | X. ZKU, Czech Republic |
| III. JSTC Japan | XI. UL, USA |
| IV. KEMA, The Netherlands | |
| V. PEHLA, Germany | |
| VI. TUV Rheinland, Germany | |
| VII. SATS, Norway | |
| VIII. STLNA, USA | |

1.22 Packing:

The complete Machines are to be export-packed and properly protected for shipment, rough transportation and storage. Specific care shall be taken for protection in store and reference is made to the climatic condition prevailing in Bangladesh. The packing used for equipment shall be 100% waterproof.

The supplier shall be responsible for damages due to inadequate packing. A packing list showing the contents of each packing shall be enclosed in a waterproof envelope secured to the outside of the packing case. A copy of the packing list shall also be enclosed inside the package.

All packages imported are liable to be opened for Customs examination and packing shall therefore be designed to facilitate opening and re-packing thereafter.

A red band (20 cm. wide) shall be painted all around each package. Each package shall have the following information printed on it in bold letters:

- Name of supplier.
- Port of Loading.
- Port of destination.
- Name of Consignee.
- Contract Number.
- Brief description of Stores.
- Number of Packages.
- Gross and net weight.
- Measurements.


In addition, each package shall be clearly marked or stencilled in red on two sides, the shipping mark, "Name of Utility, Bangladesh" inscribed within a triangle mark as shown below:

The Shipping Mark

**UTILITY'S LOGO
BANGLADESH**

On the other two sides arrow marking with the wording "THIS SIDE UP" and "FRAGILE" shall be clearly marked or stencilled to indicate the face of the package to be kept upward.

FRAGILE


THIS SIDE UP

1.23 PRE-SHIPMENT INSPECTION

The Purchaser shall appoint a team consisting Engineers and they shall be entitled at all reasonable time during manufacture and/or pre-shipment to inspect and witness the Quality Assurance Test (QAT) of the offered item to confirm quality of the equipments to the specification at the manufacturers' premises. Manufacturer shall have all routine test facilities at their own manufacturers' premises.

The contractor shall, after consulting the Purchaser, give the Purchaser reasonable notice in writing of the date and place at which any material or equipment will be ready for testing as provided in the contract and if the Purchaser does not attend at the place so named on date, which the supplier has stated in his notice, the Supplier may proceed with the tests, which shall be deemed to have been made in the Purchaser's presence, and shall forthwith forward to the Purchaser duly certified copies of Test Readings.

Inspection Team will witness the following test on random sampling basis (sample selected by the Inspection Team) during factory test in manufacturer's factory premises.

In case of purchasing more than 30,000 (Thirty Thousands) arresters, the Manufacturer shall have to perform tests described in section 1.8.2 on 15 nos. randomly selected samples. In case of purchasing less than 30,000 (Thirty Thousands) arresters, the Manufacturer shall have to perform tests described in section 1.8.2 and 1.8.3 on 10 nos. randomly selected samples.

The tests, as agreed upon by the Purchaser and the Supplier, shall be carried out as per relevant IEC/BS Standard or equivalent.

As and when the Purchaser is satisfied that any materials/equipment shall have passed the relevant tests, the Purchaser shall notify the Contractor in writing to the effect.

Should any inspected/tested goods fail to conform to the specification, the Purchaser shall have the right to reject any of the items or complete batch if necessary. In that case the Supplier shall have to replace the goods without any financial involvement to the Purchaser.

Nothing in this clause shall in any way release the Supplier from any warranty or other obligations under the contract.

1.24 POST-LANDING INSPECTION AND TESTING

The inspection team constituted by BPDB shall perform post-landing inspection in presence of supplier's representative after the delivery of the item at the designated store of BPDB.

The supplier shall arrange the program of such inspection. Any defect or damage have been found at post-landing inspection, the defective or damaged item to be repaired/ replaced by the supplier at his own cost.

The purchaser's right to inspect, test (where necessary) and reject the items after delivery at the designated store of BPDB shall in no way be limited or waived by reason of the goods having previously been inspected, tested and passed by the purchaser prior to the good's delivery.

The PLI Committee in its report shall mention the quantity of goods. The post landing inspection of goods shall generally cover the following, but not limited to:

- (i) Visual inspection of goods;

- (ii) Conformance with approved drawings with respect to dimensions and type.
- (iii) If necessary the inspection team may select randomly 5 to 10 nos. of Arresters from each lot and carryout the test(s) in following manner:
 - a. Routine test which will confirm clause no 1.8.2 (Tests which are available in Bangladesh)
 - b. Special test in accordance with clause no 1.8.3.
 - c. The selected samples will be sent to BUET/RUET/CUET/KUET to carryout the above tests. All costs of testing of samples including carrying, loading, un-loading etc. will be borne by the supplier.

If the tests of lightning arrester(s) are not satisfactory then the inspection team will randomly select double of the earlier sample size and carryout the test as per above from the same laboratory. If the test of any one of the sample fails, the batch under this inspection will be rejected and the delivered quantity will be taken back from the store by the supplier at his cost.

7.3. 14 SUBSTATION BATTERY

7.3. 14.1 Battery

7.3.14.1.1 General

Batteries shall be located in separate mechanically ventilated rooms, which will be provided with sinks and water supplies. Storage facilities will be provided for electrolyte, distilled water and maintenance equipment.

The voltage measured at the main distribution switchgear shall not vary by more than plus 10 percent or minus 20 percent of the nominal voltage under all charging conditions when operating in accordance with the requirements of this Section.

The complete equipment shall preferably be a manufacturer's standard but any departure from this Specification shall be subject to the approval of the Engineer.

7.3. 14.1.2 Type of Battery

The battery shall be of the high performance Nickel Cadmium pocket plate type complying with IEC 60623 and shall be designed for a life expectancy of 25 years.

Battery cases shall be of high impact translucent plastic or annealed glass and shall be indelibly marked with maximum and minimum electrolyte levels. The design of the battery shall permit the free discharge of the gases produced during the normal operating cycle, whilst excluding dust. Spray arresters shall be included.

The electrolyte shall be free from impurities and the Potassium Hydroxide used shall comply with BS 5634. Dilution of the alkaline electrolyte and topping up of cells shall be carried out using distilled water only.

A complete set of test and maintenance accessories, suitably boxed, shall be provided for each battery. A syringe hydrometer and a durable instruction card shall be included in each set.

Cells shall be numbered consecutively and terminal cells marked to indicate polarity.

Cells shall be permanently marked with the following information:

- Manufacturer's reference number and code
- Year and month of manufacture
- Voltage and nominal capacity at the 5 hour discharge rate

The electrolyte capacity and general design of the cells shall be such that inspection and maintenance, including topping up of the electrolyte, shall be at intervals of not less than twelve months.

7.3. 14.1.3 Initial Charge and Test Discharge

The initial charge, test discharge and subsequent re-charge of the battery must be carried out under continuous supervision. Resistors, instruments, leads, and the other apparatus will be necessary for the initial charge, test discharge and subsequent recharge of the battery.

7.3. 14.1.4 Battery Duty

The battery shall have sufficient capacity to supply the following continuous and intermittent loads for the periods specified, with the chargers out of service.

Standing DC loading for protection, control, indications and alarms for 10 hours. This loading shall be determined from all equipment to be supplied on this Contract. In addition the future circuit requirements estimated on the same basis as the present requirements.

At the end of 10 hours the battery shall have sufficient capacity to complete the operations listed below, at the end of which duty the system voltage shall not have dropped below 90 percent of the nominal voltage with the standing loads, specified above, connected.

1. Two closing operations on all circuit breakers (including future) supplied by the battery.
2. Two tripping operations on all circuit breakers (including future) supplied by the battery. Where busbar protection is provided, it shall be assumed that all circuit breakers in any one busbar protection zone trip simultaneously.
3. Charging of DC motor wound circuit breaker closing springs (where applicable) to enable the closing operations to be carried out.
4. At the end of these duties, the battery voltage shall not have dropped such that the voltage at the battery terminals falls below 90% of the nominal system voltage when supplying the standing load.
5. In addition, the voltages at the terminals of all components in the system (eg. relays, trip and closing coils) shall not be outside of the individual voltage limits applying to them.
6. A margin of 10 % shall be allowed for derating of this battery over its life time.

All quantities derived in this manner shall be quoted in the Bid, but shall not be used for ordering materials until specifically approved by the Engineer. Detailed calculations, and loading characteristics on which these are based, shall be submitted to the Engineer at an early stage.

7.3. 14.1.5 Location of Batteries

The batteries shall be housed in a ventilated battery room. The charging equipment and distribution switchboards shall be housed in a separate room.

The floor of the battery room shall be coated with a suitable electrolyte resistant protective coating. The floor shall be fitted with a drain and shall have sufficient slope to prevent any major electrolyte spillages from entering into other areas.

No ducts or any other items shall penetrate the floor or create a means whereby spillage can drain away apart from the drain provided for this purpose.

The ventilation fans and lamps in battery room shall be an explosion proof type.

7.3. 14.1.6 Battery mounting connections and accessories

Batteries shall be placed on timber boards mounted in double tiers on steel stands of robust construction and treated with acid resisting enamel or gloss paint to BS 381C No.361. The cells shall be arranged so that each cell is readily accessible for inspection and maintenance and it shall be possible to remove any one cell without disturbing the remaining cells. The stands shall be mounted on insulators and be so dimensioned that the bottom of the lower tier is not less than 300mm above the floor.

Alternatively, batteries may be mounted in a similar manner on treated hardwood stands.

Batteries shall be supplied and erected complete with all necessary connections and cabling. Connections between tiers, between end cells and between porcelain wall bushings shall be by PVC cables arranged on suitable racking or supports. Before jointing, joint faces shall be bright metal, free from dirt, and shall be protected by a coating of petroleum jelly. Terminal and intercell connections shall be of high conductivity corrosion free material.

Cartridge fuses shall be provided in both positive and negative leads, positioned as close to the battery as possible and shall be rated for at least three times the maximum battery discharge current at the highest operating voltage. The two fuses shall be mounted on opposite ends of the battery stand or rack in an approved manner. These fuse links shall comply with BS 88 Clause DC. 40 and shall be bolted in position without carriers.

Warning labels shall be fitted to warn personnel of the danger of removing or replacing a fuse whilst the load is connected and that fuses should not be removed immediately following boost charge due to the possible ignition of hydrogen gas.

Fuses between the battery and charger shall be located adjacent to the battery in a similar manner to that described above. A warning label shall be placed on the charging equipment indicating the location of these fuses and the fact that they should be removed to isolate the charger from the battery.

It shall not be possible to leave the battery disconnected (by means of switches or removal or operation of fuses) without some local and remote indication that such a state exists.

One set of miscellaneous equipment, including two syringe hydrometers, one cell-testing voltmeter, two cell-bridging connectors, two electrolyte-pouring funnels, two electrolyte thermometers, battery instruction card for wall mounting, electrolyte airtight containers, labels, tools and other items necessary for the erection and correct functioning and maintenance of the equipment, shall be provided for each station.

7.3. 15 BATTERY CHARGER

7.3.15.1 General:

Each battery charging equipment shall comply with the requirements of BS 4417 (IEC 146), shall be of the thyristor controlled automatic constant voltage type with current limit facilities and shall be suitable for supplying the normal constant load, at the same time maintaining the battery to which it is connected in a fully charged condition. All equipment shall be naturally ventilated.

All the equipment for each charger shall be contained in a separate ventilated steel cubicle. The charger cubicles shall normally be mounted immediately adjacent to the DC distribution panel to form a board and shall be of matching design colour and appearance.

Where their ratings permit, chargers shall preferably be designed for operation from a single-phase AC auxiliary supply with a nominal voltage of 230 V. Otherwise a three phase 400V supply may be utilised. Chargers shall maintain the float charge automatically for all DC loads between 0 and 100%, irrespective of variations in the voltage of the ac supply within the following limits :

- Frequency variation : 47 to 51 Hz.
- Voltage variation : $\pm 15\%$

The mains transformer shall be of a suitable rating and design. Clearly marked off-circuit tapplings shall be provided on the primary windings and change of tapping shall be by means of easily accessible links. The transformer shall be of the natural air-cooled type capable of operating continuously at full load on any tapping with the maximum specified ambient temperature.

All rectifiers and semi-conducting devices employed in the charger shall be of the silicon type. They shall be adequately rated, with due regard to air temperature within the charger enclosure, for the maximum ambient temperature.

The rating of the charger on float charge shall be equal to the normal battery standing load plus the recommended finishing charge rate for the battery.

Each charger shall also incorporate a boost charge feature which shall, after having been started, provide an automatically controlled high charge rate sufficient to restore a fully discharged battery to the fully charged state within the shortest possible time without excessive gassing or any form of damage to the battery. The boost charge shall be initiated manually or automatically upon detection of a significant battery discharge. An adjustable timer shall be provided to automatically switch the charger to the float condition after the correct recharge period.

Should the AC supply fail while a battery is on boost charge, the switching arrangements shall automatically revert the charger to float charge status and then reconnect the battery to the distribution board.

The output voltage regulator shall be adjustable for both float and boost charge modes, within limits approved by the Engineer, by means of clearly marked controls located inside the cubicle.

Although it is not intended that the charger be operated with the battery disconnected, the design of the charger shall be such that with the battery disconnected the charger will maintain the system voltage without any damage to itself and with a ripple voltage no greater than 2.0% rms of the nominal output voltage.

The charger shall automatically adjust the charging current from a value not less than the battery capacity divided by 10 hours to a minimum value of not more than the battery capacity divided by 200 hours. The charging circuitry shall be so designed that the failure of any component will not give a situation which will cause permanent damage to the battery by over charging.

Each charger shall have a float charge maximum current rating sufficient to meet the total standing load current on the dc distribution board plus a battery charging current equal numerically to 7% of the battery capacity at the 10 hour rate.

Each charger shall be designed with a performance on float charge such that with the output voltage set at approximately 1.45 V per cell at 50% load and rated input voltage and frequency, the output voltage shall not vary by more than plus 3% to minus 2% with any combination of input supply voltage and frequency variation as stipulated in this Specification and output current variation from 0-100% of rating.

Each charger shall be suitable for operating alone or in parallel with the other charger. When operating with both chargers, one charger shall be arranged to supply the standing load with the second charger in the quiescent standby mode.

Each charger shall also have a taper characteristic boost charging facility which shall be selectable by a float/boost charge selection switch and which will give boost charging of 1.60 volts per cell.

Each charger shall be designed with a performance on boost charge such that with rated input voltage and frequency the charger output shall not be less than its rating in Watts at 1.3 V and 1.6 V per cell, and also the output voltage shall be 1.60 per cell over an output range of 0 - 100% of rating.

The boost charging equipment shall be capable of recharging the battery within six hours following a one hour discharge period.

In the event of the battery becoming discharged during an AC supply failure, the rate at which recharging commences shall be as high as possible consistent with maintaining the automatic charging constant voltage feature and with the connections remaining undisturbed as for normal service.

The charger shall have an automatic boost/quick charge feature, which shall operate upon detection of a significant battery discharge. When, after a mains failure, the AC supply voltage returns and the battery have been significantly discharged, the charger will operate in current limit. If the current limit lasts for more than a specified time and the charging current does not fall back to float level, the automatic high rate charge shall be activated.

An override selector switch shall be provided inside the charger unit to enable a first conditioning charge to be made, in line with the battery manufacturer's recommendations, for batteries which are shipped dry and require forming at site.

A blocking diode unit shall be incorporated in the output circuit of each charger to limit the load voltage during boost charging of the battery. The diode unit shall not be in service in the normal float charging mode. Should the stabiliser fail in the boost charging mode, the charger shall automatically revert to the float mode.

An anti-parallel diode shall be provided in each positive feed to the DC distribution board to prevent faults on one supply affecting the other. These diodes shall be continuously rated to carry the maximum possible discharge current likely to occur in service and a safety factor of 4 shall be used to determine the repetitive peak reverse voltage rating. The I₂t rating of the diodes shall be such that in the event of a DC short circuit, no damage to the diodes shall result.

Each charger shall be capable of sustaining, without damage to itself, a continuous permanent short circuit across its output terminals. The use of fuses, MCBs or other similar devices will not be acceptable in meeting this requirement.

Suitable relays shall be provided for each charger to detect failure of the incoming supply and failure of the DC output when in float charge mode. These relays shall operate appropriate indicating lamps on the respective charger front panel and shall have additional voltage free contacts for operating remote and supervisory alarms. These alarms shall be immune from normal supply fluctuations and shall not be initiated when any one charger is taken out of service.

The charger shall also be fitted with a device to de-energise the charger in the event of a DC output float over voltage.

Each charger shall be provided, as a minimum, with the following instrumentation, indication and alarm facilities:-

- Indicating lamps for the AC supply to the rectifier and DC supply from the rectifier.
- Indicating lamps for float and boost charging operations.
- Voltmeter - Input voltage.
- Voltmeter - Output voltage.
- Ammeter - Output current.
- Alarm - Charger failure.
- Alarm - Mains failure.

The following battery alarms shall also be provided:

- Battery fuse failure
- Diode assembly failure
- Battery circuit faulty
- Low DC volts
- High AC volts
- Earth fault +ve
- Earth fault -ve

Lamp test facilities shall be included.

A “charger faulty” alarm for each charger and a “battery faulty” alarm shall be provided in the substation control room and to the SCADA system where applicable.

Each battery charger shall be equipped with charge fail detection equipment to give local indication and remote alarm if the voltage from the charger falls below a preset level which will be lower than the nominal float charge voltage. Suitable blocking diodes shall be provided to prevent the battery voltage being supplied to the equipment and so prevent charge fail detection.

The device shall not operate on switching surges or transient loss of voltage due to faults on the AC system. The voltage at which the alarm operates shall be adjustable for operation over a range to be approved by the Engineer.

Each charger shall be equipped with a switch-fuse for the incoming AC supply and an off load isolator for the DC output. An additional Ammeter for input current measurement shall be provided with the charger.

DC Battery Charger’s monitoring & controlling Devices/System shall be incorporated in SAS. Charger Controller shall monitor all voltage & current levels, physical condition of battery cells, self-supervision of charger equipment etc. There shall be protective scheme against over/under current & voltage flow. All the measurement values & alarm signals shall be available on controller display and to be indicated with necessary Annunciation with hooter/Indication LED Lamp where applicable in charger panel & shall also to be incorporated in SAS.

DC Charger panels front side shall have operational & control Mimic.

Bidders shall include particulars with their Bid on the method of adjustment included to compensate for ageing rectifier elements. The construction of the charger shall be such that access to all components is readily available for maintenance removal or replacement. Internal panels used for mounting equipment shall be on swing frames to allow for access to the charger interior.

7.3. 15.2 Earthing Screen

Earthed screens shall be provided to protect the equipment from direct lightning strikes. The screens shall be of aluminium clad steel wires of not less than 50 sq.mm. total section, and connected to provide low impedance paths to earth.

The layout of the earth wires shall be such that equipment to be protected generally lies within areas bounded by two or more conductors, in which case the protected angle shall not exceed 45 degree centigrade. Where equipment is protected by a single earth wire, the protective angle shall not exceed 35 degree centigrade to the vertical.

The earth screens shall be suitable for extension to protect the substation equipment to be installed in future stages of development.

Connections shall be made of copper strip of 30mm x 5mm cross section between the overhead earthed screen wire and the main substation earthing system at each support unless the galvanized steel support structure has sufficient area and current carrying capacity.

Earth wires shall be held in clamps with free pin type joints between clamps and supports.

Connections shall be provided for the terminations of the earth wires of the overhead lines, including bimetal connectors where necessary.

The design of all structures shall generally comply with the specification and in addition is to ensure that in the event of breakage of one earth wire, the Factor of Safety is not less than 1.5.

7.3. 15.3 INFORMATION REQUIRED

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for crucial components of **Battery and Battrey charger**.
- b) Outline and General Arrangement drawings.

7.3. 16 TECHNICAL SPECIFICATIONS 33kV DISC INSULATOR WITH FITTINGS

7.3. 16.1 STANDARDS:

These 33 kV Disc Insulator with Fittings specified in this Section shall conform to the latest edition of the following standards for operation in overhead lines in air under local ambient conditions. Design, Manufacture, Testing and Performance shall be in accordance with latest revisions of BS, IEC standards as listed below or other equivalent internationally acceptable Standards:

IEC-120	:	Ball & Socket Coupling.
IEC-305	:	Characteristics of String Insulator Unit.
IEC-383	:	Insulator Tests.
IEC-437	:	Radio Interference Tests.
IEC-506	:	Switching Impulse Tests.
IEC-575	:	Thermal Mechanical Performance Tests.
BS-137	:	Method of test & requirements.
BS-916	:	Bolts, Screws & Nuts.

7.3.16.2 SPECIFICATIONS:

A. Specification of Disc Insulator:

These 33 kV Disc Insulators shall be designed as per above standards for operation in overhead lines in air under local ambient conditions.

1.	Installation	Overhead line for suspension or termination.
2.	Nominal System Voltage, kV	33 (line to line).
3.	Type of System	Three phase, 50 Hz, Three Wire, Effectively earthed.
4.	Highest System Voltage, kV	36 (three phase).
5.	Atmospheric Condition	Moderately polluted.
6.	Altitude, meter	0-300 above sea level.
7.	Maximum Ambient Temperature, °C	45.
8.	Insulator Material	The Insulator shall be made of good commercial grade wet process porcelain. The porcelain shall be sound, thoroughly vitrified and free from defects and blemishes that might adversely affect the life of the Insulator. The exposed parts of the porcelain shall be smoothly glazed and shall be brown in color unless otherwise specified.
9.	Type of Insulator	Ball & Socket type Disc, security clip made of Stainless Steel or Phosphor Bronze.
10.	Markings	Each Insulator shall be marked with the name of Trade Mark of the manufacturer, the type of Insulator and the year of manufacture. These markings shall be legible and indelible.
11.	Maximum Nominal Diameter of Insulator, mm	255
12.	Nominal Spacing, mm	146
13.	Minimum Nominal Creepage Distance, mm	292
14.	Coupling Size, mm	16
15.	WITHSTAND VOLTAGE, MINIMUM	
15.1	Power Frequency, dry	70
15.2	(one minute), kV	40
15.3	Power Frequency, wet	
	(one minute), kV	170
	Impulse 1.2x50 micro-sec wave, kV	
16.	FLASHOVER VOLTAGE, MINIMUM	
16.1		78
16.2	Power Frequency, dry, kV	45
16.3	Power Frequency, wet, kV	180
	50% Impulse 1.2x50 micro-sec wave, positive, kV	185
16.4	50% Impulse 1.2x50 micro-sec wave, negative, kV	

17.	POWER FREQUENCY PUNCTURE VOLTAGE MINIMUM, kV	110
18.	RADIO-INFLUENCE VOLTAGE DATA MINIMUM:	
18.1	Power Frequency Test Voltage, RMS to Ground, kV	10
18.2	Maximum RIV at 1000 KC Micro-volt	50
19.	MECHANICAL FAILING LOAD MINIMUM, kN	70

B. Specification of 33 kV Strain Insulator String Set:

33 KV Strain Insulator String Set consisting of the following component parts for each set. Design, Manufacture, Testing and Performance shall be in accordance with latest revisions of BS-3288 or other equivalent internationally acceptable Standards.

- | | | |
|----|----------------|--|
| 1. | Anchor Shackle | Made of forged steel galvanized complete with cotter bolt and Pin, UTS-6800 Kg, Galvanization as per BS-729 OR ASTM A-153 part 1 or ASTM A-153. |
| 2. | Ball Eye | Oval eye type, made of forged steel galvanized, UTS-6800 Kg, Galvanization as per BS- 729 part 1 or ASTM A-153. |
| 3. | Socket Eye | Made of malleable iron galvanized complete with cotter bolt and Pin, UTS-6800 Kg, Galvanization as per BS- 729 part 1 or ASTM A-153. |
| 4. | Strain Clamp | Bolted type, Made of malleable iron galvanized or Alluminium Alloy, suitable for accommodating ACSR GROSBEAK of overall diameter 25.15 mm, complete with bolts, nuts, washers, Alluminium Alloy liner etc., UTS-6800 Kg, Galvanization as per BS- 729 part 1 or ASTM A-153 in case of malleable iron or other ferrous metal. |
| 5. | Disc Insulator | 3 (Three) Nos. are required for each set. |

7.3.17 H-TYPE CONNECTORS

7.3.17.1 STANDARDS:

The H-Type Connectors as specified in this Section shall conform to the latest edition of the following standards for operation in overhead lines in air under local ambient conditions. Design, Manufacture, Testing and Performance of the H-Type Connector shall be in accordance with the BS-3288 Part-1 & BS-4579 Part 3 or equivalent International standards.

7.3.17.2 SPECIFICATIONS:

The H-Type Connectors will be used for connecting the ACSR Conductors to ACSR Conductors, AAC Conductors to AAC Conductors and Copper Conductors to AAC conductors. These should be Uni-metal or Bi-metal type according to the contractions and applications of such connectors.

These should be made from high conductivity Aluminium and pre-filled with oxide inhabiting compound. The design of the compression type connectors should be such that galvanic corrosion is minimised. Conductor rough & tooling shall be clearly joined on the connectors.

The connector must have at least the same conductance as the conductor for which it is intended to be used and shall carry the full continuous current rating of the conductor size they are designed for.

The original quality of contacts shall be maintained through out the service life of the connectors. Glow discharge and radio interference must be reduced to a minimum level. All compression type connectors shall be suitable for installation, using either manual or hydraulic compression tools.

The size of the connectors for different Conductors is as follows:

	Grove A		Grove B		Length in mm
	Max (mm ²)	Min (mm ²)	Max (mm ²)	Min (mm ²)	
ACSR GROSBEAK/ACSR GROSBEAK	400	350	400	350	150.00
ACSR MERLIN/ACSR MERLIN	185	150	185	150	112.00
ACSR DOG/ ACSR DOG	120	95	120	95	63.00
AAC WASP/ AAC WASP	120	95	120	95	63.00
AAC ANT/ AAC ANT	70	50	70	50	47.00
AAC WASP / Service Bail	120	95	35	16	63.00
AAC ANT /Service Bail	70	50	35	16	47.00

INFORMATION REQUIRED:

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- a) Manufacturer's Printed Catalogue describing specification and technical data for offered Accessories.
- b) Dimensional drawing of offered Accessories.
- c) Detail description of testing facilities at manufacturer's plant.

7.3.18 SHIELD WIRES:

1.	Installation	Sub-station
2.	Type	Stranded
3.	Material	High Strength Steel
4.	Nominal Size	9.525 mm
5.	Number of Strand	7 (Seven)
6.	Diameter of Each Strand	3.05 mm
7.	Overall Diameter	9.525 mm
8.	Weight per KM Length	407 Kg
9.	Rated Ultimate Tensile Strength	4,900 Kg/mm ²
10.	Class of Zinc Coating	Class-A
11.	Galvanization	As per BS-729 OR ASTM A-153
12.	Grade of Steel	60,000 Kg

14.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.
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A. FEATURES

- Wires shall be shipped on standard non-returnable wooden reels Gross weight shall not exceed 800 Kg per reel. The minimum length of wire per reel shall be 1500 M.
- Each reel shall have the following information stenciled on side size and kind of conductor, length of conductor, gross and net weight. No joints of any kind shall be made in the finished wire entering into the construction of strand.
- The diameter of each zinc coated wire forming the strand shall not differ from the diameter specified by more than plus or minus 0.01 mm.
- The strand shall have a left hand lay with a uniform pitch of not more than 16 times the normal dia. of the strand.

B. PACKING AND SHIPPING

Grounding wire reels shall be constructed sufficiently strong to withstand usual requirement shipping, transporting and field erection.

C. HARDWARE FOR SHIELD WIRE

- i) Angular 90° bolted type T-connector of malleable iron galvanized steel or aluminum alloy suitable for 9.525 mm dia, 7/3.05 mm stranded high strength galvanized steel wire run to 9.525 diameter, 7/3.05 mm stranded high strength galvanized steel wire tap.
- ii) Angular 45° bolted type clamp made of aluminum alloy suitable for 9.525 mm diameter, 7/3.05 mm stranded high strength galvanized steel wire run to 9.525 mm diameter 7/3.05 mm stranded galvanized steel wire tap.
- iii) Shield wire clamp set suitable for 9.525 mm diameter 7/3.05mm stranded high strength galvanized steel wire, comprising of the followings :
 - a) Bolted wire strain clamp made of malleable iron galvanized steel or aluminum alloy complete with nuts bolts washers etc. anchor shackle made of forged steel galvanized complete with cotter bolt and pins.
 - b) Double eye rectangular made of forget galvanized.
 - c) Wire clip made of malleable iron galvanized or aluminum alloy.

7.3.19 PG CLAMP

7.3.19.1 STANDARDS:

The PG Clamps as specified in this Section shall conform to the latest edition of the following standards for operation in overhead lines in air under local ambient conditions. Design, Manufacture, Testing and Performance of the PG Clamp shall be in accordance with the BS-3288 Part-1 & BS-4579 Part 3 or equivalent International standards.

7.3.19.2 SPECIFICATIONS:

The PG Clamps will be used for connecting the ACSR Conductors to ACSR Conductors and AAC Conductors to AAC Conductors. Parallel Groove Clamp, a non tension bolted type connector, shall be made of

Aluminium Alloy, massively designed body. The bolts are made of Galvanised Steel. For the insulated conductors, 0.80 mm thick PVC insulation cover is to be provided with full length clamp.

The clamps must have at least the same conductance as the conductor for which it is intended to be used and shall carry the full continuous current rating of the conductor size they are designed for.

The original quality of contacts shall be maintained through out the service life of the clamps. Glow discharge and radio interference must be reduced to a minimum level.

The size of the connectors for different Clamps is as follows:

Inf o r m a t i o n	Conductor Size (sq. mm)	Conductor Diameter (mm)	Dimension		No. of Bolt
			L (mm)	W (mm)	
ACSR GROSBEAK, either side	370	25.15	125	50	3
ACSR MERLIN, either side	170	17.35	110	45	3
ACSR DOG, either side	100	14.15	95	30	2
ACSR RABBIT, either side	50	10.05	80	22	2
AC WASP, either side	100	13.17	95	30	2

The Bidder/ Manufacturer as per tender requirements shall provide all information. Besides these, the following information has to be submitted:

- Manufacturer's Printed Catalogue describing specification and technical data for offered Accessories.
- Dimensional drawing of offered Accessories.
- Detail description of testing facilities at manufacturer's plant.

7.3.20 LV AC DISTRIBUTION PANEL

Vermin and dust proof, completely metal enclosed by sheet steel (11 SWG) with necessary reinforcement, colour, Grey with appropriate spray painting, free standing type, compact in size, suitable for opening at the back by hinged door with locking device.

There shall be a 3 phase 400 A, 1 KV bus (Cu) arrangement with neutral. Bus being connected with the following MCCB's and instrument. :

Voltmeter with 6-position selector switch connected to the bus.

2 × 400A, 4 pole MCCB being interlocked with each other, operative one at a time to bring the input Power to the Bus. Both these incoming feeders shall have 3 x ammeter (each).

2 × 100A, 3 pole MCCB as outgoing.

10 × 60A, 3 pole MCCB as outgoing.

10 × 30A, 3 pole MCCB as outgoing.

The Short Circuit Current rating of each 3 phase MCB and MCCB shall be of at least 36 kA and that for 1 phase shall be at least 10 kA.

All MCCB's are provided with over load setting and short circuit tripping device.

There shall be a 3-φ 4-wire class 0.5 energy meter for recording the station use.

ACDB's AC supply entry point from Auxiliary TR (can be panel mounted) or Auxiliary TR's LT side shall have Over Voltage protector installed.

Necessary terminal blocks and glands/openings shall be provided for the entry of suitable cables.

All equipment/instruments inside the panel shall be arranged neatly and sufficient space shall be provided for easy approach to each equipment/instrument.

Thermostat controlled panel heater, bulb for inside illumination of panel shall be provided.

All other features as stated in the table of guaranteed data schedule shall applicable also.

LV AC distribution panel shall have a monitoring Devices/System that shall monitor all voltage & current levels, physical status of AC Supply MCBs, self-supervision of controller equipment etc. There shall be protective scheme against over/under current & voltage flow. All the measurement values & alarm signals shall be available on monitoring devices display and to be indicated with necessary Annunciation with hooter/Indication LED lamp where applicable in ACDB panel & shall also to be incorporated in SAS. AC change over switch controlling Devices shall also be incorporated in SAS; necessary measurement, controlling, status & alarm signals shall be available in ACDB & SAS.

7.3.21 DC DISTRIBUTION PANEL

The switchboard shall comply with the requirements of BS 5468 (IEC 60439)

The distribution switchboard shall be of the cubicle type or otherwise incorporated in the cubicles for battery chargers. Double pole switches and fuses or switch fuses (miniature circuit breakers to BS 4752 or IEC 60127 may only be used if it can be shown that there will be no discrimination problems with sub-circuits) shall be fitted to the DC switchboard as required by substation services but, as a minimum requirement, that set out in the Schedule A of Requirements.

Distribution panels shall be mounted adjacent to the charger control panel and shall be of the cubicle type complying with the general requirements of cubicle type control panels. No equipment associated with the chargers shall be installed in the distribution board.

Distribution panels shall incorporate double-pole switches for each of the outgoing DC circuits and double-pole isolators for the incoming DC supplies. The panel shall be provided with a voltmeter and centre zero ammeter on each incoming circuit.

A double pole switch or contactor shall be provided for the purpose of sectionalising the busbar.

A battery earth fault detecting relay, which will centre tap the system via a high resistance, shall be incorporated in the distribution panel.

A low voltage detecting device for the system shall be incorporated in the distribution panel. No-volt relays will not be accepted for these devices. The voltage setting shall be adjustable over an approved range.

In addition to any other requirements specified elsewhere, the battery earth fault detecting relays and low voltage devices shall each have three alarm contacts, one for local visual annunciation, one for the station control panel alarm indication and one for potential free contact for external supervisory alarms. A lamp test facility shall be provided.

Connections between the battery and the distribution cubicle shall be made in PVC insulated cable as required. Cable laid in runs where it may be subject to damage shall be protected by wire armouring, be sheathed overall and be cleated to walls as required.

Cable boxes or glands shall be provided as appropriate for all incoming and outgoing circuits of the distribution switchboard and associated battery chargers. Each circuit shall be suitably labelled at the front of the panel and at the cable termination where the terminals shall be additionally identified.

Charging and distribution switchboards shall be provided with an earthing bar of hard drawn high conductivity copper which shall be sized to carry the prospective earth fault current without damage or danger.

The cubicles for the chargers and distribution boards shall be of rigid, formed sheet metal construction, insect and vermin proof, having front facing doors allowing maximum access to the working parts, when open. The design of the cubicles for the chargers shall be such as to prevent the ingress of dust and minimise the spread of flames or ionised zones, shall be to IEC 60529 IP52, but at the same time shall provide all necessary ventilation and cooling. The design of the frames shall allow the clamping and holding of all chokes, transformers and similar sources of vibration, so that vibration will be minimised, satisfy relevant standards, and not limit the life of the equipment. The frame shall allow the fixing of lifting and so that the equipment remains properly mechanically supported whilst being transported, lifted and installed.

DC distribution panel shall have a monitoring Devices/System that shall monitor all voltage & current levels, physical status of DC Supply MCBs, self-supervision of controller equipment etc. There shall be protective scheme against over/under current & voltage flow and DC positive & negative earth faults. All the measurement values & alarm signals shall be available on monitoring devices display and to be indicated with necessary Annunciation with hooter/Indication LED lamp where applicable in DCDB panel & shall also to be incorporated in SAS.

7.3.22 SUB-STATION STEEL STRUCTURE

GENERAL

The structural steel shall conform to the latest provision of ASTM A36/BS-4360 and all the parts shall be hot dip galvanized as per BS-729 after fabrication.

SCOPE

The work covered by these specifications shall include design, fabrication, marking, painting, galvanizing, supply of all materials, suitable for the location, sea worthy packing, transportation to S/S site, storage on the site, site visit needed to complete the sub-station structures, miscellaneous steel members, nuts, bolts, plates etc. according to specifications and drawings prepared by the bidder and approved by the Purchaser.

DESIGN DATA

Structure shall be designed on the basis of the following:

- i) Buses, structures, conductors and shield wires shall be designed to withstand the force of a true wind velocity of 160 KM per hour (120 kg/m^2 on round surface, 200 KG/m^2 on flat surface). The over load capacity factor shall be 2.
- ii) All connections between steel members shall be bolted, minor welds will be allowed for fabrication purposes before galvanization, but no welding will be permitted in the main legs of members of terminal structure. The diagonals and struts shall be bolted directly to the structure legs and to each other. Gasket plats shall not be used unless absolutely necessary.

Members shall be design to avoid depressions that can trap water, such depressions if unavoidable, shall have drain holes, and connections shall be designed so that all bolts can be tightened in the field using a flat erection wrench. The ends of connected members, shall, where necessary, be clipped or cut to allow free movement of the wrench.

The quantity of bolts, nuts and locking devices furnished shall include the number of each size required for erection plus an additional 5% of that number to cover loss and damages.

The bus supports shall be designed to withstand a momentary short circuit current equal to the momentary short circuit rating of the associated breakers.

All shield wires for the sub-station shall be 9.525 mm dia 7 strands with high strength steel galvanized wire.

The contractor must supply complete detailed drawings, bill of materials, composition of materials etc. all connectors, clamps, fittings, hardware, etc. with their range of adjustment. Detailed catalogues, printed literatures etc. showing all significant characteristics for all those things for which the contractor intends to offer must be supplied with the offer. Particular items proposed to be supplied, must be arrow marked in the catalogue.

Material

All materials used for the sub-station structures and buses shall be new and undamaged and shall conform to the requirements given below certified test reports for all steel materials shall be submitted to the Engineer before such materials shall be fabricated. The latest revisions to the specified American Society for Testing Materials (ASTM) and General Specifications ruling.

i) STEEL STRUCTURE MEMBER

The main steel structure shall be designed for the loading specified and separate additional structures as necessary shall be provided for overhead line terminations, disconnect switches, bus supports, potential devices lightning Arresters and other equipment.

The structures steel shall conform to the latest revision of ASTM for “Steel Bridge and Buildings” or equivalent and all parts shall be hot dip galvanized after packing for fabrication.

All structures shall be shipped completely unassembled unless other-wise specified. All S/S parts shall be plainly marked as aid in assembly and the marking shall agree with the identification on the erection

drawings.

The structures shall be completed with all bolts, nuts and locking devices which are required for erection of the structures and for installation of equipment.

ii) CONNECTION FASTENERS

All connections shall be made with hot dip galvanized, sodium carbon, heat treated, regular square head, bolts to meet Feb Spec FF-B-575. Type-1, Grade-5 or of equivalent standard with hot dip galvanized, heavy semi finished hexagonal nuts. Each fastener shall have a locking device by screw and bolt, length of which shall provide 3mm (minimum) to 12.5 mm (maximum) projection beyond nut when connection is tightened. Standard ASTM-A 394 or equivalent.

iii) WELDING ELECTRODE

Where welding is permitted in Fabrication it shall be done in accordance with ASTM specification A233 using F-70 series low hydrogen electrode as recommended by American Welding Society (AWS) or equivalent for various grades of steel.

iv) GALVANIZED COATING

All angles, channels, plates and other shaped or members required for these structures shall be galvanized in accordance with ASTM specification A123 or equivalent. Galvanizing is to be applied on after fabrication is completed as per BS-729 (1971) Galvanization shall be done when fabrication is complete.

FABRICATION

The Purchaser/ Engineer shall be notified when fabrication of the materials is to begin so that Owner/ Engineer may, if desired, provide shop inspection.

Each steel component shall be completely fabricated and then galvanized in the shop. All workmanship and finishing shall be first class and equal to the best practices in modern steel fabricating shops. All angles and members shall be fabricated in accordance with the standard, specifications and details given in the edition of the "Steel Construction Hand-Book" issued by the American Institute of Steel Construction or its equivalent. Structural item as delivered to the job site shall have all members straight, free from warp, bends or local deformations, accurate, so that when the structure is assembled, proper fit will be provided. All reaming of holes shall be done at the factory before galvanizing. Punching, drilling or reaming of holes after galvanizing will not be permitted. Holes, 18mm in diameter shall be provided in the steel for ground connection on each leg of each structure. Legs or members shall be drilled with 18 holes at 1.5m intervals, in all of members where ground conductors are to be installed for grounding of shield wires or equipment. These holes shall be made before galvanizing. Holes shall be drilled and attachment devices shall be furnished on the terminal structures for all overhead circuit conductors and shield wires.

The bolt holes shall not exceed the diameter of the bolt by more than 1.5mm. Leg angles and other members shall be lap spliced and the back of the inside angle shall be round to clear the fillet of the outside angles.

i) WELDING

All welding done in the shop on steel members shall be by the shield metal arc processes using joint details performed in accordance with the American Welding Society (AWS) code or equivalent. All welding procedures and operators shall be qualified by an independent testing laboratory in accordance with AWS standard qualification procedures. Accurate records of operator and procedure qualifications shall be maintained by the contractor and shall be available to the owner or Engineer. All welds shall be continuous and shall develop full strength of the least strength component unless otherwise shown on the drawings.

Components shall be thoroughly cleaned before welding and shall be accurately fitted and rightly secured in position during welding and weld surface shall be smooth and uniform and shall be thoroughly cleaned of all slag flux before galvanizing.

ii) MARKING

Each separate structure member shall be plainly stamped with a number. All like parts shall have the same number. The marking shall be stamped into the metal with figures at least 15mm high. Impression shall be made before galvanizing and have sufficient depth so that they are plainly visible after galvanizing. The mark shall be placed as nearly as possible in the same relative position on each piece so as to be seen plainly after assembly of the structure.

The mark numbers shall be composed of letters and numbers that will designate the S/S and type of structure. These markings shall be the same as shown on the fabrication and erection drawings.

iii) GALVANIZING

All steel components of the structures shall be galvanized using the hot dip process. Fabrications shall be completed before galvanizing. All pieces to be galvanized shall be thoroughly cleaned to remove paint, grease, rust, scales or other materials that could interfere with the bonding of zinc with the steel. Galvanization shall be as per BS-729.

The contractor shall perform all works in accordance with the rules and requirements as specified under ASTM specifications A123, A153 and BS-729.

After galvanizing, steel members may be straightened, if necessary by being re-rolled or pressed only. No punching welding or any other work which may damage the protective cover shall be allowed after galvanizing, except the lapping of nuts. All holes shall be free from peler after galvanizing.

iv) DRAWINGS

The contractor shall furnish to the employer/ engineer complete fabrication and erection drawings along with the strength calculations on buses and loading on each structure foundation of each type of S/S structure for approval before fabrication. Drawings shall show outline, dimensions, drilling and details of fabrications.

STRUCTURE

All structures shall be designed, fabricated, galvanized etc. as specified and as described below :

i) TERMINAL STRUCTURES

The "Terminal Structure" is identified as the structure on which the 11 KV services cable/overhead

conductor are terminated. When designed to accept the cable termination, this shall be complete with all plates, bases and other fittings required for mounting the cable and box for 11 KV XLPE single core cable of appropriate size 2x1Cx300 Sq.mm cable per phase) with mounting switches etc.

For overload conductors and shield wires, the maximum tension per conductor shall be 450 Kg.

ii) BUS SUPPORT STRUCTURES

The bus support structures shall be pedestal type, steel columns used to support the strain ACSR S/S buses. These structures shall be designed to withstand the forces outlined herein without damage off deformation. All plates and bus support insulators shall be furnished.

STRUCTURE FOUNDATION

The contractors shall furnish the detail design for foundations of all steel structures considering soil pressure of $<4880 \text{ Kg/m}^2$. A copy of calculations and design criteria for foundation along with complete bill of materials of sand, cement, reinforcing bar and concrete aggregate etc. shall be furnished after signing of the contract and at the time of drawing approval.

PACKING

- i) Steel members shall be shipped unassembled only members with the same mark shall be bundled together.
- ii) All packages shall be securely tied with heavy gauge annealed galvanized steel bands to withstand transportation handling.
- iii) Parts shall be handled and loaded, without damaging the materials or galvanized coatings.
- iv) The contractor shall replace, free charge all materials which has been damaged due to inadequate of faulty packing.

H. TAGGING

- i) For erection purpose, each package or bundle shall be tagged to identify the number of pieces.
- ii) For shipping purpose separate tagging shall be used for each package and bundle showing the name and number of the contract, gross weight, port of dispatch and the destination in Bangladesh.

7.3.23 BUS-BAR CONDUCTOR AND JUMPERS

1.	Installation	Sub-station, Outdoor.
2.	Type	Aluminum Conductor Steel Reinforced (ACSR)
3.	Code Name	MARTIN ACSR for Bus-Bar Gross Beak ACSR for Jumpers
4.	Conductor Size	1351.5 MCM for MARTIN ACSR 636 MCM for Gross Beak (ACSR)
5.	Standard	Performance, design & testing shall be in accordance to the latest editions of ASTM B-232.
6.	Shipment	On standard non-returnable wooden reels Gross weight shall not exceed 2000 Kg per reel.
7.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC standards.

A. FEATURES

- Shall be of continuous length between supports.
- Conductors to be used for bus bars shall be stressed not more than 33% of their breaking strength.
- Overhead conductors carried by the S/S structures shall be erected with such a tension that when the conductors are subject to a transverse wind pressure of 640 Pascal's on the whole projected area, the factor of safety is not less than 2 (Two).
- When dissimilar metals are in contact, approved means shall be provided to prevent elector-chemical action and corrosion.

ELECTRICAL HARDWARE FOR 33KV SWITCHYARD

- All connectors shall be compression type and made of Aluminum alloy suitable for the conductor.
- Load support clamps shall be complete with bolts, nuts, lock washers etc. complete and of the appropriate size.
- Clamps and fittings made of steel or malleable iron shall be galvanized as per BS-729.
- Joints and connections shall be such as to permit easy dismantling. All necessary terminals and connections (bi-metallic) shall be provided for connection to the equipment. Suspension and tension conductor clamps shall be as light as possible and shall be of approved type.
- Tension conductor clamps shall be not permit slipping of or damage to or failure of the complete conductor or any part, thereof at a load less than 70% of the breaking load of the conductor.
- Catalogue with making on the catalogues of the hardware proposed shall be submitted with the offer.

7.3.24 SUB-STATION EARTHING

A. SCOPE

These Clauses describe the General Requirements for the Earthing and Lightning Protection and shall be read in conjunction with the Project Requirements and Schedules.

B. REFERENCES

American Standard

ANSI/IEEE std 80 : IEEE Guide for Safety in AC Substation Grounding

ANSI/IEEE std 81 : IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potential of a Grounding System.

DIN VDE 0141 : Earthing Systems for Power Installations with Rated Voltages above 1 KV.

British Standards

BS 1432 : Specification for copper for electrical purposes; high conductivity copper rectangular conductors withdrawn or rolled edges.

BS 1433 : Specification for copper for electrical purposes; Rod and bars.

BS 2871 : Specification for copper and copper alloys. Tubes.

BS 2874 : Specification for copper and copper alloy rods and sections (other than forging stock).

BS 4360 : Specification for weldable structural steel.

BS 6360 : Specification for conductors in insulated cables and cords.

BS 6651 : Protection of Structures against Lightning.

BS 6746 : Specification for PVC insulation and sheath of electric cables.

BS 7430 : Code of Practice for Earthing.

International Standards

ISO 427 : Wrought copper-tin alloys - chemical composition and forms of wrought productions.

ISO 428 : Wrought copper-aluminum alloys - chemical composition and forms of wrought productions.

ISO 11 87 : Special wrought copper alloys - chemical composition and forms of wrought products.

ISO 1137 : Wrought coppers having minimum copper contents of 99.85% - chemical composition and forms of wrought products.

C. GENERAL

An earthing System generally in accordance with the requirements of IEEE 80 and BS 7430 shall be designed under this contract. Installation and supply of all materials and equipment also included. The earthing system shall also be including earth electrodes and connections to all electrical equipment and metallic structures on the site. The earth electrodes shall limit the potential rise under fault conditions and buried conductors shall be provided to limit potential differences on the site and adjacent to the site to ensure safety to people and animals. Protection of all electrical equipment against lightning shall also be provided.

D. EXTENT OF WORK

The work under the clause "**SUB-STATION EARTHING**" comprises the site testing, design, supply and installation including excavation, back filling and temporary reinforcement of earthing system and connections to electrical apparatus at the substation. Also included the lightning protection scheme and the provision of portable earthing devices.

The contractor shall be required to undertake all necessary earth resistivity tests at the sub-station sites and from the tests result to undertake the design of the earthing system. The design as well as providing safe passage to earth for the stated earth fault currents, shall also include calculation of step, touch and mesh potentials, which shall be within the allowable limits of the standards quoted in the specification.

The design calculations of step, touch and mesh potentials accompanied by full installation drawings and material requirement schedules, shall be submitted to and receive the approval of the Engineer before materials procurement or installation commences.

E. SOIL SURVEY

The preliminary tender design shall be based on a value of 100 ohm-m soil resistivity.

Not later than one month after the site has been handed over for access, the Contractor shall carry out an earth resistivity survey of the sites and report in writing to the Engineer in accordance with the approved program. The report shall detail the methods and instruments used and the results of the surveys. Based on the results the Contractor shall include in the report his proposal for the resistivities to be used in the design of the earthing system.

The surveys shall show the variation of resistivity across the site and with the depth below the site. The Contractor shall consider if there is a need to model the resistivity in two layers and if there is any advantage in the use of deep rod electrodes.

The surveys shall also determine the depth and nature of any underlying rock, which may limit the depth for driving earth rods or if boring will be necessary for installing earth rods.

The weather conditions prior to and at the time of the surveys shall be recorded in the report and an assessment made of the seasonal variations in resistivity based on meteorological data for the area. The program for the project should, as far as possible, time the resistivity surveys to take place during a dry season.

The report should also state if there are any indications that the ground is corrosive to bare copper.

The report shall be approved by the Engineer before proceeding with the design of the earthing

F. FAULT CURRENT AND DURATION

Each site shall be provided with an earth grid of buried conductors designed for an earth fault current of **31.5 KA** for three second. The preliminary earthing, design shall be such that the ground potential rise shall not exceed 2 kV.

G. EARTH ELECTRODE SYSTEM DESIGN

i) Design Calculations

The design of the earth electrode systems shall be based on the approved earth resistivity data and the system fault currents and their duration.

The design calculations in detail shall be submitted for approval of the Engineer and shall be based on

the methods given in the standards listed. The calculations shall include the following parameters:-

- (a) earth resistance of the whole system and of its components.
- (b) earth potential rise
- (c) step, touch and mesh potentials inside and outside the perimeter fence
- (d) requirements for a high resistance surface layer
- (e) conductor ratings

Earthing points shall be provided such that the combined resistance of the earth grid and all other earthing points does not exceed 0.5 ohm during the dry season.

The earth potential rises shall not exceed the CHIT limits appropriate to the classification of the system unless special precautions are taken to cater for transferred potentials.

Step, touch and mesh potentials shall be within the permitted limits calculated in accordance with the standards given in IEEE 80 for the proposed surface layer.

ii) Earth Electrode

The earth electrode shall comprise a system of bare copper conductors forming a mesh buried near the surface of the ground and supplemented, if required, by one or more of the following electrodes:-

- (a) a system of interconnected rods driven into the ground.
- (b) a mesh system of bare conductors buried in the ground.
- (c) structural metal work in direct contact with the ground.
- (d) reinforcing steel in buried concrete.
- (e) a system of bare conductors buried near the surface of the ground outside the perimeter fence.

iii) Mesh System

The mesh system shall be designed with above to limit touch, step and mesh potentials taking into account the combined length of the mesh conductors, other buried conductors and rods but excluding any buried conductors outside the perimeter fence. Due regard shall be given to non-linear distribution of the fault current giving rise to the highest potentials at mesh corners.

The rating of the mesh conductors shall be compatible with the fault currents after allowing for parallel paths of hard drawn high conductivity copper strip with a minimum conductor size of 200 mm².

The conductor shall be installed in trenches excavated by the contractor at a minimum depth of 1000 mm. The system will be installed after all foundations have been laid and the site filled to 100 mm below finished level. When the earthing grid has been laid and back filled, bricks will be laid up to finished site level. Where the excavated material is rocky or may be difficult to consolidate, the back filling shall be carried out using other material to the approval of the Engineer. The cost of such material shall be deemed to be included in the Contract.

iv) Interconnected Rods

If the design calculations show that a mesh alone is unable to limit the required values, then the mesh

shall be supplemented by the use of interconnected copper earthing rods driven into the ground or installed in bored holes.

Rods shall be installed inside the perimeter fence to enclose the maximum possible area compatible with the earthing of any metallic fence. (The spacing between rods shall not be less than their length, unless rating considerations determine otherwise). The copper rod electrodes of 15mm diameter shall be interconnected in groups of four to eight rods by insulated copper conductors and non-ferrous clamps to form a ring. Each group shall be connected to the mesh by duplicate insulated copper conductor via disconnecting test links.

Individual rods may be connected directly to the mesh, provided the rod can be disconnected for testing.

Rods installed in bored holes may be used to reach lower resistivity ground strata at depths beyond the reach of driven rods or where rock is encountered and it is not possible to drive rods. After installing the rod the bored hole shall be back-filled with a low resistivity liquid mixture, which shall not shrink after pouring, to ensure good contact between the rod and the ground for the life of the installation.

The resistance and rating of individual rods and the combined resistance of the groups of rods in the proposed design shall be calculated and the rating of the interconnecting conductors shall not be less than that of the group of rods with a minimum conductor size of 200 mm².

The calculation of potentials in the design of the complete installation shall be made without the group of rods with the lowest estimated resistance to simulate the condition with the group disconnected for testing.

v) Other Conductors

As an alternative to rods to supplement a mesh, additional bare copper conductors with a cross-section area of not less than 150mm² may be used. They shall be buried in the ground within the perimeter fence to enclose the maximum possible area compatible with the earthing of any metallic fence. Such conductors may be laid below the mesh, below foundations or in areas where there is no plant. It shall be shown by calculation that the step potentials are low in such areas.

The conductor shall be in a ring, or a part of a ring, with at least two widely separated connections to the mesh or other parts of the earthing system.

vi) Reinforcing Steel

The reinforcing steel in the foundations of buildings containing the primary electrical equipment may be used as auxiliary electrodes, subject to the approval of the Engineer. The contractor shall show in the design calculations that the fault currents and d/c stray currents will not damage the structure.

Steel reinforcing mesh in the floors of the building may also be used for the control of step and touch potentials within the building subject to approval of the Engineer.

vii) Conductors Outside Perimeter Fence

If the design calculations show that the step and touch potentials outside the perimeter fence or wall exceed the limits, than additional bare conductors shall be buried in the ground outside the fence in the form of rings encircling the whole site.

The distance of the conductors from the fence and the depth shall be determined in the design to ensure that step and touch potentials are within the limits.

The minimum conductor size shall be 75mm² copper and shall be connected to the fence or the mesh with 75mm² conductors at each corner of the site and at intervals of not more than 100m. These conductors shall not be included in the calculations called for above.

POWER TRANSFORMER NEUTRAL GROUNDING

Neutral of POWER TRANSFORMER separately Grounded by 03(Three) Nos. of Electrode (round Bar) of 16 mm Dia with 04(Four) Meter Length Each and Length of the electrode will be decided as per Design calculation. From Transformer Neutral to Electrode Connection 300 sq-mm Copper Conductor will be used.

MATERIALS AND INSTALLATION

Description	Size
Mesh Conductor Cross Section Area	200 sq-mm(Min)
Dia & Length of Each electrode/Rod	16 mm & 04(Four) Meter
Total Length of the electrode & Mesh Conductor	as per Design calculation
Conductor for Neutral of Power Transformer	2x150 sq-mm(Min)

The size/type of earthing Riser/Connectors for different equipment shall be as follows:

1	Neutral of the Power Transformer 33/11kV	-not less than 2x150 mm ² copper conductor with adequate insulation
2	Body of the Power Transformer, 33/11kV	- bare copper bar of not less than 120mm ² for each power transformer 2 nos.
3	Neutral of the station transformer, 33/0.4 KV	- not less than 150 mm ² copper conductor with adequate insulation
4	Body of the station transformer, 33/0.4 KV	- not less than 120 mm ² Cu wire
5	33 KV PT LV Neutral	- 16 mm ² Cu. Wire.
6	11 KV PT LV Neutral	- 16 mm ² Cu wire
7	Steel mounting structure at the switchyard	- 120 mm ² Cu wire for each steel mounting structure 2 nos.
8	Body of the indoor 33 KV switchgear Panel	- not less than 3x120 mm ² Cu wire
9	Body of the indoor 11 KV switchyard Panel	- not less than 120 mm ² Cu wire at minimum 2 points
10	Body of the Indoor control relay panel - 33/11 KV A.C. distribution panel. DC distribution panel, battery charger and other miscellaneous indoor equipment.	- 120 mm ² Cu wire
11	33 KV Lightning Arrestor Outdoor	- not less than 120 mm ² Cu wire at minimum 2 points

There shall be no inter-connection between earthing points of Power Transformers, LAs & substation main earthing mesh.

The earthing leads with appropriate thimble shall be connected to the welded flat bar earth electrode, by bolts & nuts.

The other ends of the earthing leads shall be connected to the equipment/chassis at appropriate terminals by using thimbles/connectors etc and nuts & bolts.

Appropriate earthing devices and arrangement shall be provided for all 33KV and 11KV switching panels having provision for operation from the front.

H. DESIGN OF EARTH SYSTEM

i) Earth System

An earth system shall comprise the following components:-

- (a) the conductors between the earth electrode system and the main earth bar
- (b) the main earth bar
- (c) the conductors between the main earth bar and the metallic frames, enclosures or supports of electrical equipment
- (d) the conductors between structural metalwork and non-electrical equipment and the main earth bar

The rating of earth system conductors connected between an item of electrical plant and the earth electrode system shall be sufficient to withstand the fault currents and duration, after allowing for the parallel paths through the earth system conductors, with any one conductor disconnected.

The design comprising all the above mentioned items shall be submitted to the Engineer for approval within four months of the award of contract.

ii) Connection of the System Neutrals and Earth

The system neutral points within a substation shall be arranged in two groups with a conductor from earthing point.

The copper earth electrodes of a neutral earthing point shall be arranged in two groups with a conductor from each group to a test link and there shall be duplicate bare copper conductors of cross sectional area not less than 150 mm² from each test link to the earth grid. The duplicate connection may be in the form of a ring.

Neutral earthing connections between the substation system (transformer) neutral and the test links shall be of bare copper tape, secured and supported on stand-off insulators so that there is no contact between copper tape and transformer tank.

Neutral earthing conductors shall normally be buried directly in the ground but where necessary, they may be cleared to walls, fixed to cable racks or laid in the cable trenches.

iii) Main Earth Bar

The main copper earth bar shall be in the form of a ring or rings of bare conductors surrounding, or within an area in which items to be earthed are located. Where two or more rings are installed, they shall be interconnected by at least two conductors which shall be widely separated.

The main earth bar, or parts thereof, may also form part of the earth electrode system, providing this is bare conductor.

Each main earth bar shall be connected by at least two widely separated conductors to the earth electrode system.

The minimum conductor size for the main earth and interconnections between earth bars and the earth

electrode system shall not be less than 200 mm².

iv) Electrical Equipment Tank and Structure Connections to Earth

Connections between: (a) all HV electrical equipment and (b) LV electrical equipment comprising substantial multi-cubicle switchboards and the main earth bar shall be duplicated. The bare copper conductor size shall have a minimum cross section area of 150 mm².

All substation equipment, including disconnectors, earth switched, main transformer tanks, current and voltage transformer tanks, switchboards, electrical supporting steelwork and gantries etc. shall all be connected with the earth grid.

Surge Arresters installed for the protection of transformers and reactors shall be connected by low reactance paths both to the transformer tanks and to the earth grid.

Capacitor voltage transformers used in connection with line traps shall be connected by direct low reactance paths to a single earth rod for each Arrester, in addition to the earth grid.

An earth mat shall be installed at all operating positions for outdoor HV equipment manual operating mechanism boxes and local electrical control cubicles to ensure the safety of the operator. The mat shall be directly bonded to the cubicle and the conductors forming the mat and the bonding connection shall have a minimum copper cross-section area of 75 mm².

Galvanized structures comprising bolted lattice components shall not be used as the sole earth connection path to post and strain insulators or to overhead line earth conductors.

Buildings containing electrical equipment shall be provided, at each level, with a ring of earthing conductors which shall have duplicate connections to the earth grid outside the building. The frames of all switchgear, control and relay panels and other electrical equipment and exposed structural metal work shall be connected by branches to a ring. The ring and branch conductors shall be of the same material as the earth grid. Strip run within buildings, inside cable trenches or above ground level on apparatus shall be neatly supported on non-ferrous clamps.

Fixed earthing connectors for use with portable earthing devices below shall be provided on each bus bar and on both sides of high voltage equipment is by tubular bus bars.

Rigid loops in the copper earthing strip branch bond between the equipment and the earthing grid shall be provided adjacent to each item of high voltage equipment for use with the portable earthing devices. The rigid loops shall be marked green.

Connections between other LV electrical equipment and the earth bar need not be duplicated. The single conductor shall be rated to withstand the fault rating of the equipment.

v) Connections to Non-Electrical Structural Metalwork and Equipment

All metal work within the project area which does not form part of the electrical equipment shall be bonded to the main earth bar except where otherwise specified. The bonding conductor size shall be not less than 150 mm².

Individual components of metallic structures of plant shall be bonded to adjacent components to form

an electrically continuous metallic path to the bonding conductor.

Small electrically isolated metallic components mounted on non-conducting building fabric need not be bonded to the main earth bar.

I. MATERIALS AND INSTALLATION

i) Conductors

Conductors shall be of high conductivity copper in the form of circular conductors stranded to IEC 228(BS 6360) or solid rods or bars to BS 1433.

Conductor sheaths shall be of PVC to meet the requirements of BS 6746 Grade TM1 or IEC 502 Grade ST1 with a minimum thickness of 1.5mm.

Buried conductors which are not part of the earth electrode system shall be PVC sheathed circular stranded cable.

Bare strip conductors only shall be used for earth electrodes or voltage control meshes.

Conductors buried in the ground shall normally be laid at a depth of 800 mm in an excavated trench. The back fill in the vicinity of the conductor shall be free of stones and the whole back fill shall be well consolidated. Conductors not forming part of a voltage control mesh shall be laid at the depth required by the approved design and in the case of a PVC sheathed conductor, at the same depth as any auxiliary power or control cables following the same route.

All conductors not buried in the ground shall be straightened immediately prior to installation and supported clear of the adjacent surface.

ii) Earth Rods

Earth rods shall be driven to a depth below the ground water table level, to be determined by the Contractor during soil investigation and survey of site.

The earth rods shall be of hard-drawn high conductivity copper with a diameter of not less than 15mm with hardened steel driving caps and tips. The rods should be as long as possible but couplings may be used to obtain the overall depth of driving required by the design.

The rods shall be installed by driving into the ground with a power hammer of suitable design to ensure the minimum of distortion to the rod. Where it is not possible to drive rods to the full depth required due to the presence of a strata of rock, then holes shall be drilled or blasted in the rock. The holes shall be filled with betonies or other approved material prior to inserting the rod.

If difficult driving conditions arising from hard or rocky ground are encountered or are anticipated or there is a need for deep rods, then high tensile steel rods shall be used. High tensile steel rods shall have a molecularly bounded high conductivity copper coating with a minimum radial thickness of not less than 0.25 mm. The overall diameter shall be not less than 12 mm. Rolled external screw threads shall be used on the rod for coupling and after rolling the thickness of the copper coating on the threaded portion shall be not less than 0.05 mm.

Rods, driving caps and tips shall about at couplings to ensure that the couplings and screw threads are not subject to driving forces. All screw threads shall be fully shrouded at the couplings. Alternatively, conical couplings may be used to the approval of the Engineer.

High conductivity copper for earth rods shall have a minimum copper content (including silver) of 99.90% to ISO 1337, Cu-ETP or Cu-FRHS (BS 2894 Grade C 101 or C102) for copper earth rods and to ISO 1337 Grade Cu-ETP (BS 28734 Grade C 101) for the molecular bonded copper coating of steel rods.

The steel for copper-clad steel rods shall be low carbon steel with a tensile strength of not less than 570 N/mm² to ISO 630, Grade Fe 430A (BS 4360 Grade 43A) or better.

Couplings for copper rods shall be of 5% phosphor bronze (copper-tin-phosphorous) to ISO 427, CU Sn₄ (BS 2874, Grade PB 102M) and for copper bonded steel rods of 3% silicon or 7% aluminum bronze to BS 2874, Grade CS 101 and BS 2871, Grade CA 102.

iii) Fittings

Clips supporting strip conductors not buried in the ground shall be of the direct contact type and clips for circular conductors shall be of the cable saddle type. The clips shall support the conductors clear of the structure.

Conductors shall be connected to earth rods by a bolted clamp to facilitate removal of the conductor for testing rod.

Disconnecting links shall comprise a high conductivity copper link supported on two insulators mounted on a galvanized steel base for bolting to the supporting structure. The two conductors shall be in direct contact with the link and shall not be disturbed by the removal of the link. Links for mounting at ground level shall be mounted on bolts embedded in a concrete base.

Disconnecting links mounted at ground level and the connections at the earth rods shall be enclosed in concrete inspection pits, with concrete lids, installed flush with the ground level.

All conductor fittings shall be manufactured from high strength copper alloys with phosphor bronze nuts, bolts, washers and screws. Binary brass copper alloys will not be acceptable. All fittings shall be designed for the specific application and shall not be permanently deformed when correctly installed.

Sheathed conductor support fittings may be of silicon aluminum, glass-filled nylon or other tough non-hygroscopic material for indoor installations.

Fittings not in direct contact with bare or sheathed conductors may be of hot-dip galvanized steel.

Bi-metallic connectors shall be used between conductors of dissimilar materials and insulating material shall be interposed between metallic fittings and structures of dissimilar materials to prevent corrosion.

iv) Joints

Permanent joints shall be made by exothermic welding (Cad Welding) below ground, or crimping for above ground connections.

Detachable joints shall be bolted and stranded conductors at bolted joints shall be terminated in

exothermic welded lugs or a crimped cable socket. The diameter of any holes drilled in strip conductors shall not greater than half the width of the strip.

Connections to electrical equipment shall be detachable and made at the earthing studs or bolts provided on the equipment by the manufacturer. When an earthing point is not provided, the point and method of connection shall be agreed with the Engineer.

Connections to metallic structures for earthing conductors and bonding conductors between electrically separate parts of a structure shall be either by direct exothermic welding or by bolting using a stud welded to the structure. Drilling of a structural member for a directly bolted connection shall only be carried out to the approval of the Engineer.

Bolted joints in metallic structures, including pipe work and which do not provide direct metallic contact, shall either be bridged by a bonding conductor or both sides of the joint shall be separately bonded to earth, unless the joint is intended to be and insulated joint for cathodic protection or other purposes.

When the reinforcing in concrete is used as a part of the earthing system, the fittings used to provide a connection point at the surface of the concrete shall be exothermically welded to a reinforcing bar. This fitting shall be provided with a bolted connection for an earthing conductor. The main bars in the reinforcing shall be welded together at intervals to ensure electrical continuity throughout the reinforcing.

No connections shall be made to reinforcing bars and other steelwork which do not form part of the earthing system and are completely encased in concrete.

J. EARTHING OF FENCES

i) Method

Metallic fences shall be separately earthed unless they come within 1.8m of any equipment of structure above the surface of the ground and which is connected to the main earthing system. If the separation of 1.8m cannot be obtained, the fence shall be bonded to the main earthing system.

ii) Separately Earthed Fences

The earthing of a fence shall be provided by connecting certain metallic fence posts to an earth rod by a copper conductor. The earth rod shall be driven adjacent to the posts inside the fence line to a depth of not less than 3.0m. where no metallic posts are provided, the earth rods shall be connected directly to the metal wires, mesh or other components of the fence.

If, owing to the nature of the ground, it is not possible to drive earth rods, then fence posts shall be connected to the center point of a 20m length of bare copper conductor buried in the ground at a depth of 500mm, running closely parallel to the inside of the fence.

The earth rods or bare conductor electrodes shall be installed at each corner post, below the outer phase conductors of overhead line connections passing over the fence, at each gate and at intervals of not more than 100m.

iii) Bonded Fences

Fences which need to be bonded to the main earthing system of the installation shall be connected by copper conductors to the nearest accessible point on the main earthing system at each point where the fence comes within 1.8 m of any electrical equipment. Bonds shall also be made to each corner post, below the outer phase conductors of overhead line connections passing over the fence at each gate and at intervals of not more than 100m.

iv) Bonding of Fence components

Fences made up bolted steel or other metallic component do not require bonding between components. Where such fences have non-metallic component, bonds shall be installed to maintain continuity between metallic components. Reinforced concrete components shall be treated as being non-metallic.

Longitudinal wires for supporting other fence component or for anti-climbing guards and the wires of chain link, shall be directly bonded to each electrode or to each bond to the main earthing system.

Metallic component on masonry, brick, concrete or similar boundary wall shall be treated in the same manner as metallic fences.

Wire fence component coated for anticorrosion protection shall be earthed in accordance with this clause.

v) Gates

The fixed metallic components on both sides of the gate shall be directly bonded together by a copper conductor installed under the surface of the access way. Flexible conductors shall be installed to bond the moving parts of the gates to the metallic fixed parts. An earth rod or a bond to the main earthing system shall be installed at each gate.

iv) Potential Control Outside Fences

Where the approved design calculations show that the touch or step potentials outside the fence or boundary wall would otherwise be excessive, bare copper conductors shall be buried in the ground outside the fence or boundary wall at such depths and spacing as are shown in the approved design calculations to give acceptable touch and step potentials. The conductors shall form complete rings surrounding the installation and each ring shall be bonded to the adjacent ring and to the fence at each corner, below the outer phase conductors of overhead line connections passing over the fence at each gate and at intervals of not more than 100 m. In this case separate earth electrodes are not required for the fences.

If the boundary fence or wall is substantially non-metallic, the rings of conductors shall be bonded to the main earth system at each corner of the site and at intervals of not more than 100m. Any metallic components on such boundary fences or walls shall be bonded to the earthing system in accordance with this Specification.

If the boundary fence is metallic and is not within 1.8 m of any part of the main earthing system or equipment bonded thereto, the fence and outer conductor rings shall but be connected to the main earthing system unless the approved design calculations show otherwise.

Any meshes formed by bonding the outer conductors to the main earthing system shall be sub-divided by additional conductors, if required, to give acceptable touch, step and mesh potentials.

vii) Conductors

All conductors used for earthing and bonding the fences and components and for outer rings shall have a cross-sectional area of not less than 70 mm².

vii) Portable earthing devices

Portable earthing devices for use with outdoor 33KV apparatus in substations shall be supplied in the

numbers stated in Schedule of Technical Requirements and shall comprise:

- (a) Copper alloy earth end clamp for connection to the rigid loops in equipment earth bonding connections.
- (b) Aluminum alloy line and bus bar end clamp to suit the type supplied under the Contract.
- (c) Flexible stranded aluminum alloy conductor with clear protective PVC sheath, size suitable for the specified fault level and duration.
- (d) Telescopic operating pole of glass fibre or similar material, of sufficient length to reach the height of connections to high voltage equipment from ground, but retractable into a carrying length not exceeding 2.5m, and complete with non-slip hand grips.

K. SUB-STATION EARTHING AND EARTHING ERECTION

General earthing of all equipment shall be in accordance with the IEC recommendation No. 80 :1976- Guide for safety in alternating current sub-station Grounding, the British standard code of practice CP-1013: 1965 or other approved standard.

i) Earthing System

Each site shall be provided with an earth grid of buried copper strip conductors designed for an earth fault current of 31.5 KA for 3 seconds for all S/S. For the purpose of preliminary design it shall be assumed that the distribution of the fault current will be such that the ground potential rise of each site will not exceed 2 KV.

The preliminary design shall be based on clay silt having an assumed resistivity of 100 ohm meters. Step and touch voltages both inside and outside the station shall not exceed 50 V.

The design of earth grid over the area occupied by switchgear and associated apparatus shall be based on a maximum grid spacing of 5m x 5m. Conductors shall be buried at 800mm depth.

Earthing points will be provided so that the combined resistance of the earth grid and earthing points shall be less than 0.5 ohm under dry climatic conditions.

The operating mechanisms of isolators, earth switches and circuit breaker kiosks not integral with the circuit breaker shall be connected to the earth system by a branch entirely separate from that employed to earth their bases. The branch is to be installed such that the connection would pass beneath where and operator would stand, so as to minimize step potential.

Fences shall be earthed independently of the sub-station grid.

Connections to plant and equipment shall be made using the earthing terminals specified in the contract where a strip has to be drilled to fit an earth terminals the diameter of the hole shall not be greater than ½ the width of the strip.

Joints in earthing strip shall employ chemical welding or high compression joints or clamps.

ii) Earthing Electrode

Each Earthing point shall consist of a group of copper rods drawn into undisturbed soil to a minimum

depth of 4m. Each copper electrode shall be complete with approved non ferrous clamps for the connection of earthing conductors and with a hardened steel tip and cap for driving by means of a power hammer. The number of electrodes per group shall be not less than four and not more than eight, 16mm diameter rods and each copper electrode rod shall be 4 meter length and the number of rod groups per sub-station have been declared in the price schedule.

The electrodes of an earthing point will be arranged in two sub-groups with a conductor from each sub-group to the test link of the earth grid.

In addition to the above a single electrode is to be driven as close as possible and connected to the following :

- i) Three phase set of surge diverts.
- ii) Three phase set of voltage transformers.
- iii) Three phase set of power transformers.
- iv) The fence where an overhead line crosses at gates and at fence corners. The distance between electrodes is not to exceed 50 m.

Separate Earthing Electrode with special earth pit shall be provided for the following two items:

- (i) Power Transformer neutral earthing
- (ii) Lightning Arrester earthing

It has to be ensured that the earthing resistance of these separate earth electrode satisfies the basic requirement of earthing resistance.

iii) Insulated Earthing Conductors

Conductors for interconnection between the electrodes in any group and between groups and the connections between the link chambers and sub-station earthing main grid shall have twin conductors with a combined rating of 31.5 KA for three seconds for all S/S. The neutral points of the 11KV system shall be connected to the link chamber with twin conductors as above.

Earthing conductors shall be of annealed high conductivity copper and shall be stranded in accordance with IEC-228 table VII class-2. They shall be protected with an extruded PVC sheath of 100 volts grade.

iv) Sub-station Earthing Screen

Approved earth screens shall be provided to protect the equipment from direct lightning strikes. The screens shall be of the steel corned aluminum wires of not less than 35 Sq.mm total cross section and connected to provide low impedance paths to earth.

The layout of the earth wires shall be such that generally equipment to be protected lie within areas bounded by lines drawn from the earth wire at 35 degree to the vertical in a plane perpendicular to the axes of the earth wire. The earth screen shall be suitable for extension to protect the sub-station equipment to be installed in suitable stages of development.

Connections shall be made of copper strip of 150 Sq.mm cross section between each support for the overhead earthed screen wire and the main sub-station earthing system. Earth wires shall be held in clamps with free pin type joints between clamps and supports connections shall be provided for the terminations of the earth wires of the overhead lines including bimetal connectors where necessary.

The necessary stays, fittings, anchors, flying stays and additional masts shall ensure clearance of not less than 4600 mm over roadways for circuit breaker or transformer removal. The design of all structures shall ensure that in the event of breakage of either one earth wire or one stay wire the factor of safety is not less than 1.5.

L. REQUIREMENT EARTHING

i) 11 kV Switchgear

All metal parts including any relay instrument etc. mounted on the switchboard shall be connected to a copper earth bar which runs along the full length of the switchboard.

The cross section to the bar shall be sufficient to carry the rated short time withstand current of the switchgear for three seconds.

The frame of the draw-out circuit breakers shall be connected to the earth bar through a substantial plug type contact.

ii) Low Voltage Switchboards

Earth metal of switchboards fuse and distribution boards and distribution boards shall be bonded together and earthed to the main sub-station earthing system. Earthing connections shall be carried out in bare copper strip having a 3 second rating not less than 31.5 kA for all S/S

iii) Control Panels

Each control panel shall be provided with a copper earth bar of not less than 80 Sq.mm cross-section and arranged so that the bars of adjacent panels can be joined together to form a common bus.

The common earthing bus bar of control and relay panels shall be connected to the main station earthing systems via a copper earthing connection of not less than 80 Sq.mm.