

7.1 TECHNICAL SPECIFICATIONS FOR 33 KV GIS SUBSTATION SWITCHGEAR

7.1.1 SCOPE

This section of the document describes design, configuration, specification, functions, features, capacity, standards, quality etc. which is mandatory requirement to comply but not limited to implement the facility of [07 Nos. New 33/11kV GIS Substation, 04 Nos. 33/11kV GIS Substation (Up-gradation), 02 Nos 33 kV GIS Bay Extension] complete in all respects. This clause describes the General Technical Requirements for the new 33 KV 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 GIS has been designed, built and installed in accordance with the relevant international standards and the specification. 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 per mentioned in this Tender document. All devices necessary for operation and earthing shall be provided within the Contract Price.

The Contractor shall be responsible for providing equipment as per mentioned in this Tender document, which shall meet in all respects the performance specifications and will have satisfactory durability for the prevailing site conditions. The contractor is responsible for ensuring that all and any item of works (materials and workmanship) required for the efficient, safe and satisfactory completion and functioning of the works in accordance with this specification and all the costs are included in tender price whether they be individually described in the specification or not. It is to be noted that if the Tenderer submit in their offer multiple manufacturing vendor's options for specific item, the Employer/Purchaser shall have right to choose any one among them before contract. Moreover, Manufacturer & Tenderer has to mention only single country of origin (as per ITT 6.3) for the same manufacturer for individual specific item, otherwise his Tender/Bid shall be non-responsive.

7.1.2 REFERENCES

7.1.2.1 British Standards

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

7.1.2.2 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 60044-1 Current transformers.
9. IEC 60044-2 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 disconnectors and earthing switch

7.1.3 33KV GAS INSULATED SWITCHGEAR (GIS)

7.1.3.1 Switch gear-Design and Performance:

33 KV GIS shall be suitable for indoor location and capable of continuous operation under the climatic conditions existing on site. It shall be designed to comply with this Specification and relevant IEC Standards.

In all cases the ancillary plant facility necessary to complete installation of the equipment shall be included in the Contract. GIS installation and cable termination/connection work shall be executed and supervised by the GIS manufacturer to ensure the required performance based on standard workmanship.

The disposition of plant facility in any substation is to be such that the operation of any item of plant under the specified service conditions shall in no way create a condition that could adversely affect the performance of adjacent circuit breakers or any associated equipment.

The Contractor is to ensure that the complete substation installation will satisfy the requirements of this Specification and the appropriate Standards in respect of insulation, fault levels, mechanical stress etc., and any additional equipment found to be necessary to meet these requirements shall be deemed to have been included in the Contract Price.

The layout and design of plant facility and equipment at GIS sites shall make provision for the future extensions of same capacity substation shown on the layout drawings and shall provide for ready access for operation, maintenance and extension whilst the remaining sections of equipment are alive. Working clearances provided between isolated equipment and nearest live metal work shall not be less than the British Standard section clearances.

Insulation creepage distances shall not be less than 25mm per KV rated voltage between phases.

The Contractor shall be responsible for ensuring that insulation co-ordination in accordance with recommendation of IEC-71 is achieved. Dynamic and temporary over voltages shall be assumed to be in accordance with normally accepted IEC levels.

The 33 KV GIS with circuit breakers having vacuum interruption facility shall be Indoor, Metal clad, dust & vermin proof, factory assembled, type tested, protected against condensation and aggressive gases, single busbar and single phase encapsulated or three phase encapsulated. All high voltage components/ parts must be fully gas insulated sealed hermetically and safe-to-touch. The Switchgear (primary section) panel shall be filled with insulating gas at sight or in factory and fitted with gas monitoring device with contact. SF₆ may be used as an insulating medium, not for quenching.

All control and monitoring elements should be accessible from the front.

The arrangement of the Circuit-breaker in the panel must be such that in the event of any necessary inspections both the operating mechanism and the arc chambers can be removed and reinstalled from the front or back in a verifiably short time. The bus bars must remain in uninterrupted operation and there must be no reduction in either the insulation level (additional measures such as protective barriers are not permitted) or personal safety. Confirmation must be provided with the quotation.

Each sealed-off gas compartment must have its own pressure relief facility, which in event of arcing fault prevents uncontrolled rupturing of the compartment. The manufacturer must guarantee an adequate pressure reserve between the operating value of the pressure relief and the rupturing pressure of the vessels. The pressure relief facilities must limit the effects of a fault arc to one compartment. Gas escaping under pressure must divert in a direction that is not dangerous for operating personnel; the same applies to fixed parts (rupture diaphragms etc).

Pressure monitoring takes place with contact-making manometer gauges, which function independently for each bus bar section, three-position switch gas compartment or bus bar voltage transformer set respectively or temperature compensated gas sensors for each gas compartment, which shall be equipped with self supervision. The gas pressure gauge shall be installed at the front of the switchgear panel and shall be easily visible.

The gas compartments must be well sealed both mutually and to their surroundings. **The gas loss must not exceed 0.1% per year and compartment.** The filling pressure must be selected so that after thirty years of operation the full test voltages can still be withstand, without any topping up.

The use of plastics must be minimized, in order to likewise minimize the risk of fire in the

event of a fault.

The Current transformer must be of the di-electrically non-stressed ring type mounted outside the gas compartment and shall be easily replaceable without gas work.

The Voltage transformer for both busbar and incomer shall be of plug-in-design separate housing filled with SF6 gas to be connected to the bus bar and located outside of the gas enclosure and disconnectable by a three position isolation switch.

Cable termination shall be totally insulated. Cable per phase has to be connected as per scope. Facility with necessary accessories for plug-socket connections are to be as per scope. Sealing/cap for unused cable termination shall also to be provided.

The LV compartment shall be made of high quality sheet steel with powdered coated painting with sufficient space for mounting secondary equipment.

The complete switchgear must be compact in dimension as space is very limited. Also the Switchgear should be suitable for future extension or replacement of panels without affecting the gas enclosures.

Interlocking between the Circuit breaker and three position switch should meet the following conditions:

- a) to prevent the disconnecter from switching under load, they may only be actuated with the circuit-breaker open
- b) the three-position switch must be prevented from switching through from the closed state in to the "ready-to-earth" position.
- c) the three-position switch can only be brought into the earthing position if the circuit breaker is open.
- d) closing of the circuit-breaker must be blocked for as long as the three position switch has not reached a definite switching position.
- e) for earthing of the feeder, reliable "interrogation interlocking" must be provided. Only the three-position switch is switched into the "ready-to-earth" position, feeder can be earthed and short-circuited by closing the circuit-breaker.
- f) Earth switch operation shall be blocked when there is voltage in intended Line/ Bus/ Equipment.

Gas compartment must be provided with gas pressure monitoring by pressure gauge with signaling contacts, to signal any increase drop of gas pressure.

The individual panels shall be modular type, to be connected by SF6 insulated bus bar and plug-in outside the SF6 Gas compartment. GIS switchgear shall be suitable for future extension provision at both end or replacement of panels without affecting the gas enclosures.

The switchgear must be extendable at both ends of the bus bars. The incoming and outgoing switchgear panel width shall not be more than 600 mm to ensure the proper use of space.

The Vacuum Circuit Breaker as a making/breaking unit, including operating mechanism, must be maintenance and trip free.

The three-position disconnecter (ON-OFF-EARTH) is to reduce the number of functional elements within the encapsulation and together with the circuit breaker, provide make-proof earthing. The Three position switch/ disconnecter shall be both motor and manually operated.

In order to reduce the number of mechanical parts within the encapsulation, the operating shafts are to be located outside the encapsulation. The switches are to be operated without a seal via gas-tight welded-in bushings.

The material of the SF₆ containers is to consist of non-corroding high-quality steel or aluminium. The live parts are to be insulated against the earthed housing by SF₆ gas.

The Instrument Transformers are to be exchangeable toroidal-core or ring type transformers which are to be used outside the SF₆ encapsulation so that they are not exposed to dielectric stress.

The cable terminals of the 3-Phases are to be located horizontally next to one another on one level and are to be easily accessible from the front or rear.

High Voltage Section

The High Voltage section must be maintenance free and immune to environmental influences. The installation must be resistant to accidental arcs.

All switches are to be operated from the front. The circuit breakers must be remotely controllable.

Capacitive dividers in the bushing to the bushing to the cable terminal compartment are to allow safe testing for dead state at the panel front. The degree of protection of the switchgear must not be reduced here.

Gas Compartment Technology

The gas compartment must be tightly sealed. The filling pressure is to be such that at least 30 years service is guaranteed without the necessity of refilling. The design of the HV compartment shall be such that no disruptive discharge will occur between live parts and between live parts and earth even at atmospheric pressure at maximum system voltage.

The pressure of the SF₆ gas is to be monitored inside the gas compartment by means of pressure-gauge boxes or temperature compensated sensor with self supervision. In this way, complete temperature compensation can be achieved. Any pressure drop beyond the safe level as specified by the manufacturer shall be indicated in the form of sound and light alarm. Each Bus-section shall have individual pressure monitoring arrangement. SF₆ insulated Bus Bars are to be installed in separate compartment.

The sealed gas compartment must have its own pressure relief device which prevents uncontrolled bursting of the gas compartment when an accidental arc occurs. The manufacturer must guarantee a sufficient pressure reserve between the operating pressure of the pressure relief devices and the bursting pressure of the container.

Locking Devices

Three-position disconnectors (ON-OFF-EARTH) must be mechanically and electrically Locked and against the circuit breaker.

7.1.3.2 Current Ratings

Every current-carrying part of the switchgear including current transformer, busbars, connections, contacts and joints shall be capable of carrying its specified rated current at rated frequency continuously, and in no part shall its temperature rise exceed that specified in relevant standards.

7.1.3.3 Corona (Not Applicable)

Equipment shall be designed so as to minimize corona or other electrical discharge and radio interference. Tests for corona and radio interference shall be carried out at Manufacturer's Factory Premises.

7.1.3.4 Local, Remote and Supervisory Control

Circuit breakers and motorized disconnectors & **earth switches** with manual provision shall be electrically controlled locally, remotely and by supervisory control.

Position indication of these devices shall be provided via auxiliary switches on their operating mechanisms and the Contractor shall include the supply and fitting of the necessary auxiliary switches.

For supervisory control, the interface between the automation devices and the control equipment being provided under this Contract shall be as specified in Section- 7.2 (Substation Automation system)

7.1.3.5 CIRCUIT BREAKERS

7.1.3.5.1 Type

33 KV Gas Insulated circuit breakers having vacuum interruption facility shall have spring operating mechanism.

7.1.3.5.2 Operating Duty and Performance

i) General

The requirements of IEC-62271-100 in respect of type tests, service operation and the making

and breaking of fault currents shall apply to all types of circuit breakers. Designs shall be suitable for interrupting 3-Phase ungrounded faults.

ii) Test Certificates

Circuit breakers shall be covered by test certificates issued by a recognized testing laboratory certifying the operation of the circuit-breaker at duties corresponding to the rated breaking capacities of the circuit-breakers. The test duty shall not be less onerous than the requirements of IEC 62271 or equivalent. Test certificates shall be submitted with the Bid. Test certificates should conform to current standards for type test approval tests.

iii) Rate-of-Rise of Restriking Voltage

Attention is drawn to the requirements of the minimum inherent rates of rise of restriking voltage of test plant arrangements. Where not specifically stated in the test certificates submitted with the Bid, the Bider shall certify that the TRV to which the circuit-breaker was subjected during the short circuit tests was the most severe condition that could be imposed by the available test plant for a first phase-to-clear factor of 1.5.

Any device incorporated in a circuit breaker to limit or control the rate of rise of restriking voltage across the circuit breaker contacts shall likewise be to the Engineer's approval and full descriptions of any such device shall be given.

iii) Interrupting Duties

In addition to the requirements of IEC 62271 for interrupting terminal faults, circuit-breakers shall be capable of coping with the interrupting duties produced by the switching of low inductive currents associated with reactors or transformer magnetizing currents, or by the switching of capacitor currents associated with overhead line-charging, cable-charging or capacitor banks as may be applicable.

Circuit breakers shall be capable of interrupting currents associated with short-line faults and the out-of-phase switching conditions that may occur in service.

Bids should include a statement of the accumulative breaking capacity which the circuit-breakers are capable of before maintenance is required.

v) Insulation Coordination

The insulation strength across the open circuit breaker shall be at least 15 per cent greater than the line to ground insulation strength for all impulse, switching surge and power frequency voltage conditions.

7.1.3.5.3 General Arrangement

For indoor sub-station circuit breaker shall be suitable for mounting directly on the cubicle. Evidence shall be provided that enclosures subject to pressures in excess of normal atmospheric pressure during service operation have withstood approved pressure tests without leakage, permanent distortion or any temporary distortion such as might cause maloperation of

the circuit breaker.

7.1.3.5.4 Operating Mechanisms

Circuit-breaker mechanisms shall be “trip free” as defined in IEC 62271 and BS 5311:1976. It is recognized that it may be necessary for contacts to close momentarily prior to opening to ensure satisfactory current interruptions.

Each part of the operating mechanisms shall be of substantial construction, utilizing such materials as stainless steel, brass or gunmetal where necessary to prevent sticking due to rust or corrosion. The overall designs shall be such as to reduce mechanical shock to a minimum and shall prevent inadvertent operation due to fault current stresses, vibration or other causes.

An approved mechanically operator shall be provided on each circuit-breaker operating mechanism to show whether the circuit breaker is open or closed. Each phase shall incorporate a mechanical indicator or other approved means of position indication where operating mechanism designs do not utilize mechanical coupling between phases. Where circuit breakers comprise three independent units it shall be possible to make independent adjustments to each unit. For 3-Phase operation the three units shall make and break the circuits simultaneously. In the event of any phase failing to complete a closing operation, provision shall be made for automatic tripping of all three phases of the circuit breaker.

Power closing mechanisms shall be recharged automatically for further operations as soon as the circuit-breaker has completed the closing operation and the design of the closing mechanisms shall be such that the cannot be operated inadvertently due to external shock forces resulting from short circuits, circuit-breaker operation or any other cause.

Circuit-breaker operating mechanisms capable of storing energy for at least two complete closing and tripping operations, local to the equipment and without recharging, are preferred. Mechanisms incapable of storing energy for at least two complete operations shall utilize the substation DC supply for recharging the mechanism.

Circuit breaker shall have two tripping coils and one closing coil with in-built free-wheeling diode installed. Circuit breaker operating mechanism shall be spring charged, 230V AC/universal motor driven with following features: electrical remote controlled operating mechanism, trip & restrike free, automatically charged after each closing operation, O-C-O operation without recharging, mechanical/electrical interlocking, anti-pumping relay installed, provision for manual closing spring charging, provision for manual mechanical open/close operation, operation counter, spring charged mechanical & electrical indication etc and all other possible electrical & mechanical interlock installed as per IEC.

Circuit breaker’s emergency mechanical OFF push button shall be free from any mechanical & electrical interlocks except permanent feeder earthed & locked scheme.

7.1.3.6 OPERATING CUBICLES

Circuit-breaker operating mechanisms, auxiliary switches and associated relays, control switches, control cable terminations and other ancillary equipment shall be accommodated in aluzinc/anodized coated sheet aluminum vermin-proof and weatherproof cubicles. Where

appropriate the cubicles may be free standing. Cubicles are to be painted with RAL 7044 & RAL 7032 colour.

Cubicles shall be of rigid construction, preferably folded but alternatively formed on a framework of standard rolled steel sections and shall include any supporting steelwork necessary for mounting on the circuit breaker or on concrete foundations. Bolts or carriage keys shall not be used to secure the panels or doors. All fastenings shall be integral with the panel or door and provision made for locking. Doors and panels shall be rigid and fitted with weatherproof sealing material suitable for the climatic conditions specified.

Cubicles shall be well ventilated through vermin-proof louvres comprising a brass gauge screen attached to a frame and secured to the inside of the cubicle. Divisions between compartments within the cubicle shall be perforated to assist air circulation. In addition, thermostat controlled anti- condensation heater of an approved type shall be provided and controlled by a single pole switch mounted within the cubicle. In addition, thermostat controlled anti-condensation heater of an approved type shall be provided and controlled by a single pole switch mounted within the cubicle.

Access doors or panels shall be glazed where necessary to enable instruments to be viewed without opening the cubicles. The arrangement of equipment within the cubicle shall be such that access for maintenance or removal of any item shall be possible with the minimum disturbance to associated apparatus.

Circuit breaker control position selector and circuit-breaker operating control switches as specified in the Specification shall be installed in the cubicle. Circuit-breaker control from this position will be used under maintenance and emergency conditions only.

Where practicable an approved schematic diagram of the part of the control system local to the circuit-breaker, identifying the various components within the cubicle and on the circuit-breaker and referring to the appropriate drawings and maintenance instructions, shall be affixed to the inside of the cubicle access door. The diagram shall be marked on durable non-fading material suitable for the specified site conditions.

7.1.3.7 VOLTAGE TRANSFORMERS

Voltage transformers shall comply with IEC 61869-1 and IEC 61869-3 and the requirements of this specification.

Separate sets of fuses or MCBs shall be provided at the VT for:

- a) Each protection scheme
- b) Measuring Instruments, recorder etc.

The circuits for each main protection scheme shall be segregated in separate multicore cables from the VT to the protection panels. An (VT failure) alarm shall be provided for each set of fuses and MCB s.

The 33 KV voltage transformers shall be of the following specifications and ratings:

For All the 33kV Incomer & Outgoing Panel (1 set-Line VT): 33 KV / $\sqrt{3}$: 110V / $\sqrt{3}$, 110V/ $\sqrt{3}$ for each phase with accuracy class & Burden **0.2, 20VA** for measuring core and **3P, 20VA** for **protection core**

For All the 33kV (Each) Bus Section (1 set-Bus VT) (Can be installed in any Feeder panel): 33 KV / $\sqrt{3}$: 110V / $\sqrt{3}$, 110V/ $\sqrt{3}$ for each phase with accuracy class & Burden **0.2, 20VA** for measuring core and **3P, 20VA**

for protection core

The insulation value of the PT shall be rated maximum system voltage 36 KV and nominal 33KV, BIL-170 KV and Power Frequency withstand voltage for 1 min.70 KV. The burden of the PT shall be 20VA. Secondary voltage (measuring & protection core) of respective bus VT shall be available in all the adjacent 33kV panels related to this bus. 2 nos. voltmeter with voltage selector switch (6 position) shall be available in the 33kV bus coupler panel for indicating two adjacent bus voltage.

The inductive type Cast-resin insulated Voltage transformer shall be mounted outside the primary enclosure. The VTs can be plugged into the bus bar. The Voltage transformer on bus bar must be designed so that repeat tests can be carried out for 80% Power frequency withstand voltage on the bus bar without removal of the transformer. However, the voltage transformer on bus bar must be capable of withstanding over 100% power frequency withstand voltage under normal operating conditions.

7.1.3.8 CURRENT TRANSFORMERS

Current transformers shall comply with IEC 61869-1, IEC 61869-2 and the requirements of this Specification. Primary winding conductors shall be not less than 100 sq. mm section and shall have a three second short time current rating not less than that of the associated switchgear. Secondary windings of each current transformer shall be earthed at one point only. Magnetization and core loss curves and secondary resistance shall be provided for each type and rating of current transformer. Where the Contractor wishes to provide current transformer ratios differing from those specified, he shall first obtain approval in writing from the Engineer for each specific instance.

Current transformers for balanced protective schemes, including neutral current transformers where appropriate, shall have identical turn's ratio and shall have magnetization characteristics for each specific instance.

Except where stated in the Schedule of Requirements, all current transformers shall have a maximum continuous primary current rating not less than the primary current rating of the bay in which they are installed.

Current transformers shall be capable of withstanding, without damage, the peak and rated specific short-time currents of their associated equipment. They shall also withstand continuously a current equal to 1.2 times the CT ratio, except for transformer circuits when 1.5 times shall apply.

Current transformers provided for protective gear purposes shall have over current and saturation factors not less than those corresponding to the design short circuit level of the system. The output of each current transformer shall be not less than 20 VA with an accuracy limit factor (ALF) of 20 and it shall be ensured that the capacity of the current transformers provided is adequate for operation of the associated protective devices and instruments. Where double ratio secondary windings are specified, a label shall be provided at the secondary terminals of the current transformer indicating clearly the connection required for either ratio. These connections and ratio in use shall be shown on appropriate schematic and connection diagrams.

The accuracy class of all protection CTs shall be 5P or better and that of metering CTs shall be 0.2S or better and factor of security shall be less than 5. The burden of 33KV CT for measurement shall be 20VA and for protection 20 VA (At maximum CT ratio).

Current transformers for all unit type protection shall be of the low reactance type and their performance shall be stated in terms of the Class X parameters of IEC standard (low reactance current transformers are preferred for all forms of protection). Current transformers may be shown to be low reactance by virtue of their construction as per IEC Standard.

If all the constructional requirements are not met, then type tests will be required to prove that the current transformers are low reactance; the primary test current shall not be less than the through fault(stability) current of the protection.

The CT cores for each Main protection scheme shall be segregated in separate multi-core control cables from the current transformer through to protection panels.

Where double ratios are specified with multiple windings, it shall be possible to select either ratio for each winding without alteration to the number of primary turns.

Neutral current transformers shall be of the outdoor totally enclosed, porcelain bushing type complete with suitable mounting steelwork/cast resin insulation as specified and complete with terminal box for secondary connections.

The Contractor shall provide details of their method of calculating the outputs of the current transformers for each type of protection specified and shall submit calculations for all the current transformers to the Employer before starting manufacture.

Current transformer shall be capable of withstanding without damage at full load, peak and rated short time current.

Current transformers shall be located on the non busbar side of the circuit breaker except where current transformers are provided on both sides of the circuit breaker.

The 33 KV feeder and transformer feeder panel CTs shall have two cores for protection and metering. The capacity, ratio and accuracy class of the CT will be of the following specification and rating:

For 33 KV Line Feeders Incoming:

600-1200/5-5A	1st core 20 VA, acc. 0.2S & FS < 5 for metering 2nd core 20 VA, acc. 5P20 for protection.
1200-2400/5-5A	1st core 20 VA, acc. 0.2S & FS < 5 for metering 2nd core 20 VA, acc. 5P20 for protection.

For 33 KV Line Feeders Outgoing:

400-800/5-5A	1st core 20 VA, acc. 0.2S & FS < 5 for metering 2nd core 20 VA, acc. 5P20 for protection.
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For 33 KV BUS Coupler:

800-1600/5-5A 1st core 20 VA, acc. 0.2S & FS < 5 for metering
2nd core 20 VA, acc. 5P20 for protection.
1600-3200/5-5A 1st core 20 VA, acc. 0.2S & FS < 5 for metering
2nd core 20 VA, acc. 5P20 for protection.

For 33/11 kV, 16/20 MVA and 20/26 MVA Power Transformer feeders:

400-800/5-5-5A, 1st core 20 VA, acc. 0.2S & FS: 5 for metering
2nd & 3rd core 20 VA, acc. 5P20 for protection.

For 33/.415kV Auxiliary Transformer Feeders

CT Ratio = 400-800/5-5 A 1st core: acc.= 0.2S, FS <5, 20 VA for metering
2nd core: acc.=5P20, 20 VA for protection

The insulation value of the CT shall be rated maximum system voltage 36 KV and nominal 33KV, BIL-170 KV and power frequency withstand voltage for 1 min. 70 KV.

7.1.3.9 INTERLOCKING FACILITIES

Disconnectors, earthing switches, circuit breakers, etc., shall be provided with an interlocking system, which ensures safe operation of the equipment under all service conditions.

The items of plant supplied under this Contract shall be complete with all interlocking facilities needed for the final arrangement, avoiding the need for future modifications.

Where mechanical key interlocks are employed, they shall be effective at the point where hand power is applied so that stresses cannot be transferred to parts remote from that point.

Tripping of the circuit breaker shall not occur if any attempt is made to remove a trapped key from the mechanism. Emergency tripping devices shall be kept separate and distinct from any key interlocking system and shall be clearly labeled, suitably protected from inadvertent operation but readily accessible.

Circuit breakers shall be interlocked so that, except under maintenance conditions, it is not possible to close a circuit breaker unless the selected bus bar and circuit disconnectors are closed.

Except as stated below, disconnectors shall be so interlocked that they cannot be operated unless the associated circuit breaker is open.

All electrical interlocks shall so function as to interrupt the operating supply, and an approved system of interlocks shall be provided which shall cover the emergency hand operation of apparatus which is normally power operated. Failure of supply (or its restoration after an outage) or of connections to any electrical interlock shall not produce or permit faulty

operation. Electrical bolt interlocks shall be energized only when the operating mechanism is being operated. Visible indication shall be provided to show whether the operating mechanism is locked or free. Approved means, normally padlocked, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

7.1.3.10 AUXILIARY SWITCHES AND CONTACTORS

Circuit-breakers, disconnectors and earthing devices and circuit selector disconnectors shall be provided with suitably rated auxiliary switches and contactors, where permitted, to relay circuit information for the purpose of control, protection, indication and metering at the substation site as required by the relevant section of the Specification. In addition they shall be provided with auxiliary contacts for position indication to the central system control room via the remote supervisory system. Disconnector auxiliary switches are not to be used for current transformer switching circuits.

Auxiliary contactors shall be provided only where the circuit requirement cannot be met by the auxiliary switch arrangements and multiple contactors and relays will not be accepted in lieu of the auxiliary switches except as specifically approved by the Engineer. Auxiliary switches and contactors shall comply with the requirements of this Specification and in particular shall be capable of operation within the same voltage limits as specified for the associated circuit-breaker close and trip coils.

The connections of all auxiliary switches, including spares, and contactors as well as the associated coil connections and interconnections between auxiliary switches, shall be wired to a terminal board located in the operating cubicle or other approved position.

Auxiliary switches and contactors shall be mounted in an approved accessible position clear of the main operating mechanism but with a minimum of additional mechanical linkages and housed in a substantial weatherproof enclosure. Where adjustable linkages are provided to facilitate the timing of the auxiliary switches with respect to the main equipment, approved locking devices shall be fitted.

Auxiliary switch contacts shall be positively operated, make with a wiping action and, where necessary, discharge resistors shall be provided to prevent arcing when breaking inductive circuits.

Except for the contacts employed for control and interlocking, the requirements for auxiliary switches in respect of timing shall be as follows:

For Circuit Breakers

Normally open contacts, with the exception of two sets of this type, shall close in about 10 milliseconds after the making of the main circuit-breaker contacts and shall open in about 10 milliseconds before the separation of the main circuit-breaker contacts whilst the two remaining sets shall close in about 5 milliseconds before the making of the main circuit breaker contacts and open simultaneously with the main circuit contacts.

Normally closed contacts shall close 10 milliseconds after the opening of the main circuit-breaker contacts and open at least 10 milliseconds before the making of the main circuit-breaker contacts.

For Bus Bar Disconnectors

The operating sequence of any disconnector auxiliary switches used in D.C. circuits for high impedance bus bar zone protection shall be such that the auxiliary switches operate:-

- a) Before reaching the pre-arcing distance on closing the disconnector.
- b) After the pre-arcing distance has been exceeded on the opening of the disconnector.

For Earthing Switches

As for Bus bar disconnector auxiliary switches, Auxiliary switches shall be adjustable from normally-open to normally-closed or vice-versa.

Any deviation from the above should be stated in the GTP of Deviations from Specification.

7.1.3.11 33 KV CONTROL, SIGNALING METERING AND RELAY PANEL FOR POWER TRANSFORMER, EACH COMPRISING:

The protection, control & metering panels for 33KV system shall be simplex type so as to accommodate all the control equipment, relays and meters etc. as necessary for completeness of the protection/control scheme without overcrowding and cramping.

- a) The panels shall be vermin and dust proof free standing type completely metal enclosed by sheet steel (2.0 mm thick) with necessary reinforcement color gray with appropriate spray painting. The panels shall be neatly and completely wired before shipment. The work relating to protection, control and Metering 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-60298 standards.
- b) The complete panel shall incorporate all necessary instruments, meters, relays, auxiliary relays, control switches, indicating lamps, mimic, annunciators, audible alarms, horizontal and vertical wiring trough, wiring supports, interior lighting system, terminal blocks fuses and links etc.

7.1.3.11.2 Panel Description

7.1.3.11 2A. 33 kV CONTROL, SIGNALING METERING AND RELAY PANEL FOR POWER TRANSFORMER, EACH COMPRISING :

1.	Indicating analogue Ampere meter flush mounting with dual scales options, 0-400/800A for Transformer connection to current transformer ratio 400-800/5-5-5A	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) 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 $0.1 \cdot I_n$ 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 (3 O/C element + 1 E/F element) 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 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.	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, terminal blocks and provision for lighting etc. Mimic diagram shall contain Indicator for Isolator/Breaker/Earth switch position. The Annunciator shall have 30 windows or more and have built in buzzer and AC/DC fail relay.	1 (one) set
8.	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
9.	Remote Tap Changer Control facility shall be equipped with Automatic Voltage Regulating (AVR) to facilitate desired voltage regulation. AVR Relay shall have IEC-61850 communication protocol for SAS. It shall also be equipped with Tap position. WTI, OTI, Auto/Manual and Manual Raise and lower switch and Master/Follower control switch to 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. OTI & WTI meters measurement/temperature value shall be incorporated into SAS. All the mentioned & required Alarm signals shall be incorporated in SAS. These facilities can also be provided in separate panel (RTCC).	1 (one) set
10.	Master trip relay (02 Nos.)	1 (one) set
11.	Capacitive Voltage Divider (CVD) based Live Line Indicator (LLI) system.	1 set

7.1.3.11 2B. 33 KV CONTROL, SIGNALING METERING AND RELAY PANEL FOR INCOMING /OUTGOING LINE FEEDER, BUS COUPLER, STATION AUXILIARY TRANSFORMER EACH COMPRISING :

1.	Indicating analogue Ampere meter flush mounting with dual scales option (0-600A & 0-1200A, 0-1200A & 0-2400A any one may use) for connecting to the current transformer (ratio 600-1200/5-5A, 1200-2400/5-5A) for Incoming feeder respectively.	3 (three) nos.
	Indicating analogue Ampere meter flush mounting with dual scales option (0-400A & 0-800A any one may use) for connecting to the current transformer (ratio 400-800/5-5A) for Outgoing/ Auxiliary transformer feeder.	3 (three) nos.

	Indicating analogue Ampere meter flush mounting with dual scales option (0-800A & 0-1600A, 0-1600A & 0-3200A any one may use) for connecting to the current transformer (ratio 800-1600/5-5A, 1600-3200/5-5A) for Bus coupler respectively.	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) . 2 nos. voltmeter with voltage selector switch (7 position) shall be installed in the 33kV bus coupler panel for indicating two adjacent bus voltage and 1 nos. voltmeter with voltage selector switch (7 position) shall be installed in all the 33kV Incomer, Outgoing & Auxiliary Transformer panel.	1 (one) set
3.	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. (N.B.: EXCEPT BUS COUPLER PANEL)	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 range of the O/C & E/F relay 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 (3 O/C element + 1 E/F element) 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. All the numerical relays of 33kV Incomer, Outgoing & Bus Coupler GIS 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 circuit coil, PT supervision relay, auxiliary relay, MCB, fuse, terminal blocks and provision for lighting etc. Mimic diagram shall contain 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
8.	Capacitive Voltage Divider (CVD) based Live Line Indicator (LLI) system.	1 set

7.1.3.11. 2C. FOR 33 kV PANEL FEATURES:

Each PCM panel shall be equipped with the following:

- a.) (i) 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.
(ii) The numerical bay control IED's shall be mounted together with all the relevant bay protective relays in cubicles which is to be integrated with SAS.
- b.) Electrical push button/TNC switch for Circuit breaker & Three position switch (Disconnecter-Earth switch) Open-Close operation in the panel's front side for easy access.
- 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 high impedance REF scheme (if used) in 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.) All type of tripping shall be done through Master Trip relay.

- 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 at least 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.
- 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 Differential protection. Over current and Earth fault protection shall be combined in one relay.

- aa.) Annunciator shall have 14 nos. window for incoming and outgoing panel and 30 nos. windows for transformer panel with builtin buzzer.

- 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. Necessary Annunciation at respective panel & signaling for SAS integration shall also be provided.

dd) Transformer incomer PCM panel shall be equipped with AVR relay and tap changing control switch along with necessary indication system (Tap position, temperature etc.). These facilities can also be provided in separate panel.

ee) Alarm signal for CB operating spring charge fail shall be given using settable time delay relay (time needed for charging the spring) and this alarm signal shall be incorporated in the annunciator & SAS.

ff) Transformer Bushing CT's cable connection shall be extended to Transformer Feeder panel.

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.

7.1.3.11. 2D. Alarms

The following alarm provision shall be made:

1. 33 KV TRANSFORMER FEEDER (30 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	Trip relay-2 operated	Gas fault
Spring Charge Fail	OLTC BZ Alarm	OLTC PRD Trip	SCADA/ Remote Trip	Spare	Spare

2. 33 kV INCOMING/OUTGOING/BUS COUPLER/AUXILIARY TRANSFORMER FEEDER (MINIMUM 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	Gas fault
Spring Charge Fail	SCADA/ Remote Trip	OV/UV Trip(Only for IN/OUT Panel)	Spare

7.1.3.11.2E PROTECTIVE RELAYS

All Protective relays shall be numerical programmable type and shall comply relevant IEC or equivalent international standard. 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:-

- a) ABB (Switzerland/Sweden/Finland).
- b) Siemens (Germany).
- c) ALSTOM (UK/France)
- d) Schneider Electric (UK/France)
- e) NR, China
- f) SEL, USA
- g) Honeywell, USA

****** 33 kV Incomer, Outgoing & Bus Coupler Feeder panels Relay should have synchronization (25) function.**

Note: Supply of Related software with required license keys & accessories is within the scope of supply.

7.1.3.11.2F ENERGY METERS

KWH meter shall 3-phase 4-wire, Numerical Programmable Multifunction KWH Meter of accuracy class 0.2S with the features for measuring the parameters viz. phase voltages, phase currents, system frequency, per phase & total KW with maximum demand, KVAR, Power factor etc.

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. However, the detail specification of the meter shall be same as that for 33 kV PCM panel meter described in **clause 7.1.4.1.N**.

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: 1. Manufacturer's authorization for Protective Relays & Energy Meters (KWh) shall furnish with the offer. Necessary software & accessories is within the scope of supply.
2. The features in above section 7.1.3.11.2 can be provided in LV Compartment of GIS or in separate PCM Panel

7.1.3.11.3 PANEL CONSTRUCTION DETAILS

- a) The Control and Relay Board shall be of Simplex, completely metal closed and the access door shall be provided at the back of each Panel where no instruments or relays shall be mounted. The indicating and signaling devices etc. shall be mounted on the front side and the auxiliaries which shall be inside the Panel.
- b) Cubicles shall be drip-proof, and vermin proof, with the minimum IP41 protection degree. Equipment shall be arranged to give reasonable access to all components mounted on the panel front and inside.
- c) The individual panel shall be approximately 2300 mm in height with Channel base, 900 mm. in depth and of suitable width limited to 1000mm to accommodate the equipment at a suitable height, suitable gaps to facilitate easy workability as specified hereafter. Individual piece of Channel base of PCM Panel is to be provided to obtain the flexibility of inter-changing the Panel, if any.
- d) Each panel shall be fabricated from steel sheet (minimum 2mm thick) with necessary steel member reinforcement to make the structure self supporting. All joints are to be welded and ground to be made smooth.
- e) Doors shall be secured by locking integral handles and locking provision shall be made.
- f) Mounting brackets required shall be arranged inside the panel for mounting and fixing auxiliary devices and terminal blocks.
- g) 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.
- h) 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.
- i) The complete panel shall incorporate all necessary instruments, meters, relays, auxiliary relays, control switches, indicating lamps, mimic, annunciator, audible alarms, horizontal and vertical wiring trough, wiring supports, interior lighting system, terminal blocks , fuses and links etc.
- j) 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.
- k) A lamp shall be fitted inside each cubicle and a utility socket in selected cubicles and so arranged that all wiring is illuminated as evenly as possible without dazzle. The lamps shall be controlled from a door switch. The sockets shall be fused.
- l) Design, material selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent front outside, with all exterior surfaces tune and smooth.

- m) Cable entries to the panel shall be from the bottom. The bottom plates of the panel shall be fitted with removable gland plates and fixed with cable glands.
- n) Engraved name plate shall be provided at the top of the front enclosure with information BPDB, Contact No., Project Name, Manufacturer, Year of manufacture etc.

7.1.3.11.4 Assembly :-

Necessary items of equipment shall be assembled in the factory prior to shipment and routine tests shall be performed by the manufacturer as per the requirements of the latest issue of IEC as specified under each equipment in these specifications to demonstrate to the satisfaction of BPDB that the switchgear panels comply with the requirements of the relevant IEC standards.

7.1.3.11.5 Casting :-

Casting shall be true to pattern, of workmanlike finish and of uniform quality and condition, free from blowholes, porosity, hard spots, shrinkage defects, cracks or other injurious defects, shall be satisfactorily cleaned for their intended purpose.

7.1.3.11.6 Welding:-

Wherever welding is specified or permitted, a welding process, including stress relieve treatment as required if necessary, conforming to an appropriate and widely recognized professional standard shall be used. All welders and welding operators shall be fully qualified by such a standard.

7.1.3.11.7 Panel Wiring

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

- a) All wiring shall be carried out with 1100 volts grade single core, multistrand flexible tinned copper wires with PVC insulation which has provided its utility in tropical region against hot and moist climate and vermin.
- b) 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 or 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.
- c) 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.
- d) Splices will not be permitted in panel wiring. Each wire shall be continuous from end to end and shall not have any joint within itself individually.

- e) 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.
- f) 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.
- g) Terminal Ends of all wires shall be provided with numbered Ferrules . At point of inter-connection where a change of number is necessary, duplicate Ferrules shall be provided with the appropriate numbers on the changing end.
- h) Wire termination shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected for any purpose. Termination shall be such that no strand of a conductor shall left loose or overhanging. Conductor termination shall be secured to the holding nuts/screws, terminal blocks etc. with washers between the terminals/holding nuts/screw heads. The terminals shall be so connected that no conductor ferrule code gets masked due to overlay of conductors.
- i) Wiring connected to the space heaters in the cubicles shall have porcelain beaded insulation over a safe length from the heater terminals.
- j) All spare contacts of relays shall be wired up to terminal blocks
- k) The size of the wiring used in the panel shall be conform to the following requirements:-

Table 1

Circuit	Permissible size of wire
Metering and Relaying Circuits connected Current Transformer	minimum 4 Sq.mm.
Potential Circuits for metering and Relaying, Control, Visual Audible Alarms and Signaling Circuit	minimum 2.5 Sq.mm

The following colour schemes shall be used for the Wiring:

Table 2

Circuit where used	Colour of Wire
Red Phase of Instrument Transformer Circuits	Red
Yellow Phase of Instrument Transformer Circuits	Yellow
Blue Phase of Instrument Transformer Circuits	Blue
Neutral connection, earthed or not earthed in the instrument Transformer Circuit	Black
A.C. Control Wiring Circuits using auxiliary supply	Black

D.C. Control Wiring Circuit using Battery Supply	Grey
Earth Connection	Green

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 “7.1.3.11 2C 33 kV Panel Features”

7.1.3.11.8 TERMINAL BLOCK

Terminal blocks shall be of clip-on design made out of non-trackable insulating material of 1100 V grade. All terminals shall be stud type, with all current carrying and live parts made of tinned plated brass. The studs shall be of min 4 mm dia brass. The washers, nuts, etc. used for terminal connectors shall also be of tinned plated brass. All blocks shall be shrouded by easily removable shrouds made of transparent die-electric materials.

The terminal connector/blocks shall be disconnecting type terminal connectors for PT and same with automatic shorting of C.T. secondary terminals shall be provided in CT secondary circuit. All other terminal connectors shall be Non-disconnecting type. Terminal should be shock protected in single moulded piece. Terminal block should have screw locking design to prevent loosening of conductor. Provision shall be made on each pillar, for holding 10% extra connection (5% incoming + 5% outgoing).

At least 20% spare terminals for each type shall be provided. All terminals shall be provided with ferrules indelibly marked or numbered and identification shall correspond to the designations on the relevant wiring diagrams. The terminals shall be rated for adequate capacity which shall not be less than 10 Amps for control circuit. For power circuit it shall not be less than 15 Amps.

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.

7.1.3.11.9 INDICATING LIGHTS

The lamps shall be of LED type and suitable for being operated on S/S D.C. voltage or AC voltage or P.T. secondary supply as and where applicable. All Lamps shall be interchangeable, panel mounting type with rear terminal connection and shall afford easy replacement from the front of the panel. Lamps shall have translucent lamp covers to diffuse lights and coloured Red, green, Amber, clear white or blue as specified. The lamp cover shall be of screwed type, unbreakable and mounded from heat resisting material. The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis. It is recommended to install the CB, DS & ES Open/close indicating LED lamp/semaphore in the mimic bus. If space is not available, these indicating LED lamps/semaphore can be installed in the front panel along with other indicating LED lamps.

The colour scheme of the signal lamps shall be as follows:

Sl. No.	Functions	Quantity	Color of the Lamp
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1	Heater ON Indication	1No	Yellow
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7.1.3.11.10 POWER SUPPLY DISCONNECT

Each panel mounted devices requiring AC or DC supply, shall have separate disconnecting devices (MCB). The MCBs used in DC control circuit shall have a voltage rating 125 VDC and sufficient current rating as per use. The fuses shall be modular type with Bakelite frame and reinforced retaining clips.

7.1.3.11.11 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.

CT terminal blocks shall have isolation, shorting & jacking facility while PT terminal blocks shall have isolation & jacking facility. CT, PT, Control, Alarm, etc. wirings shall be separately grouped or segregated. SCADA Terminal Block for CT/PT/CB Close-Open facility.

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.

7.1.3.11.12 INSTRUMENTS AND DEVICES

Indicating, analogue instruments shall be semi flush panel type with 1% percent accuracy class except for energy meters which shall be of 0.2S. They shall be approximately 100 mm square with black 250 degree scales on a white back ground.

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

7.1.3.11.13 PANEL LIGHTING

- a) The Panel interior shall be illuminated by CFL lamps connected to 230 Volt Single Phase A.C. The illumination of the interior shall be free from shadows and shall be planned to avoid any strain or fatigue to the wireman likely to be caused due to sub-normal or non-uniform illumination. One emergency D.C. light shall be provided for each panel with individual switch with proper identification mark.
- b) A toggle switch or door operated switch shall be provided for control of A.C. lighting in each panel.
- c) One combined 15 Amps. 3-Pin and 5 Amps. 2-Pin Power Socket outlet together with Plus Pins shall be provided at convenient points in each Panel for A.C. Supply.

7.1.3.11.14 CONTROL AND SELECTOR SWITCHES

All switches shall be located at a convenient operating height and so constructed, mounted and wired to facilitate the maintenance of contacts without the need to disconnect wiring. Switches shall have locks incorporated in the design. Control switches must be lockable in the inactive or neutral position and selector switches in all positions. Labels shall clearly indicate all positions and function of each switch.

7.1.3.11.15 Control Switches

Control switches shall be of either the handle type and shall be arranged to operate clockwise when closing the circuit devices and anticlockwise when opening. Handle type switches shall be so designed that when released by the operator the handle and mechanism shall return automatically to the centered neutral position and interrupt the supply of current to the operating mechanism of the circuit device. All control switches shall have additional labeling giving the reference identification of the primary device. A lamp test facility shall be provided in association with any discrepancy switch.

7.1.3.11.16 SELECTOR SWITCHES

Selector switches shall have spade type handles. Where key operated switches are specified these shall be operated by inserting and turning the key to the required position. The key shall be removable in the 'off' position only.

7.1.3.11.17 ANNUNCIATOR

1. Suitable electronic Annunciator for the visual and audible alarm on the control panel using bright LEDs shall be provided in each panel to indicate over current and earth fault protection operated. In addition to above, each electronic annunciator of Transformer Control Panel shall have provision to indicate Transformer trouble trip/alarm function operated. Also one window of the Annunciator shall have to be used for Non-Trip A.C. Fail Alarm Indication and one window for Trip Circuit unhealthy indication. Each Electronic Annunciator shall have provision for connection with accept/reset/lamp test/mute Push buttons for proper functions. Electronic annunciator shall have provision for connection with Electronic Buzzer/Electronic Bell for Trip & Non-Trip Audio Alarm of common annunciation scheme. Electronic Annunciation shall have provision for flashing illuminating display with inscription for operation of respective Protection Relay. The Electronic Annunciator should have separate coloured windows for Trip & Non-Trip Annunciation for easy detection.
2. Annunciator fascia units shall have translucent plastic windows for each alarm point.
3. Annunciator fascia plate shall be engraved in black lettering with respective alarm inscription as specified. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall be about 5 mm. The inscriptions shall be visible only when the respective fascia LED will glow.
4. Annunciator fascia units shall be suitable for flush mounting on panels. Replacement of individual fascia inscription plate and LED shall be possible from front of the panel.

5. Unless otherwise specified, one alarm buzzer meant for non-trip alarms and one bell meant for trip alarms shall be provided in each control panel (mounted inside).
6. Each annunciator shall be provided with 'Accept', 'Reset' and 'Test' push buttons, in addition to external PB.
7. Special precaution shall be taken by the manufacturer to ensure that spurious alarm conditions do not appear due to influence of external magnetic fields on the annunciator wiring and switching disturbances from the neighbouring circuits within the panels.
8. In case 'RESET' push button is pressed before abnormality is cleared, the LEDs shall continue to glow steadily and shall go out only when normal condition is restored.
9. Any new annunciation appearing after the operation of 'Accept' for previous annunciation, shall provide a fresh audible alarm with accompanied visual alarm, even if the process of "acknowledging" or "resetting" of previous alarm is going on or is yet to be carried out.
10. The annunciator shall have provision for operating on both 110VDC & 240VAC, single supply at a time, mainly 110VDC operated and should generate alarm for any of the supply fail. All the annunciator shall be window type with Multicolor glowing lamp such as. Red for Trip signal and White for general alarm signals and Also Annunciator shall have built-in mute & acknowledge option accessible via SAS command.

7.1.3.11.18 INDICATING AMMETERS

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

7.1.3.11.19 INDICATING VOLTMETERS

1 (one) voltmeter with selector switch, analogue type with a multi-selector switch (phase to phase, phase to neutral, off) shall be installed on every 33kV Incomer, Outgoing, Power Transformer & Bus Coupler panel. 2 nos. voltmeter with voltage selector switch (6 position) shall be installed in the 33kV bus coupler panel for indicating two adjacent bus voltage.

7.1.3.11.20 EARTHING SYSTEM

Earthing of metallic parts or metallic bodies of the equipment on the Panel shall be done with soft drawn single conductor bare Copper Tail connections shall have minimum area of 16 sq. mm. and the main earthing connection 60 sq.mm. These wires shall be connected by suitable terminals and clamps junction. Soldered connections shall not be employed.

All metal parts other than those forming part of any electrical circuit shall be earthed to the earthing system. Any necessary terminals on any part of the equipment required for this purpose shall be provided by the Manufacturer. Earthing conductor cross section shall be in accordance with the manufacturer standards which shall be proved with necessary type test reports. However, for 33kV switchgear minimum 300 mm² cross section copper bar shall be employed for earthing. The

copper earth bar shall run along the full length of the switchboard and earthing studs shall be provided at not less than two points. The frame of the draw-out circuit breaker earthing truck shall be automatically connected to the switchgears bar through substantial plug type contact when the circuit breaker is in disconnection, service and test position.

7.1.3.12 DISTRIBUTION AND CONTROL OF AUX. POWER CIRCUIT

7.1.3.12.1 D.C. CIRCUIT

There shall be only one **110V D.C.** for the entire Control and Relay Panel fed from a D.C. Distribution Panel. A continuous D.C. Bus shall be provided in the Control and Relay Panel and D.C. supply for control, protection, indication and supervision of circuit breaker and other equipment shall be teed off from D.C. bus through a set of MCB on positive and negative side. D.C. supply to be teed off shall be distributed within the Panel as below:

- (a) Control DC scheme both positive and negative side with MCB
- (b) Close & Trip Ckt-1 with 1 nos. 10A MCB (rating shall be as required) and Trip Ckt-2 with another MCB of 10A (rating shall be as required)
- (c) Indication Circuit through a set of 6 Amp. MCB both at +ve and -ve side
- (d) Protective relay circuits through 6A MCB both at +ve and -ve side
- (e) Annunciation ckt with 6Amp MCB on both at +ve and -ve side
- (f) DC Emergency Lamp with 6Amp MCB both at +ve and -ve side

DC Supply MCBs (Main supply, Control supply, Device supply, Indication supply, Annunciation supply etc.) shall have at least 2NO+2NC contact for Indication, Annunciation & SAS integration.

7.1.3.12.2 A.C. CIRCUITS

230 Volts, Single Phase A.C. Aux. Supply to the Control and Relay Panel will be fed from A.C. Distribution Panel through a 16Amp MCB provided there. One 16 Amps rated MCB shall be provided at the Control & Relay Panel for the Incoming A.C. Supply. 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.

7.1.3.12.3 P.T. SECONDARY CIRCUIT

There may be two nos. 33KV bus PT, one in each bus section. Two sets of Fuse and link or 2 nos. 4 pole MCB of suitable rating shall be provided for the Incoming P.T supply's Measuring & Protection circuit. Colored LED indicating lamps shall be provided for supervision of the Fuse. Lamps shall be connected between respective phases and neutral. The arrangement of distribution of P.T. Secondary Circuit shall be as follows:

- (a) Measurement & Protection function of all the 33kV Incomer & Outgoing panel shall be done using respective feeder's Line VT and Measurement & Protection of all the 33kV Power Transformer, Auxiliary Transformer & Bus Coupler panel shall be done by using respective adjacent Bus's Bus VT.

- (b) Selected P.T. secondary supply to the protective relays of each panel shall be fed through 4 poles - MCB and link in neutral in each panel where necessary with two change over contacts for annunciation.
- (c) Selected P.T. secondary supply for metering and indicating instruments of each panel shall be fed through 4 pole MCB in each phase and link in neutral in each panel of 33KV system voltage.
- (d) Synchrocheck (25) function of all the 33kV Incomer & Outgoing Feeder shall be done by respective feeder's Line VT & adjacent Bus's BUS VT and Synchrocheck (25) function of all the 33kV Bus Coupler Feeder shall be done by adjacent 2 Bus's Bus VT

7.1.3.13. 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
- 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.
- e. Trip relay for OC/EF will be self-reset type and for Differential/REF & Transformer Self (mechanical) Protection shall be "Hand and Electrical Reset" type with at least two NO contacts as spare.

7.1.3.14. SUPERVISION RELAYS

7.1.3.14.1 Trip Circuit and Protection Supply Supervision

The trip circuit supervision function shall be a separate relay and independent of control part 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 (TCS) shall supervise not only the trip coil but the whole trip circuit during both breaker open and close position (pre-close & post-close). Each trip circuit shall be supervised by separate Trip Circuit Supervision (TCS) relay.

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.

7.1.3.14.2 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 Signaling, Annunciation & SAS integration. The relay shall detect failure of PT supply. As per requirement mentioned in the section 7.1.3.12.3, 1 NO contact of the PT supply supervision relay & PT 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.

7.1.3.14.3 D.C. Supply Supervision

There shall be 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.

As per requirement mentioned in the section 7.1.3.12.1; 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, 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.

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).

7.1.3.14.4 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.

As per requirement mentioned in the section 7.1.3.12.2, 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.

7.1.3.15 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, DS, ES shall be installed. 33kV bus name (1,2,3,4..) shall be indicated with visible permanent sticker in the 33kV mimic bus.

Provision shall be made for 10 mm. wide painted and overall drawing mimic diagram by the purchaser on the exterior of the front panel board to represent the single line arrangement of the station equipment. Provision shall be made in such a way that centre line of the mimic bus shall be at a suitable height from the bottom of the PCM Panel.

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(mm)</u>	<u>Dimension (mm)</u>
33 KV	Black	3	12
Earth	Green	3	12

7.1.3.16 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.

7.1.3.17 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.

7.1.3.18 Name plate & Ratings:

- a) All instruments, relays and such other similar electrical devices mounted on the control and relay panel shall be provided with name plates bearing the manufacturer's name, serial identifying number and the Electrical rating data.

	source, maximum system voltage 120V line to line.
System frequency	50 Hz

7.1.3.20.2 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)
- Current phase angle (each phase)
- Tampering indication in the register.

Memory storage : 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.

- 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.

The meter must have sufficient capacity to store data at 30 (thirty) minutes interval for at least 180 (One hundred eighty) days.

- Load Profile data [kWh, KVarh (Q1+Q4)]
- Phase voltage or Vh

- Phase amps or Ah

Accuracy class	: Accuracy class is 0.2s (point two s) for active energy (kwh) & 0.5s for reactive energy (Kvar).
Number of digit	Minimum 5 (Five) integer with 3 (three) decimal (Total 8 digit).
Type of Display	Solid-state LCD display.
Time switch	: 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.
Battery reserve	: 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.
Construction	: The meter shall be completely self-contain 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.
	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 may be surface mounted in an outdoor pole mounted metering enclosure box 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. Otherwise the bid will be rejected.
- 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.

7.1.3.20.3 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.

7.1.3.20.4 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 otherwise the bid will be rejected.
- 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.

7.1.3.20.5 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.

7.1.3.20.6 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 angel); 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 400 events) 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 Softwares 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.

7.1.3.20.7 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.

7.1.3.20.8 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.

7.1.3.20.9 PROTECTIVE RELAYS

All Protective relays & Auxiliary 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 protective relays shall be supplied from any of following manufacturers:

1. ABB (Switzerland/Finland/ Sweden)
2. Siemens (Germany/ Switzerland)
3. Schneider (France/UK)
4. Alstom (UK/France)
5. NR, China
6. SEL, USA

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

7.1.3.20.10 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 (i.e. breakers, vacuum interrupter etc.) of offered type equipment.
- b) Outline and General Arrangement drawings.
- c) The Bidder/ Manufacturer shall submit the list of available testing/ measuring equipment, meters, etc for performing Routine Test as per IEC standard.
- d) Manufacturer's ISO 9001 Certificate.

7.1.3.20.11 APPROVAL OF DRAWINGS

The successful bidder/tenderer shall submit the following drawings in AutoCAD format and in hard copy for the approval to the Engineer, Director, Design & Inspection-II, BPDB within within 15 days from the date of signing Contract.

1. Technical Specification and Guaranteed Technical
2. Detailed dimensional drawings of 33KV Switchgear including foundation drawing. with cable slots showing all equipment mounted on them along with complete panel wise list of equipment and list of Name Plates. Weight of these panels with all the equipment mounted on these shall also be furnished in the Drawing.

3. Outlined drawings of internal wiring diagram of the instrument, relays, meters, annunciator and other equipment showing external terminal connections with the equipment terminal number.
4. Complete AC and DC Schematic diagram of 33KV Switchgear Panels to indicate the followings:
 - i) Annunciator circuit
 - ii) Protection and control circuit
 - iii) Indication and Supervision circuit
 - iv) Other circuits as necessary

These drawings shall show AC power connection and Secondary connections for relays, meters, terminal blocks with their number etc. interconnection diagram between PCM and circuit breaker, Power and Instrument Transformer and other equipment as necessary

5. Cabling and wiring diagram of the cubicles and inter-connections between them. Ferrule numbers, device number and grouping for cable take off shall be distinctly shown. No work shall be performed in connection with the fabrication and manufacture of the testing equipment until the technical data and drawings have been approved.
6. Manufacturer's printed catalogue describing the type/model of offered 33KV Switchgear, Protective relays, Energy Meters
7. The Bidder shall have to submit 3 (three) sets of the same for Approval. The bidder shall also submit one set reproducible tracing of the above drawings in soft format.
8. List of switchgears electrical & mechanical interlock, BCP/Relay's BI, BO, LED, Annunciators window and related drawings shall be submitted with detail switchgear drawing during approval stage.

No work shall be performed in connection with the fabrication and manufacture of the Testing Equipment until the technical data and drawings have been approved. The manufacturing of the equipment shall be strictly in accordance with the approved drawings and no deviation shall be permitted without the written approval of the purchaser. The cost of supplying drawings and specifications shall be borne by the supplier.

At the time of delivery of Equipment, the supplier shall supply three (3) sets of all approved technical data and drawings in bound book form along with manufacturer's original catalogue of the Equipment to the office of Director, Design & Inspection-II, BPDB, 9/B, Motijheel C/A, Dhaka, Bangladesh, Telephone # 88-02-9550404

7.1.5 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.

7.1.5A 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

7.1.5.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 angel (each phase) |or P.F. Angle(each phase)
- Current phase angle(each phase)
- Tampering indication in the register.

Memory storage

: 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.

- 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 tempering. (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.

The meter must have sufficient capacity to store data at 30 (thirty) minutes interval for at least 180 (One Hundred Eighty) days.

- Load Profile data [kWh, KVarh (Q1+Q4)
- Phase voltage or Vh
- Phase amps or Ah

Accuracy class	: Accuracy class is 0.2s (point two s) for Active Energy(KWH) & 0.5s for reactive Energy (KVARH)
Number of digit	Minimum 5 (Five) integer with 3 (three) decimal (Total 8 digit).
Type of Display	Solid-state LCD display.
Time switch	: 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.
Battery reserve	: 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.
Construction	: The meter shall be completely self-contain 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.
	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 an outdoor pole mounted metering enclosure box 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 : Pulse indicator on the front of meter as per meter constant.

operation	
Special condition	: c) 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. d) 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. Otherwise, the bid will be rejected.
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.

7.1.5. 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.

7.1.5.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 otherwise the bid will be rejected.
- 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.

7.1.5.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.

7.1.5.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 angel); Load profile having minimum 8(eight) Channels data stored in different interval for atleast 180 days.
- Tamper feature: The meter must have Errors & Warnings codes, History log and Event log (minimum 400 events) 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. AMR should have remote communication GPRS.

7.1.5.F2 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.

7.1.5.F3 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 Energy meters is within the scope of supply.