SECTION – 2.04

HT SWITCHGEAR

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of 11 kV (UE- Un Earthed) HT switchgears at BESS Plant.

- 11 kV Switchgear at BESS field
- 11 kV Switchgear at MCR (Main Control Rom)

2.0.0 SCOPE OF WORK

2.1.0 The scope of work shall include the following equipment.

- 11kV HT Panel at BESS Field : 1600A busbar, 31.5kA for 1 sec (One number(01) of 20 MVA Outgoing feeder from BESS field shall be considered and Number of incoming shall be decided by bidder,)
- 11 kV HT Panel at MCR : 4000A busbar, 31.5kA for 1 sec (4 IN 1 OUT)

11kV switchgear shall be located in a suitable building with elevated height. The minimum requirement of the feeders indicated in the enclosed SLD (Annexure - 2) and may vary during detail engineering. 11kV cable, cable termination kits and lugs are in scope of the bidder.

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the following Indian / IEC Standards, except where modified and /or supplemented by this specification.

a) IS: 2705 Current transformers -Specification (Part I to IV)
b) IS: 3156 Specification for Voltage transformers (Part I to IV)
c) IS: 3231 Electrical relays for power system protection.
d) IS: 3427 A.C. Metal Enclosed Switchgear and Control gear for Rated Voltages Above 1 kV and Up to and Including 52 kV.
e) IS: 5578 Guide for marking of insulated conductors
f) IS: 6005 Code of practice for phosphate of iron and steel
g) IS: 9385 HV fuses
h) IS: 9431 Specification for indoor post insulators of organic material for system with nominal voltages greater than 1000 Volts up to and including 300 kV

i) IS: 11353 Guide for uniform system of marking and identification of conductors and apparatus terminals.

j) IS: 13118 Specification for high voltage alternating current circuit breakers

k) IS: 12729 Switchgear & Control gear for voltages exceeding 1000 V –General requirements.

l) IS: 10624 High voltage fuse-links for motor circuit applications

m) IS: 9920 High Voltage Switches for Rated Voltages above 1 kV and less than 52 kV

n) IS: 14666 High voltage alternating current switch fuse combinations.

o) IS: 12534 Application guide for the selection of high voltage fuses for transformer circuit applications

p) IEC 62271- 200 High-voltage switchgear and control gear

q) IEC-62271-100 High-voltage switchgear and control gear - alternating current circuit breakers.

r) IEC-62271-106 High-voltage switchgear and control gear - Part 106: Alternating current contactors, contactor-based controllers and motor-starters

s) IEC-60099 Non-linear resistor type gapped surge arrestor for AC systems

t) IEC- 62271-102 High-voltage switchgear and control gear – Alternating current disconnectors and earthing switches

4.0.0 DESIGN REQUIREMENTS

4.1.0 Design ambient air temperature shall be considered as 48°C for sizing the electrical equipment and relative humidity of 95% maximum.

4.2.0 Any auxiliary power supply required by the Bidder for the operation, control, protection, interlocking, and monitoring of the HT switch gear shall be derived solely from the auxiliary power source made available by the Owner / Employer at the plant. The Bidder shall not assume the availability of any additional or external auxiliary power source.

4.3.0 In the event of any variation in the available auxiliary supply voltage, the Bidder shall be entirely responsible for providing all necessary voltage conversion, regulation, isolation, and conditioning equipment required to obtain the voltage levels suitable for the Bidder's end-use equipment installed within the switchgear.

4.4.0 All such equipment, accessories, and associated works shall be deemed to be included within the Bidder's scope of supply and quoted price, and no additional cost, time extension, or claim shall be admissible on this account

4.5.0 All clearance shall be provided for the 11kV Unearthed system.

4.6.0 Insulation level

- One minute Power Frequency withstand voltage for 11 kV : 28 kV (rms)
- 1.2/50 Micro sec, impulse withstand voltage for 11 kV : 75 kV (peak)

4.7.0 Short circuit withstand rating shall be not less than the following:

- 11 kV Switchgear : 31.5kA for 1 sec

4.8.0 Internal arc withstand rating shall be not less than the following:

- 11 kV Switchgear : 31.5 kA for 0.5 second

4.9.0 Current Rating

4.6.1 The ambient temperature prevailing inside the switchgear while carrying rated current, corresponding to the maximum specified outside ambient conditions, shall be considered as the design ambient temperature for sizing of all equipment, devices, and busbars. The permissible temperature rise shall be in accordance with the applicable IEC / IS standards.

4.6.2 A design margin of not less than 10% shall be considered for the sizing of all equipment and devices.

4.10.0 Control supply and space heater supply

a) For all the feeders control supply voltage shall be 110 V DC. For each 11kV pooling switchgears, 2 Nos. 110 V DC control supply shall be provided with "O- Ring" device.

b) For each switchgear, 240 V AC supply shall be provided for auxiliary supply. For each panel space heater, cubicle lamp & socket, rated for 240 V AC supply shall be provided.

c) Thermostatically controlled space heaters shall be provided separately to keep the ambient temperature under control inside the enclosure to prevent condensation. The heaters shall be located such that wiring, buses and control devices do not get overheated.

4.11.0 Controls:

a) HV Switchgears shall have Vacuum circuit breakers
b) All feeders shall be controlled from EMS / SCADA / SAS. All the protection and safety interlocks shall be hardwired in the Switchgear itself.

c) The incomer modules shall be interlocked with their upstream breaker such that they can be closed only when upstream breaker is closed and trip automatically when upstream breaker is tripped or manually opened.

d) All HT switchgear panels shall be provided with pad lock and key arrangement with key rack.

e) Local / Remote selection shall be provided in switchgear. Local selection is envisaged for local operation from Switchgear. Remote selection shall enable starting from EMS/SCADA/SAS.

f) All hardware/software required for interfacing with the SCADA system shall be supplied by the Bidder.

4.12.0 Communication:

a) All meters shall communicate on MODBUS-RS 485 protocol. Maximum Twenty-meter devices shall be connected in one MODBUS loop.

b) The Numerical relay shall communicate on IEC 61850 Protocol for data exchange, Disturbance Recording, fault recording and event recording file transfer and Relay parameterization.

c) MOBUS -RS 485/MODBUS-TCP/IP converters shall be provided as required. The converter shall be connected to the Ethernet switch.

d) IEC 61850/Ethernet Switch shall be provided and mounted in the Switchgear panel suitably. (Bidder shall refer relevant section of tender document for detail specifications)

e) CAT 6 cable shall be used for IEC 61850 & TCP/IP communication.

f) Twisted Pair Cables shall be used for RS 485 communication.

5.0.0 TECHNICAL REQUIREMENTS

5.1.0 Switchgear Construction

5.1.1 The switchgear shall have a single front, single tier, fully compartmentalized, draw-out type, metal clad construction complying with clause No. 3.109.1 of IEC-62271 part 200, comprising of a row of free standing floor mounted panels. Each circuit shall have a separate vertical panel with distinct compartments for circuit breaker truck, cable termination, main busbar and auxiliary control devices. The adjacent panels shall be completely separated by steel sheets except in busbar compartments where insulated barriers shall be provided to segregate adjacent panels.

5.1.2 The circuit breakers , bus VTs and Line VT's shall be mounted on withdrawable trucks which shall roll out horizontally from service position to isolated position. Withdrawable bus VTs shall be preferably on front side of the panel board.

5.1.3 The trucks shall have distinct Service, Test / Isolated positions. It shall be possible to close the breaker compartment door in Isolated position also, so that the switchgear retains its specified degree of protection. While switchgear designs with doors for breaker compartments would be preferred, standard designs of reputed switchgear, provided the breaker compartment is completely sealed from all other compartments and retains the IP-4X degree of protection in the Isolated position.

5.1.4 The switchgear assembly shall be dust, moisture, rodent and vermin proof with the truck in any position Service, Test / Isolated or removed, and all doors and covers closed. All doors, removable covers and glass windows shall have gaskets all round with synthetic rubber or neoprene gaskets.

5.1.5 Circuit breakers, LV compartments, busbar chamber & cable termination chamber etc. shall be housed in separate compartment within the cubicle. The design shall be such that failure of one equipment shall not affect the adjacent units. A minimum clearance of about 800 mm shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Interphase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirement besides facilitating easy connections and disconnection of cables. Dimensional drawing of cable connection compartment showing the location of lug, glands, CTs, gland plates etc. and the electrical clearances available shall be submitted for owner's approval during detail engineering.

5.1.6 The VT/ relay compartments shall have degree of protection not less than IP:52 in accordance with IS:13947. However, remaining compartments can have a degree of protection of IP: 4X (minimum). No louvers/opening shall be provided on the top of the panel. All other louvers if provided, shall have very fine brass or GI mesh screen. Tight fitting gourmet/gaskets are to be provided at all openings in relay compartment.

5.1.7 Enclosure shall be constructed with rolled steel sections and cold rolled steel sheets of at least 2.0 mm thickness, Gland plates of minimum 3 mm thick, shall be made out of hot rolled or cold rolled steel sheets and for single core cables, it shall be nonmagnetic material.

5.1.8 The switchgear shall be cooled by natural air flow up to 2500 Amp rating, and forced cooling accepted above 2500 Amp rating. Conventional RTDs shall be provided for temperature monitoring of the main busbar and cable compartment. RTD signals shall be integrated to SCADA/SAS and local annunciator.

5.1.9 Total height of the switchgear panels shall not exceed 2500 mm. The height of switches, push buttons and other hand operated devices shall not exceed 1800 mm and shall not be less than 700 mm from bottom of the panel base. All relays, meters, indicating lamps, switches etc. shall be flush mounted on the respective cubicle front door.

5.1.10 Safety shutters complying with IEC-62271 part 200 shall be provided to cover up the fixed high voltage contacts on busbar and cable sides when the truck is moved to TEST and ISOLATE position. The shutters shall move automatically, through a linkage with the movement of the

truck. Pressure relief device shall be provided for each HV compartment to vent out safely the gases produced in case of fault.

5.1.11 The switchgear shall have the facility of extension on both sides. Complete design detail of switchgear such as busbar cross sections, enclosure material, enclosure dimensions, Flange, connection arrangement, bolt spacing & dimension, Gasket detail etc. Further manufacturer supplying equipment under present scope shall furnish all the required details in addition to mentioned above necessary for design and successful implementation of an adaptor / interface module / panel during later stage while extending switchgear board by any other manufacturer, without any help of manufacturer who has supplied the equipment in present scope. The details are to be furnished during detail engineering stage.

5.1.12 For all panels including and spare Feeders, gland plate/holes shall be designed to accommodate minimum 3 runs of 3 core / 1C , 630sq.mm aluminium cable. However feeder from 70 MVA transformer to MCR 11 kV switchgears requires large number of 1C x 630 Sqmm , bidder shall design the accordingly .

5.1.13 Similar equipment and components shall be of same make. Equipment of same type and rating shall be interchangeable.

5.1.14 Separate Tariff metering panels shall be provided for ABT / SEM meters (including but not limited to CT/PT, TTB's, MCB's, 110V DC supply, Supply selection switch, UPS supply, ABT Meters and its accessories etc.) with required sealing arrangement front (Top Bottom), Rear (Top Bottom) shall be provided. All communication ports (RS-485 and LAN Ports) of Metering system shall be brought to Control cubicle of respective panel for future connections (as metering compartment of will be sealed by concerned authorities and we intend to have access of meter communication ports.).. (Bidder shall refer requirement of communication port in relevant section of tender document.)

5.1.15 3-Phase -4 Wire Screw type front connection of standard size (compact TTB is not permitted) with back connection Test Terminal Blocks (TTB) shall be provided for all meters (ABT, PQM, MFM etc.) in all 11 kV feeders. (e.g. Dev industries model no 4SF)

5.1.16 MIMIC with Semaphore to be provided. MIMIC shall indicate symbols of transformer, bus PT, and normal power flow arrow. Details of MIMIC will be finalized during detailed engineering.

5.1.17 Breaker local / remote switch status shall be integrated to EMS /SCADA.

5.1.18 Cable trench of HT panel board shall be designed after considering adequate margin of cable bending radius.

5.1.19 Cable entry in the trench shall be at least above 1000mm to HFL (High Flood Level)

5.1.20 Annunciator having Modbus RS-485 communication port with SCADA integration to be provided for each compartment. (4 Nos of Spare window is to be provided in each annunciator), Annunciator widow size shall of large size.

5.1.21 All Gland plates shall be supplied in pre-drilled condition at site.

5.1.22 Seismic Zone as per IS 1893 compliance for switchgear.

5.1.23 MFM and PQM shall be provided with Screw type with back connection TTB. (3 element, 4 wire)

5.1.24 20% Spare TB's are to be provided for each type of TB type wise & terminal station wise e.g. breaker, CT, PT, supply, etc (subject to minimum two TB's). All control terminals shall be of Stud type (screw drive operated) and control wiring shall be terminated with ring type lugs. CT & PT TB's shall be of disconnecting type.

5.1.25 Compartment internal wiring truff fill factor shall not be more than 50%.

5.1.26 LV compartment of the panel shall be spacious for any future requirement. (Minimum 20% additional space must be available)

5.1.27 Common Hooter system (AC &DC) is to be provided for each switchgear board.

5.1.28 Drawing pockets shall be provided for each compartment.

5.1.29 Relay Test Blocks (RTB) shall be provided for all main protection relays in every feeder. Multi-finger test plugs shall be provided for secondary injection testing without disturbing the wiring.

5.1.1 Internal arc withstand requirements

a) The HV switchgear shall be arc resistant type and it shall also be effective during the process of inserting the switching devices and/or VT's into the service position or withdrawing the switching devices and / or VTs into the test position.

b) The switchgear, as per IEC-62271-200, shall be:
- Designed to provide loss of service continuity classification LSC2B-PM
- Internally arc tested front, lateral and rear (FLR) i.e. IAC A FLR for an arc fault current as specified to meet the requirements of Annex A IEC 62271-200 (criteria 1 to 5)

c) The segregation shall be designed to prevent arcs, smoke and/or vaporized metal from going directly or indirectly from one compartment to another so as to prevent the fault or its effects spreading to other compartments.

d) Compartmenting shall be such that maintenance can be carried out safely on one (1) circuit with other adjacent circuits still in service.

e) HV switchgear shall comply with IEC 60298 with regards to mechanical strength in the event of internal arc.

f) The arc detection system shall be of the light sensitive/current sensitive type or pressure switch based, and shall detect and isolate only the faulted bus section of the switchgear so that healthy bus section continues to operate satisfactorily. The fitting of the arc detection

system does not nullify any of the switchgear type tests. Preferences shall be for an arc detection system which indicates the location of the fault.

5.2.0 **Bus and Bus Taps**

5.2.1 The main buses and connections shall be of high conductivity Copper / Aluminum alloy sized for specified current ratings with maximum temperature limited to 90°C and 105°C for silver plated joints. The busbars shall be designed for specified short circuit rating.

5.2.2 All bus connections/joints shall be silver plated. Adequate contact pressure shall be ensured by means of two bolts connection with plain and spring washers and lock nuts. Bimetallic connectors shall be furnished for connections between dissimilar metals. The auxiliary contacts shall be silver plated with minimum thickness of 10 microns.

5.2.3 Busbar insulators shall be epoxy cast resin type designed to withstand stresses due to maximum short circuit current. Bus insulator shall be flame-retardant, non- hygroscopic track resistant type with high creepage surface. This shall be of non-carbonizing material such as epoxy bonded Fiberglass etc.

5.2.4 Busbars and connection shall be fully insulated for working voltage with adequate phase/ground clearances. Insulating heat shrink sleeves for busbars and cast-resin shrouds / silicon rubber shrouds for joints shall be provided. Cross section of the main horizontal busbar shall be uniform throughout the switchgear and continuous in one transport unit. All buses and connection shall be supported and braced to withstand stresses due to maximum short circuit current and also to take care of any thermal expansion.

5.2.5 Busbars shall be colour coded for easy identification and so located that the sequence R-Y-B shall be from left to right, top to bottom or front to rear, when viewed from front of the switchgear assembly..

5.2.6 The busbar chamber shall be without seal off bushing between the panels, However, Bus chamber shall be totally enclosed & separated from all other chambers and shall be provided with epoxy case seal-off bushings through which the buses shall pass so as to prevent fire from bus chamber to other chambers.

5.2.7 Creepage distance for bus bar insulation shall be 31mm/kV.

5.3.0 **Circuit Breaker**

5.3.1 The circuit breakers shall be of Vacuum type. They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism.

5.3.2 Surge arrestor shall be provided for each feeder.

5.3.3 Circuit breaker shall be restrike free, stored energy operated and trip free type. Motor wound closing spring charging shall only be acceptable. An anti-pumping relay shall be provided for each breaker. Spring charging motor winding shall be provided with Class -E or better insulation.

5.3.4 4000A rated VCBs at MCR shall be provided with two independent trip coils (TC1 and TC2), each connected to separate supply sources to ensure redundancy of tripping.

5.3.5 Trip circuit supervision shall be provided for each trip coils of all feeders to monitor the circuit breaker trip circuit both in pre-trip and post trip conditions.

5.3.6 Master trip relay – 86 trip circuit supervision shall be provided (in set and reset conditions).

5.3.7 Self-reset type lockout relay to be provided on Bus PT panel for under voltage tripping of the all feeders.

5.3.8 Each breaker feeder shall be provided with the following as a minimum:

- Anti-pumping relay
- Motor charged spring operating mechanism with spring charged limit switches & required number of contacts.
- Manual spring charging facility
- Mechanical indication for spring charged condition
- Mechanical indication for circuit breaker ON / OFF status and circuit breaker positions (SERVICE / TEST/ ISOLATED) each with having required number of contacts for interlocks.
- Closing coil and tripping coils
- CTs for protection and metering.
- Mechanical ON / OFF provision of circuit breaker
- Circuit breaker operation counter
- Phase barriers
- Shutter assembly

5.4.0 **Load Break Switch (LBS)**

5.4.1 The Load Break Switch shall be suitable for outdoor type panel, the LBS shall be air-insulated type suitable for 11 kV, unearthed system. It shall function as a three-phase isolator with load-breaking capability. LBS shall be capable of making, carrying, and breaking load currents under normal operating conditions but shall not be intended for fault interruption duty. The LBS shall be rated to carry the fault current as per the fault rating of the 11kV (Unearthed system) switchgear for a duration of 1 sec. The LBS shall be suitable for IEC 62271-102 and IEC 62271-103

5.4.2 The LBS shall be provided with a mechanically interlocked earthing switch on the cable end. Mechanical interlocking shall ensure that:

- The earthing switch can only be closed when the LBS is in the OPEN position.
- The LBS can only be closed when the earthing switch is in the OPEN position.
- Simultaneous closing of both the LBS and earthing switch shall be positively prevented under all circumstances by a direct mechanical interlock, not relying on electrical interlocking alone.

5.4.3 The LBS shall be of the stored-energy, spring-operated type for both closing and opening operations. Manual spring charging via an operating rod or handle shall be provided as standard. The operating mechanism shall be housed in a weatherproof, lockable enclosure with a minimum ingress protection of IP55. The test type reports be submitted along with Bid.

5.5.0 **Current Transformer (CT)**

5.5.1 The CTs shall be mounted on the switchgear stationary parts. The CTs shall be of cast resin, bar primary type and of Class B or better insulation. CT secondary current shall be 1 Amp. However for tariff metering CT's parameters like secondary current, ISF, Ratio, Burden shall be as approved by the STU / Concerned competent statutory or government or semi government authorities or regulatory authorities.

5.5.2 Dedicated CT's shall be provided for tariff metering purpose.

5.5.3 CTs shall be rated for switchgear fault level for 1 sec and conforming to accuracy class mentioned below :-

- Class PS for differential relaying and REF protection
- Class 5P20 for other relaying
- Class 0.2s for metering and general metering (Energy Accounting) with actual ISF<5 or instrument withstanding capabilities.

5.5.4 Separate cores shall be provided for metering and protection applications. Core balance CT and associated relay combination shall be such as to ensure a pick up sensitivity of 10 A primary ground fault current for all the outgoing feeders.

5.6.0 **Voltage Transformer (VT)**

5.6.1 Voltage transformer shall be cast-resin, draw-out type from the front of the panel. Bus VT shall be mounted on adopter panel or shall be provided in separate panel. Line VT shall be mounted on the breaker carriage itself / below the breaker compartment. Separate cores shall be used for metering and protection. Voltage Transformer mounted on breaker carriage is not acceptable. Over voltage factor shall be considered resistance grounded system as 120% for continuous duty and 190% for 8 hours.

5.6.2 Accuracy class of the voltage transformer shall be Class 3P for protection and Class 0.2 for metering. Number of cores shall be finalized during detail engineering.

5.6.3 High voltage windings of voltage transformer shall be protected by current limiting fuses. The voltage transformer and fuses shall be completely disconnected and visibly grounded in fully draw-out position. Automatic shutters shall be for safety purpose to avoid accidental access to live parts on VT withdrawal and entry of rodents. Low voltage side MCB's shall be provided.

5.6.4 Fuse failure relay on voltage balance principle shall be provided for all Bus VT's for monitoring the healthiness of primary fuse/secondary MCBs. For line VT's fuse failure relay shall be provided on the secondary side of the voltage transformers to monitor failure of MCBs. The relay shall initiate alarm and block the tripping etc., which shall operate in case of VT fuse/MCB failure.

5.7.0 **Relays**

5.7.1 Each breaker module shall be provided with multifunction numerical relay for protection.

5.7.2 Relays in protective circuits shall be flush mounted on panel front with connections from the inside. They shall have transparent and dust tight removable cover from the front.

5.7.3 The Numerical relays shall have built in protection, control, metering, monitoring, disturbance recorder and communication facility. The Numerical relays shall be networked through Ethernet switch, Gateway/Data Concentrators and shall be further integrated with SCADA based electrical monitoring system (for monitoring, measuring, fault data analysis & relay parameterization).

5.7.4 All numerical relays shall be draw out / withdrawable type.

5.7.5 All the numerical relays shall have at least two communication ports; local front port communication to laptop and a second port (RJ45/Fiber optic) on IEC 61850 to communicate with the data concentrator through LAN and Ethernet switches.

5.7.6 The successful bidder shall be fully responsible for selection of appropriate relay to provide optimum protection and discrimination of various circuits and equipment including the safety of the devices.

5.7.7 All hardware and licensed software required for communication of relays, parameterization, down load / analysis of fault data from relays and interfacing the relays with the SCADA system shall be supplied by the Bidder complete with set of cables, accessories, etc.

5.7.8 All relays and timers shall be rated for control supply voltage of 110 V DC and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings of their contacts shall be adequate for the circuits in which they are used. Interrogation voltage for the binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages.

5.7.9 Failure of a control or auxiliary supply and de-energisation of a relay shall not initiate any circuit breaker operation. All relays shall withstand a minimum test voltage of 2 kV AC rms for one minute.

5.7.10 Relays shall have separate output for individual functionality and the master trip shall be software configurable in case of multi output relays. Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping.

5.7.11 All the protective relays shall have inbuilt lock-out (86) facility with manual reset. For all feeders and incomer, a separate lockout relay shall be provided with manual reset. Each circuit breaker feeder shall be provided with, protective relay trip circuit supervision relay, necessary auxiliary relays, timers, etc. to meet circuit requirements.

5.7.12 Master trip relay shall have coil supervision system. Lock out relay function contacts shall only be provided for protection trip & reset status for use in close and trip interlocks of the circuit breaker.

5.7.13 Comprehensive single numerical relay shall have provision of both adequate number of current and voltage inputs. Relays shall be suitable for CT secondary current of 1 A / 5 A selectable at site.

5.7.14 Synchro check numerical Relays shall be provided for 70 MVA transformer feeder shall have provision of two sets of voltage signal inputs for the purpose of synchronization.

5.7.15 All CT and PT terminals shall be provided as fixed type terminals on the relay to avoid any hazard due to loose connection leading to CT opening or any other loose connection. In no circumstances Plug In type connectors shall be used for CT/ PT connections.

5.7.16 All numerical relays shall have key pad / keys to allow relay settings from relay front. All hand reset relays shall have reset button on the relay front. Relay to be self or hand reset shall be software selectable. Manual resetting shall be possible from remote.

5.7.17 Relays shall have suitable output contact for breaker failure protection.

5.7.18 Relays shall have self-diagnostic feature with self-check for power failure, programmable routines, memory and main CPU failures.

5.7.19 Relays shall have at least two sets or groups of two different sets of adaptable settings. Relays shall have multiple IEC/ ANSI programmable characteristics.

5.7.20 For breaker control from SCADA/Respective control system, hardwired potential free contacts shall be provided from SCADA/Respective control system to the numerical relays.

5.7.21 Schematics requiring auxiliary relays /timers for protection function shall be a part of numerical relay. The number of auxiliary relay and timer function for protection function shall be provided as required. Auxiliary relays for interlocking purpose shall be of self-reset type. However, separate auxiliary relays are to be provided wherever required.

5.7.22 Bus no volt condition shall be configured to an output contact of the relay of all incomers and shall be wired up to TB.

5.7.23 Timer functions shall be programmable for on/off delays.

5.7.24 The numerical relay shall be able to provide supervisory functions such as trip circuits monitoring, circuit breaker state monitoring, PT and CT supervisions and recording facilities with Post fault analysis.

5.7.25 The numerical protective relays and all IED's shall be capable of measuring and storing values of an all analogue and digital channels concurrently for, all events, faults and disturbance recordings with a time stamping (synchronized with Master clock) .

Disturbance recording shall provide adequate pre-fault and post-fault time duration, accuracy and resolution to comply with the requirements of SLDC/GETCO or other applicable statutory authorities.

5.7.26 In case the disturbance recording function within the IEDs is not adequate, a separate disturbance recorder shall be provided.150-time tagged events/ records should be able to store with time stamping last 5 faults storage including the indication, protection operated, fault location relay and operating time, currents, voltage and time. All Setting parameters, Fault data, waveforms & event logs shall be stored in Non-volatile memory only.

5.7.27 Diagnostics Automatic testing, power on diagnostics with continuous monitoring to ensure high degree of reliability shall be provided. The results of the self-reset functions shall be stored in battery back memory. Test features such as examination of input quantities, status of digital inputs and relay outputs shall be available on the user interface

5.7.28 The alarm/status of each individual protection function and trip operation shall be communicated to Data concentrator/SCADA/SAS / Respective control system. The numerical relay system shall have built-in features/hardware interface to provide such inputs to Data concentrator / SCADA /SAS/ Respective control system for analog/digital.

5.7.29 Sequence of events shall have 1 ms resolution at device level.

5.7.30 Measurement accuracy shall be 1 % for RMS Current and voltage.

5.7.31 It shall be possible to carryout open / close operation of breakers from a laptop by interfacing from the relay front port during initial commissioning.

5.7.32 Relay shall be suitable to accept both AC & DC supplies with 240 V AC/ 110V DC with tolerance of 80% to 120 % of rated voltage

5.7.33 Relay shall be immune to capacitance effect due to long length of connected control cables. Any external hardware, if required for avoiding mal operation of the relay due to cable capacitance shall be included as a standard feature. All IOs shall have optical isolation. Analog inputs shall be protected against switching surges, harmonics etc.

5.7.34 No separate earth bus shall be required for the relays. It shall be possible to connect the relay earth to the common earth bus in the switchgear panel which shall be connected to the Main earth mat.

5.7.35 Numerical relays shall have two level password protections, one for read only and other for authorization for modifying the setting etc.

5.7.36 Relays shall be rated for operation on 110 V VT secondary voltage.

5.7.37 Auxiliary supply voltage for Relays and meters shall be 110 V DC. The switchgear shall be provided with DC fail relay and DC fail indication lamp for each DC control supply incomer. Monitoring of DC fail shall be from AC supply.

5.7.38 Auxiliary Transformer feeder shall have separate auxiliary (interposing) relay e.g. Buchholz, PRDs, MOG, WTI (for each winding), OTI etc. One contact of relays each allocated for SCADA and annunciator integration and one spare contact wired up to TB for future use shall be provided. Auxiliary relay shall have flag.

5.7.39 Breaker auxiliary contacts shall be used directly. In case contact multiplication is inevitable (only if OEM is not supporting number of auxiliary contacts required) then mechanically latched electrically operated contact multiplication relays. 4NO + 4 NC spare breaker auxiliary contacts wire up to TB for future use shall be provided.

5.7.40 All main protective relays shall be numerical type with IEC 61850 communication interface and should have interoperability during integration of numerical relays to communicate over IEC 61850 protocol with RTU/SCADA/SAS/IEDs of different OEMs.

5.7.41 Numerical relay shall have the following features:

a) Type of relays shall be latest numerical high end version with highest display size and features available in proposed make and its product range
b) At least two group of settings
c) Min. no of LEDs - 10 (Minimum 2 LED's for future use)
d) LCD/LED Screen
e) Front key pad for Parameter / Navigation.
f) In built lockout function with front key resetting.
g) EMC Compatible.

h) No adopter / Convertor is acceptable.
i) At least 10 disturbance recorder
j) At least 5 Fault recorder
k) Event recording at least 50
l) Unlimited logic gates
m) In-built timers
n) Adequate number of Freely programmable Digital Inputs and Digital Outputs (DI & DO or BI and BO) (Min 4 DI and 4 DO for future use shall be wired up to TB).
o) In built CB control function with interlocking.
p) Goose messaging for inter tripping command and interlocking in addition to hardware interlocking.
q) Non -Volatile memory with battery backup or suitable arrangement
r) Time synchronization
s) self-diagnosis / watchdog / relay failure – two output contacts shall be configured. One for SAS and one for local panel annunciator.

5.7.42 Earth fault protection relay shall initiate tripping of associate breaker.

5.7.43 Requirements of protection relays and functions of various feeders including but not limited to followings :

a) Common for all the feeders.
- IDMT & DMT overcurrent protection (50/51)
- IDMT & DMT earth fault protection (50N/51N)
- Under voltage protection (27)
- Over Voltage (59)
- Local Breaker Backup (50LBB)
- Master Trip Relay
- Anti-pumping (94)
- Trip Circuit Supervision for Breaker in close and Open position for all trip coils.
- Trip Circuit Supervision for Master Trip Relay in operated and reset condition.
- Contact Multiplication relays , Interposing relays any auxiliary relays– as required.
- DC fail-1 & 2 with associated hooter
- AC fail with hooter

b) 70 MVA Transformer Feeder

In addition to common protection following relays / protection function shall be provided.

- Directional Over Current Relay (67)

- Directional earth fault (67N)
- Under Frequency (81 U)
- Over Frequency (81O)
- Neutral Over Voltage / Neural Displacement (59N)
- Synchronizing function
- Auxiliary relays
    - Winding Temperature Trip (49WX)
    - Winding Temperature Alarm (49WY)
    - Oil Temperature Trip (49OX)
    - Oil Temperature Alarm (49OY)
    - Magnetic Oil Gauge (MOG)
    - Pressure Relief Valve (PRV-1 & PRV-2)
    - Buchholz etc.

c) Auxiliary Transformer Feeder

In addition to common protection following relays / protection function shall be provided.

- Auxiliary relays
    - Winding Temperature Trip (49WX)
    - Winding Temperature Alarm (49WY)
    - Oil Temperature Trip (49OX)
    - Oil Temperature Alarm (49OY)
    - Magnetic Oil Gauge (MOG)
    - Pressure Relief Valve (PRV-1 & PRV-2)
    - Buchholz etc.

d) Bus PT shall have the following protections.

- Under voltage relay
- Over Voltage relay
- Fuse failure relay
- No voltage relay.

5.8.0 Control ,Interlocks and indications

5.8.1 The circuit breaker will normally be controlled from SAS/Respective control system. The control switch located on the switchgear / relay would normally be used only for testing of circuit breaker in TEST position.

5.8.2 The incomer modules shall be interlocked with their upstream breaker such that they can be closed only when upstream breaker is closed and trip automatically when upstream breaker is tripped.

5.8.3 The circuit-breaker shall have three distinct positions as follows:

- 'Service' both power and control contacts connected.
- 'Test' Power contacts isolated, control contacts connected.
- 'Isolated' both power and control contacts isolated.

5.8.4 Circuit breaker control switches shall be 3-position spring return to `neutral' from both close and trip positions. They shall have `Pistol Grip' handle. The contacts shall be of silver plated, air break type. The continuous current and breaking capacity of the contacts shall be adequate for the duty involved.

5.8.5 'Red', 'Green' and 'Amber' indication lamps shall be provided on the panel to indicate breaker 'Close', 'Open' and 'Auto-Trip' position. In addition to above, mechanical indicator shall be provided which shall be clearly visible to the operator standing in front of the panel.

5.8.6 Indication lamps to show the circuit-breaker 'Service' and 'Test' positions shall be provided. Further additional indication lamps shall be provided as per scheme requirement.

5.8.7 In case of force cooling system, Cooling fan "ON" indication lamp for each cooling fan shall be provided. LED indicating lamps shall be true colour cluster type.

5.8.8 Indication lamps shall be of the panel mounting, LED type. The lamps shall have escutcheon plates marked with its function, wherever necessary. Lamps shall have translucent lamp-covers as warranted by the application. LED lamps shall be of true color cluster type.

5.8.9 Facilities shall be provided for mechanical tripping of the breaker and for manual charging of the stored energy mechanism for a complete duty cycle, in an emergency. These facilities shall be accessible only after opening the compartment door.

5.8.10 The control / interlock schemes for various types of feeders shall be commensurate with their application. Contact multiplication, if necessary to meet the above contact requirement, shall be done through electrical reset latch relay.

5.8.11 Breaker Panel with forced cooling shall have an online real-time air flow, and breaker compartment temperature monitoring system, and the same shall be integrated into SCADA/BCU etc.

5.8.12 Potential free contacts for indications /alarms /SOE points shall be provided in each Breaker panel for remote panel/SCADA/Respective control system which shall include the following:

- Potential free contacts for remote SCADA for Breaker on, Breaker off, Breaker in remote, Breaker in service, Ready to start, lock out relay operation, Trip circuit trouble, PT fuse failure, switchgear disturbed, relay fault etc.
- Potential free contacts for interfacing with Bus transfer panels and other upstream/downstream breakers.
- For Transformer feeders, potential free contacts for remote SCADA for OTI alarm, WTI alarm, Buchholz alarm, Oil level low alarm, OTI Trip, WTI Trip, Buchholz relay trip, Pressure relief device operated, MOG etc.
- For each PT panel, potential free contacts for remote SCADA for Bus under voltage relay operated, Bus PT fuse failed, DC supply failed, Bus PT not in service etc.

5.9.0 **Multi-Function Meters**

5.9.1 Multifunction meters and energy meters shall be provided as indicated in the Feeder drawing. General purpose metering CT of 0.2s class for MFM meter shall be provided for each feeder.

5.9.2 Energy accounting and audit meters shall meet CEA regulations. It shall be integrated with integrated energy management system. The energy audit meters shall be suitable for measurement, recording and display of cumulative active energy with date and time. It shall have data storage capacity for at least 35 days in a non-volatile memory. It shall have facility to download the parameters through meter reading instruments as well as remote transmission of data over communication network. It shall also have the facility to measure, record and display the following parameters. All parameters excluding instantaneous electrical parameters shall also be stored in memory.

a) Phase to Neutral voltage
b) Average Phase to neutral voltage
c) Phase to Phase voltage
d) Average Phase to Phase voltage
e) Line current (L1, L2, L3 and Average)
f) Active / Reactive Current
g) Frequency
h) Power factor
i) Average Power factor
j) Active Power

k) Total Active Power
l) Reactive Power
m) Total Reactive Power
n) Apparent Power
o) Total Apparent Power
p) Active Total Import / Export Energy
q) Reactive (Q1,Q2,Q3,Q4) Energy
r) Apparent Import / Export Energy
s) Cumulative MD
t) Phase Angle
u) Power On / Off Hours
v) Load On / Off Hours
w) Feeder Interruptions Count (When Aux is also off)
x) THD Voltage
y) THD Current
z) THD Power
aa) RPM with Freq and Voltage unbalance and current unbalance
bb) Modbus on RS 485

5.9.3 Digital Multifunction Meters shall be provided with bright LED/LCD display for local indication and shall be provided with communication port suitable for communicating on MODBUS protocol to EMS/SCADA. It shall display various parameters like 3 phase currents, voltages, PF, MD, KW, KVA, etc. for local indication and shall be provided with minimum 8 nos. of user programmable registers for communicating any of the displayed parameters to the remote.

5.10.0 **Surge arrestor**

The surge arrestors shall be provided for all feeders to limit the switching over voltages to 2.2PU. The surge arrestors shall be metal oxide, gapped or gapless type generally in accordance with IEC 60099- 1 and suitable for indoor duty. These shall be mounted within the switchgear cubicle between line and earth, Surge arrestor rating shall be in such a way that the value of steep fronted switching over voltage generated at the switchgear terminals shall be limited to the requirements of feeding equipment.

The minimum rating of SA shall be 10 kA, however if as per system studies a higher kA rating is required than same shall be provided by the Bidder at no additional cost to the owner.

5.11.0 **Earthing and Earthing Devices**

5.11.1 Aluminum or copper earthing bus shall be provided at the bottom and shall extend throughout the length of each switchgear. It shall be bolted to the framework of each panel and each breaker earthing contact bar.

5.11.2 The earth bus shall have sufficient cross section to carry the momentary short circuit and short time fault currents to earth without exceeding the allowable temperature rise.

5.11.3 All joint splices to the earth bus shall be made through at least two bolts and taps by proper lug and bolt connection.

5.11.4 The truck and breaker frame shall get earthed while the truck is being inserted in the panel and positive earthing of the truck and breaker frame shall be maintained in all positions i.e. Service, Test and Isolated as well as throughout the intermediate travel. The truck shall also get and remain earthed when the control plug is connected irrespective of its position.

5.11.5 All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of suitable size.

5.11.6 Electrical Insulating mat (as per IS: 15652) shall be provided for all the panels (in front as well as back of the panel).

5.11.7 VT and CT secondary neutral point earthing shall be at one place only on the terminal block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.

5.11.8 Separate earthing trucks (1 No for busbar and 1 no for cables) shall be provided for maintenance work. These trucks shall be suitable for earthing the switchgear busbar as well as outgoing/ incoming cables or bus ducts. The trucks shall have a voltage transformer and an interlock to prevent earthing of any live connection. The earthing trucks shall in addition have a visual and audible annunciation to warn the operator against earthing of live connections.

5.11.9 Built-in earthing facilities for the busbar and outgoing/ incoming connections are also acceptable. The inbuilt earthing switches shall have provision for short circuiting and earthing a circuit intended to be earthed. These switches shall be quick making type, independent of the action of the operator and shall be suitable for operation from the front of the switchgear panel. These switches shall have facility for padlocking in the earthed condition.

5.11.10 The earthing device (truck / switch) shall have the short circuit withstand capability equal to that of associated switchgear panel.

5.11.11 Interlocks shall be provided to prevent :

- Closing of the earthing switch if the associated circuit breaker truck is in Service position.
- Insertion of the breaker truck to Service position if earthing switch is in closed position.
- Closing of the earth switch on a live connection. Three (3) nos. voltage capacitive dividers shall be provided on each phase of the section intended for and three (3) nos. "RED" neon lamps/ LEDs connected to these on the panel front for visual indication.

5.11.12 The earthing device shall have the short circuit withstand capability equal to that of associated switchgear panel. 4 NO + 4 NC of auxiliary contacts of the earthing device shall be provided for interlocking purpose.

5.11.13 All hinged doors shall be earthed through flexible earthing braid.

6.0.0 PAINTING

Painting shall be carried out by approved process. Painting procedure and thickness of paint shall be suitable for saline environment as per ISO 12944. Corrosivity grade C4 shall be considered for outdoor & Indoor equipment. After preparation of the under surface the equipment shall be painted with epoxy-based paint by powder coating. Final shade shall be RAL-7035.

7.0.0 TESTS

7.1.0 All the equipment supplied shall be of type tested quality. Type test reports shall be submitted for Switchgear panel and breaker of each voltage class and current rating as per IS 12729:

7.2.0 The Switchgear panel and circuit breaker shall be subjected to the routine test in accordance with the relevant Indian / IEC Standards. Factory acceptance tests shall be carried out (FAT) for bus transfer panel.

7.3.0 Type test reports for the following shall be submitted for Switchgear panel of each voltage class and current rating as per IS 12729:

- Dielectric tests including Lightning impulse withstand test, Power frequency withstand test, switching impulse test, partial discharge test, artificial pollution test, Power frequency withstand test on auxiliary and control circuits.
- Radio interference voltage tests
- Temperature rise test
- Measurement of resistance of the main circuit
- Short time withstand current and peak withstand current test

7.4.0 Type test reports for the following shall be submitted for Circuit breaker / Contactor of each voltage class and current rating as per applicable standard.

7.5.0 Tariff metering CT/PT testing shall be carried out at a third-party NABL-accredited laboratory (other than the OEM), in accordance with the testing requirements of GETCO/SLDC/DISCOM or other applicable authorities. The NABL laboratory shall be subject to approval by GETCO/SLDC/DISCOM. Testing shall be witnessed by representatives of GETCO/SLDC/DISCOM, and specifications shall comply with the requirements of the competent authority.

Post-testing, instrument transformers are typically sealed by the authorities and kept under their custody until commissioning. All necessary liaisoning in this regard shall be in the scope of the bidder.

7.6.0 For circuit breaker, the list of type tests shall include the following as per IS 13118:

- Dielectric tests
- Radio interference voltage test
- Measurement of the resistance of the main circuit
- Temperature-rise tests
- Short-time withstand current and peak withstand current tests
- Verification of the Protection
- Tightness tests
- Electromagnetic compatibility tests
- Mechanical and environmental tests including Mechanical operation test
- Short-circuit current making and breaking tests
- Capacitive current switching tests
- Magnetising and inductive/capacitive current switching tests

7.7.0 Routine Tests

7.7.1 The Switchgear panel shall be subjected to the routine test in accordance with the relevant Indian / IEC Standards. The tests shall include the following.

- Power frequency voltage dry test on the main circuit.
- Voltage test on control and auxiliary circuits.
- Measurement of resistance of the main circuit.
- Mechanical operating tests

7.7.2 The circuit breakers, Contactors, Switches, voltage transformers and current transformers shall be subjected to the routine test in accordance with the relevant Indian / IEC Standards.

7.7.3 For circuit breaker, the list of routine tests shall include the following as per IS 13118:

- Dielectric tests on the main circuit
- Dielectric tests on the control circuit & auxiliary circuit
- Measurement of the resistance of the main circuit
- Mechanical operating tests
- Tightness tests
- Design and visual checks

7.8.0 Site Tests

The following minimum tests/ checks shall be conducted at site. Any other tests/ checks as per the manufacturer's recommendation shall also be carried out.

a)General

- Check name plate details according to specification
- Check for physical damage
- Check tightness of all bolts, clamps and connecting terminals
- Check earth connections
- Check cleanliness of insulators and bushings
- Check heaters are provided
- HV test on complete switchgear with CT and breaker/ contactor in position
- Check all moving parts are properly lubricated
- Check for alignment of busbars with the insulators to ensure alignment and fitness of insulators
- Check for interchangeability of breakers/ contactors
- Check continuity and IR value of space heater

- Check earth continuity for the complete switchgear board

b)Circuit Breaker

- Check alignment of trucks for free movement
- Check correct operation of shutters
- Check slow closing operation (if provided)
- Check control wiring for correctness of connections, continuity and IR values
- Manual operation of breakers completely assembled
- Power closing/ opening operation, manually and electrically at extreme condition of control supply voltage
- Closing and tripping time
- Trip free and anti-pumping operation
- IR values, resistance and minimum pick up voltage of coils
- Simultaneous closing of all the three phases
- Check electrical and mechanical interlocks provided
- Checks on spring charging motor, correct operation of limit switches and time of charging
- Check vacuum pressure
- All functional checks

c)Current Transformers

- Insulation resistance between windings and winding terminals to body
- Polarity tests
- Ratio identification checking of all ratios on all cores by primary
- injection of current
- Magnetisation characteristics and secondary winding resistance
- Spare CT cores to be shorted to earth

d)Voltage Transformers

- Insulation resistance test
- Ratio test on all cores
- Polarity test
- Line connections as per connection diagram

e)Cubicle Wiring

- Check all switch developments

- It should be made sure that the wiring is as per relevant drawings. All interconnections between panels shall similarly be checked
- All the wires shall be meggered to earth
- Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component/ equipment
- Check terminations and connections
- Wire ducting
- Gap sealing and cable bunching

f) Relays

- Check internal wiring
- Insulation resistance between all terminals and body
- Insulation resistance between AC to DC terminals
- Check operating characteristics by secondary injection
- Check minimum pick up voltage of DC coils
- Check operation of electrical/ mechanical targets
- Check CT connections with particular reference to their polarities for differential type relays
- Relay settings

g)Meters

- Insulation resistance of all insulated portions
- Check CT and VT connections with particular reference to their polarities for power type meter
- Testing by secondary injection.

7.9.0 Drawings & Documents

The following drawings and documents shall be submitted for approval during detail engineering stage.

Technical data sheet

- Feeder list for each switchgear
- General arrangement and section drawing
- Single line diagram & Schematic wiring diagrams
- Metering and protection drawing
- Sizing Calculation for busbar
- Short circuit withstand calculation for busbar (Thermal & dynamic)
- Component list & Bill of Quantities for all the boards
- Panel cutout details

- Foundation Plan & loading details.
- Erection and commissioning procedures
- CT / VT sizing calculation
- Relay setting calculation and protection coordination.
- Catalogues / drawings / leaflets for all items
- Erection and commissioning procedures
- Operation and maintenance manual
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan
- Comprehensive memory mapping of ABT meters, Numerical relays and MFM's

8.0.0 TECHNICAL PARAMETERS

A. SYSTEM PARAMETERS		
a)	Nominal System voltage	11 kV
b)	Highest System voltage	12 kV
c)	Rated Frequency	50Hz
d)	Number of phases/ poles	3 Phase, 3 Wire
e)	System neutral earthing	Un earthed
f)	One minute power frequency withstand voltage	
	- for Type tests	28kV
	- for Routine tests	28kV
g)	1.2/50 microsecond Impulse withstand voltage	75kV (peak)
h)	Minimum system fault level	As per System Fault current
i)	Short time rating for bus bars, circuit breakers, current transformers and switchgear assembly.	
j)	Dynamic withstand rating	2.5 times of system fault current
k)	Control Supply	110 V DC – Dual Sources
l)	Space heaters	240 V AC single phase with neutral solidly earthed
m)	Maximum ambient air temperature	50 deg. C
n)	Internal Arc testing	As per system fault current (for Min 1 sec)

B.BUSBARS		
a)	Continuous current rating at 50ºC ambient:	As Per Requirement
b)	Temperature Rise allowed above ambient	As per IEC 62271-1, 2017
C.SWGR. CUBICLE CONSTRUCTION REQUIREMENTS		
a)	Colour finish	
	Exterior	RAL-7035 (Glossy Finish / Powder Coated)
b)	Cable entry	
	Power Cables	Bottom
	Control Cables	Bottom
c)	Earthing conductor	Galvanized steel strip
d)	Service Continuity of switchgears (LSC2B-PM)	as per IS/IEC 62271-200
D.CIRCUIT BREAKERS		
a)	The circuit breakers current rating shall be selected from the load current at an ambient of 50 deg. C.	
b)	Short circuit breaker Current	
	a) A.C. component	As per Clause 1.0 of Chapter 2-A (Part A)
	b) D.C. component	As per IS: 13118 or IEC-62271
c)	Short Circuit making current	2.5 times of system fault current (peak)
d)	Operating Duty	O-3 sec-CO-3 min-CO
e)	Total break time	Not more than 4 cycles
f)	Total make time	Not more than 5 cycles
g)	Operating Mechanism	Motor wound spring charged stored energy type as per IEC-62271
E. CURRENT TRANSFORMERS		
a)	Secondary Current	1A For tariff metering CT as per GETCO/STU/DISCOM requirement.
b)	Class of Insulation	Class E or better

c)	Rated output of each	Adequate for the relays and devices connected, but not less than five (5) VA.
d)	Accuracy class	
	Protection	5P20/PS as per requirement
	Measurement	0.2s class
e)	Instrument Security Factor for Measurement CTs	5
f)	CT Ratio	CT ratio shall be finalized during details engineering stage. Minimum CT primary side current shall be 110% of rated current.
F.VOLTAGE TRANSFORMER		
a)	Rated Voltage Factor	1.2 continuous for all VTs, and 1.9 for 8 Hours for star connected VTs.
b)	Class of insulation	Class E or better
c)	Other parameters	0.2 (metering) / 3P (protection) class. VA requirement shall be based on application/ requirement.
d)	At switchgear, Bus VTs panels and line VTs in outgoing feeders shall be provided. All other switchgear location, at outgoing feeder cable charge indication shall be provided based on voltage sensing or use of voltage transformer.	
G.DIGITAL MFM		
a)	Accuracy Class	0.2s or better
b)	Digital MFM shall be provided for VCB panels as per requirement	

9.0.0 DRAWINGS & DOCUMENTS

The following drawings and documents shall be submitted for approval during detail engineering stage.

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- Component list & Bill of Quantities for all the boards

- Panel cutout details
- Foundation Plan & loading details.
- Erection and commissioning procedures
- CT / VT sizing calculation
- Relay setting calculation and protection coordination.
- Catalogues / drawings / leaflets for all items
- Erection and commissioning procedures
- Operation and maintenance manual
- Test reports
- Sub-vendor list
- Manufacturing quality plan
- Field quality plan
- Comprehensive memory mapping of ABT meters, Numerical relays and MFM's.
- Details documentation for extension of panels in future.
- ICF files, other configuration details for SAS/ EnMS / SCADA integration