7.1.5.20 INDICATING VOLTMETERS

Each 33kV PCM panel will be provided with one digital flush mounted voltmeter with three line display having the capacity to toggle between 33 KV line and phase voltages.

7.1.5.21 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 120 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 manufacturer standards which shall be proved with necessary type test reports. However, for 33kV switchgear minimum 300 mm^2 cross section copper bar shall be employed for earthing. The copper with the earth bar shall run along the full length of the switchboard and earthing studs shall be provided at automatically connected to the switchgears bar through substantial plug type contact when the not less than two points. The frame of the draw-out circuit breaker earthing truck shall be circuit breaker is in disconnection, service and test position.

7.1.5.22 DISTRIBUTION AND CONTROL OF AUX. POWER CIRCUIT

7.1.5.22.1 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 There shall be only one 110V D.C. for the entire Control and Relay Panel fed from a 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 H.R.C. Fuse 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 fuse
b) Close/Trip Ckt 1 and Trip Ckt 2 without fuse; closing circuit with 10A fuse. Indication Circuit through a set of 6 Amp. HRC Fuse both at +ve and -ve side
c) Protective relay circuits through 6A fuse both at +ve and-ve side
d) Annunciation ckt with 6Amp fuse on both at +ve and-ve side
e) DC Emergency Lamp with 6Amp fuse both at +ve and -ve side

Three nos. of D.C. operated no-volt auxiliary relay (self-reset type) provided with hand reset type flag with inscription Main D.C. Fail', Control De fail '& Protection DC fail 'with 4NO+4NC in each relay. 2 NC contact for DC fail 'alarm and Indication, 1NO wired upto SCADA TB and 1NO wired up to spare TB. One Push button having N/C Contact used in Series with the above relay for D.C. Fall Test purpose.

7.1.5.22.2 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 HRC Fuse shall be provided at the Control & Relay Panel for the Incoming A.C. Supply. Two A.C. operated no volt auxiliary relay (self-reset type) rated for 230V shall be provided with hand reset flag with inscription A.C. Fail '& DC Fail Accept 'with 4NO+4NC contacts for each relay. One push button having N/C Contact used in Series with above relay for A.C. Fail Test 'purpose.

7.1.5.22.3 P.T. SECONDARY CIRCUIT

There may be two nos, 33KV bus PT, one in each bus section. P.T. supply shall be available from selected 33 KV Bus P.T through suitable PT selection scheme by switch. Two sets of Fuse and link of suitable rating shall be provided for the Incoming P.T supplies and two sets, one for each PT of 3 nos. 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) Potential supply to the protective relay circuit for Feeder where necessary shall be fed from selected Bus P.T. supply bus.
b) Potential supply to meters, Energy meters and indicating instrument of each panel shall be fed from selected Bus P.T. supply bus.
c) 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.
d) 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.
e) Two position (PT-1/PT-2), minimum 4(four) way PT selector switch (stay put type), minimum 16A rating shall be provided in each papel for metering ckt. Additional 4-way PT selector switch is required for protection wherever applicable. The no. of way may increase during detailed engineering.

7.1.5.22.4 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 le. 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) Hand & Electrical reset type for O/C, E/F protection
b) Operating Coil Voltage: 110 V DC (No series resistor allowed)
c) Shall have in built freewheeling diode.

7.1.5.22.5 SUPERVISION RELAYS

7.1.5.22.5.1 Trip Circuit and Protection Supply Supervision

The trip circuit supervision function shall be 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 33 kV 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 de 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.

7.1.5.22.5.2 D.C. Supply Supervision

Supervision relays are required for each protection supply, Main protection, Back-up and Trip Relay Reset. Similarly, for each trip circuit supply and for each alarm/ indications supply. 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 circuits supervision/faulty supervision wiring. DE supply supervision 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).

7.1.5.23. 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 center 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: -

Voltage	Bus Color	Thick(mm)	Dimension
33 KV	Black	3	12
Earth	Green	3	12

7.1.5.24 Auxiliary relays

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 Cubide 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.

7.1.5.25 Annunciator

Each PCM panel shall be equipped with 1 (one) set Annunciator with sufficient windows (LED type wit blinking facility) to display the alarms as per requirement. Annunciator shall have built in buzzer an 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.

7.1.5.26 Name plate & Ratings:

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.

a) 25 mm wide name plates bearing suitable identification marks shall be fixed under the terminal wiring at the test blocks, at the fuse blocks and at the cable terminals. Similar plates shall be fixed on the exterior of the switch board in appropriate places to indicate function of control switches, push button etc. such as isolator control switch, breaker control switch, DC fail test, accept reset etc. Suitable identification marks shall be provided for individual casing part of the relays and other equipment.
b) 50mm wide plastic plate bearing suitable circuit description (which will be furnished after order is placed) etched in 30 mm size letters shall be provided for each panel and mounted on the top of both outer and inner sides of the front and rear panels. These plates shall be removable type.
c) Each unit of control and relay panel shall be provided with a label located at the bottom on the front and shall contain the following details:
    i) Manufacturer's name
    ii) Year of Manufacturing
    iii) Purchase Order Number/Contract Number and date
    iv) Technical Data X Serial Number/Panel Number

7.1.5.27 PAINTING

Panel painting shall be done by the modern process of painting. All unfurnished surface of the steel panel and frame work shall be sand blasted or suitably cured to remove rust, scale, foreign adhering matter or grease. A suitable rust resisting primer shall be applied on the interior and exterior surface of steel, which shall be followed by application of an undercoat suitable to serve as base and binder

forth finishing coat.

Details of Painting: -

Surface treatment	by seven tank process
Paint type	Powder coated. Pure polyester base grade A structure finish
Paint shade	RAL 7032 for external & internal surface
Paint thickness	Minimum 80 microns

7.1.5.28 SPECIFICATION OF 63.5-110V/230-415V, 3x1(2) A, 3-PHASE, 4-WIRE, 3-ELEMENT, INDOOR TYPE MULTI-TARIFF PROGRAMMABLE METER WITH ASSOCIATED ACCESSORIES.

7.1.5.28.1 GENERAL

The meters are required for the purpose of energy metering of medium/high/extra-high voltage consumer metering at 33 kV level. KWh is the unit for the purpose. Type Tested from STL members or internationally accredited testing laboratories.

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	:	Indoor Type
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 1 amps and maximum current ≥2 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:

		• 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) • Current phase angle(each phase) Tampering indication in the register.
Memory storage	:	The meter shall have sufficient capacity (minimum 2 MB) 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 90 (ninety) days. • Load Profile data [kWh, KVarh (Q1+Q4) • Phase voltage or Vh • Phase amps or Ah

Accuracy class	:	Accuracy class is 0.2S
Number of digit		Minimum 6 (Six) integer with 2 (two) 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 inspect 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) Hx9"(22.9cm) Wx4"(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	:	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.

7.1.5.28.2 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.

7.1.5.28.3 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:

  10. The word "WZPDCL" and insignia of WZPDCL.
  11. Voltage and current rating.
  12. Frequency.
  13. Number of element, number of wire and multiplication factor.
  14. Accuracy class.
  15. Year of manufacture.
  16. Serial number.
  17. Name of manufacturer.
  18. Meter constant.

7.1.5.28.4 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.

7.1.5.28.5 Meter Parameterization Software

- The parameterization 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 400events) to record date & time of all power outages, demand resets, time change.
- In addition, each software key must bear a unique user ID and that is not transferable to another PC that has different user ID.
- The Meter should be able to display the phasor diagram.
- The software for Time of Use (TOU) shall be compatible to accommodate future tariff and can be customized, if the purchaser changes the tariff .The software shall be compatible with Windows operating system.
- The Meter must be provided with meter passwords to secure communication between meter software and meter having minimum 3(three) access levels.
- The offered meter shall be fully compatible with WZPDCL's existing AMR (Automatic Meter Reading) System. The Contractor/EPC shall be responsible for integrating the supplied meters with WZPDCL's existing AMR system (remote meter data acquisition system) at no additional cost to WZPDCL. If the Contractor/EPC fails to integrate the supplied meters with the existing AMR system, the Contractor/EPC shall provide, install, configure, and commission a separate remote meter data acquisition and logging software capable of accessing meter data through GPRS and hosting it on the WZPDCL server, including all required licenses and integration support, at no additional cost to WZPDCL.

7.1.5.28.6 EXTERNAL MODEM WITH ACCESSORIES

GSM/GPRS modem with RS-232 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.

7.1.5.28.7 Manufacturer of Energy Meter

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 panel meter described in above relevant clause.

Note: Related software with licenses & accessories 02 (Two) Copies for each Switching station for Energy meters is within the scope of supply.

7.1.5.29 PROTECTIVE RELAYS

All Protective relays & Auxiliary 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 kV Switching-station. Contract arrangement of the relays should conform to the requirements of the diagram. All relay should have rear FO port for IEC 61850 and front USB port with sufficient I/O as per requirements.

Note: Related software with licenses & accessories 02 (Two) Copies for each Switching Station for Protective Relays is within the scope of supply.

7.1.5.30 TESTS AT MANUFACTURERS WORKS FOR PCM PANEL

General

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

7.1.5.30.1 MATERIAL TESTS

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

7.1.5.30.2 TYPE TEST

Type tests are required to prove the general design of the offered equipment's/ materials. The Tenderer shall submit the type test reports of the offered equipment's/materials from as per relevant clause. Type tested from STL members and service minimum 05 year.

7.1.5.30.3 ROUTINE TESTS

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

7.1.6 Technical Specification of 33KV Isolator (2500A) with Earth blade General Specification:

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

7.1.6.1 FEATURES

- Single-Break Pattern [Vertical break or Horizontal break (center break)], OFF load type.
- Channel type mounting base insulator, blast.
- Coupling tubes for gang operation and adjustable operating rod with insulating link and

intermediate guide for operating rod.

- Auxiliary switch, operated by the phase coupling tube, to contred circuits for operating indicators, alarms, electrical inter-locking with the respective breaker to ensure that the isolator can only be operated when the breaker is in "OFF' position etc. with at least 10% spare contacts.

- Terminal connectors shall be suitable for T-TACSR / TACSR /800/55mm^2 /Merlin/ Gross Beak/ACSR Martin/ HAWK/ conductor as required.

- Earthing steel pads with provision for earth lead.

- Glands for multi-core control cables.

- Provision for pad locking in "ON" & "OFF" position.

- Provision of key interlocking.

- Galvanized Nuts, bolts & all accessories for mounting on structures.

- Interlocking magnet for electrical interlocking.

- All ferrous parts shall be hot dipped galvanized after completion of machining.

- Galvanizing shall be in accordance with BS-729.

- All control devices shall be suitable for operation on 110 V DC supplies from Sub-station.

- Operating mechanism shall be fully tropicalized and housed in waterproof housing.

- Complete supporting steel structure.

- Isolating devices shall be accordance with IEC-60129. They shall be complete with supporting steel work and installed to maintenance of any section of the sub-station plant when the remainder is alive and shall be so located that the minimum safety clearances are always maintained.

- The air gap between terminals of the same pole with the isolator open shall be of a length to withstand a minimum impulse voltage wave of 115. Percent of the specified impulse insulation rating to earth.

- Isolating switches shall be designed for life operation and isolators shall be hands operated. Main contacts shall be of the high-pressure line type and arcing contacts.

- All feeder isolators shall be fitted with approved three phase link earthing devices, mechanically, coupled or interlocked with the main isolator so that the earthing device and main isolator con not be closed at the same time.

- Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be un-effected by the climatic conditions at site. Mechanism shall be as simple as possible and comprise a minimum of bearing and wearing parts. Approved grease lubricating devices shall be fitted to all principal bearings. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729.

7.1.6.2 Blades:

All metal parts shall be of non-rusting and non-corroding material. All current carrying parts shall be made from high conductivity electrolytic copper/aluminium. Bolts, screws and pins shall be provided with lock washers. Keys or equivalent locking facilities if provided on current carrying parts, shall be made of copper silicon alloy or stainless steel or equivalent. The bolts or pins used in current carrying parts shall be made of non-corroding material. All ferrous castings except current carrying parts shall be made of malleable cast iron or cast steel. No grey iron shall be used in the manufacture of any part of the isolator. The live parts shall be designed to eliminate sharp joints, edges and other corona producing surfaces, where this is impracticable adequate corona shield shall be provided. Isolators and earthing switches including their operating parts shall be such that they cannot be dislodged from their open or closed positions by short circuit forces, gravity, wind pressure, vibrations, shocks, or accidental touching of the connecting rods of the operating mechanism. The switch shall be designed such that no lubrication of any part is required except at very infrequent intervals i.e. after every 1000 operations or after 5 years whichever is earlier.

7.1.6.3 Base:

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

7.1.6.4 Supporting Structure

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

7.1.7 Technical Specification of 33KV Isolator (2500A) without Earth blade

7.1.7.1 General Specification:

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

7.1.7.2 FEATURES

- Single-Break Pattern [Vertical break or Horizontal break (center break)], OFF load type.
- Channel type mounting base insulator, blast.
- Coupling tubes for gang operation and adjustable operating rod with insulating link intermediate guide for operating rod.
- Auxiliary switch, operated by the phase coupling tube, to control circuits for operating indicators, alarms, electrical inter-locking with the respective breaker to ensure that the isolator can only be operated when the breaker is in "OFF" position etc. with at least 10% spare contacts.

- Terminal connectors shall be suitable for ACSR Martin/Gross Beak/ ACSR Martin/ HAWK conductor as required.
- Glands for multi-core control cables.
- Provision for pad locking in "ON" & "OFF" position.
- Provision of key interlocking..
- Galvanized Nuts, bolts & all accessories for mounting on structures.
- Interlocking magnet for electrical interlocking.
- All ferrous parts shall be hot dipped galvanized after completion of machining.
- Galvanizing shall be in accordance with BS-729.
- All control devices shall be suitable for operation on 110 V DC supplies from Sub-station.
- Operating mechanism shall be fully tropicalized and housed in waterproof housing.
- Complete supporting steel structure.
- Isolating devices shall be accordance with IEC-60129. They shall be complete with supporting steel work and installed to maintenance of any section of the switching-station plant when the remainder is alive and shall be so located that the minimum safety clearances are always maintained.
- The air gap between terminals of the same pole with the isolator open shall be of a length to Withstand a minimum impulse voltage wave of 115. Percent of the specified impulse insulation Fating to earth.
- isolating switches shall be designed for life operation and isolators shall be hands operated. Main contacts shall be of the high-pressure line type and arcing contacts.
- Isolator operating mechanism shall be of robust construction, carefully fitted to ensure free action and shall be un-effected by the climatic conditions at site. Mechanism shall be as simple as possible and comprise a minimum of bearing and wearing parts. Approved grease lubricating devices shall be fitted to all principal bearings. The mechanism shall be housed in weatherproof enclosure complete with auxiliary switches, terminal blocks and cable gland plates. All steel and malleable iron parts including the support steelwork shall be galvanized as per BS-729.

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

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

7.1.8 33KV Current Transformer outdoor type:

7.1.8.1 A. GENERAL TECHNICAL PARTICULARS:

1.	Application	Metering and Protection
2.	Installation	Outdoor.
3.	Construction	Sealed Tank
4.	Insulation	Oil
5.	Number of Phase	Single
6.	Rated Frequency	50 Hz
7.	Mounting	On Supporting Structure
8.	System Primary Rated Voltage	33 kV Phase to Phase
9.	Maximum System Voltage	36kV Phase to Phase

10.	System Earthing	Effectively earthed
11.	Basic Insulation Level (1.2/50 µsec.)	170 kV
12.	Power Frequency Withstand Voltage (1 min. 50 Hz).	70 kV
13.	33 kV Feeder Ratio:	2400-1600/1-1-1A
14.	Primary	Single Winding
15.	Secondary	Three Winding (2Met, 1Pro..)
16.	Accuracy Class	0.2s for Measurement, 5P20 for Protection.
17.	Burden	30VA
18.	Short Time Current Rating	31.5 kA for 3 Sec.
19.	Extended Current Rating	120% of Rated Current
20.	Over Current Rating (safety factor)	≤ 10 A
21.	Creepage Distance	25 mm/ KV (minimum)
22.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC61869 standards.

B. FEATURES & ACCESSORIES:

a) Current transformer shall have porcelain outdoor type bushing.

b) Terminal connectors provided, shall be suitable for T-TACSR / TACSR / ACSR Merlin/ Grosbeak/ Hawk or higher conductor as required.

c) The equipment must be tropicalized and suitable for the outdoor location.

d) Galvanized nuts, bolts and all accessories required for mounting on structure.

e) All ferrous parts shall be hot-dip galvanized after completion of machining. Galvanizing shall be in accordance with BS-729.

f) Each terminal shall have cadmium-plated nuts and bolts.

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

h) Diagram plate and rating nameplate shall be provided. Rating plate and diagram plate shall be made of stainless steel and have engraved letters filled with blank enamel paint mentioning manufacturer's name, client name, year of manufacturing, contract no & model no, rating, etc..

i) Supporting clamps, all accessories shall be provided with the CT's for installation on supporting gantry structure for line feeders CT's.

j) All CT secondary connection should be in MK box.

7.1.9 Technical Specification of single phase 33KV Potential Transformer

7.1.9.1 GENERAL TECHNICAL PARTICULARS:

1.	Application	Metering and Protection
2.	Installation	Outdoor
3.	Insulation	Oil
4.	Type	Voltage Induction
5.	Construction	Oil Tank
6.	Number of Phase	Singe Phase (1Set=3Nos)
7.	Frequency	50 Hz
8.	Mounting Mounted	Supporting on Gantry Structure Mounted

9.	System Primary Rated Voltage	33 kV (Phase to Phase)
10.	System Primary Maximum Voltage	36 kV (Phase to Phase)
11.	System Earthlings	Effectively earthed
12.	Basic Insulation (Impulse withstand Voltage)	170 kV
13.	Power Frequency Withstand Voltage	70 kV
14.	The neutral end of primary winding, for direct connection to ground	Insulated to withstand the 10 kV low frequency test.
15.	Type of Secondary Winding	Double Winding
16.	Transformation Ratio	$(33/\sqrt{3})/ (0.11/\sqrt{3})/ (0.11/\sqrt{3})$ kV
17.	Creepage Distance	25 mm/ kV (minimum)
18.	Rated Secondary Burden	50 VA
19.	Voltage limit factor	1.2 continuous
20.	Class of Accuracy	0.2 for metering and 3P for protection.
21.	Standard	Design, Manufacture, Testing, Installation and Performance shall be in accordance to the latest editions of the relevant IEC 61869.

7.1.9.2 FEATURES & ACCESSORIES:

a) Potential transformer shall have porcelain outdoor type bushing.
b) Terminal connectors provided, shall be suitable for Twin T-ACSR 800/55 sq mm conductor as required.
c) The equipment must be tropicalized and suitable for the outdoor location.
d) Galvanized nuts, bolts and all accessories required for mounting on structure shall be provided.
e) All ferrous parts shall be hot dip galvanized after completion of machining, galvanizing shall be in accordance whether BS-729.
f) Each terminal shall have cadmium-plated nuts and bolts.
g) Each Voltage transformer is to be protected by PT fused isolator with high voltage fuse of the high rupturing capacity cartridge type as specified in section-8 (GTP) . All fuses are to be clearly identified and easily accessible.
h) Diagram plate and rating nameplate shall be provided. Rating plate and diagram plate shall be made of stainless steel and have engraved letters filled with blank enamel paint mentioning manufacturer's name, client name, year of manufacturing, contract no & model no, rating, etc.
i) Sealing/locking arrangement for the secondary terminal box shall be provided.
j) All PT secondary connection should be in MK box.

7.1.10 Technical Specification of 33 kV Single Phase Lightning Arrester

7.1.10.1 GENERAL TECHNICAL PARTICULARS:

1.	Application	Switching station/ line / Cable protection of heavy duty class.
2.	Type of Arrester	Station Class Metal Oxide (ZnO), Gapless
3. 4.	Construction	Single Unit, basically consisting of gapless hermetically sealed in with non-linear characteristics with high energy capacity, all enclosed in porcelain housing.
5.	Installation	Outdoor
6.	Mounting	Structure Mounted steel bracket

7.	Nominal System Voltage	33 kV
8.	Maximum continuous operating Voltage	36 kV
9.	System Frequency	50 Hz
10.	Number of Phase	1Φ
11.	Rated Arrester Voltage	36KV
12.	Continuous Operating Voltage	30 kV
13.	Nominal Discharge Current (KAp) of 8/20 micro second wave	10 KA
14.	Power Frequency withstands voltage of Lightning Arrester Housing, Dry & Wet.	70 kV (Dry & wet)
15.	Impulse Withstand Voltage of Lightning Arrester Housing.	170 kV (peak)
16.	Lightning Impulse Residual Voltage (8/20 micro-second wave)	105 kV (peak)
17.	Basic Insulation level	170KV
18.	Steep Current Impulse Residual Voltage at 10KA of 1 micro-second front time.	40 kV (peak)
19.	High Current Impulse Withstand Value (4/10 micro-second)	Minimum 100 KA
20.	Minimum Energy Discharge capability	5
21.	(KJ/KV) at rated voltage.	≥ 8.0 kJ/kV
22.	Temporary over voltage withstand capability (KVrms) for 10.0 secs	42KV
23.	Creepage distance (minimum)	25 mm/ kV
24.	Partial Discharge(pico-coulomb) when energized at 1.05 times its continuous operating voltage.	Not exceeding 10 PC
25.	Earthing system	Solid earthing
26.	System fault level	31.5 KA for 3 sec
27.	Standard	Performance, Design & Testing shall be in accordance to IEC-60099-4 or equivalent international Standards unless otherwise specified herein.

7.1.10.2 FEATURES :

- The Arrester shall be Zno type, basically consisting of gapless hermetically sealed in with non-liner volt-ampere characteristics with high-energy capacity. The Earthing terminal with clamp shall be suitable to accommodate Twin T-ACSR 800/55 sq. mm conductor of diameter from 14.1mm to 18.5mm.
- Terminal connectors shall be suitable for Twin T-ACSR 800/55 sq mm conductor / grosbeak / merlin / martin as required.
- Zno Arrester shall be excellent thermal stability for high-energy surges, external pollution & temporary over voltage.
- Operation counter on each unit shall be provided to indicate number of operation on account of lightning of switching surges.
- Identification marks on each separately housed unit shall be provided to enable it to be replaced in current position after a multi-unit Arrester has been dismantled.
- All ferrous parts exposed to atmosphere shall be cadmium plated.
- Each Arrester shall have lattice type steel, structures & shall be of sufficient high to co-ordinate with the sub-station equipment/material supplied. Each support shall be complete in all respect.

- Arresters shall be housed in porcelain containers sealed against the entry of moisture and oxygen and free of influence of moisture and weather condition.
- Each single pole Arrester shall be furnished with a rating plate; the elements shall also have an individual rating plate. The rating plate shall indicate the main characteristics of the Arrester and must permit easy ordering of spare parts units; the rating plate making shall be in English.
- The height of the lightning Arresters and supports shall be coordinated with associated sub-station equipment.
- The connecting cable (connecting lead) from LA to surge monitor shall be provided and the connecting lead shall be insulated copper cable of minimum 120 mm^2 size.
- The station class surge arresters shall be complete with fittings suitable for mounting in a vertical position on mild steel channels

7.1.11 Technical Specification of Switching station Battery and Battery Charger

7.1.11.1 Battery

7.1.11.1.1 General

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

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

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

7.1.11.1.2 Type of Battery

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

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

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

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

Cells shall be numbered consecutively and terminal cells marked to indicate polarity.
Cells shall be permanently marked with the following information:

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

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

7.1.11.1.3 Initial Charge and Test Discharge

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

necessary for the initial charge, test discharge and subsequent recharge of the battery.

7.1.11.1.4 Battery Duty

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

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

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

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

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

7.1.11.1.5 Location of Batteries

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

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

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

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

7.1.11.1.6 Battery mounting connections and accessories

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

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

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

intercell connections shall be of high conductivity corrosion free material.

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

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

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

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

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

7.1.11.2 Battery Charger

7.1.11.2.1 General:

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

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

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

- Frequency variation : 47 to 51 Hz.
- Voltage variation : ± 15%

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

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

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

Each charger shall also incorporate a boost charge feature which shall, after having been started, provide an automatically controlled high charge rate sufficient to restore a fully discharged battery to the fully charged state within the shortest possible time without excessive gassing or any form of damage to the battery. The boost charge shall be initiated manually or automatically

upon detection of a significant battery discharge. An adjustable timer shall be provided to automatically switch the charger to the float condition after the correct recharge period.

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

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

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

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

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

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

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

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

Each charger shall be designed with a performance on boost charge such that with rated input voltage and frequency the charger output shall not be less than its rating in Watts at 1.3 V and

1.6 V per cell, and also the output voltage shall be 1.60 per cell over an output range of 0 - 100% of rating.

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

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

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

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

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

An anti-paralleling diode shall be provided in each positive feed to the DC distribution board to prevent faults on one supply affecting the other. These diodes shall be continuously rated to carry the maximum possible discharge current likely to occur in service and a safety factor of 4 shall be used to determine the repetitive peak reverse voltage rating. The I^2t rating of the diodes shall be such that in the event of a DC short circuit, no damage to the diodes shall result.

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

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

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

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

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

The following battery alarms shall also be provided:

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

Lamp test facilities shall be included.

A "charger faulty" alarm for each charger and a "battery faulty" alarm shall be provided in the switching station control room and to the SCADA system where applicable.

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

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

Each charger shall be equipped with a switch-fuse for the incoming AC supply and an off load isolator for the DC output.

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