

11KV RING MAIN UNIT (RMU)

TECHNICAL SPECIFICATION OF 11KV Motorized 5 Way Outdoor RMUs

1.0 SCOPE:

The specification covers Design, manufacturing, pre dispatch testing, supply transportation, unloading at site/District Stores of APEPDCL (**The number of district stores are 05. Site/Store locations will be issued during dispatch instructions at the time of supply**) for 11KV Motorized 5 way RMUs in accordance with the technical requirements mentioned in the specification and relevant standards. Providing of FRTU enclosure along with RMU as one unit only is in the scope of bidder. Supply of FRTU is not in the scope of the bidder. Cable supporting bushings (Fiber or Epoxy) shall be provided to avoid cable load from RMU bushings.

Supply of FRTU is not in the scope of bidder and for all other conditions shall follow technical specification.

2.0 STANDARDS:

- The equipment delivered shall be new and of high quality, suitable for the purpose it is intended for, free from defects and imperfections and of the classifications listed herein, or their equivalents, subject to acceptance by the APEPDCL.
- The bidding shall be done by original equipment manufacturers only as specified in the bid.
- Materials used in the manufacture of the specified equipment shall be of the kind, composition and physical properties best suited to their various purposes and in accordance with the best engineering practices.
- The equipment design shall be suitable to render satisfactory operation under the conditions prevailing at site, and the equipment shall operate satisfactorily under normal load and voltage variations and frequency variations (**50 c/s \pm 3%**) ensuring the safety, further include all necessary provisions ensuring the safety of the operating and maintenance personnel.
- The applicable standards is as specified here below:

Description	Standard
<u>11kV 5 way Ring Main unit</u>	
AC metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV	IS 3427
Classification of degrees of protection provided by enclosures of electrical equipment	IS 12063
High Voltage Switches	IS 9920 (Parts 1 to 4)
Specification for AC disconnectors and earthing switches for voltages above 1000 V	IS 9921 (Parts 1 to 5)
HV AC Circuit Breakers	IS 13118
Dimensions of terminals of HV Switchgear and Control gear	IS 10601
General requirements of switchgear and control gear for voltages exceeding 1000 V	IS 12729
High voltage/Low voltage prefabricated substations	IEC 1330
Common clauses for MV switchgear standards	IEC 62271-100/200
Monitoring and control	IEC 6081
Current Transformers	IS 2705

Voltage transformers		IS 3156
Specification for Static Protective Relays		IS 8686
Standards for high voltage metal clad switchgear up to KV.	52	IEC 62271-200

The 11 kV RMUs(5 way) Manufactured to any other international standards like BSS,IEC or equivalent standards not less stringent than Indian standards are also acceptable, In such cases the bidders shall enclose a copy of the equivalent international standard in English language along with Bid.

11kV 5 way Ring Main unit

Key RMU Configurations of RING MAIN UNIT

- **5 WAY RMU** -One side Non extensible Two (2) Motor operated load break switches (LBSs) with manual operated earthing switches and three (3) vacuum circuit breakers with disconnectors and manual operated earthing switches WITH BUS PT metering module and base channel suitable space for mounting FRTU with dimensions of 600Width x 1000Height x 300Depth, **FRTU dimensions to be provided as per the site requirement and considering the dimensions of the standard make FRTU**, battery charger, Auxiliary PT of suitable rating inside metering cubical. The Battery charger along with batteries required for Electrical operations of RMU is in the scope of the Bidder(Compatible for SCADA/DMS System)
- **The configuration for 5 Way RMU shall be starting at left side, two load break switches, one VCB, one VCB and one VCB (2LBS +1VCB+1VCB+1VCB).**
- **Shall follow as per technical specification (OR) Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.**

3.0 RATINGS:

The Protection and control unit range shall be designed to accommodate the control power supply voltages of 24 V DC voltages.

4.0 Sulphur Hexafluoride Gas (SF6 GAS) :

The SF6 gas shall comply with relevant standard IEC-376, 376A & 376B and shall be suitable in all respects for use in 12 KV panels under the operating conditions. The SF6 shall be tested for purity, dew point air hydrolysable fluorides and water content as per IEC-376, 376A & 376B and test certificate shall be furnished to the APEPDCL indicating all the tests as per IEC-376 for each Lot of SF6 Gas.

5.0 Technical Parameters for 11 kV 5 way RMU :

5.1 Scope of Work :

- The scope of work shall include design, manufacture, testing, delivery, unloading at site/district stores of EPDCL of new Ring Main Units compatible to SCADA. **The number of district stores are 05. Site/Store locations will be issued during dispatch instructions at the time of supply.**
- Each RMU shall include its own power supply unit (including auxiliary power transformer, batteries, and battery charger), which shall provide a stable power source for the RMU.
- Each RMU shall be equipped with main-line load break switches and fault passage indicators (FPI). Furthermore, to protect each of its lateral / transformer feeders, it shall be equipped with a corresponding set of circuit breakers and self-powered numerical relays. The RMU shall include potential-free contacts so as to connect to SCADA/DMS via FRTUs, so as to:

Table-1: potential free contacts required for remote monitoring and operation from SCADA and shall terminate up to FRTU compartment.

Sl. no.	Description	Requirement
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1	Status signals to SCADA-to be wired to marshalling terminal block	2NO + 2NC
2	LBS close / open	potential free contacts
3	CB close / open	potential free contacts
3	LBS & CB Earth Switch close/open	potential free contacts
4	Battery charger Fail	potential free contacts
5	Protection relay operated	potential free contacts
6	FPI operated	potential free contacts
7	SF6 gas pressure low	potential free contacts
8	local/remote position	potential free contacts
9	RMU door status	potential free contacts
10	Commands from SCADA to be wired to marshaling terminal block	LBS/CB close / open , FPI reset

5.1.1 Distribution Network Electrical Parameters

The main parameters of the distribution network are as follows:

- Nominal system voltage :11 kV (rms)
- Highest system voltage :12 kV (rms)
- Number of phases :3
- Frequency :50 Hz
- Variation in frequency :50 ±3% Hz
- Type of earthing :Solid
- Power frequency withstand voltage :28 kV rms
- Basic impulse withstand voltage :75 kV peak

5.1.2 Testing

The specified RMUs shall be subject to type tests, routine tests, and acceptance tests. Where applicable, these tests shall be carried out as per the standards stated above.

5.1.3 TECHNICAL PARAMETERS

The scope is supply of 11 kV 5 Way RMU suitable for outdoor application.

The RMU to be supplied shall be compact and shall meet the following requirements:

- Easy to install
- Safe and easy to operate
- Compact
- Low maintenance

It shall include, within the same metal enclosure number of MV functional units required for connection, Power supply including the battery bank for controlling the LBS and breakers,

- Load break switches,
- Earthing Switches
- Breakers
- Relays
- BUS PT metering module, FPI's and other allied equipment.

Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case copies of English version of the standard adopted shall be submitted.

The electrical installation shall meet the requirement of Indian Electricity Rules, 1956 as amended up to date, relevant IS code of practice and Indian Electricity Act, 1977. The Electricity Act, 2003 and Amendment if any shall also apply. In addition other rules and regulations applicable to the work shall be followed. In case any discrepancy the most stringent and restrictive one shall be binding.

The high-tension switchgear offered shall in general comply with the latest issues including amendments of the Standards as per specification but not restricted to them.

All design features of the proposed RMU, as described in the supplier's bid and in the bid's reference materials, shall be fully supported by the equipment actually delivered. The key design features include those that relate to:

- Maintainability, expandability, and life span
- Ability to operate in severe outdoor environmental conditions like sea shore areas
- Immunity to electrical stress and disturbance.
- Acceptable insulation properties.
- Convenient FRTU interconnection features.

Maintainability, Expandability and Life Span

5.1.4 Maintainability

The Utility intends to be self-reliant for RMU maintenance. To this end, the Supplier shall provide the support, documentation, and training necessary to operate and repair the RMU. The Utility will prefer RMU designs that do not require periodic preventive maintenance and inspections. To facilitate expansion and maintenance, the RMUs should be of modular type.

5.1.5 Life Span

Each RMU shall have a design life of at least 20 years from the date of final acceptance. The Contractor shall make available, at no cost to the Employer, the manufacturing drawings, wiring diagrams, bill of material, foundation detail drawings, unpacking and transportation instructions, operation & maintenance manual, As-built drawings and other relevant documentation. The specific components of each component/sub-assembly shall be identified and referenced in Supplier-supplied documentation.

5.2 Outdoor Features

5.2.1 General

- The RMUs shall be designed specifically for outdoor installation with ingress protection degree of IP54. They shall also be suitable for conditions in which they will be exposed to heavy industrial pollution, and high levels of airborne dust.
- The Outdoor RMU shall be conformably coated to meet these climatic conditions. In this respect, standards such as IEC 62271-200, covering equipment, systems, operating conditions, and environmental conditions shall apply. In particular, the RMU equipment shall have been type tested for IP54. Failure to conform to this requirement shall constitute grounds for rejection of the proposal
- In addition to the above, materials promoting the growth of fungus or susceptibility to corrosion and heat degradation shall not be used, and steps shall be taken to provide rodent proof net.

5.2.2 Corrosion Protection

The main SF6 tank, housing the on-load break switches and the vacuum circuit breakers, should be of no other material except 2.5 mm stainless steel so as to have high corrosion resistance and ensure high longevity. This tank containing SF6 to a maximum pressure of 1.55 bars should be hermetically welded and sealed for life, ensuring a leakage rate not more than

0.1 % per annum. Except for stainless steel, all steel surfaces that are not galvanized shall be treated to protect against corrosion. As a minimum, corrosion treatment shall include the following procedures:

- The surface shall be cleaned to bare material by mechanical or chemical means.
- Must be powder coated by means of seven tank process.
- The coat thickness shall be of the order of 60 to 80 micrometers. The RMU should be of the final finish-coat as per manufacturer standard.
- **Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.**

5.2.3 Immunity to Electrical Stress and Disturbance

The electrical and electronic components of the RMU shall conform to relevant standards concerning insulation, isolation, and immunity from electromagnetic interference, radiated disturbance, and electrostatic discharge. The ability to meet these requirements shall be verified by type tests carried out by accredited test laboratories that are independent of the bidder and/or the manufacturer of the RMU components. Certified copies of all available type test certificates and test results shall be included as part of the bidder's proposal.

5.2.4 Minimum Insulation of Equipment

The RMUs shall be of SF6 gas-insulated type with a maximum gas operating pressure up to 1.55 BAR.

Shall follow as per technical specification (OR) Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.

5.2.5 Nameplate Information

RMU nameplate information shall be determined in agreement with the Employer. This information may include for example:

- Name of manufacturer and country
- Type, design, and serial number
- Rated voltage and current
- Rated frequency
- Rated symmetrical breaking capacity
- Rated making capacity
- Rated short time current and its duration
- Rated lightning impulse withstand voltage
- Purchase Order number and date
- Month and year of supply

Each RMU shall also exhibit a Danger Board to indicate the presence of high voltage (11,000 V).

5.2.6 Interconnecting Cables, Wiring, Connectors, and Terminal Blocks

- The Contractor shall provide all interconnecting wires, cables, connectors, terminations and other wiring accessories such as terminal blocks required by the RMU.
- All the control wiring shall be done with PVC insulated multi stranded flexible copper wires of size not less than 1.5 SQ.mm for with proper identification (ferrules) and colour code.

5.2.7 Metallic Cables

- All metallic cables and wiring shall be of required cross-section multiple strands of round copper conductors and have flame retardant insulation. All wiring shall be neatly laced and clamped.

- All wire and cable connectors and terminators shall be permanently labeled for identification. All connection points for external cables and wires shall be easily accessible for connection and disconnection and shall be permanently labeled. Conductors in multi-conductor cables shall be individually color-coded.

5.2.8 **RMU-FRTU Connectors**

- For ease of installation and maintenance, the interconnection between the RMU and the FRTU, (FRTU is not in the scope of the bidder) in a separate enclosure shall be supported by having heavy-duty terminal blocks with screw type terminals shall be provided by the supplier for necessary cable terminations. In using a terminal block, no more than two cables or wires shall be connected to any of its individual terminals.
- Making strips shall be used to identify all external connection blocks. Marking tags shall be read horizontally. All terminals to which battery or other high voltages are connected shall be provided with fireproof covers.
- All individual status input, AC voltage input, and control output points shall be isolatable without the need to remove wiring by means of individual terminal blocks of the removable link type. In order to avoid open circuits on the secondary side of CTs, termination blocks with by-pass bridges shall be provided for all AC current inputs.
- Terminal blocks shall comply with IEC 60947-7-1 (2009): Low-voltage Switchgear and Control Gear, Part 7-1: Ancillary Equipment, Terminal Blocks for Copper Conductors.

5.3 **RMU Characteristics**

As a minimum, the RMUs shall be equipped with on-load break switches and a fault passage indicator (FPI), circuit breakers, and numerical relays for the protection of transformer /feeders, and provision for wiring for multifunction transducer (MFTs are in the scope of the bidder) for monitoring voltage, current, power, energy, power factor readings and the Communicable Numerical relay for tripping and protection functionalities to be provided on the RMU. The Load Break Switches and the Circuit Breakers used in the RMU shall be of SF6 insulated and vacuum interrupter type. **Shall follow as per technical specification (OR) Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.**

- In addition, each RMU shall be equipped with all necessary connectors, terminal blocks, and other accessories that will allow it to be connected to the FRTU, which in-turn will send required indications and measurements to the DMS via the communications system.

5.4 **General Requirements**

- Each RMU shall include its own aux power supply of 230V AC including battery and battery charger of **conventional linear type**(SMPS type is also accepted). In addition, RMU should have a bus connected PT panel (air insulated), of 110v AC for metering.
- Within this context, the general requirements of the RMU shall include, but shall not be limited to provision of the following monitoring and control features:
 - Positions of local/remote switches as used to control local and remote access to circuit breakers and load break switches
 - Power supply indications including battery failure and voltage alarms
 - Open/closed position of load break switches, circuit breakers, and earthing switches
 - SF₆ gas-pressure low indication.
 - Circuit breaker relay indications
 - Indications of fault in the RMU's main feeder circuit as detected by the FPI

- Load break switch and circuit breaker open/close control
- FPI reset control
- **Supply of FRTU is not in the scope of bidder and for all other conditions shall follow technical specification.**

5.5 Parameter Requirements

The RMUs shall be suitable for cable networks of 630 Amps and loop cable networks of 400 Amps. The minimum design parameters to which their major components shall conform or exceed are summarized in the following tables.

Table 2: System Parameters

Parameter	Value
Nominal System Voltage	11 kV
Highest System Voltage	12 kV
Rated Voltage	12 kV
System frequency	50 Hz
Number of Phases	3 Phase/3 Wire

Table 3: Circuit Breaker Parameters

Parameter	Value
Lightning Impulse Withstand Voltage Phase-to-Phase & Phase-to- Earth:	75kV (peak)
Power Frequency Withstand Voltage to Earth, Between Poles, & Across Opening Span	28kV rms for 1 minute
Rated Short Time Withstand/Breaking Current:	20kA (rms)
Rated Duration of Short Circuit:	3 seconds
Rated Normal Current:	630 Amps (rms)

Table 4: Bus bars

Parameter	Value
Material	Tinned Copper. Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.
Rated Current	630 Amps
Breaking Current for 3 sec.	20 kA for 3 seconds wherever it is applicable
Insulation of bus bars	Epoxy or PVC sleeved insulation to be provided. Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.
Bus bar connections	Anti-oxide grease
Bus bar end Caps	Yes Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.
RMU	Load break switches to be coupled with each other by common bus bars and circuit breakers.

Bus bar & Cable boxes installation facility	Yes
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Table 5: Load Break Switch Parameters

Parameter	Value
Rated Short Circuit Making Capacity	50 kA peak at rated voltage
Rated Load Interrupting Current	630 Amps
Rated Cable Charging Interrupting Current of Incomer Load break switch.	As per the IEC-62271/100-200 only.

Table 6: Earth switches

Parameter	Value
Rated short time current	20KA
Rated short time	3 sec
Rated peak withstand current	50KA peak at rated voltage

The RMU switchgear shall be capable of withstanding the specified currents without damage in accordance with the latest versions of IEC 60694 (Common Specifications for High-Voltage Switchgear and Control Gear Standards) and IS 3427 (AC Metal Enclosed Switchgear and Control Gear for Rated Voltages above 1 kV and up to and including 52 kV).

5.6 Design Details

- The RMU shall be designed to operate at the rated voltage of 12 kV.
- It shall include, within the same metal enclosure, On-load break switch, circuit breakers and earthing switches for each Load Break Switch/Circuit Breaker.
- Suitable fool-proof interlocks shall be provided to the earthing switches to prevent inadvertent or accidental closing when the circuit is live and the concerned Load Break Switch/Circuit Breaker is in its closed position.
- The degree of protection required against prevailing environmental conditions, including splashing water and dust, shall be not less than IP 54 as per IS 12063.
- The active parts of the switchgear shall be maintenance free. Otherwise, the RMU shall be of low-maintenance type.
- The tank shall be made of minimum 2.5 mm thickness of stainless steel or 10 mm Thick Metalized Cast Resin.
- The Stainless Steel tank should be completely welded & metalized cast resin tank shall be sealed So as to ensure IP 67 degree of protection and shall be internal arc tested.
- The RMU shall be suitable for mounting on its connecting cable trench.
- For each RMU enclosure, a suitably sized nameplate clearly identifying the enclosure and the electrical characteristics of the enclosed devices shall be provided.
- The access to the cable compartment should be from the front / Side /Rear of the switchgear only to have minimum operating & maintenance space at site.
- The RMU design shall be such that access to live parts shall not be possible without the use of tools.
- The design shall incorporate features that prevent any accidental opening of the earth switch when it is in the closed position. Similarly, accidental closing of a Circuit Breaker or Load Break Switch shall be prevented when the same is in an open position.
- The RMU tank must be equipped with a suitable pressure relief device. The pressure relief must ensure that the escaping gases are dissipated to the rear / top of the switchgear. IAC classification may be AFL/AFLR.
- The complete RMU shall be tested in an accredited INDIAN or FOREIGN laboratory and designed for an Internal Arc.

5.6.1 Single line diagram

Single line diagram indicating the operational status of the Switchgear shall be provided at the front of the cubicles (shall not be acceptable with stickers).

5.7 Earthing

- **Earthing pit shall not be in the scope of RMU manufacturer**
- There shall be continuity between metallic parts of the RMUs and cables so that there is no dangerous electric field in the surrounding air and the safety of personnel is ensured.
- The RMU frames shall be connected to the main earth bars, and the cables shall be earthed by an Earthing Switch having the specified short circuit making capacity.
- The Earthing Switch shall be operable only when the main switch is open. In this respect, a suitable mechanical foolproof interlock shall be provided.
- The Earthing Switch shall be provided with a reliable earthing terminal for connection to an earthing conductor having a clamping screw suitable for the specified earth fault conditions. The connection point shall be marked with the earth symbol. The flexible connections between the earthing blade and the frame shall have a cross-section of at least 50 mm² copper or equivalent in GI
- The Earthing Switch shall be fitted with its own operating mechanism. In this respect, manual closing shall be driven by a fast acting mechanism independent of the operator's action.

5.8 Load Break Switches

- The Load Break Switches shall be maintenance free. With outdoor canopy doors open, the position of power contacts and earthing contacts shall be clearly visible from the front of the RMU through the Mimic facia.
- The position indicator shall provide positive contact indication in accordance with IS 9920. In addition, the manufacturer shall prove the reliability of indication in accordance with IS 9921. These switches shall have three positions (or states), i.e., Open, Closed, and Earthed, and shall be constructed in such a way that natural interlocking prevents unauthorized operations.
- The switches shall be fully assembled, tested, and inspected in the factory.
- In case of Manual operation without motors, opening and closing shall be driven by a fast-acting mechanism independent of manual operator action.
- The Load Break Switches shall be provided with a motorized operating mechanism suitable for SCADA control.
- A facility shall be provided with an electrical operating mechanism allowing an operator at the RMU site to operate the Load Break Switches without any modification of the operating mechanism and without de-energizing the RMU.
- The switch and earthing switch mechanisms shall have a mechanical endurance of at least 1,000 operations.
- Load break switch status aux contacts shall be 2NO+2NC and for Earth switch 1NO+1NC

5.9 Circuit Breakers

- The Circuit Breakers shall be maintenance free and, when standing in front of the RMU with outdoor canopy doors open, their positions shall be clearly visible, through the Mimic facia. The position indicator shall provide positive contact indication in accordance with IS 9920. The breakers shall have three positions (or states), i.e., Open, Closed, and Earthed, and shall be constructed in such a way that natural interlocking prevents unauthorized operations. They shall be fully assembled, tested, and inspected in the factory.
- An operating mechanism shall be used with motor and manual spring charging stored energy for remote closing / tripping from SCADA centre. It shall be fitted with a local system for manual closing /tripping. There shall be no automatic reclosing. The Circuit Breaker shall be capable of closing fully and latching against the rated making current. Mechanical indication of the OPEN, CLOSED, and EARTHED positions of the Circuit Breaker shall be provided. The mechanical spring charge indications like free/charged shall be shown in the front of the circuit breaker.
Shall follow as per technical specification (OR) Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.
- Each Circuit Breaker shall operate in conjunction with a suitable protection relay under transformer feeder/ circuit phase and earth fault conditions.
- All operating handles for the switches/circuit breaker shall be located on the front panel of the Ring Main Unit.
- Breaker status aux contacts shall be 2NO+2NC and for earth switch 1NO+1NC
- Min no. of operations of Circuit breakers at rated current (as per IEC 62271-100) shall be guaranteed with Mechanical Endurance – Class M1 (2000 operations).

5.10 Cable Termination

- Bushings shall be conveniently located for working with the specified cables and shall allow for the termination of these cables in accordance with the prevailing practice and guidelines of cable manufacturers. The dimensions of the terminals shall be in accordance with IS 10601.
- A non Ferro-magnetic cable clamp arrangement shall be provided for each cable to be terminated in the RMU.
- A suitable arrangement for the Circuit Breakers, Earthing Switches, and Load Break Switches shall be provided so that these devices can be padlocked in the "Open" and "Closed" positions.
- A permanent "Live Cable" indication as per IEC 61958 shall be provided for each cable using a capacitor voltage divider.
- It shall be possible to test the core or sheath insulation of the cables without disconnecting the cables in the cable compartment, after accessing the cable compartment. The cable termination shall be suitable for XLPE Cables to conductor sizes up to 300 Sq.mm
- All necessary material for connection of conventional cable sealing ends shall be delivered with each RMU.
- The ring cable connections shall only be accessible when the load break is in "EARTH" position. As long as the ring cable connections are accessible, it shall not be possible to switch the load break switch / Circuit Breaker to 'ON' position.
- The cable termination bushings for the RMU shall be placed on the sides and rear of the RMU. This is to ensure maximum operator safety in case of explosion in the cable termination.
- Cable supporting bushings (Fiber or Epoxy) shall be provided to avoid cable load from RMU bushings

5.11 Safety of Equipment

- With respect to the RMU's SF6-filled equipment, any accidental overpressure inside the sealed chamber shall be limited by the opening of a pressure-limiting device in the enclosure so that the gas will be released away from the operator and to the rear bottom or top of the tank without endangering the operator or anyone else in the vicinity of the RMU.
- All manual / motorized operations, monitoring of open/close position of switches/breakers, live line indicators, FPI indication, SF6 gas pressure indication and access to the cable compartment shall be carried out from the front of the RMU only.

5.12 Current and Voltage Transformers

The RMU shall be provided with current and voltage transformers. These CTs & PTs shall meet the electrical and mechanical ratings as per the relevant standards 157083.

5.12.1 Current Transformers

- 3 nos., ring type, single core CTs shall be provided in each load break switch for metering purposes. A similar arrangement shall be provided in each circuit breaker cable compartment to mount a 3nos., Dual-core ring type CT for Metering and protection purposes.
- The CTs shall conform to IS 2705. The design and construction shall be sufficiently robust to withstand thermal and dynamic stresses during short circuits. Secondary terminals of CTs shall be brought out suitably to a terminal block, which will be easily accessible for testing and terminal connections.
- Further characteristics and features distinguishing CTs used for metering from CTs used for protection are listed as follows:

CTs for Metering:

- Material: Epoxy resin cast/ Tape wound
- Burden: 2.5VA
- Ratio: 200-100-50 /1 A
- Accuracy Class: 0.5

CTs for Protection:

- Material: Epoxy resin cast/ Tape wound
- Burden: 2.5VA
- Ratio: 200-100-50 /1 A
- Accuracy Class: 5 P 10

5.12.2 Potential Transformers

- A 3 phase single or 3 nos. single phase potential transformers shall be provided. These should be housed in a separate air insulated PT Panel, directly connected to the RMU through main bus. The burden per transformer shall be 50 VA and the voltage ratio shall be 11000/110 V and the accuracy class shall be 0.5.
- HRC fuses shall be provided on the HV side.
- The PTs shall be of cast epoxy-resin construction, and they shall conform to IS 3156. Their design and construction, in particular, shall be sufficiently robust to withstand the thermal and dynamic stresses during short circuits.

5.13 Fault Passage Indicator for RMU

- The FPI shall be digital and facilitate quick detection of faulty section of line. The fault indication may be on the basis of monitoring fault current flow through the device. The FPI should be self-powered and should have internal lithium battery for external indication and setting of FPI in the absence of current. One set of FPIs are to be provided for Each Load break switch.
- **Fault passage Indicator: Local fault indication – LCD display on FPI front panel along with LED indication on front panel of RMU enclosure (OR) The FPI may be mounted on RMU front fascia and have LED indication for Cable fault indication. But, it shall meet the respective load for RMU 3 way/5 way.**

5.13.1 The FPIs shall include:

- Fault detection - Phase to phase and Phase to earth faults.
- One potential-free output contacts for hardwiring to FRTUs. On this basis, the SCADA/DMS will be able to monitor phase / earth fault condition.
- Local fault indications – LCD/LED display on FPI front panel along with LED indication on front panel of RMU enclosure.
- Multiple reset option –
- End of time delay (Adjustable from 2 to 16 Hrs)
- Remote reset 1NO+1NC (Via potential free input contact of FPI)
- Manual reset (Reset button on front panel of FPI)
- Automatic reset on current restoration.

5.13.2 The characteristics of the FPIs shall include:

- Phase fault thresholds configurable from at least 100/200 to 800 A
- Earth fault thresholds configurable from at least 20 to 160/200 A
- Multiple number of steps for adjusting phase and earth fault thresholds.
- Fault current duration range configurable from at least 40 ms to 100 ms in 20 ms steps and further 100 ms to 300 ms in 50 ms steps. **Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.**
- Variations with respect to these characteristics may be acceptable as long as they prove applicable and provide the same or better flexibility.

5.13.3 Protection Relay

- The RMU shall be equipped with self-powered numerical relays communicable, to trip the RMU circuit breakers.

5.14 General

The Circuit Breaker in the RMU shall be fitted with a communicable-type, self-powered numerical relay, i.e., one for each outgoing circuit breaker. The protection relay's auxiliary contacts shall be provided for hardwiring to the FRTU. The relay shall also interface with the FRTU via an RS 485 port in order to send, as minimum, real-time readings using the MODBUS/IEC 103 protocol with serial port RS 485.

The numerical relay shall be self-powered and should provide Inverse Definite Minimum Time (IDMT) and Instantaneous protection characteristics. On this basis, the relay as a minimum shall provide:

- Phase Over current Protection (50/51)
- Earth Fault Protection (50N/51N)

The relay shall be provided with an input for remote tripping, which shall be realized via an electric output pulse even without presence of phase current. A flag indicator shall be installed for signaling the occurrence of trip conditions.

Features and Characteristics

The numerical relay shall have the following minimal features and characteristics noting that variations may be acceptable as long as they provide similar or better functionality and/or flexibility:

- It shall be housed in a flush mounting case and powered by the RMU power supply unit.
- It shall have three phases' overcurrent elements and one earth fault element.
- IDMT trip current settings shall be 20-100% in steps of 1% for phase overcurrent and 10-80% in steps of 1% for earth fault.
- Instantaneous trip current settings shall be 100-2000% in steps of 50% for phase overcurrent and 50-1200% in steps of 50% for earth fault. **Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.**
- Selectable IDMT curves shall be provided to include, for example, Normal Inverse, Very Inverse, Extreme Inverse, Long Time Inverse, and Definite Time. Separate curve settings for phase overcurrent and earth fault shall be supported.
- For IDMT delay multiplication, the Time Multiplier Setting (TMS) shall be adjustable from 0.01 to 0.1 in 0.01 steps.
- The relay shall also be provided with:
 - Alphanumeric Liquid Crystal Display (LCD) for relay setting.
 - Communications via a MODBUS/IEC 103 with RS485 port to provide the FRTU with phase current measurements. It is also desirable that this same means of communication can be used by the FRTU to send setting and control commands to the relay.
- Parameter change capability that is password protected.
- **Supply of FRTU is not in the scope of bidder and for all other conditions shall follow technical specification.**

5.15 Power Supply and auxiliary power transformer

Each RMU shall be fitted with one auxiliary power transformer unit with Transformer output as 230v AC of required capacity which shall be including batteries and battery charger, suitable for operating the motors of the On-load Isolators and Circuit Breakers. On this basis, the following operational specifications shall apply:

- The power supply unit shall conform to the following requirements:
 - Input: 230 V AC nominal from the RMU's auxiliary power transformer allowing for possible variations from 190 to 300 V AC
 - Output: Stable 24 V DC.
 - Batteries: 24 V DC (2 Nos. of 12 V DC with 10AH cap each)
 - Battery Charger shall be conventional linear type /SMPS type with MCBs and protections from surges shall be provided.
 - **Battery Charger of conventional linear type (SMPS type may also accepted). But it should meet the respectively load for RMU 3 way/5 way.**
 - **Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.**

- The auxiliary power transformer shall be of required rating to meet the load requirement and the Auxiliary power transformer inputs shall be equipped with surge protection devices in accordance with IEC 62305.
- The 24 V DC batteries shall have 2x10AH capacity to supply power to the following devices with a nominal backup of 4 hours:
 - RMU's motors for a minimum of five (5) operations
 - RMU's trip coils, close coils, FPI.
- The batteries shall be of sealed lead acid VRLA (SMF) or dry type and shall have a minimum life of 36 months from the date of supply at 45°C.
- The battery charger shall be fully temperature compensated.
- To prevent deep discharge of the batteries on loss of AC power source, the battery charger shall automatically disconnect all circuitry fed by the batteries following a user-adjustable time period or when the battery voltage falls below a preset value. If the battery voltage falls below the pre set value, the time to fully recharge all batteries shall not exceed twenty-four (24) hours.
- An automatic battery checking device shall be provided to check the battery's health and initiate a battery-failed alarm signal in case battery deterioration is detected. Such detection may be based on comparing measurement values with set values (e.g., internal resistance, voltage, etc.).
- The battery charger shall be provided with an alarm displayed at the local control panel and remotely at the DAS to account for any of the following conditions:
 - Low battery voltage
 - High battery voltage
 - Battery failed
 - Battery charger overvoltage
 - Grounded battery/battery-charger
 - Others according to manufacturer's design

5.16 Multi-Function Transducer (MFT)

- The bidder shall supply multi function meter i.e. Trivector Energy Meter with RS-232 communication port instead of MFT. **Multi function meter i.e Tri-Vector energy meter with RS 232 communication port is in the scope of the bidder only.**
- **Multi function meter i.e Tri-Vector energy meter with RS 232 communication port is in the scope of the bidder only.**
- **MFT/MFM is in the scope of bidder. Dimensions will be as per the specification**

5.17 Construction

- The RMU shall be sufficiently sturdy to withstand handling during shipment, installation, and start-up without damage. The configuration for shipment shall adequately protect the RMU equipment from scraping, banging, or any other damage.

5.17.1 Enclosures

- All supplied enclosures shall be sized to provide convenient access to all enclosed components. It shall not be necessary to remove any component to gain access to another component for maintenance purposes or any other reason.

- The enclosures shall also be designed to ensure that the enclosure remains rigid and retains its structural integrity under all operating and service conditions with and without the enclosure door closed.
- The thickness of all enclosure panels shall be at least 2.5 mm. The appropriate corrosion treatment and finish requirements shall apply to both inside and outside enclosure surfaces. Other required features are as follows: **Shall follow as per technical specification (OR) Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.**
- Constructed of mild steel according to IEC 60529 with IP rating 54 or better. Must be grit/shot blasted, thermally sprayed with Zinc alloy, phosphate, and subsequently painted with polyurethane based powder paint, the overall paint layer thickness including Zinc spraying shall be of the order of 80 to 90 microns
- Means, such as insulated heat shields and/or air vents, to prevent high temperatures from damaging the RMUs enclosed components. If air vents are installed, these vents shall in no way reduce the effectiveness of the enclosure's protective characteristics.
- A metal pocket attached to the inside of the front door to hold documentation, maintenance log sheets, and other such information.
- Door opening mechanism with built-in key-lock facility suitable for padlocking. An opening mechanism that is less prone to breaking than a projecting door handle is preferred, e.g., a push-button opening mechanism. **Shall follow as per technical specification (OR) Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.**
- A grounding terminal including grounding bolt and lock washer for connecting a 50 mm² copper or galvanized steel grounding conductor. The grounding bolt and lock washer shall be made of stainless steel.
- Means of preventing moisture from condensing on electronic components mounted inside the enclosure proposed for housing the FRTU. If necessary, heaters providing adjustable thermostat-control within the range 20 to 60 °C shall be installed in the enclosure for this purpose.
- Means of protection against rain water, and high levels of airborne dust, should be provided.
- Means of enabling the SCADA to monitor the open/closed status of the enclosure door. A SCADA equipment alarm shall be produced whenever the enclosure door is open. **Shall follow as per technical specification (OR) Shall be provided as per the manufacturer's type tested design and accordingly the respective type test to be submitted.**
- The outdoor RMU shall include having a minimum protection class of IP 54. It shall be tested in accordance with the latest IEC 60529 standard.
- The outdoor canopy shall have a hinged front access door with a two-point latch locking system with a latch operating lockable handle. The door shall be fitted with a perimeter flange and gasket (Neoprene Rubber) to prevent the entrance of water. In addition, a means of monitoring and indicating that the door is open shall be provided.

5.17.2 Motors

- The RMU shall be fitted with 24V DC operated spring charging motors of high insulation class allowing the circuit breakers and load break switches to be operated without manual intervention.
- Electrical feature for Prevention of Motorised operation more than one LBS/CB at a time is to be provided.
- In addition to allowing circuit breaker tripping by the RMU's protection relays, the motorized operating mechanism shall be suitable for remote control by the SCADA.
- The motors along with the supplied control card and push buttons shall allow Utility's personnel to electrically operate the circuit breakers and load break switches at site without any modification of the operating mechanism and without de-energizing the RMU.
- Electrical / mechanical Interlock shall be provided as Electrical signal shall cut-off completely during manual operation. If LBS/C.B fail to operate, the supply to motor shall be disconnected after certain time period to prevent burning of motor due to continuous supply.
- **Interlock to be provided in-line with safety at site. Ensure by OEM.**

5.18 Inspection and Test

Inspections and tests shall be performed to ensure RMU compliance with these Technical Specifications. Responsibility for conducting the inspections and tests shall rest with the Supplier. The Utility representatives will participate in the RMU inspections and will witness the testing as described in the following sub-clauses.

5.18.1 Inspections

- Employer's representatives shall be allowed access to supplier's facility where the RMU or its parts are being produced or tested. Such access will be used to verify by inspection that the RMUs are being or have been fabricated and tested in accordance with the Technical Specifications.
- The supplier shall give the utility's representatives 15 days notice in writing concerning the date and place at which the equipment will be ready for inspection or testing. The supplier shall provide all the necessary assistance and facilities to Employer's representatives to carry such inspections and test witnessing in case the Employer decides to waive the inspection, it will be communicated within 7 days of receipt of notice.
- The supplier shall provide any and all documentation that is necessary to complete the inspections. The representatives shall be allowed to inspect the supplier's quality assurance standards, procedures, and records. Inspections, as a minimum, shall include checks on inventory, general appearance, cabling, drawing conformance, and labeling.

5.18.2 Test Procedures

- The supplier shall provide test plans and detailed procedures for all required testing. The plans and procedures shall ensure that each test is comprehensive and verifies proper performance of the RMU under test and, in this respect, shall be submitted for review and approval by the Utility.
- The test plans shall include all routine tests and acceptance tests as per relevant BIS/IEC standards and shall describe the overall test process including the responsibilities of the test personnel and how the test results will be documented.

- The test procedures shall describe the individual tests segments and the steps comprising each segment, particularly the methods and processes to be followed.

5.18.3 Test Reports

- The Bidder along with the tender documents should submit copies of all Type test certificate of their make in full shape as confirming to relevant IS/IEC of latest issue obtained from a International/National Govt. Lab/Recognized laboratory.
- The above type test certificates should accompany the drawings for the materials duly signed by the institution that has type test certificate.
- The supplier shall maintain complete records of all test results. The records shall be keyed to the test procedures.
- Upon completion of each test, the supplier shall submit a test report summarizing the tests performed and the results of the tests.

5.18.4 Factory Acceptance Test

A formal factory acceptance test shall be conducted to ensure that the RMUs have been designed to meet the utility's functional requirements in all respects. Utility representatives shall witness the test on selected RMUs, and the tests shall be carried out in accordance with the supplier's test plan and procedures as approved by the Employer. In case, the factory acceptance tests prove unsatisfactory in any way, the Employer reserves the right to reject the lot or if applicable, request further improvements in the supplier's RMU design.

5.18.5 Routine Factory Tests

- These tests shall be carried out during RMU manufacture as a quality control measure, i.e., to ensure each RMU to be delivered meets the Employer's minimum requirements including all relevant standards. Recording and reporting the routine test results shall be the responsibility of the Supplier.
- At the Utility's discretion, Utility representatives will witness such testing. This may include requesting the Supplier to perform tests on RMUs selected at random from each batch of RMUs that the Supplier deems ready to be delivered to site. Should any such test prove unsatisfactory, the Utility reserves the right to reject the lot for delivery to take place until a mutually agreed course of action has been reached.
- **Further for additional reliability of the manufactured RMU it is mandatory to have the complete assembled tank tested for partial discharge at factory.**
- Field test report format is to be prepared and submitted along with drawings for prior approval.

5.19 Operating Manuals

The Supplier shall submit operating manuals for all RMU components including items such as FPI, Relay, and other equipment provided by the bidder. These manuals shall be in English. They shall include the RMU operating instructions. Context sensitivity shall be used to go directly to the appropriate place in the manual.

The manuals shall be organized for quick access to each detailed description of the operator procedures that are required to interact with the RMU functions. This shall include the procedures to define, build, edit, and expand all data points provided with the RMU.

The manuals shall present in a clear and concise manner all information that operators, including maintenance personnel, need to know to understand and operate RMUs satisfactorily. The manuals shall make abundant use of diagrams and/or photographs to illustrate the various procedures involved.

One soft copy of manuals as well as data integration procedure with FRTU shall be provided.

Supply of FRTU is not in the scope of bidder and for all other conditions shall follow technical specification.

5.19.1 As-Built Documents and Drawings

The supplier shall submit as built documents including applicable drawings for review and approval. All deliverable documents and drawings shall be revised by the supplier to reflect the as- built RMU components including all the FPI, LLI & Relay. Any errors in or modifications to an RMU resulting from its factory and/or site acceptance test shall be incorporated. Within this same context, all previously submitted documents that are changed because of engineering changes, contract changes, errors, or omissions shall be resubmitted for review and approval. The successful bidder has to provide his quality document to Employer. One soft copy is to be provided as desired by the Employer.

Test certificates certified as per IEC 62271-100 / 200 or relevant IS Standard with latest amendments not more than 10 years. Following Test Certificates has to be submitted.

- Dielectric Withstand Test
- Short time withstand - STC withstand test
- Mechanical endurance test
- Internal Arc test - IAC Test, Classification AFL/AFLR. Tank & Cable compartment test Degree of protection test – IP test

5.20 Guarantee:

The period of Guarantee will be 5 years (five years) the date of commissioning.

ANNEXURE – I

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS RING MAIN UNIT.

Sl. No.	Description	As per Tenderer
(A)	RING MAIN UNIT PANEL	
1	Manufacturer's Design / Type ref/Model.	
2	Material used for making the body of the enclosure	
3	Standards of manufacturing	
4	Whether painting for RMU metal enclosure is done as per high standards. (RMU painting shall be done with epoxy board power coating at least two layers to avoid rusting)	
5	Whether the enclosure is fire resistive, anti-corrosive	
6	Sufficient space for inspection, testing, e	
7	Earthing arrangements	
8	Whether the enclosure are designed to withstand the in all weather conditions (Seashore area)	
9	Over all dimensions of the RMU enclosure (L x B x H)	
10	Gauge of the Material used for the fabrication of the RMU enclosure	
11	Whether the RMU enclosure is manufactured as per IEC/IS standards to hold SF6 gas without leakage	
12	Whether the RMU enclosure made provision for sensors for temperature compensated pressure. measurement in the relevant gas compartment to monitor the pressure of SF6 GAS	
13	Whether the RMU enclosure is sealed pressure system.	
14	Weight of RMU complete with operating mechanism for 3way & 5way separately.	
15	RMUs are provided with necessary take off terminals	
16	The gas chamber is made of which material and thickness	
(B)	For Vacuum circuit breakers :	
1	Maker's Name and Address	
2	Continuous rating current at 40 deg C	
3	Fault Breaking capacity	
4	Fault Making capacity	
5	Short time current withstand capacity	
6	No. of poles	
7	Maximum temp. rise of contacts at normal rating and frequency	
8	Method of closing and Operating Mechanism	
9	Min no. of Mechanical operations	
10	Type & Designation	
11	Standards	
12	Rated service voltage	
13	Frequency	

Sl. No.	Description	As per Tenderer
14	Installation	
15	Duty	
16	No. of breaks per phase	
17	Type of main contacts	
18	Minimum clearances in SF6	
	i) Between Poles	
	ii) Between live parts & earth	
	iii) Between fixed and moving contacts in the open position	
19	Vacuum bottle	
	Make:	
	Vacuum pressure(Torr)	
	Rated current	
20	CB open time	
21	CB closing time	
22	Short time current capacity for 1 sec.	
23	Cable charging interrupting current	
24	Magnetizing interrupting current	
25	Spring charge Motor rated voltage	
26	Emergency trip/open push button	
27	Whether battery charger conventional type	
28	Battery Charger cap / rating	
29	Battery type and capacity	
(C)	Load Break Switches	
1	Continuous rating current at 40 deg C	
2	Fault Breaking capacity	
3	Fault Making capacity	
4	Short time current withstand capacity	
5	Total length of break per pole	
6	Type of arcing contacts and arc	
7	control device	
8	Steady hydraulic test pressure tank can withstand for one minute without distortion.	
9	Operating mechanism and type of closing.	
10	Type of motor and details	
11	Fault passage indicators	
	a) Type/model	
	b) Self powered (Self powered relay software related files shall be supplied along with RMU)	
	c) Current readings	
	d) Phase currents	
(D)	Earth switch	
1	Operating mechanism for close and open	
2	Fault making cap of 50KA	
3	Min no. of operations at No load mechanical endurance.	

Sl. No.	Description	As per Tenderer
4	Making cap Endurance of Earth switch as per IEC 62271-102)	
5	Switching in dielectric medium	
6	Pad lock facility for all Earth switches.	

ANNEXURE – II

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS FOR 11KV RING MAIN UNIT OUTDOOR TYPE (SF6)

Sl.No.	Description	As per Tenderer
A)		
	BUS BAR	
1	Material & Grade	
	a) Cross Sectional area (mm)	
	b) Size (mm)	
2	Continuous current	
	a) Standard	
	b) At site conditions and within cubicle.	
3	Short time current for 1 sec (kAmps)	
4	Minimum clearance from bare bus bar connection	
	a) Phase to Phase (mm)	
5	SF6 gas pressure	
6	Reference standard	
7	a) Maximum temperature rise over ambient oC)	
	b) Phase to earth (mm)	
8	Bus bar provided with	
	a) Insulation sleeve	
	b) Phase barriers	
	c) Cast Resin shrouds for joints	
9	Bus Bar connection	
	a) Silver plated	
	b) Made with anti oxide grease	
10	Bus bar support spacing (mm)	
11	Bus support insulators.	
	a) Make	
	b) Type	
	c) Reference standard	
	d) Voltage Class (kV)	
	e) Minimum creepage distance (mm)	
	f) Cantilever strength Kg/mm.	
	g) Net weight (Kg).	

ANNEXURE-III
GUARANTEED TECHNICAL PARTICULARS FOR CURRENT TRANSFORMERS for LBS
with ratio 200-100-50/1A and for CB with 200-100-50/1-1A

Sl.	Details	As per APEPDCL	As per Tenderer
1	Type	Ring type and resin cast/tape wound	
2	Manufacturer's Type &	—	
3	Rated Voltage/Highest voltage	11 KV/12KV	
4	Rated Primary current	200-100-50	
5	Rated Secondary current	Core-I : 1A Core-II: 1A	
6	No. of cores (Secondary core ratio)	Two	
7	Turns ratio	200-100-50	
8	Rated Output in VA	a. Core I : 2.5VA, Core II :2.5VA	
9	Class of Accuracy	Core I : 5P10,CoreII:0.5S	
10	Accuracy Limiting factor	10 for protective core	
11	Knee point voltage of PS cores	—	
12	Maximum excitation current for PS	—	
13	Method of ratio change and secondary connection details & connection diagram.	Secondary Tapping	
14	Secondary voltage	Core-I: Core-II-	
15	Secondary Limiting Voltage	Core-I:15V Core-II-5V	
16	Short time current	20 KA/3Sec	
17	Rated current dynamic (Peak	-	
18	Rated continuous thermal current temperature rise over ambient.	As per IS: 2705	