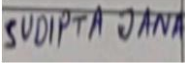
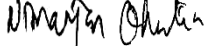

TECHNICAL SPECIFICATION

Specification of FRTU (Feeder Remote Terminal Unit) for RMU

Prepared By	Reviewed By	Reviewed By	Reviewed By	Reviewed By	Approved By	Released By
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08.05.2025	13.05.2025		08.05.2025	08.05.2025	14.05.2025	

Central Engineering Services - TP Odisha DISCOMs

TPCODL/TPNODL/TPWODL/TPSODL

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1. SCOPE

The scope of this specification covers all the technical requirement with all accessories, tools and tackles of Design, Engineering, Supply, Insurance, Testing at Manufacturer's works, packing, forwarding, Transportation, Delivery at site, unloading at site/stores, material storage, Installation, Testing & Commissioning of FRTU with all accessories and seamless integration with Purchaser's SCADA Systems, and RTU system of the 33/11 kV Primary Substations, Standard Warranty support as per the detailed specifications. Including all works required for successful integration with all RMUs (I/Os, IEDs, Meters etc.).

Any item though not specifically mentioned but is required to complete the project shall be considered and the same shall be supplied and installed by the bidder.

Bidder to note that the proposed solution shall give more emphasis on the following aspects

- a. Reliability
- b. High Availability
- c. Cyber Security Resilience

2. APPLICABLE STANDARDS

The design, manufacture and performance of the FRTU System shall comply with all the requirements of the latest editions of international codes and standards applicable. Nothing in this specification shall be construed to relieve the Bidder of this responsibility.

Emissions Standards		
1	EN55011 (CISPR 11)	ISM RF Equipment – Electromagnetic Disturbance Characteristics
2	60255-25	Electromagnetic emission tests for measuring relays and protection equipment
3	61000-3-2:2000	EMC-Limits for harmonic current Emissions.
4	61000-3-3:1994+2001	EMC Limits-Limitations in voltage changes, voltage fluctuations and flicker in public low-voltage supply systems.
Immunity Standards		
1	61000-4-2 1995-01 60255-22-2, IEEE C37.90.3	Electrostatic discharge (ESD) immunity test
2	61000-4-3 1998-11, 60255-22-3 IEEE C37.90.2 (10V/m)	Radiated, radio-frequency electromagnetic field immunity test
3	61000-4-4 1995-01 60255-22-4	Electrical fast transient/burst immunity test
4	61000-4-5 1995-02	Surge immunity test

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5	61000-4-6 1996-03	Immunity to conducted disturbances, induced by radio- frequency fields
6	60255-22-6	Electrical fast transient/burst immunity test
7	61000-4-81993-06	Immunity to power frequency magnetic fields
8	61000-4-12	Oscillatory waves immunity test
9	1995-05, 60255-22-1, IEEE C37.90.1	(Damped Oscillatory and Ring wave)
Safety		
1	61010-1	Harmonized Safety Standard
2	60255-5 2000-12	Insulation coordination for measuring relays and protection equipment- Requirements and tests
Power Supply Standards		
1	61000-4-11 1994-06	AC Power supply interruptions
2	61000-4-16 1998-01	Immunity to conducted, common mode disturbances.
3	61000-4-17	Ripple on D.C. power supply
4	61000-4-29+ 2000-08 60255-11	Voltage dips, short interruptions & voltage variations on D.C. input power port immunity test
Environmental Standards		
1	60068-2-1 1994-05	Environmental Testing Cold
2	60068-2-2 1974	Environmental Testing Dry Heat
3	60068-2-6 1995-03 60255-21-1	Environmental Testing Vibration tests (sinusoidal)
4	60068-2-27 1987	Environmental Testing Shock
5	60068-2-29 1987	Environmental Testing Bump
6	60068-2-30 1980	Environmental Damp Heat cyclic (12+12 hour cycle)
7	60068-2-31 1969	Environmental Testing Drop and Topple
8	60255-21-2	Shock and bump tests
9	IEC 61850-3	Substation Environment Requirement
Communication Standards		
1	IEC 61850-5 to 10 IEEE 802.3 CSMA/CD	Substation Comm. Standard access method and physical layer specifications
Other Applicable Standards		
1	IS 9000	Basic Environmental testing procedure for electrical and electronic items

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2	IS 694-1990	PVC insulated cables for working voltage up to and including 1100V
3	IS 2629-1985	Recommended practice for Hot Dip Galvanizing of iron & Steel.
4	IS 2633-1986	Test for uniformity of Zinc Coating
5	IEC 60529	Degrees of Protection provided by enclosures (IP Code)
6	IEC 62052-11	Electricity metering equipment (a.c.) – General requirements, tests & test conditions
7	IEC 62053-22	Static meter for active energy (Class 0.2S and 0.5S)

Product Conformance as per Gol Letter No. 12/34/2020-T&R dated 8th June 2021, Ministry's Order No. 25-17/6/2018-PG dated 2nd July 2020

1	• IEC 60870-5-104, Security Conformance • IEC 62351-100-1: Clause 5, Clause 6, Clause 7, Clause 8 • IEC 62351-100-3: Clause 5, Clause 6, Clause 7 (IEC 62351-3:2014 / AMDI: 2018, Clause 7), • IEC TS 62351- 5/IEC TS 60870-5-7	IEC 60870-5-7 Telecontrol equipment and Systems – Part 5-7; Transmission protocols – Security extensions to IEC 60870-5-104 protocol (Applying IEC 62351) IEC 60870-5-7 Security extension & IEC 62351 series (IEC 62351-100 parts 1 & 3) and other cross-referenced standards. IEC 61850 – 5, 6, 7, 8, 9, 10 Certificate of Common Criteria as per ISO/IEC 15408
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Wherever, new standards and revisions are issued during the period of the contract, the Bidder shall attempt to comply with such standards, provided there is no additional financial implication to Purchaser.

In the event of the bidder offers to supply material and/or equipment in compliance to any standard other than those listed herein, the bidder shall include with their proposal, full salient characteristics of the new standard for comparison.

3. CLIMATIC CONDITIONS OF THE INSTALLATION:

1	Maximum ambient temperature	50 deg.C
2	Max. Daily average ambient temp	35 deg.C
3	Min Ambient Temperature	07 deg.C
4	Maximum Relative Humidity	100%
5	Minimum Relative Humidity	40%

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6	Average No. of thunderstorm days	50 annum
7	Average Annual Rainfall	2380mm
8	Average No. of rainy days per annum	120 days max.
9	Rainy months	June to Oct.
10	Altitude above MSL not exceeding	1000 meters
11	Wind Pressure	Zone V (maximum recorded 300Kmph)
12	Earthquakes of an intensity in horizontal direction	equivalent to seismic acceleration of 0.3g
13	Earthquakes of an intensity in vertical direction	equivalent to seismic acceleration of 0.15g (g being acceleration due to gravity)

TPCODL/TPNODL/TPSODL/TPWODL service area has heavy saline conditions along the coast and High cyclonic Intensity winds with speed up to 300 Kmph. The atmosphere is generally laden with mild acid and dust in suspension during the dry months and is subjected to fog in cold months.

Note: Climatic Condition will be considered as per respective TP DISCOM TPC-Mumbai/TPDDL/TPCODL/TPNODL/TPSODL/TPWODL.

4. GENERAL TECHNICAL REQUIREMENTS

CONTENTS

Section No	Description	Page No.
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FRTU Technical Specification

The Intent of this specification is to commission FRTUs for RMUs of Secondary Distribution Network for Remote Monitoring & Control and its integration with Purchaser's SCADA/ADMS System. The proposed Feeder Remote Terminal Unit (FRTU) shall facilitate controlling and monitoring of the RMUs / Field Equipment from the SCADA/ADMS System at Main Control Center (MCC) and Backup Control Centre (BCC) over IEC 60870-5- 104 and MQTT protocol.

Guaranteed Technical Parameters

Data Sheet : FRTU			
SL. NO.	TECHNICAL PARTICULARS	TPCODL REQUIREMENT	BIDDER's RESPONSE
1	Feeder Remote Terminal Units (FRTU)	Din Rail Mounted	
		It shall have capability to be part of a larger RTU family for T&D function	
2	Make & Model Proposed	Make	
		Model	
3	RTU Redundancy	Optional (CPU, Power, Communication & Memory)	
4	Digital Inputs (Physical)	As per RFP / RMU type and Indicative Signal List	
5	Digital Outputs (Physical)	As per RFP / RMU type and Indicative Signal List	
	Close / Open	Required	
	Raise / Lower	Required	
6	Analog Inputs (Physical)	As specified in the I/O Requirement	
7	Energy Meters / Numerical Relays Integration	Facility to interface Multifunction Meters and Numerical Relays	
7.1	Accumulator Data from Multi-Function Meter	Capable of Acquiring 32 bit Analog and Accumulator Data from Multifunction Meters	
8	Distributed I/O modules	Required	
9	Ports Requirement and Type	All ports shall be galvanically isolated	
		2Nos. RS485 electrical ports for communication with Serial Devices over IEC60870-5-103, Modbus protocol	
		2 Nos. Ethernet Ports / FRTU (Both the ports should support IEC 104, IEC 61850 & other standard protocols for Communication with Control Center and Field IEDs)	

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Data Sheet : FRTU			
SL. NO.	TECHNICAL PARTICULARS	TPCODL REQUIREMENT	BIDDER'S RESPONSE
	For Structuring (Configuration) System (Separate Port)	A galvanically isolated USB port for local engineering through laptop	
10	Protocol Support	IEC61850 (Ed1 & Ed2), IEC60870-5-103, IEC60870-5-104 (Master & Slave), MODBUS (Serial & TCP/IP), SNTP & SNMP with Server and Client licenses	
11	Time synchronization between FRTU, I/O modules, IEDs	Required on SNTP and direct pulse (1 PPS, 1 PPM). FRTU shall have capability for Time Synchronization from Minimum 2 Server with priority selection	
	Real time stamping at FRTU level, I/O level	Required, Mandatory	
12	Response Time		
	Digital Input	1 msec or better	
	Analog Measurement	1 sec or better	
	Digital Output	<1 sec or better	
13	I/O handling Capacity	Min 1000 Physical Tags / RTU	
14	Pseudo Points (Digital, Analog)	Required	
15	Calculated Points (Digital, Analog)	Required	
16	SOE List storage	Min 1000 (shall be user configurable)	
	SOE list Retention Period	1 Month	
	Measurement Events	10000	
17	Fault Disturbance Recorder	1000 events	
	FDR Retention Period	1 Month	
18	Development of Interlock logic	Required, Mandatory	
19	Support of mathematical function - Arithmetic, Logical, Trigonometric functions, Differential and Integration functions, Timer, Counter etc.	Required, Mandatory	
20	Logic and Calculation functionality	Required, Mandatory	
21	Check-Before-Execute Scheme for Control	Required (Bidder shall submit their Check-before-Execute scheme)	
22	Auxiliary Relays for Digital Outputs	Required, Auxiliary relays with Min 10 Ampere rating with 2 NO contacts for each digital output	
23	Status LEDs on all module – for fault indication and Inputs /	Required	

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Data Sheet : FRTU			
SL. NO.	TECHNICAL PARTICULARS	TPCODL REQUIREMENT	BIDDER'S RESPONSE
	Outputs		
24	Module replacement in RTU	Hot-Swappable module	
25	Software – All diagnostic tools, simulator tool, maintenance tools, configuration application for database and process control program development, documentation, and maintenance	Required Licensed FRTU configuration software minimum 5 numbers	
26	Engineering Functions	a) Configuration shall be possible both locally and remotely	
		b) FRTU shall have multilevel passwords	
		c) On-line monitoring facility of real time data for monitoring/analyzing the real time status of the process, program logic from the engineering station	
		d) Allow configuration of the FRTU with different versions of the Configuration Tool	
		e) ICD file generation shall be possible from the proposed Configuration Tool	
		f) FRTU must have the provision to configure IP of the redundant SCADA Systems (Socket IP)	
27	Cyber Security	Bidder to confirm Cyber security measures as indicated in the Specification	
28	Battery Backup / Flash-PROM backup	Required	
29	Auxiliary Power Supply	Auxiliary Power Supply of FRTU shall be 18-72 V DC (24V DC) Supply. The FRTU shall have adequate protection against reversed polarity, over current and under voltage conditions, to prevent the internal logic from being damaged and becoming unstable causing mal operation.	
29.1	Auto-Startup and Restoration	In case of Power Supply Failure, Auto-Startup and Restoration of the FRTU required	
30	RTU health monitoring contacts (CPU, Communication, I/O modules, Power Supply)	Required both Physical and Soft, Mandatory	

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Data Sheet : FRTU			
SL. NO.	TECHNICAL PARTICULARS	TPCODL REQUIREMENT	BIDDER'S RESPONSE
31	Environment Requirement, Reliability & Cooling	FRTU with accessories will be installed in the Relay/Control room with no temperature or humidity control. The RTU shall be capable of operating in ambient temperature from 0 to +65 degree C with rate of temperature change of 20 degree C/hour and relative humidity of 95%, non-condensing	
		All the modules shall be with conformal coating	
32	Number of Multi Master Reporting possible with same ASDU	8 Nos.	
33	Web Based Monitoring	Required, Mandatory	
34	FRTU's Digital Input/Output Capacity	Capacity of I/O should be sufficient for Two 4 way RMU automation (Minimum 80 DIs and 32 DOs & 16 AI hardwired capacity).	
35	CPRI report for the product offered as per the GoI order no. 25-17/6/2018-PG dated 2nd July 2020 and subsequent order No. 12/34/2020-T&R dated 8th June 2021	Mandatory, Bidder to submit the CPRI report along with Bid Document	

1.1 Technical Specification for Feeder Remote Terminal Unit (FRTU)

FRTU is envisaged for data acquisition and integration with control centers to carry out remote monitoring and control of the RMUs. A state-of-art microprocessor based industrial FRTU designed for the electrical process environment in both decentralized and centralized manner shall be considered. The FRTU shall guarantee high availability and ensure safe and secure operations of all substation equipment.

The FRTU shall be multifunctional, designed in accordance with applicable International Electro-Technical Commission (IEC), Institute of Electrical and Electronics Engineer (IEEE), American National Standards Institute (ANSI), and National Equipment Manufacturers association (NEMA) standards, unless otherwise specified in this Technical specification. In all cases the provisions of the latest edition or revision of the applicable standards in effect shall apply.

FRTUs shall be a modular and reliable system for acquisition of required information from IEDs e.g. FRTUs, BCPUs, Numerical relays, Multifunction meters, and other communicable devices as well as hardware signal through I/O cards.

DI/DO card should have sufficient ratings to take care of operations without CMR.

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All functional capability described herein shall be provided by the bidder even if a function is not initially implemented. As a minimum, the FRTU shall be capable of performing the following functions:

- 1.0 The proposed FRTU, I/O and Interfacing modules shall be of the same family of FRTU or Embedded, industrial grade system with high availability & reliability. FRTU hardware shall be easily scalable for expansion and to integrate IEDs/IOs in future on open protocols.
- 1.1 The FRTU shall be non-redundant for the current application, however proposed FRTU shall support redundancy in hot standby mode with bump less Auto Changeover.
- 1.2 FRTU shall have vast protocol support capability, adaptable for customization and additional protocols and Multi master communication capability.
- 1.3 The FRTU shall support a wide range of Server/Client protocols including IEC61850 (ED1 & ED2 edition), IEC 60870-5-104 (Master/Slave), IEC 60870-5-103, Modbus - RTU, Modbus - TCP/IP (Master), MQTT. FRTU shall support optional modbus TCP, Zigbee.
- 1.4 The FRTU shall have min 1,000 Physical I/O tags and shall support integration of at least 10 IEDs on IEC 61850 and at least 10 IEDs on serial protocols. Bidder to consider the hardware such as I/O peripheral, Serial Ports, Communication processors, Converters etc., in the FRTU accordingly.
- 1.5 The proposed FRTU shall communicate simultaneous with eight independent remote master (redundant) stations on IEC 60870-5-104 and MQTT Protocol.
- 1.6 FRTU to the Purchaser's SCADA Systems shall allow scanning & control of all defined points (Physical/Pseudo points) within the field substation independently to each of the SCADA systems. Proposed system shall simultaneously respond to independent scans & commands from Purchaser's SCADA/ADMS Systems. Proposed system shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol for each remote-control center. Also, each control center's data scan and control commands may be different for different data points within the proposed system's database.
- 1.7 The FRTU shall be Din Rail Mounted.
- 1.8 Disturbance and fault record collection over IEC 60870-5-104 protocol
- 1.9 It shall support IEC 61131 based programming logic. The FRTU shall support programming language (Functional Block) with arithmetic & logical functions to incorporate Interlock Logic for SCADA Controls. Bidder to ensure supply of necessary hardware and software to achieve the functionality without any price implication.
- 1.10 Web Server functionality to monitor and configure the FRTU along with Substation IEDs by authorized users (AAA functionality).

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- 1.11 Should provide latest Microsoft Windows based maintenance and configuration tools. The tools should have functionality of both remote and local access.
- 1.12 Time synchronization based on SNTP (Server/ Client) and Protocol specific synchronization (IEC 60870-5-104 etc.). The FRTU shall accept minimum two independent sources for time synchronization over SNTP/Protocol specific Synchronization. FRTU in turn shall synchronize the IEDs integrated on different protocols.
- 1.13 FRTU shall support SNMP protocol for device monitoring and management from Purchaser's Network Management System.
- 1.14 FRTU shall support configuration File Upload and Download from the Engineering Station (Configuration Laptop), functionality shall support both Local & Remote configuration.
- 1.15 FRTU shall be capable of acquiring 32-bit analog and accumulator data from Multi-function meters on MODBUS (RTU & TCP/IP)/IEC61850/IEC60870-5-104/MQTT.
- 1.16 FRTU communication protocol shall be configured to report analog & Status changes by exception to master stations. However, FRTU shall support periodic reporting of analog data and periodicity shall be configurable from 1 sec to 1 hour. Digital status shall have higher priority than the analog data. In addition, analog values shall also be reported to Master station by exception on violation of a defined threshold limit.
- 1.17 The XML based Substation Configuration Description Language (SCL) of IEC 61850 configuration interfaces shall allow information to be shared between the various configuration tools, reducing the overall engineering time.
- 1.18 User friendly on-line health and data monitoring facility shall be provided to maintenance engineer for monitoring/analyzing the real time status of the process, program logic from the engineering station (Configuration tool – Laptop) from local and Remote.
- 1.19 The Master Station user shall be able to perform a virtual connection through FRTU with any IED, provided by the communication protocol functionality, to support the information transfer to/from IEDs. e.g., the Master Station shall gather on-demand IED data; visualize IED configuration parameters. On the other hand, the Master Station shall be able to download to the IEDs configuration parameters, code changes, etc.
- 1.20 The system shall comprise of features namely failsafe control (i.e. check-before-execute, selection timeout etc.), Interlock & Sequential Logic Control system, Sequence of Event Recording (SER), Interfacing with third party IEDs (e.g. Multifunction Meters, Condition Monitoring & Protection system etc.), interfacing with third party computer system, Integration of data as per time base (e.g. 15 minutes energy integration), direct GPS clock

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connectivity, through SNTP server or through the Master (Main & Standby) for time synchronization.

- 1.21 In case of power supply failure, auto start-up and restoration of the FRTU shall be possible without manual intervention.
- 1.22 The FRTU should support features i.e. Logic Development, Auto-Change over of source functionality, Communication between FRTUs for automatic GRID management. These features shall be available by default without any additional hardware & Software.
- 1.23 All the cards/modules of the FRTU, Ethernet Switch etc. must have conformal coating for protection against harsh environments.
- 1.24 It shall be possible to increase the number of communication ports in the FRTU by addition of cards, if required in future. The FRTU shall support the use of a different communication data exchange rate and scanning cycle on each port and different database for each master station.
- 1.25 Internal battery backup to hold data in SOE buffer with time & date in case of failure of supply.
- 1.26 The proposed FRTU shall be KEMA Certified or by equivalent certification body like NABL /CPRI/International Accredited Lab.
- 1.27 It shall be capable to perform all functions as per the current RFP requirement including future requirements. Processor & RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing & memory are used.
- 1.28 FRTU shall communicate to MCC, BCC system over IEC60870-5-104 and MQTT protocol.
- 1.29 Continuous self-supervision function with self-diagnostic feature shall be included.
- 1.30 Shall support Scheduled rebooting and hard rebooting.
- 1.31 Hard rebooting of FRTU through SMS (modem should have single DO)
- 1.32 Local operation of RMU feature shall be there from FRTU

1.33 *Communication*

1.33.1 Ports

- 2 Nos. Ethernet Ports / CPU, each port shall support IEC60870-5-104, IEC61850 (ED1, ED2), MQTT for simultaneous communication with Min Eight (8) independent redundant master's and IEDs (IEC61850 ED1, ED2).
- 2 Nos. RS 485 electrical ports for communication with serial devices over serial protocols such as IEC60870-5-103, Modbus protocol in the FRTU. Bidder to mention all other protocol supported by the proposed FRTU in the technical offer as standard/default solution.

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- In addition to above, Ports for internal communication, maintenance and configuration shall be considered.

1.33.2 **Protocols**

- The communication protocol for FRTU to Master Control Center must be IEC 60870-5-104 and MQTT.
- IEC 61850 ED.1 & 2, IEC 60870-5-104, IEC 60870-5-103, MODBUS (Serial and TCP/IP) MQTT shall be supported. The RTU shall meet the IEC 61850 standard in every respect and interoperability with other manufactures IEDs and tools shall be verified.
- Time synchronization over SNTP and Communication protocol from Master.
- Master and slave licenses shall be considered for all the above-mentioned protocols.
- Should generate XML file for integration/engineering with vendor Independent SCADA systems
- FRTU shall support RSTP.
- SNMP (v1, v2c and v3) for Health monitoring of the Hardware.

1.34 *Input / Output Requirement*

- a. Hot replacement of all I/O modules
- b. A complete set of process interface
- c. High disturbance immunity, meeting the requirements of the IEC directives 89/336/EEC and 73/23/EEC when placed in cabinets.
- d. Comprehensive self-diagnostics
- e. On-board processing capabilities such as time-tagging, event handling, filtering & gain control.
- f. Modularity, permitting step-by-step expansion
- g. Reliability and auto-diagnostics
- h. Easy to configure
- i. Quick fault finding with help of LEDs of each module and channel
- j. The relative time error between events (DI signals) handled within one controller shall be <1 ms (interrupt driven). The relative time error between events handled within separate FRTU shall not be more than 2 ms.

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- k. Input / Output Requirement for each Substation: Typical Input/Outputs requirement

I/O Requirement	Digital Inputs (DI)	Digital Output (DO)	Analog Input (AI)
IO Configuration (Current Requirement)	64	16	8
Expandable	80	32	16

The following Input / Output modules are envisaged to acquire the field information.
Bidder to note that, the I/O requirement considered from hybrid architecture, i.e.
Acquisition of I/O from IEDs and as well from proposed I/O modules.

- a. Analog input
- b. Digital inputs
- c. Digital outputs

1.34.1 Dummy breaker latching relay

The Contractor shall provide a latching relay to be used to simulate and test supervisory control from the Master station. The latching relay shall accept the control signals from the FRTU to open and close and shall provide the correct indication response through a single point status input.

1.34.2 Analog Input Sub System

- The entire analog, Telemetered, Non-Telemetered and calculated point values shall be stored in the database in engineering units
- The system shall provide the capability to perform analog-to-digital conversion accuracy monitoring and raising an alarm should any such points exceed tolerance

a. Analog Signal Conditioning

- Galvanic isolation of input and output signals
- Input filtering and non-linear filtering for attenuation of noise-level
- Amplification of low-level signals
- Cold junction compensation

b. Analog Signal Monitoring

- Power supply failure monitoring due to loose plug connection, short circuit, wire break and

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voltage interruption

- Transducer / Energy Meter monitoring for parity, wire break, live zero and end limit values
- Short circuit proof
- Monitoring of A/D conversion
- On-line simulation
- Cable monitoring for open circuit
- Fuse protection and fuse failure detection
- Communication monitoring
- Configurable Dead band

C. Design and Performance requirement of Analog Input modules

The Analog Input module shall be a solid-state type. The following features shall be provided:

- The decoding logic shall ensure that no two channels are selected simultaneously
- Cross-Talk attenuation between selected and unselected channel shall be more than 80 dB
- The Analog – to – digital converter (ADC) shall preferably be of successive approximation type, the following feature shall be provided:
 - Guarded input section to ensure large common mode noise rejection
 - Provisions for ADC overflow detection
 - Repeatability of +/- 0.025% of full scale
- The following design features shall be provided to offer protection to the analog input modules:
 - Protection for continuous overload up to 200% of all input ranges. Such overload on any analog input point shall not affect the accuracy of the next analog input in the same range.
 - Features to ensure that power line voltage variations up to +/-20% and line frequency variation up to +/- 10% do not affect the accuracy of the system
 - Connection of any point for indefinite time shall not damage the system
 - Provision for isolating failed channels and for ensuring that such partial failure does not affect remaining healthy channels
 - Modular design to enable easy field expandability
 - Provision for two high accuracy reference voltages to be used for checking the accuracy of the ADC for linearity, zero drift and gain. The reference voltage shall be set at equal intervals

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with respect to the ADC range. This check shall be made automatically at periodic intervals not exceed 6 secs and shall be alarmed if conversion is out of tolerance

- On-line replacement of individual modules in case of failures
- Surge withstands capability as per IEEE standards.
- Measurement range: +/- 2.5 V, +/- 5 V, +/- 10 V, 0-+/- 5 mA, 0-+/- 10 mA, 0-+/- 20 mA, 4-20mA
- Resolution: 14 bits + sign
- Type of input: Differential
- Input impedance (Voltage input) – 2 Mega ohms
- Shunt resistance – 250 ohms
- Common Mode Voltage – 100 V
- Conversion time - < 100 millisecond
- Fusing of Transducer Supply – Individual
- Temperature drift with Gain=1 - 0.05%/10°C (Typical), 0.1%/10°C (Max)

1.34.3 Digital Input Sub System

Digital input with memory shall be considered in case when two items of information received simultaneously i.e. the current point state and flag indicating if the state has changed more than once since the last scan cycle. Number of changes shall be computed using the new state, the memory flag & the last state.

a. Digital Input Signal Conditioning

- Galvanic isolation of input signals
- Input filtering for noise-level

b. Digital Input Signal Monitoring

- Contact monitoring
- Contact bounce protection
- Power Supply failure
- Fail safe condition on failure of card / channel
- On-line simulation / blocking
- Fuse protection and fuse failure detection
- Communication monitoring

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- Cable monitoring

c. Design and Performance requirement of Digital Input modules

The digital input modules shall be provided for the periodic scanning of both low resolution and high-resolution digital inputs. The following design features shall be provided:

- Internal voltage source to convert contact state of potential free contacts, either changeover or ON-OFF into logic level signals. Possibility of surface film or contamination on the contacts shall be considered while selecting this source
- Voltage level sensing units, with non-zero values for the binary status output
- Differential input circuit to offer common mode isolation
- Choice of polarity and threshold range
- Buffer registers
- Filtering to protect against contact bounce or electrical noise on input lines
- Detection of card power supply failure
- Surge withstands capability as per IEEE standards
- Self-Checking features for detecting faulty operation
- Status indicating LEDs for each input
- On-line replacement of individual modules in case of failure
- Simulation facility
- Digital inputs with interrupt-controlled updating
- Provision for isolating failed channels and for ensuring that such partial failure does not affect remaining healthy channels
- The digital input can be inverted so the value is 1 when the electrical signal is off, and 0 when it is on
- Rated Voltage – 24 V DC / 48 V DC
- Input Voltage Range “1” – 18 – 30 V / 36 – 72 V
- Input Voltage Range “0” – (-) 28 – 10V / (-)28 – 20 V
- Input Resolution – 1 m Sec
- Time Stamping – at Card level
- Event Detection – Yes
- Current consumption (+5V) – 460 mA

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- Number of channels per module / card – 16 (max)

1.34.4 Digital Output Sub System

a. Digital Output Signal Conditioning

- Galvanic isolation of output signals

b. Digital Output Signal Monitoring

- Contact monitoring
- Contact bounce protection
- Power Supply failure
- Fail safe condition on failure of card / channel
- On-line simulation / blocking
- Fuse protection and fuse failure detection
- Communication monitoring
- Cable monitoring

c. Design and Performance requirement of Digital Output modules

The digital output module shall provide contact closure outputs by driving relays. Features to be provided are as follows:

- On-line replacement of individual modules in case of failure
- Long life, bounce free, high-speed mercury wetted or dry reed relays
- Surge withstands capability as per IEEE standards
- Type of Output – Opto isolated short circuit protected transistor output
- Number of channels per module / card – 32 (max)
- Voltage rating – 24 V DC /48V DC
- Load Supply – 19.2 V (minimum), 56 V (maximum) / 38.4 V (Min),112 V (Max)

1.35 Algorithm and Logic

- The FRTU shall be based on advanced and proven algorithms and an easy and efficient upgrade of the FRTU functionality shall be possible.
- The FRTU shall support IEC61131 for constructing the interlock logic functions.
- The FRTU shall facilitate user defined logic functions such as automatic control sequences by

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means of available logic elements. e.g., with one command perform a safe change of the connection of a selected line from one bus-bar to another bus-bar in double bus- bar switchgear.

- d. Command is always to be given in two stages: selection of the object and command for operation under all mode of operation. Final execution shall take place only when selection and command are actuated (Select-before-execute).
- e. It shall also be possible to interconnect and derive input and output signals, logic functions, using built-In functions, complex voltage and currents, additional logics (AND- gates, OR gates and timers).
- f. A delay/integrator shall allow the pick-up and reset of binary signals of IEDs to be delayed before being displayed or used to control other functions.

1.36 Self-Supervision

- a. The FRTU shall have extensive self-supervision including all functional module and communication channel.
- b. The FRTU shall have LEDs for healthiness / error indication
- c. FRTU shall have the facility to generate & download the log files for maintenance and troubleshooting.
- d. Command execution timer (configurable) must be available for each control point. If the control action is not completed within a specified time, the command should get cancelled (Run Time Command cancellation). The timer for time-out feature shall also be user configurable.
- e. In case of restoration of communication links, power supply after failure, the software along with hardware shall be capable of automatically synchronizing with the remaining system without any manual intervention.
- f. It shall be possible to re-boot the FRTU through the LAN/WAN from a remote location.

1.37 Event Recording pertaining to FRTU

- a. The FRTU shall support event recorder that can handle up to 1000 time tagged events. Events shall be stored in non-volatile memory. In case of failure of RTU or communication channel, the recorded events shall be communicated to the master as soon as communication is restored after failure.
- b. The FRTU shall have an internal clock with the stability of minimum 10 ppm or better. The FRTU time shall be set from time synchronization messages received from GPS clock or Master station. SOE time resolution shall be 1ms or better.

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- c. The FRTU shall maintain a clock and shall time-stamp the digital status data. Any digital input data in the FRTU shall be assignable as an SOE point. Each time a SOE status indication point changes the state, the FRTU shall time-tag the change and store in SOE buffer within the FRTU. SOE shall be transferred to Master Station through FRTU as per IEC 60870-5-104 protocol.
- d. It shall be possible to retrieve the recorded event on the Purchaser's SCADA system.
- e. FRTU shall support Event storage capacity as follows:

Measurement Events	10000
System Events	1000
Alarms & Events	5000

- f. FRTU shall support web-based monitoring from remote as well as local.

1.38 Power Supply

- a. The FRTU shall be powered from the 18-72 VDC (24/48 V DC) Power Supply. The FRTU shall accept power from the DC system with the following characteristics:
- b. Nominal Voltage of 24V DC/ 48V DC with operation between 18 - 72 VDC. The voltage may vary during normal operation between these limits with a duration not less than 1 msec.
- c. Reverse polarity protection.
- d. The RTUs shall operate with grounded input power from purchaser
- e. The RTU shall have adequate protection against reversed polarity, over current and under voltage conditions.
- f. Each Input / Output Supply within the panel shall be through power supply distribution module with MCBs with NO contacts (for supply monitoring).

1.39 Time Synchronization

- a. FRTU time synchronization shall be over the Communication protocol from master (IEC 60870-5-104, MQTT).
- b. FRTU in turn shall be capable of synchronizing all the slave IEDs
- c. Timing Accuracy: The FRTU shall time-tag event reports to an absolute accuracy of 1ms or better.
- d. FRTU shall generate an alarm if it gets drifted or loose the synchronization signal.
- e. FRTU shall have min 2 (two) source input for Time synchronization with priority provision
- f. Bidder to propose the solution for time synchronization of the FRTU, if the same drifts beyond

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specified limit (e.g. 30 minutes drift)

- g. With each power cycle the FRTU shall time synchronize with the available source.

1.40 Environment requirements, Reliability & Cooling

- a. The Unit shall have high reliability in operation and shall not use cooling fans. The unit shall have vermin proof enclosure and shall insulate electronics, internal components and electronics from external environment in order to avoid failures due to dust, humidity, fungus etc.
- b. The FRTU Panel hardware installed shall comply to IP54 or better enclosure.
- c. The FRTU panel shall be rugged, environment independent and can be installed in the harsh environment (Outdoor/Indoor) with no temperature or humidity control. FRTUs shall be capable of operating in ambient temperature from 0 to +65-degree C with rate of temperature change of 20-degree C/hour and relative humidity 95%, non-condensing.

1.41 Expansion in future

Offered system shall be suitable for extension in future for additional equipment & other IEDs. During such requirement, all the drawings and configurations shall be designed in such a manner that its extension shall be easily performed by the Purchaser. During such event, normal operation of the existing system shall be unaffected, and system shall not require a shutdown. The Bidder shall provide all necessary hardware and complete set of software tools along to perform addition of equipment/IEDs in future and complete integration with Purchaser's SCADA System. These hardware and software tools shall be able to configure IED, add additional analogue measurements, digital I/Os, modify interlocking logics etc. for additional IEDs/equipment which shall be added in future.

1.42 Cybersecurity

- (a) Secure access- Level Wise enabling of settings with User Rights should be incorporated with Password protection in the FRTU. Each User shall have his/her own User Id & Passwords.
- (b) User Credentials to access FRTU shall be authenticated through Purchaser's Active directory Server.
- (c) All actions/modifications/deletions shall be logged in the FRTU. These logs shall be pushed to Purchaser's Central Asset Management system/SOC.
- (d) It shall be possible to access the FRTU through a web browser (Https Support) anywhere from the LAN for configuration, diagnosis, monitoring, file upload & download, simulation and log retrieval by using appropriate user account management viz. Role based access control & password complexity

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- (e) The FRTU should also supports Authentication and Authorization of individual users, Security logging.
- (f) FRTU shall be NERC-CIP/NIST 7628, IEC62351, IEC 62443 and IEEE 1686 compliant.
- (g) FRTU shall be enabled with System hardening viz. disabling/removal of unused ports and services.
- (h) FRTU Should support System Audit Logs, SYS logs etc.

1.43 Reliability

Reliability of the equipment's offered shall be better than 99.9999% per year availability for overall end equipment. FRTU reliability and availability calculation shall be provided with engineering document for approval.

1.44 Configuration and Management Tool

Bidder shall provide all the Configuration and Management software tools, which can be installed on Purchaser's existing Engineering Laptops. The proposed configuration and management software shall be compatible with Microsoft Windows version 10 and above. Bidder to consider software tools for FRTU configuration, diagnosis, simulation, Logic development.

A Software tool for user friendly engineering and disturbance handling shall be available for

- a. Configuration of all input and output logical, communication interfaces and other built-in functions and signals shall be possible both locally and remotely from the Master Station for configuration & maintenance activity.
- b. Configuration application shall have multilevel passwords to safeguard control, logic, and automation settings.
- c. Data collection, data modelling, configuration and parameter setting
- d. Engineering of process information for automation and control center systems
- e. Engineering of process information for automation of non-bidder systems and their individual parameters.
- f. User friendly on-line monitoring facility of real time data shall be provided to maintenance engineer for monitoring/analyzing the real time status of the process, program logic from the engineering station. The FRTU simulator shall be capable of emulating master and slave protocols for all the applicable open protocols. Bidder shall submit the details of the offered simulator packages along with the bid.

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- g. Shall be used to monitor all communication traffic on a channel.

1.45 Layer 2 Industrial Grade Managed Ethernet Switch

Technical specifications for the Managed Layer 2 Industrial grade, 61850-3 compliant Ethernet switch is given below:

- a. The switch shall be of industrial grade type designed for continuous operation.
- b. Switch shall have minimum 8 ports –
 - o No. of CU Ports : 6 Ports (RJ45 - 10/100Mbps)
 - o No. of FO Ports : 2 Ports (SM)

Speed of FO: 1000 MBPS, Type of Connector: LC Type – 1000 FX

- c. Switch shall be DIN Rail mounted with Power Socket and Ports
- d. LED indicators for link establishment and data transfer for each port
- e. Should support remote configuration
- f. It should own separate maintenance/console port
- g. Latency shall not be more than 10 μ s.
- h. Should support SNMP Server v1.0/v2.0/v3.0
- i. Should be KEMA Certified or equivalent
- j. All the cards/modules of the Switch must have conformal coating for protection against harsh environments.
- k. Switch shall support IEEE802 series for VLAN, RSTP, MSTP and Suitable for ring configuration etc.
- l. Switch shall be IEC 61850 EMC and operating conditions for Power Substations environment.
- m. Switch shall be IEEE 1613 Environmental Standard for Electric Power Substations environment.
- n. Switch shall have design for minimum Heat generation and high MTBF (minimum time between failure)
- o. Switch shall Support Simple plug and play operation - automatic learning, negotiation, and crossover detection
- p. Switch shall Support Quality of Service (802.1p) for real-time traffic
- q. Switch shall Support SNTP time synchronization (client and server) for synchronization of networks
- r. Switch shall Support Industrial automation features (e.g. Modbus, Ethernet/IP and IEC61850 protocols for transparent data transmission)

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- s. Switch shall be suitable for PRP/HSR configuration and devices.
- t. Switch shall Support Management Tools like:
 - Web-based, Telnet & Command Line Interface (CLI) for quickly configuring major managed functions
 - SNMP v1/v2c/v3 for different levels of network management
 - Remote Monitoring (RMON)
 - Rich set of diagnostics with logging and alarms
 - Bidder shall supply Console Cable along with each switch

1.45.1 LAYER 2 features

- a. The Switch should support Layer 2 switch ports with Secure VTP or similar protocols to reduce administrative burden of configuring VLANs on multiple switches in turn eliminating the configuration errors & troubleshooting in secure manner.
- b. The Switch should support Rapid Spanning Tree Protocol & Multiple Spanning Tree Protocol.
- c. The Switch shall have IEEE compliance for 802.1Q VLAN, 801.2p, 802.1d STP, 802.3ad (Port aggregation), 802.1w RSTP, 802.1s MSTP, 802.3ad LACP, IEEE 802.1ab Link Layer Discovery Protocol.
- d. The switch should have support for Port mirroring
- e. The Switch should be able to discover the neighboring device of the same vendor giving the details about the platform, IP Address, Link connected through etc, thus helping in troubleshooting connectivity problems or equivalent
- f. The Switch should support a mechanism to prevent edge devices not in the network administrator's control from becoming Spanning Tree Protocol root nodes

1.45.2 Management features

- a. Switch Latency period: 7 Microsecond or better
- b. Transfer Rate of the Switch: 50.4 Gbit/sec
- c. The Switch should support SNMP v2, V3
- d. The Switch should support Configurable SNMP traps
- e. The Switch should support Logging to syslog with time stamp
- f. Java Run time version - Latest
- g. The Switch should support NTP, SNTP support.

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- h. Full environmental monitoring of PSUs, Fans, temperature and internal voltages, with SNMP traps to alert network managers in case of any failure

1.45.3 Power supply

- 18-72 V DC power supply module, with $\pm 15\%$ tolerance
- Separate MCB with appropriate rating shall be used to power up the Switch
- Provision for connecting redundant power supply option should be available.

1.45.4 Environmental

- The switches should have IEEE 802.3az Energy efficient Ethernet and ROHS compliance
- Switch should be capable of operating under normal room temperature without the requirement of Air conditioning.
- Conformal Coating: Required
- Operating Temperature: -5° to $+85^{\circ}\text{C}$.
- IEC60068-2-1 - Cold
Temperature IEC60068-2-2 - Dry Heat
IEC60068-2-30 - Humidity (Damp Heat, Cyclic) IEC60068-21-1 - Vibration
IEC60068-21-2 - Shock, IEC61850-3- Environmental

1.45.5 Product Conformity

Product Conformity	Purchaser Requirement
02.3-10BaseT	Yes
02.3u-100BaseTX	Yes
02.3u-100BaseFX	Yes
02.3ab-1000BaseT	Yes
02.3ad-Link Aggregation	Yes
02.3x-Flow Control	Yes
02.1d-MAC Bridges	Yes
02.1d-STP	Yes
02.1p-class of service	Yes
02.1Q-VLAN tagging	Yes
02.1Q-2005 (formerly IEEE 802.1s) MSTP	Yes
02.1w-RRST	Yes
02.1x-port based Network Access Control	Yes

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1.46 Networking Accessories

1.46.1 Patch Panel

All structured Ethernet copper cabling shall be terminated on of Cat 6 E type patch panels on switch side.

1.46.2 I/O Box

All the structured CAT6 cabling on the device side shall be terminated on I/O boxes.

1.46.3 Ethernet Patch cords

All the terminations on the switches / devices shall be done using factory crimped, flexible Cat 6 E UTP Patch cords of suitable length.

1.47 FRTU Panel

1.47.1 Panel and other Accessories

- a. The panel shall be of IP 65/67 class and industrial grade along with CANOPY.
- b. Control panel shall be suitable for bottom cable entry.
- c. Interconnection between panels shall be by prefabricated cables.
- d. The Bidder shall submit the GA drawing considering the maintenance and aesthetic requirements and submit the drawings along with bill of material for purchaser's review.
- e. The bidder shall guarantee the satisfactory functioning of the system hardware mounted in the panel's even in the event harsh environment.
- f. Proper size Cable trays shall be provided in the panel after reviewing the number of cables to be terminated in the panel.
- g. Enough space (for easy termination, for easy viewing of cable tags) shall be provided between the terminal channels and cable trays.
- h. Terminals shall be distributed functionally in the panel.
- i. Panel door locks shall have the common key.
- j. Acrylic glass sheet shall be provided, wherever the power cables & terminations are exposed and prone to be fatal.
- k. Electrostatic strap shall be fitted with each panel.

1.47.2 Sheet Metal Work

The panel frame shall be fabricated using suitable mild steel structural sections or pressed and shaped cold rolled sheet steel of thickness not less than 2.5 mm.

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Frames shall be enclosed by cold rolled sheet steel of thickness not less than 2 mm, smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary. The Panels shall be provided with MS Base Channel of 75 x 50 mm.

All panel edges and door edges shall be reinforced against distortion by rolling, bidding or by the addition of welded reinforcement member.

Cut-Outs shall be true in shape and devoid of sharp edges.

The complete structure shall be rigid, self- supporting, free from vibration, twists and bends.

1.47.3 Galvanizing

All galvanizing shall be carried out by the hot dip process, in accordance with Specification ISO : 1460 or IS: 2629. However, high tensile steel nuts, bolts and spring washers shall be electro - galvanized to service condition four. The zinc coating shall be smooth, continuous and uniform. It shall be free from acid spots and shall not scale, blister or be removable by handling or packing. There shall be no impurities in the zinc or additives to the galvanic bath, which could have a detrimental effect on the durability of the zinc coating.

Before pickling, all welding, drilling, cutting, grinding and other finishing operations must be completed and all grease, paint, varnish. Oil, welding slag and other foreign matters completely removed. All protuberances that would affect the life of galvanizing shall also be removed.

The weight of zinc deposited shall be in accordance with BS 729 and shall not be less than 0.61 kg/m² with a minimum thickness of 86 microns for items of thickness more than 5 mm, 0.46 kg/m² (64 microns) for items of thickness between 2 mm and 5 mm and 0.33 kg/m² (47 microns) for items less than 2 mm thick.

Parts shall not be galvanized if their shapes are such that the pickling solution cannot be removed with certainty or if galvanizing would be unsatisfactory or if their mechanical strength would be reduced.

In the event of damage to the galvanizing the method used for repair shall be subject to the approval of the Project Manager or that of his representative. Repair of galvanizing on site will generally not be permitted.

The threads of all galvanized bolts and screwed rods shall be cleared of shelter by spinning or brushing. A die shall not be used for cleaning the threads unless specifically approved by the Project Manager. All nuts shall be galvanized. The threads of nuts shall be cleaned with a tap and the threads oiled. Partial immersion of the work shall not be permitted, and the galvanizing tank must therefore be sufficiently large to permit galvanizing to be carried out by one immersion.

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After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing.

To avoid the formation of white rust, galvanized material shall be stacked during transport and stored in such a manner as to permit adequate ventilation. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanization.

The galvanized steel shall be subjected to tests as per IS-2633 and BS: 729

1.47.4 Constructional Features

SAS cabinet shall be outdoor type, floor mounted, with suitable to accommodate all electronics, auxiliary relays, Ethernet switch, modem, battery and battery charger with front side opening.

As these FRTU are for outdoor application, proper concrete plinth to be established for erection of the FRTU panels to protect it from high wind speed of more than 150 Km/ hr and water logging.

The panel shall be -

- a. Panel shall be of the metal, floor mounted.
- b. Panel shall be of reputed vendor
- c. Made up of the requisite vertical sections of dust, moisture and vermin proof construction.
- d. It shall have lifting i-bolts for hooks of good capacity and even distributed lifting. Test certificates shall be available for the lifting bolts.
- e. Suitable to provide a degree of protection of not less than IP 55/IP65/IP67 as per IS: 2147.
- f. It is the responsibility of the bidder to ensure that the equipment specified, and such unspecified complementary equipment required for completeness of the SAS design shall be properly accommodated in the panel, in such a way that the maintenance, identification, isolation of any component or circuit shall be easy. Equipment shall be mounted such that removal and replacement can be carried out individually without affecting the services of the adjacent devices. No price increase at a later date on this account shall be allowed.
- g. Self-cooled design with adequate louvers on sides. The louvers shall have screens and filters on inner side of panel. The screens shall be of fine wire mesh made of brass or GI wire.
- h. Shall have maintenance access to the hardware and wiring through lockable full height doors.
- i. Shall have the provisions for bottom cable entry.
- j. The safety ground shall be isolated from the signal ground and shall be connected to the ground network each ground shall be a copper bus bar. The grounding of the panels to the owner's grounding network shall be done by the contractor.

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- k. All panels shall be supplied with 230 V AC, 50 Hz, single-phase switch and socket arrangement for maintenance.
- l. FRTU panel shall be with 1 No. internal maintenance lamps (CFL) and space heaters and gaskets.
- m. All panels shall be outdoor, dust-proof with rodent protection, and meet IP55/IP65/IP67 class of protection.
- n. There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.
- o. Document Holder shall be provided inside the cabinet to keep test report, drawing, maintenance register etc.
- p. Provided with labels on the front and rear indicating the panel designation.
- q. Proper provision must be provided for the entry of FO cables and Ethernet cables at the bottom along with AC & DC power supply cable.
- r. Provided with neoprene gaskets all-round the perimeter of covers, gland plates, removable covers and doors.
- s. All sheet steel work shall be degreased, pickled, phosphate and then applied with two coats of zinc chromate primer and two coats of finishing synthetic enamel paint, both inside and outside. The paint shade shall be Siemens Grey (RAL 7032). The final finished thickness of paint film on steel shall not be less than 100 microns and shall not be more than 150 microns.
- t. For every distribution of AC and DC circuits MCB's must be provided. These MCB's must be rated according to the load on the distributed circuit.
- u. Each FRTU panel shall be provided with 20% spare terminals.
- v. Each FRTU panel should have 20% free space for future expandability.
- w. Terminal blocks shall be having provision for isolation, with full-depth insulating barriers made from moulded self-extinguishing material. Terminal blocks shall be appropriately sized and rated for the electrical capacity of the circuit and wire used. No more than two wires shall be connected to any terminal. Required number of TBs shall be provided for common shield termination for each cable.
- x. All materials used in the enclosures including cable insulation or sheathing, wire troughs, terminal blocks, and enclosure trim shall be made up of flame-retardant material and shall not produce toxic gasses under fire conditions
- y. Space heater with thermostat shall be provided in the panel to maintain the required temperature.

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- z. Disconnecting type terminal blocks shall be used for CT, PT and for all Digital Outputs.
- aa. Enough space (for easy termination, for easy viewing of cable tags) shall be provided between the terminal channels and cable trays.
- bb. Terminals shall be distributed functionally in the panel.
- cc. Horizontal and vertical Grounding bus shall be provided in the panel. Green colored wires shall be used for grounding purpose. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the Panel/Station through a flexible braided copper conductor rigidly.

1.47.5 FRTU supplied alongside RMU Panel

If a single vendor is supplying both the RMU and FRTU, then the FRTU panel should not be standalone & separate from the RMU Panel. The FRTU should be an extended part of the RMU panel by housing it in separate compartment of RMU panel and the mounting method is to be same as per specification of mounting the RMU panel. No cables including the power cables, instrumentation cables, CT/PT cables should be laid outside from RMU compartments to FRTU compartments and proper cable entry should be provided from side entry.

The FRTU compartment should be designed to house all the equipment including the LIU box and should have the provision of space for expansion of the I/Os as per the tender document. There should be provision of FO cabling through gland plate in the base.

The FRTU panel should have indication for AC Power, DC Power, and Local & Remote at the front side of the panel. The FRTU front panel must have marking “TPC-M/TPDDL/TPCODL/TPNODL/TPWODL/TPSODL/TPADL FRTU PANEL, PO, WARRANTY, and QR CODE PARAMETERS” with white color printed on black color acrylic sheet. The FRTU panel compartment shall be designed to be tamper proof and separate battery charger & battery to be considered for FRTU compartment as per the GTP provided in Section-E.

Earthing of the FRTU compartment should be considered along with the RMU compartments as it is integrated Panel housing both. However, it is to be ensured that the earthing resistance should be less than 2 ohms for FRTU applications.

The metal sheet work/ panel paint/IP class should be same as RMU specifications. However, the FRTU internal wiring, earthing terminals, terminal blocks etc. should be as per the specification mentioned at point no 1.45.6 to 9.

1.47.6 Wiring /Cable Requirements

The FRTU panels shall gather all signals from and to the devices located in RMU. Pre-wired and prefabricated cabling may be used. All wires that carry low-level signals shall be adequately protected and separated as far as possible from power wiring. All wires shall be identified either by using

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ferrules or by colour coding. In addition, cables shall be provided with cable numbers at both ends, attached to the cable itself at the floor plate where it enters the cubicles. The cable distance shall be site surveyed by the bidder. The distance between FRTU panels and RMU panels at site is maximum 6 mtrs. These cable lengths mentioned are for indicative purpose only. The bidders are required to quote as per their site survey.

All the external Cabling between the FRTU and RMU panels shall use armored cables. The external cables (except communication cables) shall have the following characteristics:

- All cables shall have stranded copper conductor
- Minimum core cross-section of (3/20) 2.5 mm² for Control outputs and 0.5 mm² for Status inputs
- Minimum core cross-section of (3/20) 2.5 mm² for PT cables and for CT cables.
- Rated voltage Vo/V of 0.6 / 1.1kV
- External sheathing of cable shall have oxygen index not less than 29 & temperature index not less than 250. Cable sheath shall meet fire resistance test as per IS 1554 Part-I.
- Shielding, longitudinally laid with overlap.
- Dielectric withstand 2.5 kV at 50 Hz for 5 minutes
- External marking with manufacture's name, type, core quantity, cross-section, and year of manufacture.
- The Communication cable shall be of shielded, twisted pairs and of 0.22sq mm² size with dielectric withstand of 1 kV at 50 Hz for 1 minute.

FRTU cabinet shall be wired with all the DC distribution wiring and AC wiring for the Illumination and fans. Following sizes of wires shall be used

Colour Codes

DC wiring	1.5 sq.mm	Red/Black
AC wiring	1.5 sq.mm	Red/ Black

Engraved identification ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. These ferrules shall fit tightly on the wires and should not fall off when the wire is removed. The wires should be terminated on terminal blocks using soldering crimping type of tinned copper lugs. Insulated sleeves shall be neatly punched and cleaned without affecting access to equipment mounted within the cabinet. Wiring troughs shall be provided for cable routing inside the cabinet. One piece molded, 650 V grade terminal blocks complete with insulated barriers, screws, identification strips shall be used. Terminals links shall be of Elmex or Connectwell make. Terminals

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for power connections shall be adequately rated for the circuit current and the rating of other terminal blocks for central indication etc. shall not be less than 15 amps. At least twenty percent spare terminal blocks shall be provided. All the terminal blocks should be provided with proper identification strips. Terminal blocks shall be provided with transparent acrylic covers.

All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Cable ways & troughs shall be used for this purpose.

Wire termination shall be made with solderless crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks.

1.47.7 Labels

All equipment shall be provided with individual labels with equipment designation engraved. Also, the control cabinet shall be provided on the front with a label engraved with designation of the cabinet as furnished by PURCHASER. Labels shall be made up of non-rusting metal or 3 ply lamicaid. Labels shall have white letters on black or dark blue background. Sizes of labels and lettering are subject to PURCHASER's approval.

Manufacturer's label should be provided at the side wall, which should mention the project ref, substation, P.O ref, circuit details, drawing ref.

1.47.8 Earthing Terminals

Control cabinet shall be provided with two separate earthing terminals suitable to receive PURCHASER's earthing conductors of size specified.

Positive connection between all the frames of equipment mounted in the switchboard and earth bus bar shall be provided by using insulated copper wire/bars bus bars of cross section equal to that of the bus bar or equal to half the size of circuit load current carrying conductor, whichever is smaller.

All equipment shall be connected to the earth busbar using 1100V grade PVC insulated 2.5 sq.mm stranded tinned copper earthing conductor.

All hinged doors shall be positively connected to the earthing bus terminals, with the help of braided copper conductors of adequate size.

An electrostatic discharge arrangement shall be provided in each panel so as to discharge human body before he handles the equipment inside the panels

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1.47.9 Terminal Blocks

Terminal blocks shall be having provision for disconnection (isolation), with full-depth insulating barriers made from mounded self-extinguishing material. Terminal blocks shall be appropriately sized and rated for the electrical capacity of the circuit and wire used. No more than two wires shall be connected to any terminal. Each analog input signal, digital status input and digital output signals shall require two terminals per point plus a common shield termination for each cable. All terminal blocks shall be suitably arranged for easy identification of its usages such as CT circuits, PT circuits, analog inputs, status inputs, control outputs, auxiliary power supply circuits, communication signals etc.

1.48 FRTU Test

The contractor shall supply type tested FRTU. The bidder shall submit FRTU type test reports along with the bid and model of FRTU. The type test reports minimum shall include the tests indicated in Table 1. Type test reports as per other equivalent standards are also accepted provided, they meet or exceed minimum requirements specified in this specification. In case the FRTU type test report do not meet specification requirements, the relevant type tests shall be performed without extra cost to Discom. The vendor should submit proof of FRTU certificate (As conforming to IEC 61850, IEC 60870-5-104) BY KEMA.

Routine test to be performed in the factory and the field test to be performed in the site on the FRTU are indicated in Table – 1.

Table – 1: List of Tests on FRTU

No.	DESCRIPTION OF THE TEST	Type test	Routine test	Field test
1.0	Functional Tests for FRTU			
1.1	Check for BOQ, Technical details, Construction & Wiring as per FRTU drawings		√	√
1.2	Check for FRTU database & configuration settings		√	√
1.3	Check the operation of all Analog inputs, Status input & Control output points of FRTU		√	√
1.4	Check operation of all communication ports of FRTU		√	√
1.5	Check for communication with multiple master stations using partitioned databases		√	√
1.6	Check for auto restoration of FRTU on DC power recovery after its failure		√	√
1.7	Test for FRTU self-diagnostic feature		√	√

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1.8	Test for FRTU time synchronization from Master		√	√
1.9	Test for FRTU SOE feature		√	√
1.10	Test for downloading/uploading of FRTU data base from master station		√	√
1.11	End to end test (between FRTU & Master station) for all I/O points			√
1.12	FRTU Analog accuracy test for Analog inputs		√	
1.13	Test for FRTU operation with DC power supply voltage variation		√	
1.14	Test for FRTU internal Clock stability		√	
1.15	Test for FRTU Noise level measurement		√	
1.16	Test for M Q T T , IEC 60870-5 -104 & IEC 61850 protocol implemented and matching with protocol profile		√	
1.17	Test for Control Security and Safety for Control outputs		√	√
1.18	Other functional tests as per technical specification requirements		√	
1.19	Test for FRTU as Data concentrator for IEC 60870-5-104, M Q T T and MODBUS, IEC60870-5-103 protocol		√	√
1.20	Test for operation of CPU and Power supply unit		√	√
1.21	Test for Modems		√	√
2.0	EMI/EMC Immunity Tests for FRTU			
2.1	Surge Immunity Test as per IEC 60870-2-1	√		
2.2	Electrical Fast Transient Burst Test as per IEC-60870-2-1	√		
2.3	Damped Oscillatory Wave Test as per IEC 60870-2-1	√		
2.4	Electrostatic Discharge test as per IEC 60870-2-1	√		
2.5	Radiated Electromagnetic Field Test as per IEC 60870-2-1	√		
2.6	Damped Oscillatory magnetic Field Test as per IEC-60870-2- 1	√		
2.7	Power Frequency magnetic Field Test as per IEC-60870-2-1	√		
3.0	Insulation Test for FRTU			
3.1	Power frequency voltage withstand Test as per IEC 60870-2- 1	√		
3.2	1.2/50 μs Impulse voltage withstand Test as per IEC 60870- 2-1	√		
3.3	Insulation resistance test	√		
4.0	Environmental Test for FRTU			
4.1	Dry heat test as per IEC60068-2-2	√		
4.2	Exposure to cold as per IEC 60068-2-1	√		

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4.3	Damp heat test as per IEC60068-2-3	√		
4.4	Exposure to damp heat as per IEC 60068-2-78	√		
4.5	Cyclic damp heat test as per IEC 60068-2-30	√		
4.6	Temperature variation as per IEC 60068-2-14	√		
4.7	Salt spray test as per IEC 60068-2-52	√		
5.0	Mechanical tests	√		
5.1	Vibrations as per IEC 60255-21-1	√		
5.2	Shock test as per IEC 60255-21-2	√		
5.3	Seismic test as per IEC 60255-21-3	√		
5.4	Packaging impact protection as per IEC 60068-2-32	√		
5.5	Enclosure protection as per IEC 60529 & IEC 62262	√		

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Chapter # 2 Multi-Function Meter (Optional)

Technical Specification for Multi-Function Meter (MFM)

Bidder to consider Multifunction meter for each Breaker panels of RMUs, which shall be mounted on the RMU panel. These meters shall be integrated to FRTU on MODBUS in daisy chain loop. Necessary cutout to be made to flash mount these MFMs in the RMU panels.

Sl. No.	Description	Functionality Expected
1	Sampling rate	128 samples per cycle for true RMS measurement
2	Voltage Input	0 to 690VAC
3	Voltage Burden	< 0.15VA
4	Current Input	1 A or 5A Site selectable
5	CT Burden	0.1VA
6	CT range	0.1% to 200%
7	Current over range	Three times continuously, eighty times for one sec
8	Accuracy kW / kWh	0.5S as per IEC62053:22
9	Real time & average parameters	Required
10	Four quadrant measurement	Required
11	LED Load Bar Indication	Optional
12	Self-Diagnostic LED	Required
13	Real time clock	Required
14	Min./Max of parameters	Required
15	THD	Required
16	Individual Harmonics upto 39th	Required
17	Real time waveform monitoring	Standard software to monitor real-time waveform
18	RS485 communication	Min 1 port
19	Isolation	Galvanic
20	Communication protocols	MODBUS RTU, ASCII, selectable at site
21	User defined registers	Optional
22	Energy pulse LED for calibration test	Required
23	Relay output	Optional
24	Aux. power supply	18-72 V DC

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25	Ambient operating temperature	60 °C
26	Mounting Panel cutout	6 mm

Chapter # 3 Modem cum Router

2.0 Technical Specification for Modem cum Router

1	The Modem should be in the active phase of the product life cycle and Bidder to submit the details in this regard.	
2	Radio Interface	
2.1	Radio Interface	5G Fall back to 4G/3G/2G
2.2	Data interface	Cat 5 , Download and Upload 1000 Mbps
2.1	Supported frequency band	1. Modem should support multiband connectivity with FDD 5G & TDD 5G. 2. It should support Band 1, 3, 5, 8, 40 and Band 48. 3. The offered cellular modem should support and compatible to the data & radio interface of the network of public mobile service provider in Odisha City.
2.4	Radio Transmitter Power	Vendor to provide details of radio transmitter power
2.5	Receiver Sensitivity	Vendor to provide details of receiver channel sensitivity
2.6	Cellular Module / Chip	Vendor shall give details of cellular chip /Module used along with datasheet
3	Operating Condition	
3.1	Operating Temperature	-20 C to 70 C
3.2	Operating Humidity	5 % to 100 % (non -condensing)
3.1	Power Consumption	Vendor to provide power consumption for idle and max during data transmission
3.4	Storage /transport temperature	-40 °C to 85 °C
3.5	MTBF	Vendor to provide details of MTBF
3.6	Protection from pollution	Vendor shall provide design details such as protective paint /conformal coating on MCB, high grade electronic components uses to protect from environmental pollution.
4	System Characteristics	

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4.1	CPU	1. Vendor to provide make & technical details of CPU used. 2. Vendor should also attached technical data sheet of CPU. 3. CPU usage should not crossed 40 % in typical operating & maintenance condition
4.2	RAM	1. Vendor to provide details of memory type, Speed & Size. 2. Usage of memory should not crossed 60 % in typical operating & maintenance condition
4.3	Flash Storage	Vendor to provide details of flash storage Memory Provision to store system logs, event logs, configuration file
5	Mechanical Construction	
5.1	Dimension (W X H X D)	Vendor to provide details of Dimension (W X H X D)
5.2	Weight in Kg	Vendor to provide details of Weight in KG
5.3	Housing	Metal Preferred Aluminum alloy having better heat dissipation & ruggedness
5.4	Mounting	DIN rail Mounting
5.5	Degree of Protection	IP30
6	Interface/Port Type	
6.1	Ethernet	1. Minimum 2 X RJ45 Port ethernet, Speed 10/100 Mbps auto negotiable having status LED indication. 2. Port should be configurable as LAN /WAN as required.
6.2	Cellular interface	1. Cellular modem should have dual SIM provision. 2. Dual SIM for network redundancy /backup. 3. Dual SIM operation ensures that the cellular connection is always available. 4. It will automatically disconnect the 1st SIM card's low/weak cellular connection and will reconnect to establish a stronger connection using the 2nd SIM card.
6.3	Ethernet Cable (CAT 6)	Vendor to provide Ethernet Cable (CAT 6) minimum 1.5 M
7	Software Features / Supported protocols	
7.1	Network Protocols	TCP/IP ,UDP/IP, HTTP, ARP,DHCP, ICMP, SNMP, V1/V2 & V1, NTP, SSL/TLS
7.2	Routing	Astatic Routing, RIP 1 & 2 ,OSPF V2 & V1
7.3	VPN	Open VPN , IP Sec, L2TP, PPTP, GRE
7.4	Alarm Message	Device shall have alarm notification on SNMP trap

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7.5	Management /Monitoring	1. Cellular modem should shall support Local/ Remote management through web HTMLS, SSHP & Telnet4. 2. It shall support monitoring through system logs & SNMP version V1/V2 & V3. 3. Notification & command shall be possible over SMS. 4. Firmware upgradation through Web, backup & restore of configuration shall be possible. 5. Modem should be enabled through SMS 6. Modem shall support remote soft rebooting of modem over SMS 7. On receipt of SMS, modem shall disconnect the power supply of RTU for configured time and again restore power supply after it. This feature ensures remote rebooting of RTU over SMS 8. Modem should be capable of sending Modbus Data over104 and MQTT simultaneously along with SMS features to configured contact numbers.
7.6	Operating System	Vendor to give the details of operating system & its Version
7.7	Application	Vendor to give the details of application & package installed in modem
7.8	AT Command Support	YES /NO
7.9	Scheduled rebooting	Device should be capable to program auto rebooting as per configured / scheduled configured scheduled time.
7.1	Watch dog feature	Modem Shall have feature of tracking data connectivity status by periodic ping test and switchover on backup.
7.11	Factory Reset	Provision of Resetting the device for factory configuration.
7.12	Diagnosis Feature	Device Shall support real time diagnostic such as active connection, traffic on interfaces

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7.13	SCADA Protocols	1. Transparent Mode: The modem should be capable for communicating with multiple protocol FRTUs in Transparent Mode 2. Modbus Master Mode: The modem should be capable of reading Multiple Modbus Meters connected to it 3. Data Segregation Mode: modem should segregate the collected data as per Instantaneous 4. Parameters, Billing, Load Profile and Tamper parameters in separate files per Meter 5. IEC 104 – 104 Master – Multi Slave Mode: The modem should be capable to reading FRTUs in IEC60870-5-104 and MQTT protocol and communicate with SCADA system on IEC 60870-5-104 and MQTT protocol upto 5 masters. Adequate data interlock mechanisms should be implemented to avoid data loss. a. IEC 104 Slave mode Multi Master support b. Other Data Sending Modes: modem should support TCP, UDP, HTTPS, MQTT data sending formats c. Simultaneous Operations of multiple protocols. d. Ex modem should be capable of sending Modbus Data over 104 and MQTT simultaneously
8	Security	
8.1	Security	HTTPs, SSH, Authentication with RADIUS or TACACS + , activate cellular interface with SMS ,Ethernet 802.1X(EAP-PEAP/MsCHPv2 or EAP -TLS
8.2	Authentication	User Management (local, RADIUS, TACACS + , Mixed)
8.3	State inspection firewall	Static firewall IPv4 / IPv4 with incoming and forwarding ruleset, DoS protection, IP /Port/Protocol filtering, NAT
9	Antenna	
9.1	No Of Antenna	The 5G Cellular modem Should have two antenna connection (MIMO). One is primary cellular antenna & second is diversity antenna (MIMO)
9.2	Cable Length	Cable should have Low loss RF Cable with minimum 5M
9.3	Type of Antenna	Antenna Should be Omni directional with high gain (High gain ≥ 5)
9.4	Construction of antenna	It should be Steady, good quality material, water/ weatherproof having adequate gold plate connector compatible with cellular modem antenna. Port. It should be suitable mounting arrangement to installed indoor
9.5	Antenna Length	5 Meter length is required ; MIMO type antenna is preferable

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9.6	Frequency Band, impedance & Polarization	Vendor Shall provide the details of frequency Band. Antenna should be compatible with offered device & network service provide with frequency band, port impedance & radio signal polarization
9.7	VSWR	Vendor Shall provide details of VSWR
9.8	Gain of antenna	Vendor Shall provide Gain details of primary & secondary antenna
10	Power Supply	
10.1	Power Supply	18V to 72 V dc
10.2	Connector Type	Modem Should have preferable screw type firm connection. It should have reverse polarity protection & surge protection
11	Status & diagnostics indicator	
11.1	LED indicator	Vendor to provide details of status & diagnostics indicator. (Power- ON & OFF, ERR- Error Red, Signal, network, SIM status)
12	Certification: - IEC Specified as below or equivalent to international Standard	
12.1	Electrostatic discharge immunity test	IEC EN 61000-4-2
12.2	Radiated, radiofrequency, electromagnetic field immunity test	IEC EN 61000-4-1
12.3	Electrical fast transient/burst immunity test	IEC EN 61000-4-4
12.4	Surge immunity test	IEC EN 61000-4-5
12.5	Immunity to conducted disturbances, induced by radio- frequency fields	IEC EN 61000-4-4
12.6	Information technology equipment –Safety	IEC 60950
12.7	Environmental testing- Vibration (sinusoidal)	IEC 60048-2-4

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12.8	Environmental testing-Shock	IEC 60048-2-27
12.9	Environmental testing-Free Fall (withdrawn)	IEC 60048-2-12
12.1	Proof of check	vendor should give one number of modem along with Technical offer for performance & application compatibility check for period of minimum 15 days
12.11	Country of manufacturing	Vendor to provide Country of manufacturing details
12.12	Service Centre in India	Vendor to provide details of Service Centre in India
12.13	Regulatory compliance	Vendor shall confirm that offered product is complied & certified by all Indian government bodies related to telecommunication/ wireless communication (WPC, DOT) to operate & user this product in country . Vendor to share compliance certificate of the same
12.14	Surge protection /electrical isolation	It should be available on all Ethernet communication port & power supply input. vendor shall share certification
12.15	Environmental Condition	Cyclonic environment with wind velocity up to 250kmph. Some of the regions, where the work will take place includes coastal areas, subject to high relative humidity, which can give rise to condensation. Onshore winds will frequently be salt laden. On occasions, the combination of salt and condensation may create pollution conditions for electronic equipment. Some places are in heavily industrial polluted areas. Therefore, all supplied material and equipment shall be designed and protected for use in exposed, heavily polluted, salty, corrosive and humid coastal atmosphere.

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Chapter # 4 Battery & Battery Charger

3.0 Technical Specification for Battery & Battery Charger

- 4.1.1 VDC SMPS battery charger 230VAC input, 10 Amps Output.
- 4.1.2 FRTU should be capable to monitor Battery and battery charger healthiness. It is more preferable if the battery charger have inbuilt feature of Battery health monitoring
- 4.1.3 Battery and battery charger should be capable for all FRTU required operation and Aux. supply to Modem & MFM etc.
- 4.1.4 Battery Rating: 24 V DC, 50AH, SMF-VRLA with chargers suitable for indoor as well as outdoor applications.
- 4.1.5 The batteries are intended to operate the isolators of 11kV/22kV/33kV RMU. The rating of closing coil is in the range from 90 watts to 120 watts.
- 4.1.6 The battery & its charger must withstand average operations of 10nos for max 30 seconds.
- 4.1.7 Power supply package shall meet the power supply requirement for the MFM and modem as well.
- 4.1.8 Suitable provision in FRTU shall be present to supervise/monitor and prevent accidental serious discharge of battery.
- 4.1.9 Battery and battery charger plays very important role in remote operation while restoration of power supply to the customer. Hence to monitor healthiness of battery continuously in services condition, routine tests for battery condition monitoring shall be ensured.
- 4.1.10 FRTU must be able to perform the battery discharge test at a manual set period or period can be pre-defined for auto discharge test.
- 4.1.11 Battery Health Monitoring Unit must be of standard make.
- 4.1.12 Ambient Temperature Operation: -5deg C to +60degC
- 4.1.13 Ambient temperature Storage: -20deg C to +65 deg C.
- 4.1.14 Humidity: 100% RH, non –condensing
- 4.1.15 Adhere to Standards IEC60927-1, IEC61000 with ingress protection of IP20.
- 4.1.16 Monitoring The power supply shall deliver the following status to the SCADA
 - a. End of life detection
 - b. Battery disconnected
 - c. Absence of power input

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- d. Voltage output faults
- e. Battery fault
- f. Any other data should be available through a serial link communication.

4.1.17 Type 3 Pluggable Surge Protection Device in accordance with IEC 61643 with KEMA & UL approval must be installed at the incoming power supply of FRTU. DIN Rail Mounted Suitable Surge Protection must be installed on all communication lines (Ethernet/RS 485)

Sl. No.	Technical requirement	DISCOMS Requirement
1	Scope	The battery & battery charger are intended for operating 33kV/22kV/11KV RMU isolators. The rating of closing & opening coils is from 90-120 watts. Operating time 50ms Max. The battery should be capable of withstanding normal load of FRTU & operational load of RMU isolators
2	Average Number of Operations	Minimum 10 nos. for 30 sec
3	Standards	IS 1885/IEC 600504, IS -15549/2005
4	Climate	Must be able to operate efficiently considering hot & humid climate of Mumbai, India region. The battery shall be capable of operating satisfactorily in outdoor applications when it is housed in a Cubicle between 10 deg. C and 65 deg. C and in locations where the relative humidity between 30% to 100%
5.1	Voltage	24 VDC specified at 27 deg. C.
5.2	Battery Type	SMF, VRLA with chargers of conventional type
5.3	Voltage/cell	2 volts
5.4	Capacity of Batteries	65 AH,10Amps
5.5	Connecting cables	Cable size selection should provide the lowest voltage Drop possible between battery system and operating Equipment.
5.6	Method of charging	Constant voltage method and current limit (variable Current)
5.7	Efficiency	Not less than 90% at full rated load
6.1	Battery Charger type	Constant Voltage and Current limiting charger. Charger with inbuilt battery health monitoring is highly preferable.
6.2	Charger Input Voltage	Single phase (2 wire) voltage 250V AC +30% to -20% Frequency 50Hz $\pm$ 5%.

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6.3.1	Regulation	$\pm 1\%$
6.3.2	Charger current	10 Ampere
6.3.3	Efficiency	Not less than 85% at full rated load
6.3.4	Current limit	110% of rated load
6.3.5	Insulation	Not less than 5 mega Ohms.
		i. between DC output terminals and AC input terminals.
		ii. Between AC input terminals and earth
6.3.6	Indication	The charger shall have suitable indicators to visually know its mode of operation. Charger indication as below must be available:
		Mains on (Red LED), Charger on (Yellow), Boost on (Yellow LED), Float on (Green LED) and Battery reverse polarity (Red LED), O/p DC fuse blown (Red LED) LED lamp indication. (LED colors can be changed)
6.3.7	Protection	Input single pole MCB's for AC & DC of 10 Amperes separate for battery & charger.
		The battery charger must include protections like:
		i) AC input MCCB & ELBS with input ON/OFF switch and fuses/ contactor.
		ii) DC output MCCB with output ON/OFF switch and fuses.
		iii) Current limit protection, soft start feature, surge suppressor.
		iv) Fast semiconductor fuses for rectifier bridge.
6.3.9	Battery & charger Alarms	Potential free contacts must be available to integrate with SCADA for abnormality if any. Most preferred alarms are like: AC supply fail, DC supply fail, Battery Low, Battery Fail, Battery Charger fail, Battery polarity reverse, Battery test. Serial Communication is preferred.
6.3.8	Cooling	External exhaust fan (Optional)
6.4	Climate	Must be able to operate efficiently considering hot & humid climate of Mumbai, India region. The battery shall be capable of operating satisfactorily in outdoor applications when it is housed in a Cubicle between 10 deg. C and 65 deg. C and in locations where the relative

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		humidity between 30% to 100%
6.5	Wiring	The internal wiring of the charger shall be carried out with PVC insulated
6.6	Accessibility	650V grade standard copper conductor. The control wiring shall be carried out with 2.5 Sq.mm copper conductors. All the important components of the charger must be easily accessible for maintenance, repair, replacement in case of trouble without giving interruption to total D.C. supply as far as possible.
6.7.1	Acceptance And Routine Tests	All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the bidder. The test certificates are to be furnished for approval.
6.7.2	Acceptance test for battery charger with batteries	1. Marking 2. Verification of dimensions. 3. Regulation test. 4. Ripple test 5. Megger values and HV Test. 6. Test for battery discharge capacity.
6.7.3	Type Tests	Following shall constitute type tests in respect of chargers and batteries. 1. Insulation resistance 2. High voltage test at 1.5KV for 1 minute 3. Regulation (Load & Line) 4. Dry heat test at 55°C for 16 hrs with full load on as per IS: 9000 part3/Sec5/1977. 5. Damp heat test at 55°C and at 95% RH for two cycles as per IS: 9000 part5/Sec1/1981 6. Cold test at -10°C for 4 hrs as per IS: 9000 part 2/Sec4/1977
7	Drawings	Detailed drawings, circuit details and technical literature of batteries shall be enclosed to the offer. Tenders not accompanied by the above are liable for rejections. Trouble shooting charts shall be supplied with each unit to trace faults in the charger with voltage and Resistances to be measured at various test joints.
8	Painting	The box shall be painted with powder coating with siemens grey colour.

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Chapter # 5 Control Cables

4.0 Technical Specification for Control Cables

4.1 SCOPE

This part of the specification covers the technical requirements of design, Engineering, manufacture, stage testing, inspection and testing before dispatch, packing, forwarding, delivery at site the PVC, armoured, copper control cables for installation in substations

The material offered shall have been successfully type tested during last five years on the date of bid opening. The front page of type test report showing the evidence of successful type test of the items asked for in this Specification shall be uploaded with the signature of bidder. The full text of the type test report is to be submitted along with the technical proposal.

The control cables shall conform in all respects to highest standards of engineering, design, workmanship in accordance to this specification and the latest revisions of relevant standards, mentioned below.

4.2 STANDARDS IEC / ISO Indian Standard Title

Except where modified by this specification, the control cables shall be designed, manufactured and tested in accordance with the latest editions of the following standards.

Sl. No.	Standard Code		Brief Description of the Codes
1	IEC 811	IS-18-10810:1982	Testing cables
2	IEC 502	IS - 1554:1988 (Part 1)	PVC Cables 1100V
3	IEC 227	IS - 5819:1970	Short circuit ratings for PVC cables
4	IEC 228	IS-8130:1984	Conductors for insulated cables
5	IEC 287		Calculation of the continuous current rating of cables.
6	IEC 540	IS - 5831: 1984	Test Methods for insulation and sheaths of electric cables and cords IEC 287
7		IS - 3975: 1979	Mild steel wires, strips and tapes for armouring of cables

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The Bidder may propose alternative standards, provided it is demonstrated that they give a degree of quality and performance equivalent to or better than the referenced standards. Acceptability of any alternative standard is at the discretion of the Tata Power Discoms. The Bidder shall furnish a copy of the alternative standard proposed along with technical proposal. If the alternative standard is in a language other than English, an English translation shall be submitted with the standard.

In the case of conflict, the order of precedence shall be

- a. Indian Standards
- b. IEC

This list is not to be considered exhaustive and reference to a standard or recommendation in this Specification does not relieve the Bidder of the necessity of providing the goods complying with other relevant standards or recommendations.

4.3 Technical Details

4.3.1 1.1 kV POLYVINYL CHLORIDE (PVC) INSULATED CABLES All control cables to be used shall be armored PVC type. The outer sheath of control cable shall be Polyvinyl chloride (PVC) type ST-2 of IS 5831.

4.3.2 Rated Voltage and Temperature Control and Panel Wiring Cables (PVC Insulated)

The conductor shall be of round stranded plain copper wires complying with IS - 8130:1984/ IEC 228.

N.B. - Conductor screening not required in this case.

4.3.3 Insulation

The insulation shall be of Polyvinyl Chloride (PVC) compound. 'Heat Resisting' Type C for the Control and Panel Wiring cables. Both shall conform to the requirements of IS - 5831: 1984.

Type of Insulation	Normal Continuous Operation	Short Circuit Operation
General Purpose	70 ⁰ C	160 ⁰ C
Heat Resisting	85°C	160°C

The PVC insulation shall be applied by extrusion and the average thickness of insulation as specified in IS – 1554 (part 1): 1988.

The insulation shall be applied so that it fits closely on to the conductor and it shall be possible to remove it without damage to the conductor.

Insulation Screening not required.

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Core Identification and Laying up of Cores.

In multi-core cables, the cores shall be laid up together with a suitable lay as recommended in IS - 1554 (Part 1): 1988. The layers shall have successive right- and left- hand lays with the outermost layer having a right hand lay.

4.3.4 Inner Sheath

The laid-up cables shall be covered with an inner sheath made of thermoplastic material (PVC) applied by extrusion. The thickness of the sheath shall conform to IEC 502/IS - 1554: 1988. Single core cables shall have no inner sheath.

The outer serving shall incorporate an effective anti-termite barrier and shall be capable of withstanding a 10 kV DC test voltage for five minutes after installation and annually thereafter. Current ratings shall be calculated in accordance with IEC 287 "Calculation of the continuous current rating of cables with 100% load factor".

4.3.5 Conductor Sizes

The following shall be used for Control and Panel Wiring:

The no. of Cores & Sizes of the Control Cable with flexible Copper Wires shall be 4 Core, 7 Core, 10 Core, 12 Core and 19 Core, 24 Core etc. There shall be one single core copper cable of 16 sq. mm size for earth wire. All panel wiring shall be done by 0.5 mm² for digital inputs, 1.5 mm² digital outputs, 1.0 mm² for Analog Inputs, 2.5 mm² for CT, 4 mm² for PT, CVT, AC & DC Supply connection.

4PX0.36 mm² armoured, pair shielded, Overall shielded multistrand serial communication cable for Multi-Function Meters and Other Condition monitoring devices.

Bidder shall consider the cable size, number of conductors as per the site requirement and as mentioned in the indicative BOM.

4.3.6 Cable Drum Length

The cable shall be supplied in 500 meter lengths or more but with prior approval for the owner.

4.3.7 Cable Identification

The manufacturers and Owner's name or trademark, the voltage grade, cable designation and year of manufacture shall be indented or embossed along the whole length of the cable. The indentation or embossing shall only do on the outer sheath. The alphanumerical character size shall be not less than 20% of the circumference of the cable and be legible.

4.3.8 Sampling of Cables

4.3.8.1 Lot

In any consignment the cables of the same size manufactured under essentially similar conditions

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of production shall be grouped together to constitute a lot.

4.3.8.2 Scale of Sampling

Samples shall be taken and tested from each lot to ascertain the conformity of the lot to specification.

4.3.8.3 Sampling Rates

The number of samples to be selected shall be as follows:

Number of Drums to be taken as samples	Number of Drums to be taken as samples
Up to 25	3
26 to 50	5
51 to 100	8
101 to 300	13
301 and above	20

The samples shall be taken at random. In order to achieve random selection, the procedure for selection detailed in IS - 4905: 1968 shall be followed.

4.3.9 Number of Tests and Criterion for Conformity

Suitable lengths of test samples shall be taken from each of the selected drums. These samples shall be subjected to each of the acceptance tests. A test sample shall be classed as defective if it fails any of the acceptance tests. If the number of defective samples is less than or equal to the corresponding number given in the lot shall be declared as conforming to the requirements of acceptance test.

4.3.10 TESTS ON 1.1 KV PVC INSULATED Armored Control Cable

4.3.10.1 Type Tests

Certification of type tests already completed by independent test laboratories shall be presented with the bid for each cable type. These tests shall be carried out in accordance with the requirements of IS -8130: 1984/IEC 502, IS - 5831:1984/IEC 540 and IEC 811 unless otherwise specified. Type testing of 1.1 kV cables shall include the following:

Test Requirement Reference Test Method as a Part of IS-10810/IEC 811

(a)	Tests on conductor Annealing test (copper)	IS-8130: 1984/IEC 502
(b)	Resistance test	IS-8130: 1984/IEC 502
(c)	Tests for thickness of insulation and sheath	IS-5831:1984/IEC 540

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(d)	Physical tests of Insulation Tensile strength & elongation at break	IS-5831:1984/IEC 540
	Ageing in air oven	IS-5831:1984/IEC 540
	Hot test	IS-5831:1984/IEC 540
	Shrinkage test	IS-5831:1984/IEC 540
	Water absorption (Gravimetric)	IS-5831:1984/IEC 540
(e)	Physical tests for outer sheath	
(f)	Tensile strength and elongation at break	IS-5831: 1984/IEC 540
(g)	Ageing in air oven	IS-5 831: 1984/IEC 540
(h)	Shrinkage test	IS-5831: 1984/IEC 540
(i)	Hot deformation	IS-5831: 1984/IEC 540
(j)	Loss of mass in air oven	IS-5831: 1984/IEC540
(k)	Heat shock	IS-5831: 1984/IEC540
(l)	Thermal stability	IS-5831: 1984/IEC540
	Insulation resistance test	IS-8130:1984/IEC502
	Volume resistivity	As per IS / IEC
	High voltage test	As per IS / IEC
	Flammability test	As per IS / IEC

4.4 Acceptance Tests

The following shall constitute acceptance tests:

- Tensile test (Aluminum)
- Annealing test (copper)
- Wrapping test
- Conductor resistance test
- Test for thickness of insulation and sheath
- Hot set test for insulation*

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- Tensile strength and elongation at break test for insulation and outer sheath High voltage test
- Insulation resistance (volume resistivity) test
- PVC insulation only

** Test to be completed on full drum of cable

4.5 Routine Tests

Routine tests shall be carried out on all the cable on a particular order. These tests shall be carried out in accordance with the requirements of IS - 8130: 1984/IEC 502 and IS - 5831:1984/IEC 540 unless otherwise specified.

The following shall constitute routine tests.

- Conductor resistance test
- High voltage test
- Test to be completed on full drum of cable

4.6 DETAILS OF TESTS

General

Unless otherwise stated, the tests shall be carried out in accordance with the appropriate part of IS -10810/IEC 502: 1994 and the additional requirements as detailed in this specification.

4.7 Bending Test

The diameter of the test cylinder shall be $20 (d + D) \pm 5\%$ for single core cables and $15 (d + D) \pm 5\%$ for multicores, where D is the overall diameter of the completed cable in millimeters and d is the diameter of the conductor.

After completing the bending operations, the test samples shall be subjected to partial discharge measurements in accordance with the requirements of this specification.

4.8 Dielectric Power Factor Test

Tan δ as a Function of Voltage

For cables of rated voltage 1.1 kV and above the measured value of tan δ at up shall not exceed 0.004 and the increment of tan δ between 0.5 up and 2 up shall not be more than 0.002.

4.9 High Voltage Test

4.9.1 For Type/ Acceptance Test

The cable shall withstand, without breakdown, at ambient temperature, an ac voltage equal to $3U_0$, when applied to the sample between the conductor and screen/ armour (and between conductors in the case of unscreened cable). The voltage shall be gradually increased to the specified value and

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maintained for a period of 4 hours. If while testing, interruption occurs during the 4 hour period the test shall be prolonged by the same extent. If the interruption period exceeds 30 minutes the test shall be repeated.

4.9.2 Routine Test

For Routine Test Single core screened cables, shall withstand, without any failure, the test voltages given in this specification for a period of five minutes between the conductor and metallic screen.

Single core unscreened cables shall be immersed in water at room temperature for one hour and the test voltage then applied for 5 minutes between the conductor and water.

Multicore cables with individually screened cores, the test voltage shall be applied for 5 minutes between each conductor and the metallic screen or covering.

Multicore cables without individually screened cores, the test voltage shall be applied for 5 minutes in succession between each insulated conductor and all the other conductors and metallic coverings, if any. When a DC voltage is used, the applied voltage shall be 2.4 times the power frequency test voltage.

In all instances no breakdown of the insulation shall occur.

4.9.3 Flammability Test

The period for which the cable shall burn after the removal of the flame shall not exceed 60 seconds and the unaffected portion (uncharged) from the lower edge of the top clamp shall be at least 50mm.

4.10 Control / LV Wiring Accessories

4.10.1 Terminations

Control wire terminations shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor. Insulated sleeves shall be provided at all the wire termination. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule. Numbers 6 and 9 shall not be included for ferrules purposes except where underlined and identified as 6 and 9.

Control cable terminals shall be provided with adequate size crimp type lugs. The lugs shall be applied with the correct tool, which shall be regularly checked for correct calibration. Bi-metallic joints between the terminals and lugs shall be provided where necessary. Terminals shall be marked with the phase colour in a clear and permanent manner. A removable gland plate shall be provided by the contractor at every cable entry to mechanism boxes, cabinets and kiosks. The Contractor shall be responsible for drilling the cable gland plate to the required size.

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4.11 *General Particulars and Guarantees*

4.11.1 Compliance with Specification

The control cables shall comply in all respects with the requirements of this specification. However, any departure from the provisions of the specification shall be disclosed at the time of bidding in the Deviation Schedule in this document.

4.12 Compliance with Regulations

All the equipment shall comply in all respects with the Indian Regulations and Acts in force.

The equipment and connections shall be designed and arranged to minimize the risk of fire and any damage which might be caused in the event of fire.

4.13 Non-Conforming Product

The Project Manager shall retain responsibility for decisions regarding acceptance, modification or rejection of non-conforming items.

4.14 Inspection and Testing

The equipment shall successfully pass all the type tests, acceptance tests and routine tests referred to in the section on Tests and those listed in the most recent edition of the standards given in this specification.

Tata Power the right to reject an item of equipment if the test results do not comply with the values specified or with the data given in the technical data schedule.

Type tests shall be carried out at an independent testing laboratory or be witnessed by a representative of such laboratory or some other representative acceptable to the Project Manager. Routine and acceptance tests shall be carried out by the Bidder at no extra charge at the manufacturer's works.

Type Test certificates shall be submitted with the bid for evaluation. The requirement for additional type tests will be at the discretion of the Tata Power Discom.

All costs in connection with the testing, including any necessary re-testing, shall be borne by the Bidder, who shall provide the Tata Power Discom with all the test facilities which the latter may require, free of charge.

4.15 Guarantee

The Bidder shall guarantee the following:

- a. Quality and strength of materials used;
- b. Satisfactory operation during the guarantee period of one year from the date of commissioning, or 18 months from the date of acceptance of the equipment by the Project Manager following

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delivery, whichever is the earlier.

- c. Performance figures as supplied by the Bidder in the schedule of guaranteed particulars.

4.16 Packing and Shipping

4.16.1 Packing

The cable shall be wound on strong drums or reels capable of withstanding all normal transportation and handling. Each length of cable shall be durably sealed before shipment to prevent ingress of moisture. The drums, reels or coils shall be lagged or covered with suitable material to provide physical protection for the cable during transit and during storage and handling operations. In the case of steel drums adequate precautions shall be taken to prevent damage being caused by direct contact between the cable sheath and the steel. These precautions shall be subject to the approval of the Project Manager.

If wooden drums are used, then the wood shall be treated to prevent deterioration from attack by termites and fungi.

Each drum or reel shall carry or be marked with the following information:

- a. Individual serial number
- b. Owner's name
- c. Destination
- d. Contract Number
- e. Manufacturer's Name
- f. Year of Manufacture
- g. Cable Size and Type
- h. Length of Conductor (meters)
- i. Net and Gross Mass of Conductor (kg)
- j. All necessary slinging and stacking instructions.
- k. Destination:
- l. Contractor's name
- m. Name and address of Contractor's agent in Odisha
- n. Country of origin

The direction of rolling as indicated by an arrow shall be marked on a flange.

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4.16.2 *Storage*

The site selected for the storage of cable drums shall be well drained and preferably have a concrete/firm surface which will prevent the drums sinking into the ground or being subjected to excess water thus causing flange rot.

All drums shall be stood on battens, in the upright position, and in such a manner to allow enough space between them for adequate air circulation. During storage the drums shall be rotated 90° every three months. In no instances shall the drums be stored "flat" on their flanges or one on top of each other.

4.17 *Hazardous substances*

The Bidder shall submit safety data sheets in a form to be agreed for all hazardous substances used with the equipment. The Bidder shall give an assurance that there are no other substances classified as hazardous in the equipment supplied. The Bidder shall accept responsibility for the disposal of such hazardous substances, should any be found. The Bidder shall be responsible for any injuries resulting from hazardous substances due to noncompliance with these requirements.

4.18 *Spare Parts and Special Tools*

The Bidder shall provide prices for spare conductor, joints and termination equipment. The Tata Power DISCOM may order all or any of the spare parts listed at the time of contract award and the spare parts so ordered shall be supplied as part of the definite works.

A spare parts catalogue with price list shall be provided for the various cables, joints and termination equipment and this shall form part of the drawings and literature to be supplied. Any spare apparatus, parts or tools shall be subject to the same specification, tests and conditions as similar material supplied under the Contract.

They shall be strictly interchangeable and suitable for use in place of the corresponding parts supplied with the equipment and must be suitably marked and numbered for identification. Spare parts shall be delivered suitably packed and treated for long periods in storage. Each pack shall be clearly and indelibly marked with its contents, including a designation number corresponding to the spare parts list in the installation and maintenance instructions.

5. GENERAL CONSTRUCTIONS

PAINTING

6. MARKING

- a) The FRTU panel should have indication for AC Power, DC Power, Local & Remote at the front side of the panel. The FRTU front panel must have marking

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“TPC-M/TPDDL/TPCODL/TPNODL/TPWODL/TPSODL/TPADL FRTU PANEL, PO, WARRANTY, QR CODE PARAMETERS” with white color printed on black color acrylic sheet.

- b) External marking to be provided with manufacture's name, type, core quantity, cross- section, and year of manufacture.

7. TESTS

• Test Responsibilities

Both Purchaser and the Bidder shall designate, in writing and prior to the start of the factory test, a test coordinator. Each coordinator shall be responsible for ensuring that the tests are conducted in accordance with the requirements of this Contract. The coordinators shall each have the authority to make binding commitments for their Purchaser such as approvals of test results and scheduling for variance corrections or, as a minimum, to cause such commitments to be expeditiously made.

Unless otherwise stated in this Specification, the Bidder shall be responsible for all factory tests. This responsibility shall include the conduct of the tests and all record keeping and document production. Bidder will support the factory testing by supplying staff to execute the test procedures under the Purchaser's supervision.

• Test Documents

Test plans, procedures, and records shall be provided by the Bidder for all tests to ensure that each test is comprehensive and verifies the proper performance of the FRTU and Communication Systems elements under test. During the development of test plans and test procedures, emphasis shall be placed on testing each conditional logic statement, checking error conditions, and documenting the simulation techniques used. The test plans and test procedures shall be modular to allow individual test segments to be repeated as necessary.

All test plans and test procedures (standard, modified standard, and custom functions) shall be submitted to Purchaser for approval and shall be subject to the approval process as defined in Section-D, Item 2.5 Document Review and Approval.

• Test Plans

The test plans shall describe the overall test process, including the responsibilities of individuals and the documentation of the test results. The following shall be included in the test plans:

- The schedule for the test

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- The responsibilities of Bidder and Purchaser personnel, including record-keeping assignments
- Any forms to be completed as part of the tests and the instructions for completing the forms
- Procedures for monitoring, correcting, and testing variances
- Procedures for controlling and documenting all changes made to the hardware and software after the start of testing
- Block diagrams of the hardware test configuration, including the Bidder and Purchaser supplied FRTUs, external communication channels, and any test or simulation hardware.

Test plans shall be provided for the Factory Acceptance Test, Site Acceptance Test, and Availability Test.

- **Test Procedures**

The test procedures shall describe the methods and processes to be followed in testing the FRTU and Communication Systems. The test procedures shall be modularized, such that individual functions of the FRTU and Communication Systems can be independently tested and so that the testing proceeds in a logical manner. This section uses the term segment to refer to a higher-level part of a test procedure and the term step to refer to the most detailed level of test instruction.

The test procedures shall include the following items:

- The name of the function to be tested
- References to the functional, design, user, and any other documents describing the function
- A list of test segments to be performed and a description of the purpose of each test segment
- The set-up and conditions for each segment, including descriptions of the test equipment and data to be supplied by the Bidder and by Purchaser.
- Descriptions of the techniques and scenarios to be used to simulate system field inputs and controlled equipment
- Descriptions, listings, and instructions for all test software tools and displays
- Step-by-step descriptions of each test segment, including the inputs and user actions for each test step

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- Forms for the recording of test results
- The expected results for each segment, including pass/fail criteria
- Copies of any certified test data to be used in lieu of testing, if approved by Discom.

The Bidder shall note that Purchaser will not accept any certified test data in lieu of testing except where specifically stated in the Contract.

- **Test Records**

Complete records of all tests result shall be maintained. The records shall be keyed to the test procedures. The following items shall be included in the test records:

- Reference to the appropriate test procedure
- Date of the test
- Description of any test conditions, input date, or user actions differing from that described in the test procedure
- Test results for each test segment including a passed/failed indication. All information recorded during the test such as measurements, calculations, or times shall be included in the results.
- Identification of the Bidder's and Purchaser's representatives performing and witnessing the test
- Provision for comments by Purchaser's representatives
- References to all variance reports generated
- Copies of reports, display copies, and any other hardcopy generated as part of the test.

- **Variance Recording and Resolution**

A variance tracking system shall be placed in service no later than one month before the start of Pre-FAT and shall remain in use through the completion of the warranty. Both the Bidder and Purchaser may initiate variances at any time. Variances may be used to record system deficiencies at any time, even if the system is not undergoing testing. This variance tracking system shall record and track variances for:

- Documentation deficiencies
- Functional deficiencies
- Performance deficiencies

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- Procedural deficiencies (as when deviations from contractually required QA procedures are observed)
- Test deficiencies (as when the system cannot satisfactorily complete a test procedure due to a problem with the test).

The variance recording and tracking system shall produce reports of all variance information and shall produce subsets of the variances based on searches of the variance parameters singly and in combination. Variance reports shall always be available to Purchaser. The Bidder shall periodically distribute a variance summary that lists for each variance the report number, a brief overview of the variance, its category, and its priority.

Variance Records

The record of each variance shall include the following information:

- The date of the initial discovery of the variance
- A variance number – a sequential number assigned when the variance is entered into the tracking system
- An identification of the person submitting the variance and the names of any other witnesses or knowledgeable Purchaser or Bidder staff
- An identification of the FRTU and Communication Systems component, such as a hardware item or software function, against which the variance is being written
- An identification of the test plan or procedure, if applicable. The stage or step of the plan or procedure shall be identified
- An overview of the variance suitable for use in keyword searches
- A detailed description of the variance
- A variance category:
 - Open (recorded but not scheduled for further action)
 - ii. Assigned (scheduled for further action)
 - iii. Pending (the variance has been resolved but not tested)
 - iv. Closed (Purchaser has accepted the resolution)
- i. The date of assignment into each category

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j. A variance priority:

Critical To be used only if the FRTU and Communication Systems is in commercial use, this priority identifies a problem that prevents the use of a system features that is essential to Purchaser's operation of the power system

High Denotes the failure of the FRTU and Communication Systems to perform a required feature in a manner that significantly reduces the utility of the systems or feature or which delays further testing of the systems or features

Normal Denotes the failure of the FRTU and Communication Systems to perform a required feature in a manner that reduces the utility of the systems or features. Normal priority variances shall not delay any testing

Low Denotes the failure of the FRTU and Communication Systems to perform a required feature in a manner that reduces the utility of the systems only slightly. Low priority variances shall not delay any testing. Variances that record transient failures, which cannot be readily reproduced, shall be initially assigned to this priority. Subsequent occurrences of the transient failure shall result in raising the priority of the variance.

A description of the resolution, including identification of all hardware, software, and documents modified or otherwise changed and the names of the Bidder or Purchaser staff involved with the resolution

k. A record of all testing performed

l. Identification of Purchaser staff accepting the resolution and the date of acceptance.

- **Schedule for Variance Correction**

The Bidder and Purchaser shall meet periodically to review the variance list. Each new variance opened since the previous meeting shall be scheduled for correction at the meeting. Purchaser and Bidder shall follow these guidelines for scheduling corrections:

- A schedule for the correction of critical and high priority variances shall be set within one working day of their discovery. The schedule for correction of all other variances shall be set within one working week of their addition.

- Purchaser and the Bidder shall assign resources for the correction of critical variances with the intent of correcting the variance within two working days of their opening.

- Purchaser and the Bidder shall establish a mutually agreeable date for the

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correction of high priority variances, with the overall objective of:

- i. If the FRTU and Communication Systems is in productive use, correcting the variances within one calendar week of their discovery
 - ii. Prior to the commencement of productive use, maintaining the overall project schedule
- Purchaser and the Bidder shall establish a mutually agreeable date for the correction of normal priority variances, with the overall objective of:
- i. If the FRTU and Communication Systems is in productive use, correcting the variances within one calendar month of their discovery
 - ii. Prior to the commencement of productive use, maintaining the overall project schedule
- Low priority variances may be scheduled for correction at any time and shall not exceed 30 days after identification.

- **Variance Resolution**

A variance shall be deemed resolved only upon written acceptance of the correction by Purchaser. Prior to submitting the corrected variance for acceptance by Purchaser, the Bidder shall take all reasonable steps to verify that the correction has resolved the variance and the Bidder shall update the variance record to reflect the corrective action taken. Purchaser shall then schedule any testing to be performed in conjunction with the Bidder.

A variance shall be deemed accepted and the variance record shall be completed only after Purchaser has tested the corrected variance to its satisfaction. The Bidder shall support all testing deemed necessary by Purchaser to verify the corrections.

- **Test Schedule**

The sequence of tests to be performed and their scheduling with respect to other activities shall be mutually decided.

- **Test Initiation**

The following conditions must be satisfied before starting any test:

- Purchaser has approved all plans and procedures for the test
- Purchaser has reviewed or approved all relevant documentation
- A copy of all relevant documentation including design and maintenance documents,

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user manuals, test plans, and test procedures has been placed on the test floor

- A complete regeneration of the software under test has been performed immediately prior to the start of testing
 - All operating system parameters, files, and configuration information has been saved to archive media so that the FRTU and Communication Systems operating environment can be recreated.
 - All database, display, and report definitions have been saved to archive media so that the System databases, displays, and reports can be recreated if necessary.
 - All source code libraries have been saved to archive media so that FRTU and Communication Systems software can be regenerated if necessary.
 - For the factory test, preliminary testing, as described in **Item-12.4.15 Preliminary Factory Testing** has been completed and the Bidder has submitted written certification that the preliminary testing has been successfully completed.
- For the availability test, all critical, high, and normal variances have been corrected and verified to the satisfaction of Purchaser

- **Test Completion**

A test shall be deemed to be successfully completed only when:

- All variances have been resolved to the satisfaction of Purchaser
- All test records have been transmitted to Purchaser
- Purchaser acknowledges, in writing, successful completion of the test.

- **Test Suspension**

If Purchaser believes, at any time, that the quantity or severity of FRTU and Communication Systems variances warrants suspension of any or all testing, the test shall be halted, remedial work shall be performed, and the test shall be repeated. The repeat of the test shall be scheduled for a date and time agreed upon by both the Bidder and Purchaser.

- **Modifications to the FRTU and Communication Systems during Testing**

No changes shall be made to the FRTU after factory testing has started without the express authorization of Purchaser. It will be Purchaser's intent to carefully control the test environment so that all changes can be readily identified and so that any changes installed for any purpose can be removed and the previous test environment restored. Purchaser shall have the right to suspend testing, to revert to a previous version of any software or hardware, and to restart any testing previously performed if, in its opinion, changes have

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been made to the system under test without authorization.

- **Preliminary Factory Testing**

The Pre-FAT shall be a complete dry run of the FAT, following the test plans and procedures. The intent is for the Bidder to detect and correct most design, integration, database, display, and performance problems prior to the FAT. The Bidder's project manager shall sign off each test. The completed test results shall be sent to Purchaser for inspection before Purchaser's personnel travel to the Bidder's facilities for the FAT. All tests shall be conducted using Purchaser-specific databases unless Purchaser authorizes the Bidder to use a test database.

The Bidder shall notify Purchaser at least fifteen days prior to the start of the Pre-FAT, and Purchaser shall have the option to witness all or parts of it. The Bidder shall notify Purchaser when the Pre-FAT has been successfully completed and the FRTU and Communication Systems is ready for FAT.

FAT should be integrated one, we will put our SIM in FAT and complete end to end P2P will be done from factory itself, and all FRTU's shall be configured before dispatch, this will reduce visits of automation field engineer visits during ITC

- **Site Acceptance Test (SAT)**

The site test includes the installation test, the functional test, and the performance test as specified in the factory test that will be conducted at Purchaser's site after shipment and installation of the FRTU and Communication Systems.

SAT shall cover all equipment and functions as specified for the complete system (all hardware & software) and connectivity with Purchaser's system. As such SAT shall cover all the tests listed in FAT along with site-specific tests including interconnections with field equipment and other systems. Apart from testing and commissioning, SAT shall include one month of continuous trouble-free operation of the complete system without major intervention. In case of interruptions, one month trial shall be restarted after attending to the problem.

- i. IEDs used for protection, control, etc.; the inter-bay bus (and associated communications hardware/software), the station bus (and associated communications hardware/software), the time synchronization system and the local/station HMI (if any) are to be considered as SAS components, and shall undergo commissioning requirements as part of the SAT.
- ii. Vendor shall furnish, advance SAT protocols and list of vendor's instruments for site

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testing. Tests shall include demonstration of loading & expandability of the system.

- iii. SAT shall be performed after the system has been installed, the final software has been loaded in each subsystem, all I/Os and functionality checked, system has been running and all commissioning checks have been completed successfully.
- iv. Unstructured tests shall be employed as necessary, to verify overall system operation under field conditions.

- **Installation Test**

The installation tests shall be conducted by the Bidder and include:

- A repetition of the equipment test
- Loading of configuration of the FRTU and Communication Systems software and starting the system. At the option of Purchaser, configuration shall be recompiled, if required.
- In cooperation with Purchaser, establishment of the communication with all data sources and other systems that interface with the Systems
- Initialization and preliminary tuning of application software as needed.

- **Functional and Performance Tests**

The site functional and performance tests shall be comprised of a subset of the functional and performance tests of Section 14, The tests to be performed shall be proposed by the Bidder and approved by Purchaser. These tests shall be extended as necessary to test functions simulated during the FAT, such as communications with all field devices and all other systems that interface with the FRTU and Communication Systems. The extended tests shall be performed to a test procedure prepared by the Bidder and approved by Purchaser. Unstructured tests shall also be employed, as necessary, to verify overall operation of the systems under actual field conditions.

- **Availability Test**

FRTU and Communication Systems and device availability in accordance with the criteria specified in the specification, System Availability shall be demonstrated by the availability test.

Predicted availability of equipment supplied shall exceed the following:

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System Function	System Availability
Control and Monitoring of any one equipment (Breaker, Isolator etc.)	99.99%
Monitoring of Any One Single Alarm	99.99%
Monitoring of Any One Analog Input	99.99%

- **Test Activity**

The test activity shall consist of normal FRTU and Communication Systems in use. Purchaser will modify the configuration during the availability test. Such modifications will be described to the Bidder at least 48 hours in advance of implementation to allow assessment of impact on the availability test, except where such changes are necessary to maintain control of the power system.

- **Test Definitions**

The definitions of the time periods used in determining the duration of the test and the success of the test shall be as follows:

Downtime

Downtime occurs whenever the criteria for successful operation defined in specification, Availability Requirements – FRTU and Communication Systems, are not satisfied. Downtime shall be measured from the start of diagnostic procedures until full service is restored. In the event of multiple failures, the total elapsed time for repair of all problems (regardless of the number of maintenance personnel available) shall be counted as downtime.

Hold time

Certain periods of time during which the FRTU and Communication Systems is down may be due to circumstances that are beyond the control of either party. These contingencies may prevent successful operation of the systems but are not valid for the purpose of measuring systems availability. Such periods of unsuccessful operation may be declared hold time by mutual agreement of Purchaser and the Bidder. Specific instances of hold time are:

Scheduled shutdown –

During scheduled shutdowns or if an equipment failure occurs due to scheduled

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maintenance, the resulting system outage shall be hold time, provided that service can be restored according to the Bidder- specified procedures within 30 minutes.

Power Interruption & environmental excursion –

Loss of power or manual shutdown of the FRTU and Communication Systems is the event of power excursion or the loss of environmental control shall be considered hold time. If the systems are operated during periods of power or environmental conditions beyond those specified, any resultant downtime shall be considered hold time.

Intermittent failure –

Periods during which an intermittent, recurring failure is experienced will be considered hold time, provided that the Bidder is engaged in remedial action and normal operation of the FRTU and Communication Systems can be restored within 30 minutes by Bidder-defined procedures whenever the failure occurs. Instead of accounting for the actual intermittent downtime, one hour of downtime shall be counted for each 120 hours of otherwise successful operation while the problem persists.

Failure of Purchaser software –

Time during which the FRTU and Communication Systems software is upgraded shall be considered hold time. Of course, Systems can be restored within 30 minutes by Bidder-defined procedures.

Corrected design defect –

Hold time may be declared by mutual agreement to ensure against similar future occurrences if a failure occurs due to a defect in design for which the Bidder defines and implements corrective measures. In such a case, enough hold time shall be allocated to allow verification of the corrective action.

Logistics delays

If repairs are delayed due to previous use of spare parts or because of Purchaser's failure to purchase recommended spare parts, hold time will be declared after diagnosis of the failure and while the Bidder is pursuing replacement parts in an expeditious fashion. A maximum of 48 hours of hold time will allowed for each occurrence of logistics delay.

Service response time

Hold time shall be declared from the time that a failure is detected until diagnostic procedures are begun. A maximum 24 hours of hold time will be allowed for each failure.

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Total time:

The time elapsed from the start of the availability test until the end of the availability test

Test time - The time elapsed from the start of the availability test until the end of the availability test, excluding hold time. That is, *Test_time = Total Time – Hold_time*

- **Duration and Criteria for Passing**

In order to establish that all failures have been satisfactorily repaired prior to the end of the availability test, no downtime, intermittent (hold time) failures, or more than one un-commanded failover shall have occurred within 200 hours of the test's conclusion. The test shall be extended, if necessary, to satisfy this requirement.

After successful completion of site acceptance test and 72 hours have passed, system availability shall be computed using the following formula:

$$\text{System_Availability} = [(\text{Test_time} - \text{Down Time}) / \text{Test_time}] \times 100\%$$

If the system availability requirements presented in the specification, System Availability, have not been met, the test shall continue until the specified availability is achieved. Alternatively, and at Purchaser's discretion, the test may be restarted.

When it has been determined that the system availability requirement has been met, the availability of each System device shall be calculated and compared against the device availability requirements as specified, Availability Requirements – FRTU and Communication Systems. If one or more devices do not meet the requirements, the test shall be extended until Purchaser and the Bidder mutually agree that corrective action has been completed for those devices. Corrective action shall include all necessary procedures to test and verify proper operation to Purchaser's satisfaction.

8. TYPE TEST CERTIFICATES

The Bidder shall furnish the type test certificates of the quoted item for the tests as mentioned above as per the corresponding standards. All the tests shall be conducted at Internationally Accredited testing Laboratory, CPRI/ERDA/Government Labs/ KEMA / International Accredited Lab as per the relevant standards. Type tests should have been conducted in certified Test laboratories during the period not exceeding time span as per CEIG Guideline 5 years from the date of opening the bid. In the event of any discrepancy in the test reports, i.e. any test report not acceptable, same shall be carried out without any cost implication to Tata Power Discoms.

9. PRE DISPATCH INSPECTION

The Material shall be subject to inspection by a duly authorized representative of the Tata

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Power Discoms. Inspection may be made at any stage of manufacture at the discretion of the purchaser and the equipment, if found unsatisfactory as to workmanship or material, the same is liable to rejection. Bidder shall grant free access to the places of manufacture to Tata Power Discoms's representatives at all times when the work is in progress. Inspection by the Tata Power Discoms or its authorized representatives shall not relieve the bidder of his obligation of furnishing equipment in accordance with the specifications. Material shall be dispatched after specific MDCC (Material Dispatch Clearance Certificate) is issued by Tata Power Discoms.

- **Factory Acceptance Test (FAT)**

Factory tests shall include:

- Equipment test
- Functional test
- Performance test
- Stability test
- Unstructured test
- *Equipment Test*

The equipment test shall verify that the FRTU and Communication Systems includes all required equipment, that the equipment is properly configured, and that the equipment can successfully execute the diagnostic programs provided.

The equipment tests shall include a visual inspection for proper workmanship, including cables, connectors, and labeling. The assembly drawings and configuration drawings shall also be verified at this time. These tests shall also verify that the required FRTU and Communication Systems capacity performance and expansion requirements as specified in this specification have been satisfied.

- *Functional Test*

The functional test shall use an equipment configuration that may include an extension of the Bidder's deliverables as required to prove the correct functionality of the FRTU and Communication Systems. The test procedures shall consider all additional test equipment and shall ensure that the additional equipment does not create false test results. The functional tests shall rigorously exercise all functions and devices, both individually and collectively, and shall verify the correct functional operation of all hardware and software. These tests shall include the following, as may be applicable to the system under test:

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- a. Verification of all required functionality of the system, such as FRTU and Communication Systems, applications, data exchange, and information storage and retrieval. Verification shall include all standard and custom functions as well as purchased options.
- b. Verification that all software has been correctly sized and meets Purchaser's capacity requirements
- c. Verification of proper acquisition, processing, and storage of data from appropriate sources, and verification of protocol and data exchanges with all external systems that will interface with the system. Where necessary, the Bidder shall provide appropriate simulations of the external systems; such simulations must themselves be verified before being used.
- d. Verification of all user interface functions
- e. Verification of the application program and system development capabilities including, software configuration management, source code development, documentation management, user interface development, real-time data set development, database generation and maintenance, report generation and modification, alarm and event message definition, test environments, and other utility functions
- f. Verification of communications maintenance capabilities including diagnostics, communications maintenance (FRTU, data links, interfaces etc.), and local input/output maintenance.
- g. Verification of all hardware maintenance capabilities.
- h. Verification of the proper response of the system to at least the following abnormal situations:
 - i. Loss and restoration of processors and servers, including auxiliary memory
 - j. Loss and restoration of user interface equipment
 - k. Loss and restoration of archive storage devices
 - l. Loss and restoration of external subsystems
 - m. Loss and restoration of input power
 - n. Loss and restoration of communication network processors
 - o. Loss and restoration of any other peripheral devices
 - p. Loss and restoration of local and wide area network elements

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- q. Detection of and recovery from communication errors
- r. Demonstration of the security of the system from unauthorized access
- s. Verification of the redundancy and failure recovery schemes of the system
- t. Verification that changes of system time will not prevent the system from operating properly and that the system can correctly handle the beginning of a new day, month and year, leap years and the change in century and decade.
- u. Documentation verification that will verify that all documentation to be delivered with the system is present and meets requirements.

➤ *Performance Test*

The performance test shall verify that the specified performance requirements are met. Simulation shall be provided by the Bidder, where necessary, to create the conditions for the specified performance scenarios. The simulations shall be tested first to verify that the desired activity is being simulated. Execution of the performance tests shall be automated as much as possible so that test runs can be reproduced.

➤ *Stability Test*

A 100-hour continuous run of the system shall be performed after successful completion of the functional and performance tests. The stability test will be considered successful if no critical function is lost, no major hardware failure occurs, no failover occurs, and no restarts occur within the test period.

Major hardware failure is defined for the purpose of this test as the loss of hardware such as a processor, Power Supply, Communication port, I/O cards etc.

During this test, the system shall be exercised (with simulated inputs, events, and conditions) in a manner that approximates an operational environment. Purchaser will simulate unstructured user activity during this test. Purchaser will not purposely cause any hardware or software failure, that is, failover and restart testing is not a goal of this test.

The Bidder shall assist Purchaser in this test as required by Purchaser; this assistance will be primarily in the form of helping the set-up of the test, explaining the best procedures to run the test, and explaining all unexpected results.

➤ *Unstructured Test*

The test schedule shall allow time throughout the functional testing for unstructured

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testing by Purchaser. Time for unstructured testing shall be reserved at the rate of at least two hours of unstructured testing for each eight hours of structured testing, but no less than two days total. This time will be used by Purchaser to perform additional tests, the need for which may be recovered during the formal testing, and to investigate any potential problems detected. The unstructured tests will be performed during the functional and performance test period and during the stability test at the discretion of Purchaser.

The Bidder shall assist Purchaser in this test as required by Purchaser; this assistance will be primarily in the form of helping the set-up of the test, explaining the best procedures to run the test, and explaining all unexpected results.

Following documents shall be sent along with material:

- a) Test reports
- b) MDCC issued by Tata Power Discoms
- c) Invoice in duplicate
- d) Packing list
- e) Drawings & catalogue
- f) Guarantee / Warrantee card
- g) Delivery Challan
- h) Other Documents (as applicable).

10. INSPECTION AFTER RECEIPT AT STORES

The material received at Tata Power DISCOM store will be inspected for acceptance and shall be liable for rejection, if found different from the reports of the pre-dispatch inspection and one copy of the report shall be sent to Project Engineering department.

11. Warranty, Maintenance, Upgrades, Patch Management & Database Modification Requirements

This Section specifies the requirements for Warranty, hardware and software maintenance for the System, Warranty maintenance and support, system upgrades, patch management etc.

Bidder to note the environmental condition of locations, the proposed system is being planned to be installed and operational.

Bidder shall provide facilities for carrying out online and offline maintenance of the

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components supplied as a part of the system. In general, this should include adequate testing equipment, tools, safety devices and other accessories. Bidder shall provide the details in their bid.

a. Bidder should provide Maintenance strategy of the product (Own & Sub-Vendor) being offered so as to schedule appropriate timeline for maintenance.

• *Maintenance Performance Requirement*

Purchaser envisaged that all offered equipment shall not require routine or planned maintenance. Therefore, no fans or moving parts shall be used in any of the system to avoid any need for maintenance. To ensure this, all the supplied equipment should be constructed to resist the entry of Dust, Water etc. A single technician shall be able to remove and replace for repair purposes, without special tools and test equipment, all equipment involved in the offered system. Restoration of equipment to full operational use shall be possible within 15 minutes (nominally) of repairs being completed. It should not be necessary to dismantle (remove multiple pieces of) the system in order to replace a module.

• *Service Life*

Purchaser prefers that the equipment shall be capable of complying with this standard, including performing its intended purpose, for a minimum of 10 years from the date of commissioning.

The supplier shall indicate the following:

- a. The date at which the product was released for sale.
- b. The anticipated date at which the product will be withdrawn from sale, but support will continue to be provided for Spares and Services.
- c. The anticipated date that product support will be withdrawn, i.e., spares and technical support will no longer be available.

• *Interchangeability*

All the parts/modules shall be interchangeable individually (e.g., FRTU parts/modules shall be interchangeable individually, and FRTU). This is applicable for all the parts/module supplied by the bidder under this contract.

Any such change or replacement shall not reduce the capability of the equipment to conform to the requirements of this specification.

• *Definitions*

The responsibility for maintenance of hardware and software will vary depending on

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the time during the Contract. So that the times for changes in responsibility can be determined, the following definitions shall be used:

Delivery – Delivery of any item shall be interpreted as receipt of the item at Purchaser's facility.

Commissioning – Commissioning of any item shall be interpreted as receipt of the item at Purchaser's facility, installation on-site, successful completion of the site tests, and correction of all variances from the tests.

• *Deliverable Hardware and Software Version*

The delivered Hardware and Software shall be the latest version being delivered by the manufacturer of the Hardware & Software six months prior to its delivery to Purchaser's facility. During delivery of the system, all the FRTU of a Bidder across the Tata Power Discoms network shall be upgraded to the latest version.

All hardware and software shall be of compatible versions. That is, the Bidder shall be responsible to ensure that all delivered hardware and software versions will inter-operate successfully. If it becomes necessary to upgrade some hardware or software to meet this requirement, the cost and time shall be borne by the Bidder. If it is necessary to revert to a previous version of any hardware or software to overcome incompatibilities among the hardware or software, the Bidder shall bear the cost and time of the "downgrade" and shall present a plan to correct the problems with the newer release. Such corrections shall also be at the Bidder's sole expense.

• *Warranty support*

a. **Maintenance services** for the supplied Hardware, System and application Software up-gradation, Patch Management services including sub-vendor products during the Standard warranty period of 5 Years from the date of system handover after SAT, resolution of all punch point of SAT and trouble-free operation of the entire system for a period of one month.

b. Bidder shall provide Software up-gradation (if any), Patch Management services including sub- vendor products for next 5 years over and above as mentioned in item a.

c. Training

SLA will be prepared and adhered by Bidder, Sub-Vendor's of bidder for extending the Hardware, Software and Service support to Purchaser for the period mentioned above. To mitigate major failure like Complete system failure, FRTU system instability, loss or failure of any major subsystem or system component such as to cause a significant adverse impact to

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system availability, performance, or operational capability. Some of the salient points as example are documented below:

- a. Bidder shall report to site within 48 hours of receipt of reporting of the failure occurrence
- b. Bidder shall provide replacement of the faulty equipment within 7 days after confirmation of the fact that the equipment can't be repaired at site. Failure to this clause may have some penalty reference on Bidder.
- c. Bidder will mandatorily provide detailed analysis report of the faulty equipment within 30 days from the date of the site visit.
- d. Any spare Equipment replacement, testing and its commissioning to be done by bidder, with no cost implications to Purchaser. Any tools, equipment, Software or Hardware required for testing of the System (e.g., IEDs/FRTU/Communication Equipment) will be the responsibility of the Bidder, this includes all system supplied by bidder under this contract.
- e. Any up gradation in application software and hardware will be informed to Purchaser and necessary up gradation to be carried out by Bidder with no cost implications to Purchaser.

Bidder to note that Tri-Party agreement will be prepared for Bidder, Sub-Vendor to have protection against quitting of executing bidder and its alliances during commissioning, warranty and post warranty period as specified in this document.

• **Hardware Maintenance**

The project schedule shall include an allowance for hardware maintenance prior to the availability test. The Bidder will not be granted any relief for project delays caused by maintenance problems prior to the availability test.

• **Pre-Delivery Maintenance**

The Bidder shall have the responsibility for maintenance of all hardware prior to delivery to Purchaser's site. This maintenance may be performed by a maintenance contract with Original Equipment Manufacturers (OEMs) or other parties or by the Bidder staff using spare parts from the Bidder's stores or other sources.

• **Maintenance During Commissioning**

The Bidder shall have the responsibility for maintenance of all hardware after delivery and

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prior to commencement of the Warranty. This maintenance may be performed by a maintenance contract with OEMs or other parties or by Bidder staff using spare parts from the Bidder's stores or other sources.

Failed equipment shall be replaced or repaired, and spares inventories (if any) replenished to their delivered level throughout the period of commissioning. Any spare parts found to be defective during initial delivery inspection or during this period shall be replaced within one week after notification. There shall be no charges to Purchaser for these replacement parts, including delivery charges. All spare parts replaced under maintenance shall be new parts unless otherwise accepted by Purchaser.

• **Maintenance Under Warranty**

Maintenance during the warranty shall be in conformance with the terms of the warranty sections of this RFP **(Item 14.6)**.

During the warranty period, Purchaser's hardware maintenance responsibilities will include the following:

- a. Provision of trained staff, responsible for call-out when problems occur
- b. Providing local assistance to the Purchaser during problem resolutions

The Bidder's hardware maintenance responsibilities shall include the following:

- a. Providing maintenance of all equipment, including spare parts
- b. Providing materials and instruction for appropriate engineering changes for equipment
- c. Provision of technical guidance towards the resolution of all hardware problems for equipment.

When needed, the Bidder shall respond to requests for technical support within Two Hours, 24 hours a day, seven days a week.

Failed equipment shall be replaced or repaired, and spares inventories replenished to their delivered level throughout this period. Any spare parts found to be defective during initial delivery inspection or during the Warranty period shall be replaced within one week after notification. There shall be no charges to Purchaser for these replacement parts, including delivery charges. All spare parts replaced under maintenance shall be new parts unless otherwise accepted by Purchaser.

The Bidder's technical support staff shall work with Purchaser's technical staff to establish a strategy to efficiently resolve each identified problem. If at any time, Purchaser believes that

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the Bidder's technical support is not effectively resolving a problem, Purchaser may request that the Bidder's system expert or staff from the equipment's manufacturer be dispatched to Purchaser's facility. The Bidder's technical team shall be at Purchaser's facility within 48 hours of that request to provide hands-on support towards the problem resolution. Purchaser will not be responsible for any expenses connected to the technical support, including travel expenses.

The Resolution time for different complaints shall be as per the below matrix:

Category	Definition	Maximum Resolution Time
Severity 1 Urgent	Complete system failure, severe system instability, loss or failure of any major subsystem or system component such as to cause a significant adverse impact to system availability, performance, or operational capability	0-14 hrs.
Severity 2 Serious	Degradation of services or critical functions such as to negatively impact system operation. Failure of any redundant system component such that the normal redundancy is lost Non-availability of Manpower at site during working hours	0-36 hrs.
Severity 3 Minor	Any other system defect, failure, or unexpected operation Request for information, technical configuration assistance "how to" guidance, and enhancement requests.	0-72 hrs.

Failure by the Bidder to comply with the above-mentioned timelines, shall attract a penalty as per contractual LD clauses

Hardware Minimum Support Period

The Bidder shall guarantee the availability of spare parts and hardware maintenance support services for all System equipment for a minimum period of 10 years. Subsequent to this minimum support period, the Bidder shall provide to Purchaser a minimum of two year's advance notice of their intent to terminate such services.

Upgrades, Patch Management & Modifications

- c. Bidder shall continuously keep the Purchaser informed of all Software and Hardware upgrades as & when these are released.
- d. Bidder shall supply upgrades and patches of all installed software (both own and third party) for a period of ten years from the date of system acceptance without commercial implication.
- e. Bidder shall rectify all design defects and software bugs at no extra cost for a

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period of 10 years from the date of system acceptance.

- f. Bidder shall support the system totally for ten (10) years, even if no upgrades are implemented.
- g. Bidder shall provide lifetime support (10 years) for the system. To meet this requirement, Bidder shall refer with OEMs on the product's life cycle management and obsolescence. Bidder shall attach the product life cycle matrix for hardware and software offered under this RFP.
- h. The system referred to above includes Bidder's own as well as third party components.

- *Database modification during Warranty Period*

All database modification major or minor is in the scope of the bidder, after the system handover and during the warranty period. The Scope covers FRTU configuration and necessary changes for control center communication. It is bidder's responsibility to provide resources as and when required by the purchaser for these changes and testing of the same as per the project and planned activity schedule. One of the examples of Configuration changes/modification are as mentioned below:

- a. Addition of Tags
- b. Addition/ Deletion of System/IEDs/Devices/SCADA enabled equipment/sensors

12. PACKING

Bidder shall ensure that all equipment covered under this specification shall be prepared for rail/road transport (local equipment) and be packed in such a manner as to protect it from damage in transit.

13. TENDER SAMPLE

NA, However, Bidder has to offer a prototype before mass production in case of first supply to Tata Power Discoms.

14. QUALITY CONTROL

The bidder shall submit with the offer Quality Assurance Plan indicating the various stages of inspection, the tests and checks which will be carried out on the material of construction, components during manufacture and bought out items and fully assembled component and equipment after finishing. As part of the plan, a schedule for stage and final inspection within the parameters of the delivery schedule shall be furnished. The Purchaser's engineer or its nominated representative shall have free access to the manufacturer's/sub-supplier's works to carry out inspections. The bidder shall ensure that the material supplied is as per the Guaranteed Technical Particulars as specified in the specifications.

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15. TRAINING:

Bidder shall provide training to the Purchaser's personnel on the operation and maintenance of the system supplied equipment including Non-OEM equipment/3rd Party equipment. The training shall cover development, integration, installation and commissioning of both software & hardware components of the system.

The Bidder shall provide Classroom as well as hands-on training on the offered System. All required training materials such as System Catalogs, Test Instruments, Demo Equipment, and Simulation Jigs, etc. shall be arranged by the Bidder for own and Sub-Vendor Equipment. The training shall equip the Purchaser's engineers for Installation, Commissioning, Operation and Warranty Maintenance of Hardware, Software (Operating System, Administration and Applications), protocols and all Sub-Vendor systems.

The Bidder shall prepare and deliver a comprehensive training program on the operation and maintenance of FRTU, Communication equipment and associated accessories under this project. Configuration of FRTU, training shall cover the skills required for the maintenance and expansion. Hardware training shall qualify Purchaser to perform routine preventive maintenance, diagnostic testing on the processors, peripheral equipment, LANs & communications equipment.

Bidder shall indicate their Training facilities including test tools and simulation facilities. Bidder shall provide the training calendar and details of topics considered for the equipment offered.

The schedule, location and detailed content of each course will be finalized during detailed engineering.

Bidder to consider 10 man-days of the trainer for on-site training to Purchaser's personnel. Bidder to note that the indicated man-days will be utilized in batches, according to availability of the Purchaser's personnel.

15.0 Training Requirement

Bidder shall provide training to the purchaser's personnel on the operation and maintenance of the system supplied by him.

General requirements relating to the training are specified below:

- a) Personnel who speak understandable English and who are experienced in instruction shall conduct training courses.
- b) Classroom and Hands-on training shall be on the identical system being supplied to

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Purchaser.

- c) Bidder shall provide all necessary training material. Each trainee shall receive individual copies of the technical manuals and pertinent documents. These materials shall be supplied at least one month before the scheduled commencement of the training course.
- d) The purchaser shall be permitted to video tape all training classes.
- e) Class materials, including documents sent before the training classes and class handouts, shall become the purchaser's property. The purchaser may copy this material for in- house training and organization use only.
- f) Training sessions conducted at site shall accommodate the number of candidates in batches.
- g) Bidder to note that, requirement of Training for FRTU system is explained in detail, on similar line bidder to arrange training for all Non-OEM systems such as Ethernet Switch etc.
- h) Training Requirement- Shall provide all procedure in MP4 format

15.0.2 **Course Descriptions**

Course descriptions shall be included with the training plan that shall provide the following information for each course included in the training plan:

- a) The course name (and number if applicable)
- b) A brief description of the course
- c) A description of the intended audience for the course
- d) A description of the relation of the course to others in the training plan
- e) The duration of the course
- f) A breakdown of the course schedule, identifying classroom and hands-on periods
- g) A list of the training materials to be supplied
- h) A list of reference material to be used in the course
- i) A list of any prerequisite training or experience expected of the students.

At Purchaser's request, the Bidder shall provide a description of all courses offered by the Bidder and its Sub-vendors.

15.1 Training Curriculum

The training curriculum presented in this section is intended to describe the contents of the training when viewed. The subjects covered by individual courses may differ as long as the overall objectives are satisfied.

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15.1.1 FRTU Hardware Training

FRTU system hardware course shall be designed to provide Purchaser's personnel enough knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs, and communicate with OEM personnel. The following subjects shall be covered:

- a) Configuration of the System Hardware.
- b) Basic and advance training of operation, maintenance techniques and diagnostic procedures for each element of the offered system, e.g., Processors, Auxiliary Memories, LANs, Routers etc. Configuration of all the hardware equipment.
- c) Techniques and procedures to expand and add IEDs/Feeder/Substation/Communication channels etc.
- d) Theory of operation and maintenance of the redundant/non-redundant hardware configuration, failover hardware, configuration control panels, and failover switches. Maintenance of protective devices and power supplies.
- e) Theory of design and operation, maintenance techniques and practices, diagnostic procedures, and (where applicable) expansion techniques and procedures. Course content shall include hands-on training for the specific subsystems that are part of Purchaser's equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be covered in detail.
- f) Preventive and Corrective maintenance of all equipment, including use of special tools and instruments.
- g) Capable to diagnose and debug problem in the FRTU. Course should familiarize the different error code of the FRTU and how to rectify them.

15.1.2 System Software Training

The Bidder shall provide a System Software course that covers the following topics:

- a) All applicable programming languages, Stand-alone Service and Utility packages of the system. An introduction to software architecture, effect of tuning parameters (OS software, Network software, database software etc.) on the performance of the system.
- b) Operating System course consisting of the user aspects of the operating system, such as program loading and integrating procedures; scheduling, management, service, and utility functions; and system expansion techniques and procedures.
- c) System Initialization and Failover, execution of diagnostic procedures and the interpretation of diagnostic outputs.

15.1.3 Application Software Training

Comprehensive application software course, covering all applications database Logic and

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display building etc. The training shall include minimum the following:

- a) Overview of the application software and data flows.
- b) Programming Standards and Interface conventions.
- c) Functional capabilities, design, and major algorithms. Associated maintenance and expansion techniques.
- d) Software development techniques and conventions for the preparation and integration of new software functions.
- e) Generation of application software

15.1.4 FRTU Configuration/Engineering Training

The database and logic building course shall cover how to configure the inputs & outputs signals of the FRTU, communications with IED, communication with Control Centre, build the configuration database, storing and retrieving of the configuration file, database administration to maintain and modify the database and its structures. Following minimum topics shall be covered:

- a) How to set up configuration database for FRTU, identifying different component for configuration
- b) How to configure I/Os
- c) How to configure IEDs
- d) How to configure Control Centre Communication
- e) How to Configure Cyber Security features of FRTU
- f) How to Compile Configuration
- g) How to Import / Export configuration file
- h) How to download/upload configuration file
- i) How to maintain different configuration file

15.1.5 FRTU System Administration

System administration course shall cover the procedures necessary to operate the FRTU configuration software, managing users and their roles. At the end of this course, participants shall be able to:

- a) Start up the FRTU configuration Tools and its components
- a) Shut down the Software and its components
- b) Switch functions to backup equipment

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- c) Take equipment out of service and its restoration
- d) Interpret and react to messages generated by error-monitoring functions
- e) Test field device and communication links
- f) Implement procedures for installing new devices
- g) Use procedures for altering and replacing the configurations
- h) Identify procedures for using diagnostics
- i) Describe the backup functions required for normal maintenance
- j) Upgradation of System Software, Patch Management and Firmware
Upgradation of OS and Application Software etc.

15.1.6 Simulator Training

This course shall cover the operation of the Simulator, scenario building, and maintenance. Enable the Purchaser personnel to:

- a) Prepare training scenarios using the scenario building tools
- b) Simulate the communication over IEC 61850 protocol with devices
- c) Simulate the communication over IEC 60870-5-104/101/103/MQTT and Modbus protocol

Similarly, the bidder shall arrange training on Sub-vendor equipment supplied under this RFP.

16. MINIMUM TESTING FACILITIES

Bidder shall have adequate in-house testing facilities for carrying out all routine tests & acceptance tests as per relevant International / Indian standards.

17. MANUFACTURING ACTIVITIES

The successful bidder will have to submit the required documents & drawing as mentioned in clause no-19, to get the CAT-A approval before mass manufacturing as a mandatory requirement.

18. SPARES, ACCESSORIES AND TOOLS

- a. Bidder needs to include competitive price for Mandatory Spare parts against the below specified list and schedules.
- b. Bidder shall include list of spares with quantities as recommended by him required for 10 years trouble free operation of equipment.
- c. The spares supplied shall be strictly interchangeable with parts for which they are intended for replacement.

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- d. The spares shall be treated and packed for long storage (minimum 10 years) under the Climatic conditions prevailing at the site.
- e. The start-up spares shall be delivered at the site well in time before the start- up and commissioning of the system.
- f. Bidder to note the environmental condition of locations, the proposed system is being planned to be installed and operational.
- g. The Bidder shall give an assurance that spares will continue to be available through the life of the equipment, which shall be 15 years minimum.
However, the supplier shall give a minimum of 12 months' notice in the event of plan to discontinue manufacture of any component used in this equipment.

18.01 Start-Up Spares:

The start-up spares are those spares which will be required during start-up and commissioning of the equipment/systems, and until Final Take Over. It is the responsibility of the bidder to supply all the necessary spares as required until the equipment/systems are handed over to the Purchaser. An adequate stock of start-up spares shall be available at the site such that the start- up and commissioning of the equipment/systems, performance testing and handing over the equipment/systems to the Purchaser be carried out without hindrance and delay. All start-up spares which remain unused after the taking over the system shall remain the property of the Purchaser. The Bidder shall furnish the Schedule of Start-up Spares.

18.02Mandatory Spares

Essential spares are those considered necessary by the owner for ten (10) years of normal Sub- Station Automation System operations. A list of such spares has been listed in the below mentioned table and the same shall be included in bidder's scope. When an item of spares is indicated as 'percentage', it shall be considered as percentage of total number of that item of spares of overall project, unless specified otherwise and the fraction shall be rounded-off to the next higher whole number. Whenever the item of spares has been indicated as 'set' the same shall mean the supply for a single equipment/system. One set of spares for the particular equipment shall mean the total quantities of that particular spares for a single equipment e.g. 'set' of RTU, SIC etc. The 'set' shall however include all components required to replace that item of spares. The Owner reserves the right to buy any of the essential spare parts as considered necessary.

In case during start-up and commissioning certain essential spares are used up, the same

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shall be replaced within one (1) month without any commercial implications.

Bidder shall furnish details for all essential spares as per the approved vendor document list. Bidder to consider mandatory spares in the offer as per the BOM in Section E.

Note: Bidder to note that all above equipment shall be supplied along with Power supply, communication and specialized cables (if any)

Spares mentioned above shall be same as of installed system with necessary software key and licenses.

The table above indicate the minimum requirement of the owner, bidder to include 5% spares, which are not part of this table, but required for maintenance and upkeep of the system.

18.03 Recommended Spares

In addition to the spares mentioned above, the Bidder shall also furnish in his bid a list of recommended spares which may be required for ensuring the availability during the guaranteed availability period with unit prices. The final list of spares shall form part of scope of supply and accordingly the price thereof shall be quoted by the bidder and shall be considered in the evaluation of the bids. The Purchaser reserves the right to buy any of the recommended spare parts as considered necessary by him. The prices of recommended spares shall be consistent with those of start-up/essential spares. Purchase of these spare parts will be covered under this order / by a separate order / an amendment to the contract.

The Bidder shall provide a list of recommended spares for a period of Ten (10) years from the date of handover of the project to Purchaser. The shelf-life of these spares is such as to last for at least Ten (10) years from the date of handover of the project. Spare parts supplied by the bidder shall be made available to the bidder for usage subject to replenishment at the earliest (within a month). Thus, at the end of every quarter the inventory of spares with the Purchaser shall be fully replenished by the bidder. However, any additional spares required to meet the availability of the system (which are not a part of the spares supplied by the bidder) should be supplied immediately by the bidder free of cost to the Purchaser The list shall include the following:

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Sl. No	Item Part Description	Recommended Quantity	Procurement Lead Time	Quantity of item held in Local office of Bidder	Quantity of item held in Head Office of Bidder as an emergency spare	Unit Price	Total Price

The Bidder shall provide the MTBF of various components, sub-assemblies, assemblies etc. (recommended as spares) and the relationship between MTBF and spare quantities recommended. The bidder is required to list the spares.

The Bidder shall submit the product life cycle details of all the hardware offered under this RFP.

Note: - The spares shall be included in PR only after furnishing requirement from user group.

19. DRAWINGS AND DOCUMENTS

Documentation shall be provided by the bidder for all equipment and functions offered as part of this procurement including Sub-vendors equipment/systems and functions. All documentation shall be in English. The documentation shall cover all systems required by Purchaser, including all its hardware, software, and interfaces and shall cover functionality, testing, installation, system startup, operations, and maintenance.

- a) Bidder shall provide all documentation in soft / hard form about licensing information for each software supplied (OS, application software, configuration, diagnostics, simulation & testing tools). (Please refer below i.e.19.2 onwards)
- b) The Documents shall be submitted as proposed. Master Document List (MDL) shall be prepared by Bidder and submitted for Purchaser's approval.
- c) The offered system shall store the copy of the system configuration, user configurable database, tools and relevant software as a backup at Purchaser's identified location for restoration under a disaster recovery plan.
- d) The bidder shall provide complete engineering data, drawings, reports, manuals and services offered etc. i.e., complete set of documentation / drawings / architectures/ Inter- Operability Tables (IOTs) submission of Test Reports, job progress reports etc.
- e) It is the responsibility of the Bidder to handover all project related drawings in AutoCAD formats only. The pdf version of above drawings / documents shall also be submitted for formal approval process.
- f) Submission of technical documentation related to design, installation, testing,

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operation & maintenance of the equipment and submission of Test Reports, job progress reports etc. in hard copies (3 sets) and soft copies (preferably in PDF).

- g) Providing complete source code, including customization.
 - h) BA shall provide the license free web based application software without any additional cost accessible to all pre-defined users of TATA Power all Discom or else LAPTOP shall be provided. (Software shall be free of cost declaration needs to be provided by the manufacturer).
 - i) Video Manuals for configuration and troubleshooting of FRTU, help in understanding the things in better way and skill enhancement.
 - j) QR code sticker on FRTU panel, which will help in accessing the schemes, architecture and other important documents. Respective utility will generate QR code and keep data in share folder, the will be accessed by the responsible person who has authorized to access the same
- k) PLC logic software license to be provided by the manufacturer without any additional cost.

19.1 General Requirement

- a. The Bidder shall furnish the following drawings/documents during detailed engineering as per schedule **(Refer Section-A, Item 9.0)** from date of PO Placement Bidder to submit all datasheets, detailed GTP of the proposed BOM items during detailed engineering for the approval and finalization by Purchaser.
- b. System Architecture Drawing and design documentation. This drawing should show in detail of the following:
 - i. Network connections
 - ii. Protocol used
 - iii. Type of interconnecting cable
 - iv. All equipment, systems, FRTU, Modem, I/O devices, network switches etc. which are part of the complete proposed solution.
- c. Panel GA, BOM and Complete wiring diagram
- d. Functional Design Specification document
- e. Step by Step test procedures for Factory Acceptance Test (FAT) and Site Acceptance Test (SAT)
- f. SCADA I/O List with protocol details along with addresses
- g. Interconnection Schedule (ICS) for Automation, detailed drawing indicating interconnections between various components.
- h. Hardware, Software and Application manuals for all the equipment

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supplied including that of Third parties.

- i. All Software Licenses (both own & third party), key for Hardware Locks
- j. All interoperability tables
- k. Software matrix indicating the details regarding versions, current license, expandability, tags/license limitations (if any) etc. along with the offer.
- l. Guaranteed technical parameters & Guaranteed availability and reliability
- m. Calculation for power supply dimensioning
- n. Bill of Material listing equipment designation, make, type ratings, etc. of all the equipment's supplied
- o. Logic Diagram (Hardware & Software)
- p. Submit the details of all databases proposed and its relationship with application. Data flow diagram with entity relationship shall be submitted for key applications. The detail shall clearly mention the list of application which are required to build data models manually.
- q. Operator's Manual
- r. Complete documentation of implemented protocols between various elements
- s. IP addressing chart for all the systems, FRTU, network switches and other components/ equipment which are connected to the network
- t. Other network diagram with all details pertaining to IP address and interfaces used to be provided as a controlled and restricted copy.
- u. Password management policy document to be provided with mechanism for storage and changing of password at specified interval clearly defined.
- v. Credentials created for all OEM systems for support to be provided as consolidated document stating clearly the SLA timelines agreed with each of the OEM.
- w. SLA signed document for system support and restoration in case of breakdown to be clearly document and provided as submission document.
- x. Bidder to provide recommendation on proposed network bandwidth required for smooth operation of the system in non-blocking mode. Diagnostic and performance evaluation software and hardware tools
- y. All tools and documents necessary to develop and maintain software

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such as compiler, CASE tool-kits and version control software shall be delivered along with FRTU Software.

- z. Details of software (Operating systems, application software, engineering tools, communication systems management software, license details, I/O distribution protocol- wise etc.) for all offered systems (including FRTU and configuration laptop computers etc.) and loadable in CD/DVD ROM.
- aa. Final as built drawings of all automation and communication system as final documents in AutoCAD & PDF format
- bb. Other documents as may be required / applicable during detailed engineering
- cc. All drawings and data shall be annotated in English.
- dd. Bidder shall furnish Four (4) hardcopies and 3 soft copies on reliable media of all drawings, manuals (Administration, Operation & Maintenance, Configuration, Troubleshooting and Installation), Technical catalogues, Test Certificates and Acceptance Test Reports.
- ee. Two copies of the internal test report, FAT and SAT documents with test protocol formats shall be submitted for approval at least four (4) weeks before Factory Acceptance Test. Two copies of SAT protocol shall be submitted for approval at least four (4) weeks before Site Acceptance Test.
- ff. Bidder shall also furnish Original plus one copy of all System Software (OS, Application and tools) along with delivery. Bidder shall submit two copies of all the configuration, application, display, database backup of all equipment on reliable secondary media.

19.2 Definitions

For the purposes of this project, the following definitions shall be used:

- a. **Documents or Documentation** – Textural and graphical information describing the offered equipment, systems, and other items peripheral for Substation Automation System, whether embodied in hardcopy or electronic form such as common word processor files. Documents may also be referred to as manuals, guides, books, drawings, transmittals, and specifications. Documents are further divided into standard, OEM, and custom documents.
- b. **Standard documents** – Documents produced by the Bidder and used prior to the award of this contract that are applicable to all users of the equipment and software, including Purchaser. It is expected that the Bidder will use a

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formal revision control scheme to maintain its standard documents. Documents not maintained under such a scheme shall be considered custom documents.

- c. **OEM documents** – OEM (Original Equipment Manufacturer) documents are those standard documents produced by Vendor, Sub-vendors. Documents produced by Vendor, Sub- vendors for customized elements of the System shall be deemed custom documents.
- d. **Custom documents** – All documents not categorized as standard or OEM documents including the Bidder’s standard documents that are modified to meet Purchaser’s specific requirements.
- e. **Project Documents** – Project documents are those documents produced for the conduct of the project, but which do not directly describe the Sub-Station Automation System. Examples of project documents include meeting minutes, action item lists, test plans and procedures, and transmittal and document lists.

19.3 Document Format

Documents shall be delivered in two phases:

- a. Approval documents, submitted for Purchaser’s review and approval
- b. Final documents

Purchaser prefers that documents be delivered in both hard and soft form. Softcopy shall be delivered on magnetic media. Final documents shall be delivered on hardcopy, and on softcopy on Secondary Media. Any user shall be able to access on-line documentation on Engineering Laptop including functional design documents, user guides, maintenance manuals, on-line help, and operating procedures via a simple procedure involving a one-click operation.

Documents shall be supplied in a format that can be edited by Purchaser. Handwritten texts are not acceptable. Purchaser’s standard word processing software is Microsoft Office. The Bidder is encouraged to use this software for documents. If the Bidder uses other word processing or document production software, four copies of the software, suitable for installation on a personal computer using the Windows10 operating system or newer versions, shall be provided.

Drawings and diagrams may be supplied embedded in the document files or may be supplied as separate files. Purchaser’s standard drawing software is AutoCAD. If the Bidder uses other drawing software, four copies of the software, suitable for installation

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on a personal computer using the Windows10 operating system or newer versions, shall be provided.

Documents delivered as hardcopy shall be printed on both sides of A4 size paper and bound in three-ring binders. Divider pages with appropriately labeled tabs shall separate chapters. The spine of each volume shall be labeled with the document title and volume number so it may be easily identified when shelved.

Documents delivered on softcopy media shall be formatted for printing on A4 size paper.

Each document shall include a title or information page showing the document number, title, and revision record. The document number shall be a unique number assigned in accordance with the Bidder's standard practice. The title page shall include a space into which Purchaser may enter a document number assigned from Purchaser's document management system. The revision record shall describe each new version of the document since its original production. The revision record shall include:

- i. The date of the change
- ii. A brief description of the change
- iii. An indication that the change has been reviewed and approved in accordance with the Bidder's quality assurance procedure
- iv. The version or release of the hardware or software to which the document applies.

Each document shall include a table of contents. If a document is divided into several physical volumes, each volume shall contain the complete table of contents of the whole document. Furthermore, each document shall have a cross-reference table, listing all topics of significance covered by the document, and giving the page or section references of all pages or sections with discussions of the topic.

Documents that describe generic or typical Substation Automation elements will not be acceptable to Purchaser unless the specific material applicable to this project can be readily identified and material not applicable to this project can be similarly identified. Custom documents shall not contain any material that is not pertinent to this project.

Where the phrase "on-line documentation" is used in these Specifications, it shall be interpreted to mean the ability to view the document from any workstation. The Bidder shall provide all software necessary to provide this capability. For non-OEM documentation (documentation produced by the Bidder), the Bidder shall also provide the capability to edit and annotate the document.

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19.4 *Document Review and Approval*

All standard and OEM documents provided pursuant to this contract shall be subject to review by Purchaser. Custom documents provided pursuant to this contract shall be subject to approval by Purchaser.

19.4.1 **Document Review**

Purchaser's review of documents shall be limited to determining that:

- The documents have been produced in accordance with the documentation standards of the Bidder or Sub-vendors
- All hardware and software are in full conformance with the contract
- The documents clearly and accurately describe the features and options of the hardware and software that pertain to the Substation Automation System and other applications
- The documents are written in English, and hard copies are printed legibly, and well bound.

Purchaser will review documents as per the schedule mentioned in the MDL. If Purchaser does not transmit comments on the documents within the review period, the Bidder shall discuss with the Purchaser.

If Purchaser transmits comments on any documents, the Bidder shall respond to the comments within seven working days or as per the MDL after receipt of the comments. If the comments address OEM documents, the Bidder shall act as an advocate of Purchaser to initiate and facilitate resolution of the comments with the Sub-vendor.

19.4.2 **Document Approval**

All custom documents shall be subject to a formal approval process. The review for approval performed by Purchaser will be similar to that for document review process but will more closely examine the functionality and design aspects of the hardware or software. Clarity and completeness of the presentation of the material within the documents will be a key element of the review for approval.

The approval process shall proceed as follows:

- The Bidder shall transmit documents subject to the approval process to Purchaser as per MDL. This MDL time may be adjusted by mutual agreement to accommodate the other activities of Purchaser and the Bidder. Requests by either party to change the time shall be made within two working days of receipt of the documents by Purchaser.

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- Purchaser shall return comments to the Bidder within the agreed time. The transmittal cover for the comments shall clearly indicate that the document is either:

Approved (CAT-A) - If approved, the Bidder may proceed with the work covered by the document. No further approval action is required.

Approved with Comments - If approved with comments, the Bidder may proceed with the work covered by the document and the comments.

Not Approved (CAT-C) - If not approved, the Bidder may proceed with the work covered by the document and the comments only at their risk. No schedule or cost relief will be granted for any work undertaken prior to approval of the appropriate documents.

- If desired by any party, the comments may be discussed to clarify Purchaser's intent.
- The Bidder shall then revise and resubmit the documents within five working days after receipt of the comments from Purchaser. This time may be adjusted by mutual agreement to accommodate the other activities of Purchaser and the Bidder. Requests by either party to change the time shall be made within two working days of receipt of the comments by the Bidder.

All changes made to documents to reflect approval comments shall be clearly highlighted and the revision record shall be updated to reflect the changes. Purchaser prefers the use of the change-tracking feature of the word processor used to produce the documents.

- The review and comment process shall be repeated until the document is accepted. After the document is accepted, Bidder shall deliver the required number of final copies free of highlighting due to tracking of changes.

All changes made to documents to reflect approval comments shall be clearly highlighted and the revision record shall be updated to reflect the changes. Purchaser prefers the use of the change-tracking feature of the word processor used to produce the documents.

19.4.3 Scope of Reviews and Approvals

The acceptance or approval of any documents by Purchaser shall not relieve the Bidder of the responsibility to meet all the requirements of the contract or of the responsibility for the correction of the documents. The Bidder shall have no claim for additional costs or extension of time on account of delays due to revisions of the documents that may be necessary for ensuring compliance with the contract.

All deliverable documentation shall be revised by the Bidder to reflect the delivered System. Any modifications to the offered/installed system resulting from the factory and

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site acceptance tests shall be incorporated in this documentation. All previously submitted documents that have been changed because of engineering changes, contract changes, or errors or omissions shall be resubmitted for review and approval.

19.5 Deliverable Documentation

Two soft copy and three hard copies shall be provided for review and approval. Two soft copy and five hard copies shall be provided for all the final documentation for each site.

Document	Delivery Date
Basic hardware documents i. List of deliverables, configuration diagram ii. Network configuration, interconnection lists iii. Site installation drawings and procedures	As per MDL
Equipment manuals	With each hardware delivery
Hardware maintenance manual	With each hardware delivery
Software list of deliverables	As per MDL
Software development standards	As per MDL
Database definition	i. For standard software – As per MDL ii. For other software – with the software functional description
Interface Requirements Document	With the software functional description
Software functional description	As per the project schedule
Installation images and source code	With the System delivery
Detailed design document	As per the project schedule
System maintenance manual	With the System delivery

19.6 Document Standards

The Bidder shall provide a document defining the standards used to create and maintain all documentation supplied by the Bidder. The standards shall define:

- a. The word processing or document production software used to create the documents
- b. Templates for each document type

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- c. Definitions of the contents for each document type
- d. Drawing standards to be followed
- e. The approval process to be followed for document releases.

19.7 *Hardware Documentation*

The following documentation shall be provided for all hardware provided pursuant to this contract:

- a. List of deliverable hardware
- b. Equipment configuration diagram
- c. Network configuration diagram
- d. Interconnection list
- e. Site installation drawings and procedures.

The other hardware documentation to be supplied shall be commensurate with the hardware maintenance philosophy to be employed by Purchaser.

Equipment manuals shall be provided for all hardware to be maintained by the Bidder or a third-party maintenance Bidder. Equipment manuals and hardware maintenance manuals shall be provided for all hardware to be maintained by Purchaser.

19.7.1 **List of Deliverable Hardware**

The list shall itemize each hardware item and include equipment configuration information. The configuration information shall be enough so that Purchaser can procure an identical item from the manufacturer. The list shall also include network names and addresses (or these shall be included in the network configuration diagram) and shall include a space for Purchaser to enter equipment identification for their own purpose.

19.7.2 **Equipment Configuration Diagram**

The equipment configuration diagram shall depict the logical interconnection of all the Bidder- supplied equipment and its connection to Purchaser supplied equipment. The configuration diagram shall use the same terminology as the list of deliverable hardware so that the correspondence between the two can be readily determined.

19.7.3 **Network Configuration Diagram**

This document shall show the design of the local and wide area networks supplied by the Bidder as well as the communications network supplied by Purchaser. Both logical and physical depictions shall be provided for the network supplied by the Bidder. Only a logical depiction is required for the network supplied by Purchaser.

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19.7.4 Interconnection List

The physical interconnections among the components, other than those shown on the network configuration diagram, shall be depicted. Each cable shall be identified, along with its terminations.

19.7.5 Site Installation Drawings and Procedures

The site drawings shall depict the physical arrangement of the components. References to the appropriate equipment manuals are acceptable. The drawings and procedures shall include:

- Equipment physical drawings showing dimensions, cabinet internal arrangements, and the size and weight of each enclosure
- Unpacking, moving, handling, and other installation details
- The location of external connections including types and sizes of connectors
- Input power and grounding requirements
- Environmental requirements

19.7.6 Equipment Manuals

Equipment manuals shall contain the following:

- A description of the function of the equipment
- Installation, setup, and operating instructions
- A block diagram showing the logical and physical interconnections among the major components
- Expansion and upgrade capabilities and instructions
- Preventative maintenance instructions
- Detailed functional, logical, electrical, and mechanical characteristics of all interfaces to the device, including protocol descriptions
- Troubleshooting and repair guides including a description and instructions for the diagnostics furnished.

19.7.7 Hardware Maintenance Manuals

The hardware maintenance manual shall describe the preventive maintenance and restorative procedures required to maintain the equipment in good operating condition. The information in the manuals shall include:

- Operating details – This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the

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equipment. Descriptions of external data transfers with other equipment, including data patterns, security check-codes, and transfer sequences shall be included. The operational sequence of major assemblies within the equipment shall be described and illustrated by functional block diagrams and timing diagrams. Detailed logic diagrams shall also be provided as necessary for troubleshooting analysis and field repair actions.

- Preventive maintenance instructions – These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the equipment. Instructions on how to load and use any test and diagnostic program and any special or standard test equipment shall be an integral part of these procedures.
- Corrective maintenance instructions – These instructions shall include procedures for locating malfunctions down to the field-replaceable module level. These guides shall include adequate details for quickly and efficiently locating the source of an equipment malfunction. The instructions shall also include explanations for the adjustment or replacement of all items, including printed circuit cards. Schematic diagrams of electrical, mechanical, and electronic circuits, parts-location illustrations, photographs, cable routing diagrams, and sectional views giving details of mechanical assemblies shall be provided as necessary to replace faulty equipment. For mechanical items requiring field repair, information on tolerances, clearances, wear limits, and maximum bolt-down torque shall be supplied. Information on the loading and use of special off-line diagnostic programs, tools, and test equipment, as well as any cautions or warnings that must be observed to protect personnel and equipment shall be included.
- Parts information – This information shall include the identification of each replaceable or field-repairable module. All other parts shall also be identified. The identification shall be of a level of detail enough for procuring any repairable or replaceable part. Cross-references between the Bidder's part numbers, and the manufacturer's part numbers shall be provided.

19.7.8 Bidder shall submit equipment warranty details of all the supplied system/equipment with detailed inventory list with make, model, Serial number, Software versions.

19.8 *Software Documentation*

The following documents shall be provided for all software:

- a. List of Deliverable Software

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- b. Software development standards

The Bidder or Sub-vendors shall provide the following documents for all software that has been produced for the offered solution. This shall include all the required OS and application software for the systems mentioned in the specification:

- a. Database definition and data flow, along with an explanation of stored procedures
- b. Interface Requirements Document
- c. Software functional description
- d. Installation images and source code
- e. Source code version control and revision control documentation.
- f. Software release / Patch details as consolidated document to be submitted by Bidder.
- g. Recommended update frequency of all the software should be submitted as consolidated document by bidder.

The following documents shall be produced for all software produced specifically for this contract:

- a. Software Requirements Matrix
- b. Detailed design documents

19.8.1 List of Deliverable Software

The list shall itemize each software item and include version and license information. The distribution media for each software item shall be identified. The list shall also indicate for each item whether source code is supplied.

19.8.2 Software Development Standards

The Bidder shall document the development standards used to develop the Substation Automation System and other systems software. Purchaser reserves the right to reject software that does not conform to the development standards. The standards shall define:

- Program design disciplines
- Cyber Security measures
- Resources under which the program must operate

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- Basic services
- Interface definitions
- Linkage conventions
- Input and output specifications
- Database naming and access conventions
- Storage rules
- Quality assurance procedures
- Configuration design review methods
- Software configuration control schemes.

19.8.3 Database Definition

The database definition shall identify the characteristics of all systems databases. It shall include, but shall not be limited to, the following:

- The name or identification of the database
- A description of the intended use of the database. If the database is specific to a single application, the application shall be identified
- A description of the organization of the database (the database schema or model)
- A description of each field of each data item
- Instructions for generating and populating the database
- Details of programming interfaces. This shall encompass access methods, address schemes, and read, write, and modify actions
- Initialization description – How or by what software is the data initialized & to what value(s)
- Details of maintenance actions.

Purchaser encourages the use of "self-documenting" database technology, where the database definition is developed and stored with the data. The resulting documentation should be printable.

19.8.4 Interface Requirements Document

The Interface Requirements Document shall describe in detail the interfaces between the offered systems and Purchaser provided/existing systems and networks. The Interface Requirements Document will be used by both the Bidder and Purchaser as the definition of the interface between the Substation Automation System, SCADA/ADMS and all other

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systems, so that each system can be designed or modified to meet its requirements. Purchaser will provide all required information to the Bidder so that it can prepare the document accordingly.

As a minimum, the Interface Requirements Document shall cover the following aspects:

- Description of the hardware interface
- Description of the communication protocols and the options and parameters selected
- Data exchange requirements including timing, priority, volume, and security requirements. A specific list of data to be exchanged during factory and site testing shall also be included.
- Description of the performance requirements
- Exception (for example, error) processing
- Failover/Backup processing
- Alarm conditions
- Archiving requirements.

19.8.5 **Software Functional Description**

The intent of the software functional description shall be to describe the functions to be performed by each software module from the standpoint of a user. (Software functional descriptions are also referred to as user guides.) The functional operation of the Substation Automation System and other systems shall be clearly described so that it can be understood without understanding the detailed operation of each software module.

Software functional descriptions shall also be used as the first step in the design of a custom (for example, new functionality). Thus, it shall have enough information for Purchaser to determine that the new functionality will meet the requirements of the contract.

The software functional description shall include the following minimum content:

- Functional description – A narrative description of each program. Where appropriate, solution algorithms shall be described
- Performance requirements – The execution periodicity, processing capacity, and tuning and execution parameters that control or limit the capabilities of the software

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- Resource requirement – The expected minimum requirements for main memory, auxiliary memory, processor capacity, and other resources required by the software
- User interface – A description of the interface used to control the software, including all user inputs and program responses
- Software interface requirements – A description of the logic interfaces with other programs
- Data requirements – A description of all data and databases accessed by the software, including execution parameters
- Error messages – A concise description of all error messages and possible corrective actions
- Diagnostic messages – Where the software generates a record of its internal operations, the messages shall be described
- Maintenance and expansion procedures – A description of either maintenance procedures or expansion procedures that is relevant to maintenance of the program or expansion of the program.

It is Purchaser's strong preference that software functional descriptions are provided as on- line documentation.

19.8.6 Installation Images and Source Code

All software shall be delivered in three forms:

- As a fully operational system installed on auxiliary memory
- As distribution images suitable for installation on the system

The distribution images shall include all operating system, platform software, application software, and library of modifications incorporated into the delivered software. All standard software shall be supplied on the original installation media used by the Bidder to build the system. All customized software shall be supplied as part of the code management library along with the source code or other distribution image against which the code changes are to be applied.

It shall be possible for Purchaser to completely generate, build, install, and configure the entire System from the distribution images, source code, and software utilities provided with the System. To this end, "make files" or other compilation, generation, and installation tools, scripts, and directives shall be delivered.

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For the purposes of this requirement, "software" shall specifically include the databases supplied with the System. That is, enough definition and content images shall be supplied such that the System databases can be created and installed on the Sub-Station Automation System and other offered systems.

19.8.7 Software Requirements matrix

The Bidder shall provide a list of all software requirements, cross-referenced to show where each requirement is discussed in the relevant software document.

The Software Requirements Matrix shall list each of the requirements for the Sub-Station Automation and other systems stated in this specification, in numerical order, referenced by chapter, section, and paragraph number. This list of specified requirements shall be supplemented by a list of all functions provided by the Bidder's software system that go beyond the specified requirements.

For each requirement on the list, a reference shall be given to the chapter and section where the requirement is described or covered in each of the following of the Bidder's documents:

- Item on the List of Software Deliverables
- Software Functional Description
- Operations Manual
- Factory Acceptance Tests
- Site Acceptance Tests.

19.8.8 Detailed Design Document

The detailed design documents are intended as a second level of detail to the software functional descriptions. In general, a detailed design document shall relate to a single software functional description. It is expected that, for customized software, the Bidder will first deliver a software functional description for approval by Purchaser. After approval, the Bidder will then produce a detailed design document for approval. Production of the software will proceed after approval of the detailed design document.

The detailed software design documentation shall include, but shall not be limited to, the precise design information needed for planning, analysis, and implementation of the software. It shall include a show the divisions of the software design entities; a dependency description specifying the dependent entities, their coupling, and required resources, an interface description providing details of external and internal interfaces not provided in the software functional description; and a detailed design description

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containing the internal details of each design entity.

The detailed software design documentation shall provide a detailed description of how the software will support the functions described in the software functional description. Detailed software design documentation shall include a diagram of the software indicating major modules and an overview of the operation of each module. It shall describe data structures and flow, and a diagram or description of the way the modules interfaces with other modules.

19.8.9 System Maintenance Manual

The System Maintenance Manual shall describe all user procedures necessary to build and maintain the Sub-station Automation System and other supplied systems. It shall provide information on optimizing system performance.

It shall include details on Configuration upgrades, firmware and patch upgrades

The System Maintenance Manual shall also include documentation of the distributed system software supporting the configuration control function, data integrity, startup, restart, and the network management subsystem.

The manual shall provide a list of the Internet Protocol (IP) addresses of all devices in a manner compatible with Purchaser's security standards and shall describe the procedures for upgrading or adding additional devices. The System Maintenance Manual shall provide detailed information on troubleshooting all processors of the Substation automation and other supplied systems. It shall describe the use of error logs, the meaning of all program-generated error or informational messages, and the recommended response to these messages. It shall explain what the user should do to save information after a processor failure and shall describe the procedures to gather this information to allow the user to communicate in an informed manner with maintenance personnel. It shall include a description of the procedures to restore normal operation after a failure of the offered systems.

19.9 Operating Manual

The Bidder shall submit, for review and approval, operating manuals for all Substation Automation functions. The operating instructions associated with all features shall be incorporated into these manuals. 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 user procedures that are used to interact with the Substation Automation functions. The

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manuals shall present in a clear and concise manner all information that a user needs to know to understand and operate satisfactorily. The manuals shall make abundant use of screen snapshots to illustrate the various procedures.

19.10 System Administration Documentation

The Bidder shall submit, for review and approval, all system administration manuals. The system administration instructions associated with all features shall be incorporated into these manuals. Context sensitivity shall be used to go directly to the appropriate place in the manual.

19.11 Database Editor's Manual

The Database Editor's Manual shall describe the procedures to define, build, edit, archive, and expand all the databases of the delivered systems. It shall contain information describing how a user may define and add new attributes to an existing database entity. It shall also describe how to restore any database to a previously saved version if the database had been corrupted.

19.12 Acceptance Test Procedures

Acceptance test procedures (FAT & SAT) designed to test the specified requirements shall be provided. The procedures will comprise step-by-step instructions to verify that:

- a. The system hardware and software are fully present and fully integrated, and its documentation is complete.
- b. All the functional and performance requirements of the contract are met.

The test procedures shall be organized in the order that they are to be performed. Tests that require collection of data under controlled conditions shall be carefully planned with data collection procedures scheduled, as needed, before the tests themselves.

The test procedure shall be prepared in the format of step-by-step guides. Test descriptions, initial conditions, functions to be tested, expected responses, and recording areas are contained in the acceptance test procedures. The steps to achieve these functions may be provided as references to the user manuals or maintenance manuals. An attempt shall be made to cover all normal and abnormal circumstances in the procedures. The goal is to be able to rigorously test the system by strictly following carefully pre-planned procedures with minimum reliance on unstructured testing.

Following documents shall be prepared based on Tata Power Discoms specifications and statutory requirements with Drawing including complete BOM and shall be submitted with the bid:

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- a) Signed & stamped copy of clause-wise compliance on Technical Specification
- b) General description & drawing of the equipment
- c) Type test Certificates with drawings
- d) Experience List
- e) Drawing with complete BOM
- f) Signed & stamped copy of pre-bid queries
- g) Signed & stamped copy of No deviation certificate

After the award of the contract, following documents shall be submitted by the successful Bidders before starting of manufacturing

- a) Signed & stamped copy of clause-wise compliance on Technical Specification
- b) complete equipment drawing with BOM
- c) Foundation Plan Details
- d) spare list
- e) compliances on undertaking provided during technical evaluation as applicable
- f) O&M/Instruction Manual
- g) QAP

DRAWING (General Arrangement shall be as per drawing. However, dimensions are subject to change as per Manufacturers type tested design while maintaining required clearances and relevant Specification)

Note: Degree of protection shall be IP 55 instead of IP 54 mentioned in drawing

*For Reference purpose only.

Dimensions may vary as per ACB rating and Manufacturer's type tested design.

20. GUARANTEED TECHNICAL PARTICULARS

Bidder shall have to comply & submit clause wise compliance of this specification.

21. SCHEDULE OF DEVIATIONS **(TO BE ENCLOSED WITH TECHNICAL BID)**

All deviations from this specification shall be set out by the Bidders, clause by Clause in this schedule. Unless specifically mentioned in this Schedule, the tender shall be deemed to

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confirm the purchaser's specifications:

	Clause No.	Details of deviation with justifications

We confirm that there are no deviations apart from those detailed above.

Seal of the Company:

Signature

Designation

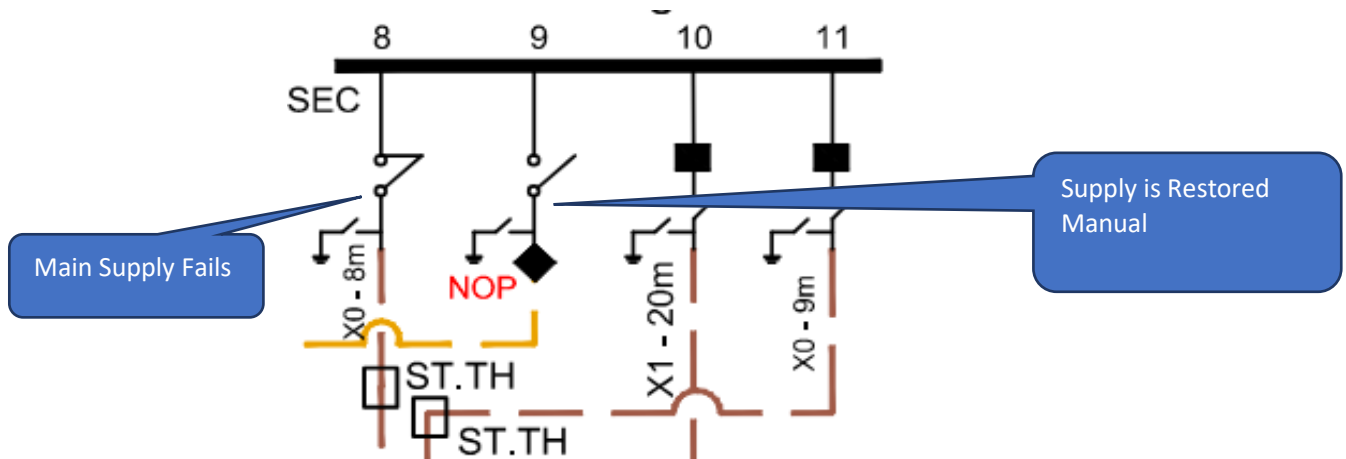
Door layout of FRTU



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Annexure -II

Auto Changeover logic Concept of Self-Healing via Auto Changeover



Self-Healing Logic Implementation

Primary (LBS1) and Secondary (LBS2) Sources: The system designates one LBS as the primary and another as the secondary source, enabling auto-switching between them based on supply status.
Step-by-Step Process:

1. When primary supply (LBS1) fails, LBS1 opens and LBS2 closes to restore supply from the secondary source after approximate 30 seconds (10 seconds delays for confirmation of each status)
2. Once primary supply is restored, the system reverts to the original configuration, with LBS1 closing and LBS2 opening, re-establishing the main source.

Each self-healing logic operation takes 30-34 seconds: 10 seconds for status confirmation and 7 seconds for each motor operation.

Conditions for Activation of Self-Healing Logic

The self-healing logic activates only when the following conditions are met:

1. FRTU Power Status: FRTU must be powered ON.
2. SF6 Gas Pressure: SF6 pressure must be at acceptable levels; low SF6 will disable the self-healing feature.
3. Switches in Remote Mode: Local/Remote switch status must be in Remote mode across LBS1, and LBS2 panels, however it should be independent of FRTU Local/Remote.
4. No General Trip or Fault Indicators: Fault Passage Indicators (FPI) or general trip indicators must be inactive; otherwise, the self-healing logic remains disabled.

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Logic matrix for operation

Event	Operation	SF6 GAS PRESSURE	Auto/ Manual Switch	LBS1 VPIS status	LBS2 VPIS status	LBS1 status	LBS2 status	FPI (E/F)	FPI (O/C)	General Trip	Self-Healing Logic (From Scada)	FRTU Local/ Remote Switch	LBS1 Panel Local/ Remote Switch	LBS2 Panel Local/ Remote Switch
New RMU charged	LBS1 Close	Healthy	Auto	On	On/Off	Off	Off	Off	Off	Off	Enable	Local/ Remote	Remote	Remote
Primary supply fail	LB1 Open	Healthy	Auto	Off	On	On	Off	Off	Off	Off	Enable	Local/ Remote	Remote	Remote
Primary supply fail	LBS2 Close	Healthy	Auto	Off	On	Off	Off	Off	Off	Off	Enable	Local/ Remote	Remote	Remote
Restoration of Primary Supply	LBS2 Open	Healthy	Auto	On	On/Off	Off	On	Off	Off	Off	Enable	Local/ Remote	Remote	Remote
Restoration of Primary Supply	LBS1 Close	Healthy	Auto	On	On/Off	Off	Off	Off	Off	Off	Enable	Local/ Remote	Remote	Remote

Annexure -III

Standard PIN Configuration of FRTU for RMU

TB No	Signal List For LBS	
1	24V Positive / Common for Command	16 Pin harting Pin Connector & Cable size : 19CX1.5Sqmm Copper Control Cable
2	LBS1 ON Status	
3	LBS1 OFF Status	
4	E/S ON Status	
5	E/S OFF Status	
6	L/R In Remote Status	
7	24V Negative/Common for Command	
8	FPI Reset	
9	FPI S/C Status	
10	FPI E/F Status	
11	VPIs Status	
12	LBS ON Command	
13	LBS OFF command	
14	Motor enabled condition	
15	Common for Status	
16	Spare	
TB No	Signal List for CB	
1	24V Positive / Common for Command	16 Pin harting Pin Connector & Cable size : 19CX1.5Sqmm Copper Control Cable
2	CB1 ON Status	
3	CB1 OFF Status	
4	E/S-1 ON Status	

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5	E/S-1 OFF Status	
6	DC-1 ON Status	
7	DC-1 OFF Status	
8	L/R In Remote Status	
9	24V Negative/Common for Command	
10	RELAY OPERATED	
11	VPIs Status	
12	CB ON Command	
13	CB OFF command	
14	Motor enabled condition	
15	Common for Status	
16	Spare	
TB No	Signal List _ Miscellaneous	
1	24V Positive / Common	16 Pin harting Pin Connector & Cable size : 19CX1.5Sqmm Copper Control Cable
2	AC FAIL	
3	BATT.LOW	
4	BATT. FAIL	
5	BATT.CHARGER FAIL	
6	SF6 PRESSURE LOW	
7	FRTU _Door _Open	
8	FRTU _L/R _ Remote	
9	24V Negative/Common	
10	Trafo-01 Trouble (Site Specific_ Optional)	
11	Trafo-02 Trouble (Site Specific_ Optional)	
12	LT ACB -01_ Open (Site Specific_ Optional)	
13	LT ACB -02_ Open (Site Specific_ Optional)	
14	Dummy Breaker ON	
15	Dummy Breaker Status	
16	RMU Door Open Status	
01	Self healing of RMU _ Soft signal	
Serial Comm : PROTECTION RELAY	RX+	Cable: 0.36 sqmm. 4P, shielded twisted pair RS-485 serial cable
	TX+	
	RX-	
	TX-	

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Annexure – IV: Preferred/Approved Make of Equipment/System

Sl. No.	Item Description	Preferred Make / Model
1	FRTU	ABB / SIEMENS / SCHNEIDER / GE / Synergy/ Reputed Make for T&D function
2	4G Modem cum Router	Lantronix / Teltronics /XNet /Schneider/ Equivalent
3	Industrial Grade FRTU Panels	Rittal /Siemens/Pyrotech/Equivalent
4	Layer 2 Managed Ethernet Switch	Ruggedcom / Hirschman / MOXA/CISCO/ Equivalent
5	I/O Boxes	Systemax/Tyco/CommScope/ Equivalent
6	Armored SFTP CAT6 Cable	Systemax/Tyco/CommScope/Finolex/Polycab/Digisol/Any reputed OEM
7	Unarmored SFTP Cable	Systemax/Tyco/CommScope/Finolex/Polycab/Digisol/ Any reputed OEM
8	Patch Panel (RJ45) with Connectors, I/O boxes	Systemax/Tyco/CommScope/ Equivalent
9	CAT6 UTP Patch Chords	Systemax/Tyco/CommScope/ Equivalent
10	4P X 0.36 Sq.mm. Armored Communication Cable (Multistrand, individual pair and overall shielded)	Belden/LAPP/SATYAM/KEC/Digisol/Polycab/Parashield/ Equivalent
11	4P X 0.36 Sq.mm. Unarmored Communication Cable (Multistrand, individual pair & overall shielded)	Belden/LAPP/SATYAM/KEC/Digisol/Polycab/Parashield/ Equivalent
12	RS 232 / RS 485 converter	MOXA / Advantech/ Equivalent
13	Battery Charger	Delta/Amara raja/Mass tech/Chloride /Schneider/Go Gate/ Equivalent
14	Diode-Oring Unit	Paramount / Phoenix/ Equivalent
15	Droppable type Terminal Block for Digital Output, CT & PT	Connect well – CBT4U or equivalent
16	Disconnecting type (Knife edge) Terminal Block for Digital Input	Connect well – CKT4U or equivalent
17	Battery	Amaron, HBL, Coslight, Exide or equivalent
19	Multifunction Meter	SATEC/ Secure / Rishav / Accord /Equivalent
20	Auxiliary Relays	OMRON / ABB / Sulzer / OEN / Paramount/ Equivalent
21	Control Cable	CCI / FORT GLOSTER / FINOLEX / HAVELLS / Indian aluminum Cables / Universal Cables / Incab / Asian Cable / KEI / Polycab / Ruchika/ Any reputed OEM
22	MCB	Siemens / Schneider / Anchor / Havells/ Any reputed OEM