

Chapter-1

INTRODUCTION & GENERAL INFORMATION

1.0 Introduction: -

As per Government of India's commitment for providing 24x7 uninterrupted, quality, reliable and affordable power supply, that the Revamped Reforms Based and Results Linked Distribution Sector Scheme has been formulated by Ministry of Power for supporting DISCOMs to undertake reforms and improve performance in a time bound manner.

The Revamped Reforms-based and Results-linked, Distribution Sector Scheme seeks to improve the operational efficiencies and financial sustainability, by providing conditional financial assistance to DISCOMs for strengthening of supply infrastructure based on meeting pre-qualifying criteria and achieving basic minimum benchmarks.

The Revamped Distribution Sector Scheme has the following parts:

Part A - Metering & Distribution Infrastructure Works: Facilitating in installing smart prepaid meters for all consumers, communicable meters integrated with AMR for all DTs & Feeders and a unified billing and collection system¹; Feeder Segregation, aerial bunched cables, SCADA and distribution management system (DMS) in urban areas and regular distribution infrastructure creation and strengthening works in all areas.

Part B - Training & Capacity Building and other Enabling & Supporting Activities: Supporting and enabling components, such as Nodal Agency fee, enabling components of MoP (communication plan, consumer awareness and other associated measures such as third-party evaluation etc), up-gradation of Smart Grid Knowledge Centre, training and capacity building, awards, and recognition etc.

1.1 Objectives

The objectives of the scheme are to:

- Improve the quality, reliability and affordability of power supply to consumers through a financially sustainable and operationally efficient distribution sector.
- Reduce the AT&C losses to pan-India levels of 12-15% by 2024-25;
- Reduce ACS-ARR gap to zero by 2024-25.

The state-wise targets will depend on their current levels of AT&C losses and ACS-ARR gap.

1.2 Parts of the Scheme

The Scheme has the following parts -

- **Part A**
 - Component I: Metering
 - Component II: Distribution Infrastructure Works
 - Component III: Project Management
- **Part B:** Training, Capacity Building, and other Enabling & Supporting Activities.

1.2.1 Eligible Works and Activities under Part A – Metering

- Facilitating in installing prepaid smart meters for all consumers along with associated AMI, communicable meters for DTs & Feeders, ICT including Artificial Intelligence (AI), Machine Learning (ML), etc. based solutions for power Sector and a unified billing and collection system.
- Distribution infrastructure works as required for strengthening and modernizing the system as well as measures for loss reduction. The infrastructure strengthening works will include separation of Agriculture feeders to enable implementation of the KUSUM scheme, Aerial Bunch cables and HVDS for loss reduction, replacement of HT/LT lines as required, construction of new/ up-gradation of substations, SCADA and DMS system etc. Each DISCOM/ State will draw up the scheme according to its requirement with the end objective of reducing losses and ensuring 24 x 7 supply.

1.2.2 Eligible Works and Activities under Part A- Distribution Infrastructure Works

Under this component, DISCOM can take up work related to loss reduction and system strengthening. 33kv level and below will be eligible under this component. In areas, where 33kv system does not exist, 110 kV/ 66kV shall be permitted. A list of indicative works is given below:

- i. Construction of new substations, augmentation of substations
- ii. Provision of Armored / Aerial bunched Cables (ABC) or High Voltage Distribution System in high loss areas.
- iii. Segregation / Bifurcation of feeders and other allied works
- iv. Replacement of conductors, which are old/frayed.
- v. Additional HT lines to improve quality of supply.
- vi. IT/OT works
- vii. Supervisory Control and Data Acquisition (SCADA) and Distribution Management System (DMS) in urban areas
 - SCADA/DMS/OMS AND SUB-STATION AUTOMATION in 100 towns (approx.) with eligibility of towns having-population ≥ 1 Lacs. in special category states and towns having population ≥ 2.75 Lacs in other states as per Census 2011 data, as well as all Capital/DISCOM HQ towns, if not covered earlier.
 - Basic SCADA in 3875 towns approx. based on district-wise or Circle-wise common control centers in all other statutory towns.

- viii. Works like new feeders, capacitors etc. for loss reduction
 - ix. Under-ground cabling works
 - x. Any other works required for system strengthening and loss reduction.
- Segregation of feeders dedicated only for supply of power for agricultural purpose, which are proposed to be solarized under Kisan Urja Suraksha Evam Utthan Mahabhiyan (KUSUM) scheme will be sanctioned on priority under the scheme. Further, agricultural feeders once segregated will not be used for serving other non-agricultural consumers.

1.2.3 Eligible entities for Part A

All State-owned Distribution companies and State /UT Power Departments (referred to as DISCOMs collectively) excluding private Sector power companies will be eligible for financial assistance under the revamped scheme. The State transmission utilities which own and operate network at 110 kV and 66 kV levels in areas where 33 kV system does not exist shall also be eligible (for this purpose, all eligibility, and other relevant parameters of respective DISCOMs shall be evaluated) Further, funds release and any coordination shall be through DISCOM only, for such works to be executed in the specific manner by the transmission utility).

The scheme would be optional to DISCOMs and will be implemented in urban and rural areas of all States/UTs except private DISCOMs.

1.2.4 Eligible Works and Activities under Part B -

Part B encompasses work related to Training, Capacity Building and other Enabling & Supporting Activities

1.3 SCADA /DMS system

The objective of reducing Aggregate Technical and Commercial (AT&C) losses in the project area can be achieved by plugging pilferage points & reliability by improvement in supply of quality power, faster identification of faults & early restoration of power, proper metering, strategic placement of capacitor banks & switches, proper planning and design of distribution network. Bidder /Contractor responsible to implementation of the system shall be SIA (SCADA Implementation Agency)

1.3.1 Groups of SCADA system eligibility criteria's & components

1.3.1.1 Group-A : SCADA /DMS system in towns

1.3.1.1.1 Eligibility

The real time monitoring & control of the distribution system through state-of-the art SCADA/DMS/OMS AND SUB-STATION AUTOMATION system encompassing all distribution Sub-stations & secondary network emanating from S/S achieve objective of this scheme. SCADA/DMS/OMS AND SUB-STATION AUTOMATION system for Towns with following criteria shall be eligible.

Non special category states	
	<ul style="list-style-type: none"> • Town population ≥ 2.75 Lacs (as per 2011 Census data) in non-special category states and Capital /Discom/PD HQ towns
Special category states	
	<ul style="list-style-type: none"> • Town population ≥ 1 Lacs (as per 2011 Census data) in special category states and Capital /Discom HQ towns

Further, works in existing SCADA /DMS towns due to outgrowth /suburb and differential area/electrical network (newly added S/S , Feeders) or functions such as OMS ,FPI , additional RTU/ FRTU w.r.t RAPDRP or legacy SCADA/RT-DAS (For new locations or locations where faulty equipment or equipment with end of life) may be considered as up-gradation of the system as **Group U towns**

Further, where under IPDS is commissioned, the FRTU shall act as Sub RTU to new RTU and report all Input points captured to new RTU and I/O card for differential points may only be considered in configuration of new RTU in order maximize usage of infrastructure created under RT-DAS

In case of numerical relays, RTU at substations to act as gateway, data concentrator for numerical relays/ BCPUs connected over IEC 61850 and I/O Cards in RTUs to be configured accordingly i.e. for bays where requisite I/Os are not served through numerical relays/ BCPUs

1.3.1.1.2 Components of Group- A Noida towns

Major components that a SCADA /DMS implementation would include are given asunder. However, the final scope of work will be finalized by the utilities as per their requirements in the relevant RFP document. Survey, Design, Engineering , Installation, Testing ,Commissioning , Go-Live & service based (SLA) for utility for:

- a. SCADA/DMS/OMS AND SUB-STATION AUTOMATION Control Centre (SDCC) at each Group-A town
- b. Common Disaster Recovery Centre for SCADA/DMS/OMS AND SUB-STATION AUTOMATION for group-A towns per utility or town as per requirement and availability of infrastructure (Building etc.) by utility (CDRC)
- c. SCADA & Information Storage & Retrieval (ISR) Functions
- d. Load Shed application (LSA)
- e. Outage data analytics and reporting (ODAR)
- f. DMS Functions
 - i. Network Connectivity Analysis (NCA)
 - ii. State Estimator (SE)
 - iii. Load Flow (LF)

- iv. Voltage VAR Control (VVC)
- v. Fault Management and System Restoration (FMSR)
- vi. Feeder Reconfiguration, Loss Minimization, Load Balancing, LMFR, LBFR)
- vii. Operation Monitor (OM)
- g. OMS Functions
 - i. Trouble call & Outage Management System (TCOMS)
 - ii. Crew assignment & Work Order Management (CAWOM)
 - iii. Mobile APP, Web client for Crew (MAWC)
- h. SCADA/DMS/OMS AND SUB-STATION AUTOMATION/ Dispatcher training simulator (DTS) for each town
- i. SCADA/DMS/OMS AND SUB-STATION AUTOMATION system to supervise & control primary S/S & secondary HV Distribution network.
- j. RTUs at all primary S/S & FRTUs at RMUs, /Auto Reclosers/Sectionalizes, FPI communicable on secondary HV Distribution network etc. MFTs at Feeders
- k. Ring Main Units (RMUs) suitable for multi-feed systems for proposed loads
- l. Sectionalizes for sectioning the circuit.
- m. Auto reclosers at proposed feeder heads
- n. Fault passage Indicators (Communicable) for fault reporting
- o. Secured Communication using VPN/SSL
 - i. MPLS network for connecting all S/S RTUs to Main & DR center.
 - ii. Secured GPRS/DLC etc. for communicating FRTUs /FPIs with control centers.
- p. Protocols for communication
 - i. IEC 60870-5-104 –RTU, IEC 60870-5-104/101 for FRTUs, FPI to control centers.
 - ii. MODBUS or IEC 60870-5-101/104 – MFTs to RTUs/FRTUs
 - iii. ICCP (TASE.2) between SCADA/DMS/OMS AND SUB-STATION AUTOMATION Control center /DR center & state-load dispatch center(optional)
 - iv. Support /compliance to IEC61850, IEC 60870-5 suite for RTU/CC for numerical relays
- q. Support /compliance to DLMS/ IEC 62056 for SMART meters.

- r. Cyber security compliance from CERT.IN empanelled agencies and any other notified MoP/Nodal agency /CEA from time to time.
- s. Machine to Machine requisite data transfer of reliability to National Power Portal or any other portal as directed by MoP /PFC / CEA in the desired format such as JSON Object, XML , CSV etc.
- t. Conducting Factory Acceptance Test (FAT), Site Acceptance Test (SAT), Type test (as required), etc. successfully, Go live, operational acceptance & handing over to customer.
- u. Service based (SLA) support for utility post enterprise Go-Live to utility

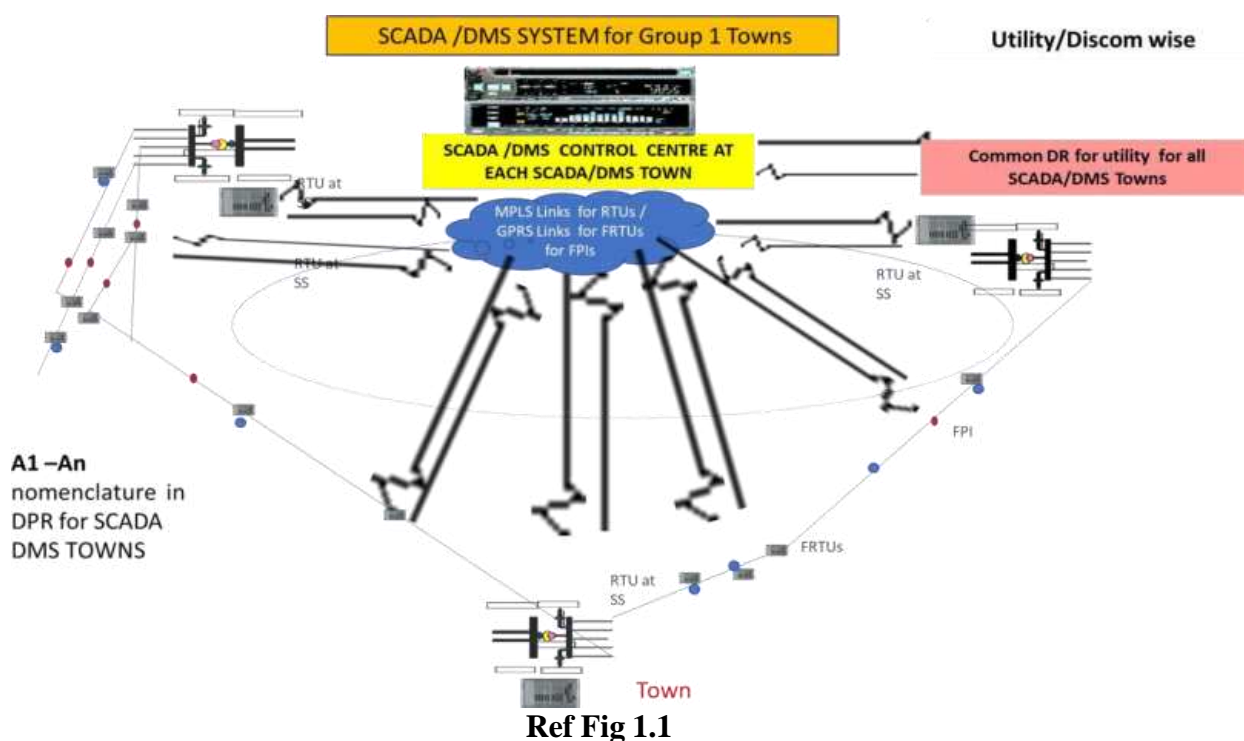


FIG - SCADA DMS CONTROL CENTRE (SDCC) FOR EACH SCADA/DMS TOWN (GROUP A

1.3.1.2 Group-B : SCADA system in towns

1.3.1.2.1 Eligibility

The real time monitoring & control of the distribution system through state-of-the art SCADA system encompassing all distribution Sub-stations & FPIs at secondary network emanating from S/S to achieve objective of this scheme. SCADA system for Towns with following criteria shall be eligible.

- **SCADA in towns based on Common district-wise or Circle-wise or Zone wise common control centers in all other statutory towns (2011 census) with population 25000 or more.**

1.3.1.2.2 Components of Group- B Noida towns

Major components that a SCADA implementation would include are given as under. However, the final scope of work will be finalized by the utilities as per their requirements in the relevant RFP document. Survey, Design, Engineering, Installation, Testing, Commissioning, Go-Live & service based (SLA) utility for :

- Common District/ Circle /Zone - wise, Standard SCADA Control Centre (SSCC) for all eligible in the district. (A district control center can be clubbed in to Zonal SCADA control centers (ZSCC) adjoining districts if present count of aggregated O/G Feeders is up to 400 feeders This includes monitoring of Substations of Group C also) . Further, for Ladakh, Manipur, Mizoram, Nagaland, Meghalaya, Sikkim, Arunachal Pradesh, Tripura, Andaman, Puducherry, DNH&DD ,Goa , Lakshadweep shall have common ZSCC in each state for all towns for SCADA besides SDCC for capital town.
- Common Data Recovery Centre for SCADA for group-B towns per utility
- SCADA & Information Storage & Retrieval (ISR) Functions
- Network Connectivity Analysis (NCA)
- State Estimator (SE)
- Load Flow (LF)
- Load Shed Application (LSA)
- Outage data analytics and reporting (ODAR)
- SCADA Dispatcher training simulator (DTS) per Control center
- SCADA system to supervise& control primary S/S & monitor FPIs at secondary HV Distribution network.
- RTUs at all primary S/S &, FPI communicable on secondary HV Distribution network etc. MFTs at Feeders
- Fault passage Indicators (Communicable/ Non-Communicable) for fault reporting
- Secured Communication using VPN/SSL
 - MPLS network for connecting all S/S RTUs to Main & DR center.
 - Secured GPRS/DLC etc. for communicating FPIs with control centers.
- Protocols for communication
 - IEC 60870-5-104 –RTU, IEC 60870-5-104/101 for FRTUs, FPI to control centers.

- MODBUS or IEC 60870-5-101/104 – MFTs to RTUs
- ICCP (TASE.2) between SCADA/DMS/OMS AND SUB-STATION
AUTOMATION Control center /DR center &state load dispatch
center(optional)
- Support /compliance to IEC61850, IEC 60870-5 suite for RTU/CC for
numerical relays

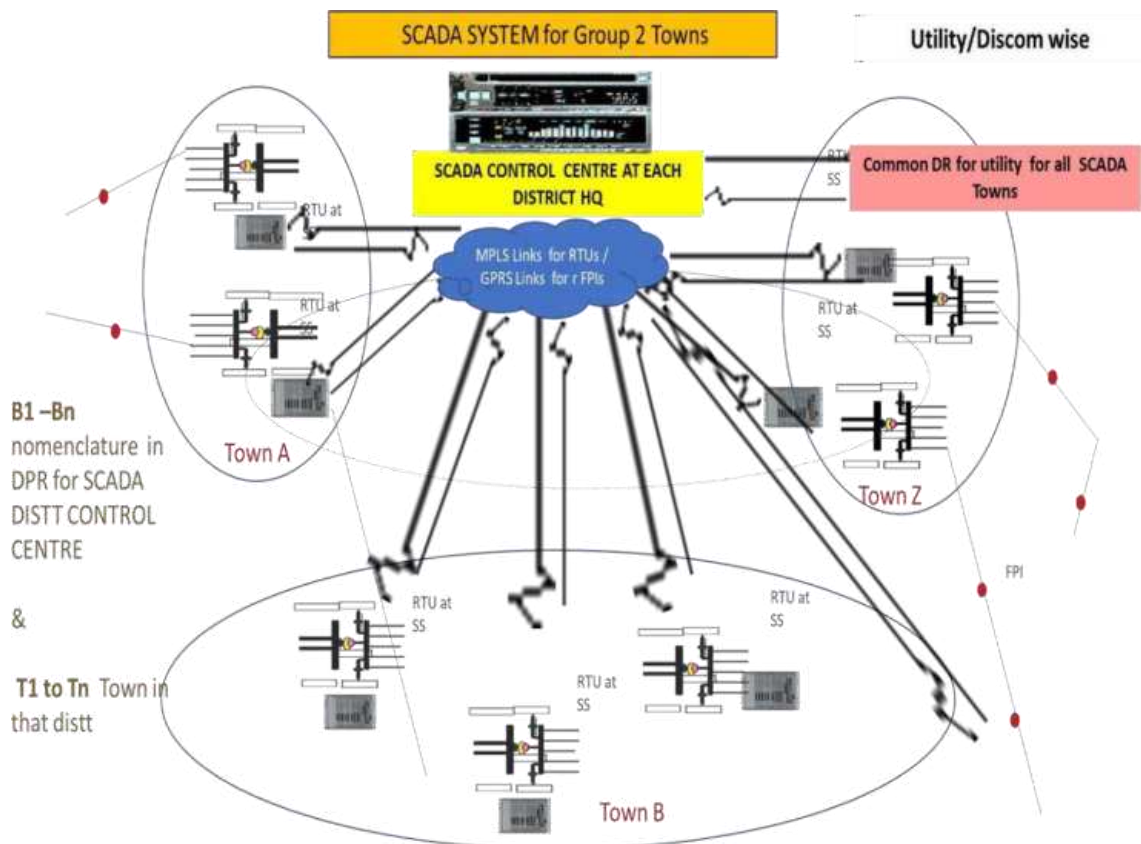


FIG – STANDARD SCADA CONTROL CENTRE (SSCC) FOR DISTT OR ZONAL SCADA CONTROL CENTRE (ZSCC EACH SCADA AND RT-DAS TOWNS (GROUP B & C)

Ref. Fig 1.2

- Support /compliance to DLMS/ IEC 62056 for SMART meters.
- Cyber security compliance from CERT.IN empanelled agencies and any other notified MoP/Nodal agency /CEA from time to time.
- Machine to Machine requisite data transfer of reliability to National Power Portal or any other portal as directed by MoP /PFC / CEA in the desired format such as JSON Object, XML, and CSV etc.

- Conducting Factory Acceptance Test (FAT), Site Acceptance Test (SAT), Type test (as required), etc. successfully, Go live, operational acceptance & handing over to customer.
- Service based (SLA) support during FMS for utility post Operational acceptance (S.A.T)
- Further , where under IPDS is commissioned , the FRTU shall act as SubRTU to new RTU and report all Input points captured to new RTU and I/O card for differential points may only be considered in configuration of new RTU in order maximize usage of infrastructure created under RT-DAS
- In case of numerical relays, RTU at substations to act as gateway, data concentrator for numerical relays/ BCPUs connected over IEC 61850 and I/O Cards in RTUs to be configured accordingly i.e. for bays where requisite I/Os are not served through numerical relays/ BCPUs

1.3.1.3 Group-C : RT-DAS system in Noida towns

1.3.1.3.1 Eligibility

The real time monitoring of the distribution system through state-of-the a RT-DAS system encompassing all distribution Sub-stations & FPIs at secondary network emanating from S/S to achieve objective of this scheme. SCADA system for Noida Towns with following criteria shall be eligible.

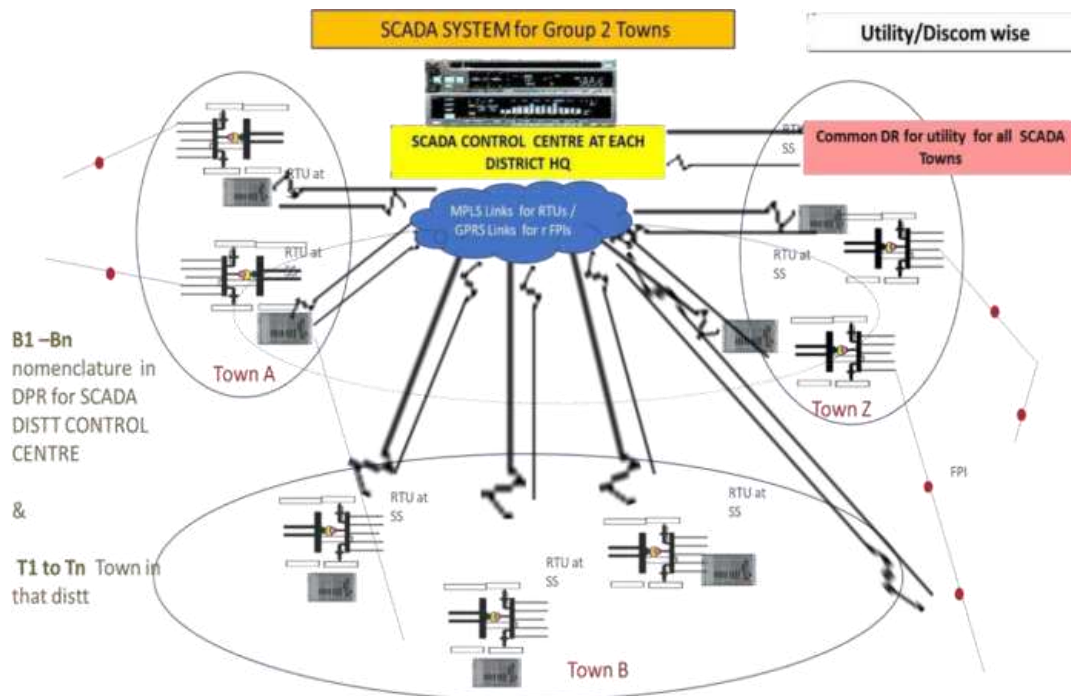
- **RT-DAS in Noida towns based on Common district-wise or Circle-wise or Zone wise common control centers of Group B in all other statutory towns (2011 census) with population less than 25000.**

1.3.1.3.2 Components of Group- C towns

Major components that a RT-DAS implementation would include are given as under. However, the final scope of work will be finalized by the utilities as per their requirements in the relevant RFP document. Survey, Design, Engineering, Installation, Testing, Commissioning, Go-Live & service based (SLA) for utility for:

- Common District/ Circle /Zone - wise, Standard SCADA Control Centre (SSCC) for all eligible in the district. (A district control center can be clubbed Zonal SCADA control centers (ZSCC) adjoining districts if present count of aggregated O/G Feeders is up to 400 feeders This includes monitoring of Substations of Group C also . Further, for Ladakh, Manipur, Mizoram, Nagaland, Meghalaya, Sikkim, Arunachal Pradesh, Tripura, Andaman, Puducherry, DNH&DD, Goa, Lakshadweep shall have common ZSCC in each state for all towns for SCADA besides SDCC for capital town.
- Real time Data Acquisition & Information Storage & Retrieval (ISR) Functions
- Network Connectivity Analysis (NCA)
- State Estimator (SE)
- Load Flow (LF)
- Outage data analytics and reporting (ODAR)
- RT-DAS system to supervise primary S/S & monitor FPIs at secondary HV Distribution network.
- RTUs at all primary S/S &, FPI communicable on secondary HV Distribution network etc. MFTs at Feeders
- Fault passage Indicators (Communicable/ Non Communicable) for fault reporting
- Secured Communication using VPN/SSL
 - MPLS network for connecting all S/S RTUs to Main & DR center.

- Secured GPRS/DLC etc. for communicating FPIs with control centers.
- Protocols for communication
 - IEC 60870-5-104 –RTU, IEC 60870-5-104/101 for FRTUs, FPI to control centers.
 - MODBUS or IEC 60870-5-101/104 – MFTs to RTUs
 - ICCP (TASE.2) between SCADA/DMS/OMS AND SUB-STATION AUTOMATION Control center /DR center &state load dispatch center(optional)
 - Support /compliance to IEC61850 ,IEC60870-5 suite for RTU/CC for numerical relays



Ref Fig 1.3

RT-DAS FOR GROUP C TOWNS

- Support /compliance to DLMS/ IEC 62056 for SMART meters
- Cyber security compliance from CERT.IN empanelled agencies and any other notified MoP/Nodal agency /CEA from time to time.
- Machine to Machine requisite data transfer of reliability to National Power Portal or any other portal as directed by MoP /PFC / CEA in the desired format such as JSON Object, XML , CSV etc.
- Conducting Factory Acceptance Test (FAT), Site Acceptance Test (SAT), Type test (as required), etc. successfully, Go live, operational acceptance & handing over to the customer.
- Service based (SLA) support during FMS for utility post Operational acceptance (S.A.T)

1.3.2 Make in India

Keeping in view the aims and objectives of Atma Nirbhar Bharat Abhiyan, Ministry of Power has issued Public Procurement (Preference to Make in India) for Purchase Preference (linked with local content) Order in respect of Power Sector on 28.7.2020. This order is in line with the DPIIT Notification No.P-45021/2/2017-PP (BE-II) dated 4th June, 2020. This order along-with amendments, if any, from time to time, shall be followed by the DISCOMs and bidder in the implementation of the scheme.

1.3.3 Broad Role Definition for SIA

The SIA in coordination with utility (as per the requirement to be given in the detailed RFP and Group A (Noida Town) , B , C, U towns) shall carry out field survey, design ,engineering, supply, installation, testing & commissioning of SCADA/DMS/OMS AND SUB-STATION AUTOMATION software applications, Dispatcher Training Simulator (DTS) , hardware (including PCs, Servers, Routers, Switches, VPS, RTU, FRTUs, Multi-function Transducers (MFTs), Communication equipment , Auxiliary power supply etc.), software (including operating system, databases, network management system etc.), network (LAN,WAN), RMUs, Sectionalizers, A/R , FPIs etc.

Integration with existing /under implementation IT system under IPDS & any other relevant SCADA/ DMS or RT-DAS legacy/ Numerical relay in the identified project areas of the utility in the RFP

DATA of outage /SAIDI/SAIFI to be transported In machine to machine mode to National Power portal or any other GoI portal as notified in future.

Integration with State Load Dispatch center (SLDC) for the state for exchanging relevant real time data & scheduling data over ICCP if opted by utility. In case utility includes data exchange facility with SLDC, then it is their responsibility to do necessary bilateral agreement for data exchange with TRANSCO or owner of SLDC. &facilitate necessary help to SIA

Facilities management services for maintaining infrastructure as per SLA , post successful completion of acceptance tests for a period of five years from the date of completion of acceptance test.

The key components of the model RFP includes & not limited to following:

- 1) **Hardware:** site survey, planning, assembly/ manufacturing, design & Engineering, Supply, loading, transportation, unloading, insurance, delivery at site, handling, storage, installation, testing, commissioning and documentation of all necessary hardware and networking equipment and its connectivity, as specified in the detailed specifications. The SIA shall take the responsibility to install the servers, RTU/FRTU, MFTs, Video Projection System (VPS) switches, routers, backup and tape devices, Workstation PCs, Aux Power supply, communication equipment, RMUs, Sectionalizes, A/R, FPIs etc. and other necessary hardware/software at the sites. The SIA shall provide the time frame for procuring and delivering all the necessary hardware. Though the scope covers establishment of a SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center along with associated hardware and software, the SIA shall design and provide the Software & hardware at SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center including RTU/FRTU locations with 100% expandability for future growth in electrical distribution network of the city. The delivered hardware (Processor ,HDD, RAM & software etc.) for servers, PCs, RTU, FRTU etc. shall be sized for ultimate system sizing while maintaining the performance, availability & functions as per specification. However, other items such as I/O modules, additional workstation can be added as per the growth in the network. The SIA shall provide the necessary design & engineering documents, drawings and plan, sizing, cabling and connectivity and the bill of material, etc. & obtain approval from utility
- 2) **Software:** Site survey, planning, assembly/ manufacturing, design & Engineering, Supply, loading, transportation, unloading, insurance, delivery at site, handling, storage, installation, testing, commissioning and documentation of operating systems at servers/desktops, database and SCADA/DMS/OMS AND SUB-STATION AUTOMATION, OMS, application software etc.
- 3) **Facilities management services (FMS)** for maintaining infrastructure, activities for creation/ modification /deletion of database / display, reports , GIS data maintenance and activities related to additional RTU/FRTU/ and enablers etc. procured by utility to cater growth of electrical distribution network . During the FMS period any creation modification/addition/deletion of database incl. GIS , RTU/FRTU/displays/ reports, limits setting etc. shall be ensured in line with growth of electrical network in form of new like RTU/FRTU/ RMU/Sectionalizes/ FPIs , numerical replays etc. and requirement provided by utility. The activities shall be ensured for at-least post successful completion of acceptance tests for a period of seven years from the date of completion of operational acceptance of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION System. However, under RDSS scheme, utilities will be funded & awarded for FMS for two years from the date of Go-Live / S.A.T only but bids will be evaluated considering 5 years of FMS

The Contractor shall be required to provide the services under FMS so as to manage entire system including all equipment, installations including hardware, software &

networks installed & commissioned by Contractor for the utility in order that they meet the availability requirement as specified in the document.

The System Management Services shall be provided by SIA as FMS Contractor in order that maximum uptime & performance levels of systems installed are ensured. As such, FMS Contractor is expected to provide services as per ITIL (IT Infrastructure Library) standards with performance levels meeting or exceeding those mentioned in Service Level Agreement (SLA) agreed between utility & Contractor.

To achieve the desired Service Levels, the Contractor may need to interact, coordinate and collaborate with the other Service Providers as required. The Contractor will act as the Single Point of Contact for all issues relating to the Service Levels. The Contractor will have the responsibility to deal with the other vendors (during warranty period) /other vendors as selected by utility (after warranty period) as the case maybe, to provide the services at agreed service levels. However, the prime responsibility of providing desired services shall be that of lead Contractor during warranty period. The role of SIA as FMS Contractor (shall start immediately after systems are installed, commissioned and handed over to the owner after Operational acceptance (S.A.T) of the System.

The Scope of Work shall include the software and hardware maintenance support to be provided by the Contractor in respect of the system supplied including interim audit in case of major change and regular annual Cyber security audit by CERT.IN empanelled agency or any agencies notified by MoP/GoI /Nodal agency under this project during 5 year Facility Management Services (FMS) period along with Supervision & Operationalizing 7 year warranty of the SCADA,DMS, System and communication network after the Operational Acceptance of the same.

- 4) **System Design and Engineering:** The SIA shall be responsible for detailed design and engineering of overall system, sub-systems, elements, system facilities, equipment, services, including systems application software and hardware etc. It shall include proper definition and execution of all interfaces with systems, equipment, material and services of utility for proper and correct design, performance and operation of the project.

SIA shall provide complete engineering data, drawings, reports, manuals and services offered etc. i.e. complete set of documentation /drawings for Utilities review, approval and records

- 5) **Supply of Equipment and Material:** The SIA shall also be responsible for manufacture, inspection at manufacturer's works, supply, transportation, insurance, delivery at site, unloading, storage, complete supervision, installation and successful commissioning of all the equipment, systems and application software. The proposed deliverables should be state of the art in architecture and engineering practices In case of third party products/software packages, SIA should furnish at least 7 years warranty along with supporting plan from respective OEMs to support FMS time line

Any item though not specifically mentioned, but is required to complete the project works in all respects for its safe, reliable, efficient and trouble free operation & to meet performance ,availability & functional requirements as envisaged in the RFP shall

also be taken to be included, and the same shall be supplied and installed by the SIA without any extra cost

- 6) **Testing and Commissioning:** The SIA shall be responsible for the testing processes such as planning (includes preparing test plans and defining roles and their responsibilities), preparation (consists of preparing test specification, test environment and test data) for all tests viz. Type tests, FAT, SAT and successful commissioning. During the FMS period any modification/addition/deletion of database/displays/reports etc. shall be ensured in line with growth of electrical network in form of new like RTU/FRTU/ RMU/Sectionalizers / FPIs provided by utility. SIA shall also be responsible for successful conduction of cyber security audit by CERT.IN empanelled agency.
- 7) **Geographical Scope:** The Locations where the systems shall be implemented shall be detailed by the particular utility in the RFP
- 8) **Integration Scope:** SIA should ensure that legacy systems and the new solutions lined up by them are tightly integrated and do not remain stand-alone and shall perform on real time basis as envisaged in specifications. All required external systems shall be integrated using an integration middleware layer. The scope of integration of external systems includes, legacy SCADA/DMS/OMS AND SUB-STATION AUTOMATION system, RTU/FRTU, IT systems, Numerical relays etc. including billing , customer care , GIS etc. already existing and functional in the utility, but outside the present scope of work and defined in RFP by utility . The integration is expected to be Industry Standards Based on IEC 61968-1 Bus (SOA Enabled on enterprise Bus) using CIM/XML, OPC, ICCP etc., which is, on-line, real time or offline where appropriate and shall operate in an automated fashion without manual intervention, which is documented for future maintenance.
SIA shall make necessary provisions/software linkages in the proposed solution so that the IT system or any legacy SCADA/DMS/OMS AND SUB-STATION AUTOMATION system may be integrated seamlessly.
- 9) **Training for Employees:** The SIA shall organize training to the core Group of implementation team of the utility as well as end user training. Representatives from the successful bidder, Purchaser's implementation project and change management teams will be involved throughout in the development of training strategy, training material design and development, standards and training delivery to ensure that change management issues are incorporated, and that training strategies and materials are aligned to the requirements of the project and as business-specific as possible
- 10) **Assist Utility and PMA for responding to queries to Nodal Agency:** SIA may be responsible for preparing responses to the queries raised by the Nodal Agency. Adequate support will be provided by the utilities to the SIA
- 11) **Progress Update:** The SIA may also provide periodic status update reports highlighting critical issues to the utility. Further, any information (progress report, etc.) as and when sought by the Nodal Agency/Ministry of Power shall be furnished by the SIA.
- 12) In addition to the above, following works are also in the scope of the contractor:

- (a) Database, Reports and display development
- (b) Training
- (c) Obtaining the statutory clearances required, if any from Ministry of Communication/ Govt Authority. All the charges deposited to aforesaid authority for obtaining statutory clearance will be reimbursed by the owner. The owner will also provide the necessary support if required in getting the clearances
- d) Hired /leased communication network & arrange SLA with service provider in line with SLA of FMS period. Once SIA is appointed, a tripartite agreement among Utility, service provider & SIA shall be signed.
- e) Sufficient SPARES /INVENTORY for FMS period of 5 years to meet SLA

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13) Other Services and Items: The scope also includes, but not limited to the following services/items described herein and elsewhere in specification:

- a. **Project Management and Site Supervision:** The bidder shall be responsible for the overall management and supervision of works, including the implementation of risk management as well as change management initiatives. He shall provide experienced, skilled, knowledgeable and competent personnel for all phases of the project, so as to provide the utility with a high quality system
- b. **Interface Coordination:** The bidder shall identify all interface issues with utility and other agencies if any, and inform utility which shall interface, coordinate and exchange of all necessary information among all concerned agencies.
- c. **Scope Change Management:** Utility to finalize the scope change management procedure during development/Implementation stage
- d. Suitable Electronic Earthing and surge protection devices to insulate SCADA system including RTU/FRTU from fault current / voltage surges in the HV electrical system etc.
- e. Any compliance notified by GOI/ MoP/CEA from time to time such as cyber security guidelines dtd-07.10.21 etc.

1.3.4 Specific Exclusions

The SIA is not expected to address the following:

- a. All civil & architectural works, internal and external electrification, Air conditioning and ventilation, fire-fighting system and Access control system required for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system are outside the scope of the SIA, however contractor has to indicate the space requirement for control center, DR center, RTU / FRTU/Auxiliary power supply & communication equipment any other specific requirement, power supply requirement including standby supply requirement, so that the utility can provide the same as per bidder's requirement

- b. Manpower required operating SCADA/DMS/OMS AND SUB-STATION AUTOMATION, SCADA, system.
- c. A.C. input power supply
- d. Augmentation of field devices to make existing field devices, CT/PT, breaker, switches etc. SCADA ready

The detailed technical requirements including Bill of Quantity of the above components is described in subsequent sections of this volume.

The responsibility of the Contractor shall include supplying, laying and termination of the cables, wherever required for:

- a. Acquiring analog data using MFT , transducer, sensor which shall be connected with the primary devices.
- b. Acquiring the digital data for status of field devices relays in the control room.
- c. Extending control output to field devices through heavy duty relays
- d. Interconnection between Contact Multiplying Relays (CMRs) and RTUs/FRTUs & field devices (CMRs to be supplied by the contractor as per BOQ),
- e. Power and signal cabling between the supplied equipment & Owner's equipment Incl. Outdoor panels
- f. Any other cabling required for completion of the project.

1.3.5 Generic requirements:

The contractor shall undertake detailed site survey immediately after award of the contract of all the sites to access the various requirements such as space, identification of input terminals, and availability of air-conditioning, spare contacts etc. for completion of engineering, site installation, testing and commissioning of the project. The type and number of hardware and software elements (Bill of Quantity) within the scope of the project to be supplied for the various sites are identified in the Appendices. The individual functions to be performed by the hardware and software and system sizing criteria are described in the relevant sections. The specification defines requirements on a functional basis and does not intend to dictate a specific design. On the other hand certain minimum requirements must be met in accordance with the particular details provided elsewhere in the specification.

The items, which are not specifically identified but are required for completion of the project within the intent of the specification, shall also be supplied & installed without any additional cost implication to the employer/owner.

The utility can invite bids in multiple packages i.e. Group of districts /zone/region including upgradation separately (Zone size for packaging shall be maximum 2 Zones per package). Similarly for Group A (Noida Town) Noida Towns of SCADA/DMS/OMS AND SUB-STATION AUTOMATION, bidding can be done in multiple packages (Maximum 5 towns of Group A (Noida Town)). Also, for Group U Towns of SCADA/DMS/OMS AND SUB-STATION AUTOMATION, bidding can be done in multiple packages (Maximum 5 towns of Group U)

1.3.6 Facilities to be provided by Employer/Owner (Utility)

- a. Arranging necessary shutdowns and work permits at various sites.
- b. Formation of team for SCADA works at control center and field level both.

- c. Timely approval of documents, tests etc.to ensures completion of project in time.
- d. Timely release of payment to contractor on achievement of milestones/compliances
- e. Reconductoring of line for switching of loads in case of RMU connected networks
- f. Retro-fitment of breaker for SCADA ready
- g. Any other communication infra like Fiber/ radio optic etc. other than MPLS ,GPRS
- h. Providing all the necessary data regarding the power distribution system network.
- i. Providing storage space at site free of cost wherever available. Special storage needs such as watch and ward services and air conditioning shall be provided by the contractor.
- j. The existing earthing system at the substations may be utilized for earthing of the offered equipment. However, the contractor shall assess its suitability for the offered equipment and carry out the modifications if required. It is recommended to provide separate electronic earthing for SCADA equipment's by contractor.
- k. Suitable space/Infrastructure incl. civil works, electrical raw supply , Air-conditioning , firefighting , building security , lighting , furniture etc. for Control center/DR, Substations for installation of control center/ DR equipment's, RTUs /FRTUs/APS etc.in line with SCADA/DMS/OMS AND SUB-STATION AUTOMATION system implementation schedule.
- l. Providing details of Existing Legacy systems if any SCADA/DMS/OMS AND SUB-STATION AUTOMATION/ , RTU/FRTU, IT, Numerical relays RMU/FPI, GIS etc. system under R-APDRP for integration.
- m. Utility shall ensure Project implementation to be done O&M dept. of utility where IT dept. /cadre shall work as support. This is mandatory.

1.3.7 General Requirements

The Bidder's proposal shall address all functional, availability and performance requirements within this specification and shall include sufficient information and supporting documentation in order to determine compliance with this specification without further necessity for enquiries.

An analysis of the functional, availability and performance requirements of this specification and/or site surveys, design, and engineering may lead the Contractor to conclude that additional items and services are required that are not specifically mentioned in this specification. The Contractor shall be responsible for providing at no added cost to the employer all such additional items and services such that a viable and fully functional system is implemented that meets or exceeds the capacity, and performance requirements specified. Such materials and services shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items and services in their proposal.

All equipment provided shall be designed to interface with existing equipment and shall be capable of supporting all present requirements and spare capacity requirements identified in this specification.

The offered items shall be designed to operate in varying environments including suitability as per higher altitude requirement. Adequate measures shall be taken to provide protection against rodents, contaminants, pollutants, water & moisture, lightning & short circuit, vibration and electro-magnetic interference etc.

The Contractor shall demonstrate a specified level of performance of the offered items

during well-structured factory and field tests. Further, since at the substation's limited space is available the contractor shall make all the efforts to economize the space requirement.

The Bidders are advised to visit sites (at their own expense), prior to the submission of the proposal, and make surveys and assessments as deemed necessary for proposal submission.

The successful bidder (Contractor) is required to visit all sites. The site visits after contract award shall include all necessary surveys to allow the contractor to perform the design and implementation functions.

After the site/route survey the Contractor shall submit a survey report for all the sites. This report shall include at least the following items; however, the exact format of the report shall be finalized by the contractor with the approval of Employer.

- a. Proposed layout of Equipment in the existing rooms and buildings.
- b. Proposed routing of power, earthing, signal cables and etc.
- c. Confirmation of adequacy of Space and AC Power supply requirements
- d. Proposals for new rooms/buildings, if required
- e. Identification of facility modifications, if required
- f. Identify all additional items required for interconnection with the existing equipment.
- g. Requirement of Modification to existing earthing arrangement, if any.

1.3.8 General Bidding Requirements

The offered equipment/system/ solution must be in successful operation for at least one year as on the date bid opening. However, the computer software /hardware shall be of latest current industry technology/ standard models as per section 2. The Bidder shall be responsive to the technical requirements as set forth in this specification. To be considered responsive, the Bidder's proposal shall include the following:

1. A detailed project implementation plan and schedule that is consistent with the scope of the project. The plan shall include all the activities required, show all key milestones, and clearly identify the nature of all information and project support to be provided for completion of the project. Manpower resources, proposed to be deployed by the Contractor during the execution phase, shall be clearly indicated.
2. Documentary evidence in support of the qualifying requirements specified in the bidding document i.e. RFP shall be submitted along with the bid.
3. Performance certificate for the offered equipment/systems from the user's in line to the requirements mentioned in the bidding documents.
4. The type test certificates for the offered equipment. In case it is not type tested. The commitment for same to be conducted during implementation
5. Completed equipment Data Requirement sheets/Questionnaire
6. Technical details of the offered equipment/systems.
7. Description of existing IT system shall be included by utility
8. SLA & Cyber security compliance plan

1.3.9 Items of Special Interest

To assist in understanding the overall requirements of the project, the following items of special interest are listed. The Bidder shall pay particular attention to these items in preparing the proposal.

- a. The contractor shall be responsible for overall project management, system integration and testing to complete all the facilities under the project.
- b. The project shall be implemented in the time schedule described in section 8.
- c. The database displays and reports for SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS/RT-DAS system are to be developed by the contractor; however, the contractor shall associate the employer/owner's engineers also during the data base development. The required hardware & software for completion of this activity may be used out of the hardware & software to be supplied under this contract.
- d. The APIs (Application Program Interfaces) specified/needed section 2 is to be supplied. However the supply of source code is not mandatory. (only for customized portion ,if any)
- e. Integration with legacy system if indicated in the RFP

1.3.10 Site Conditions

The sites are located in the towns of Group A (Noida Town) for SCADA/DMS/OMS AND SUB-STATION AUTOMATION as per Hst in Annexure1 The minimum to maximum temperature & relative 13 generally falls between 04 to 48 C. & 13 to 90 % respectively. Utility shall also indicate locations at above 2000 m from M.S.L if any for suitable hardware. The system/equipment shall be designed as per the environmental conditions mentioned in the relevant section of this specification.

1.3.11 Applicable Standards

The applicable standards are mentioned in the respective technical section. The offered equipment shall conform to the standards mentioned in the specification except to the extent modified by this specification. In case of any discrepancy between the description given in the specification and the standards the provisions of the technical specification shall be followed. The parameters not specifically mentioned in this specification shall conform to the standard mentioned in this specification.

Wherever, new standards and revisions are issued during the period of the contract, the Contractor shall attempt to comply with such standards, provided there is no additional financial implication to employer/owner.

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

or better.

For Group A (Noida Town) , SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS and Group B , SCADA and Group C and Group U shall be considered irrespective of terms of SCADA , DMS,OMS, is mentioned in any combination in specification as per the relevant functional requirements common and specific both that group .

1.3.12 Warranty

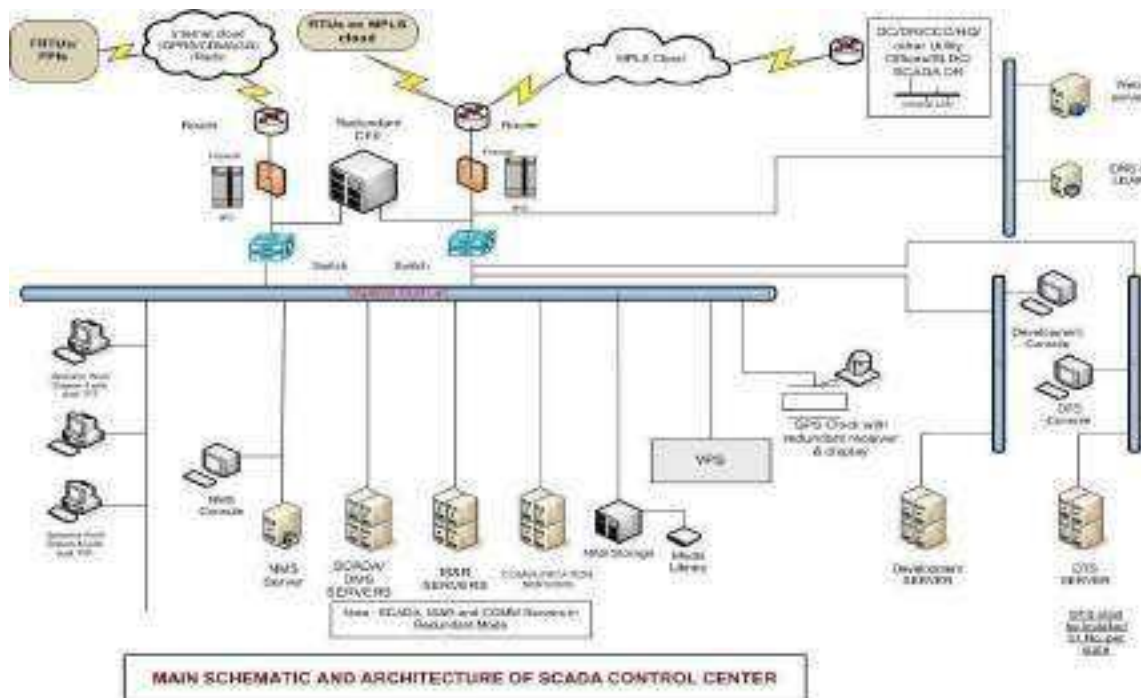
This would include seven years warranty for the related hardware & software supplied under the SCADA/DMS/OMS AND SUB-STATION AUTOMATION project after the Site acceptance test (S.A.T), operational acceptance of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION System. The 7 year warranty shall include a comprehensive OEM on-site warranty for all components (H/W and Software including OS) supplied including reloading and reconfiguration of all Software and device drivers/patches etc. if required. In case 7 Years warranty is beyond standard warranty period of the equipment, the extended warranty shall be the responsibility of SIA.

1.3.13 Terms for utility & SIA

The term contractor & bidder shall be referred as SCADA/DMS/OMS AND SUB-STATION AUTOMATION implementation agency (SIA) & owner; employer shall be referred as utility wherever mentioned in the RFP /Model Technical specification (MTS)

1.3.14 Proposed SCADA/DMS/OMS AND SUB-STATION AUTOMATION system

Utility shall write in brief about the proposed system for Group A (Noida Town) ,B &C



Ref Fig 1.3

1.3.15 Existing System for Group A (Noida Town) , B, C & U towns separately.

Utility shall include write up about their existing geographical details (pop (2011 census), annual energy in MUs , sq.km, organization setup , hierarchy, town , district, no. of substations, DT, RMU , electrical network etc. Of the project area. Utility shall provide details electrical system considered /committed, enabling SCADA/DMS/OMS AND SUB-STATION AUTOMATION implementation.

Utility shall also list all existing infrastructure / legacy systems viz SCADA/DMS/OMS AND SUB-STATION AUTOMATION, RTU, FRTU, MFTs , RMU/Sectionalizes, Numerical relays/ IT system under R- APDRP viz. billing ,customer care, GIS etc., if any that are required to be integrated with this system. Utility shall provide details of Existing Legacy systems SCADA/DMS/OMS AND SUB-STATION AUTOMATION, RTU/FRTU, IT system under R-APDRP for integration including protocol implementation profiles, interface details etc.

Utility shall give configuration diagram & technical write up of IT data center, customer care center DR center , sub div, other offices under R-APDRP.

Utility shall provide details electrical system considered for enabling SCADA implementation.

Utility shall mention details of existing communication, power supply, building infrastructure for SCADA system. Utility shall ensure the data mentioned above is true & according to approved DPR for the project area.

SECTION -2, CHAPTER -1

SCADA FUNCTIONS

1. General requirements

This section describes the functions to be performed by the SCADA applications for distribution system for the project area. Bidders are encouraged to supply standard, proven & tested products that meet or exceed the Specification requirements. This chapter describes the requirements of ISR functions also. Unless specified as optional functions/ features all functions/ features mandatory for the project area. This chapter is applicable to Group A (Noida Town), B, C towns as per functional requirements.

1.1. Design requirements

The software shall be modular in nature. The software shall be able to work platform based on minimum 64-bit architecture. All the variable parameters of SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications, which require adjustment from time-to-time, shall be defined in the database and shall be adjustable by system personnel. All Periodicities and time intervals contained in the Specification that define these parameters shall be considered as initial values to be used for performance purposes. The adjustments made to parameters by the user or programmer shall become effective without having to reassemble or recompile programs or regenerate all or portions of the database.

The specific requirements for output results are described along with the other requirements of each function. However, all results that the user deems to be important shall be stored in a form accessible for display and printing, whether or not explicitly specified in the particular subsection.

The SCADA functions specified for Group A (Noida Town) Towns only means that system will presently use the same due to consideration of corresponding field equipment like FRTU at RMU, SECTIONLIZER etc. but the system for Group B Towns shall also be compliant to use the function to use field devices if available on field/ will be available in future. In the specification SCADA/DMS/OMS AND SUB-STATION AUTOMATION or SCADA or shall be considered by per functional requirement of Group A (Noida Town) , Group B towns , Group C and term SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall be read as SCADA for B, C Towns accordingly as per functional and BoQ requirements .

1.1.1. SCADA/DMS/OMS AND SUB-STATION AUTOMATION Function Access

Various application functions shall be designated as single user/ multi-user. For a single-user function, the user with access to the function must relinquish access to it before access can be granted to another user. For a multi-user function any number of users, up to the maximum designated for the function, may have access to the function simultaneously. All such actions shall be recorded as events in the event log

1.1.2. Critical & non-critical functions

The functions defined in this specification shall be classified as Critical or as Non-critical. Every critical function must be supported by sufficient hardware & software redundancy to ensure that no single hardware & software failure will interrupt the availability of the functions for a period exceeding the automatic transfer time defined in the specification.

Non-critical function may not be supported by hardware & software redundancy and can be suspended in case of non-availability of corresponding hardware.

Generally the following are to be classified as Critical functions:-

- a) All SCADA applications
- b) Information Storage and Retrieval (ISR)
- c) Load Shed application (LSA)
- d) Outage data analytics and reporting (ODAR)
- e) All DMS & OMS applications (Group A (Noida Town) Towns only)
- f) Data exchange among the contractor supplied SCADA/DMS/OMS AND SUB-STATION AUTOMATION system, IT system established under R-APDRP
- g) Web server applications , Security applications
- h) Network Management system (NMS)
- i) Disaster Recovery for Group A (Noida Town) & Data recovery function (DR) for Group B& C

The following are Non-Critical functions

- a) Dispatcher Training Simulator (DTS)
- b) Database modification and generation
- c) Display modification and generation
- d) Report modification and creation
- e) Data exchange with Remote VDUs ,if any

1.2. SCADA Functions

The following SCADA functions are envisaged under this specification.

- Data Acquisition from RTUs at S/S & FPIs , FRTUs at RMU/Sectionalizers for Group A (Noida Town) towns only
- Data Acquisition from RTUs at S/S & FPIs for Group B Towns
- Time synchronization of RTUs,, FRTUs & FPIs(if time synch is supported in FPI)
- Data Exchange among the contractor supplied SCADA/DMS/OMS AND SUB-STATION AUTOMATION system, IT system established under IPDS (in specified format (OPC / CIM-XML / ICCP /ODBC Format) Model & Data Exchange over IEC 61968-1 Enterprise SOA Based BUS), or any other legacy system defined in the RFP
- Continuous real-time data storage and playback
- Sequence of event processing
- Supervisory Control
- Fail-soft capability
- Remote database downloading ,diagnostics & configuration
- CIM compliance IEC61968

- GIS adaptor (GIS Land base data, network model using GIS engines/adaptors supporting Native Adapters , CIM/XML Model for Distribution / Power System, using Model Exchange & Data Exchange over IEC 61968-1 Enterprise SOA Based BUS) (Group 1 Towns only)
- Information Storage & Retrieval (ISR)
- Load Shed Application (LSA)
- Disaster Replica Recovery (DRR) for Group A (Noida Town) & Data recovery function (DR)for Group B& C

The System Design Parameters of SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions ,The power system sizing, Performance requirements for complete SCADA/DMS/OMS AND SUB-STATION AUTOMATION system are specified are specified in DESIGN PARAMETERS AND PERFORMANCE given section8

The SCADA system shall have capability to accept data from the following sources:

- (a) Telemetered data received from RTUs,
- (b) Telemetered data received from FRTUs (Group A (Noida Town) Towns only)
- (c) Telemetered data received from FPIs
- (d) Data received from IT system established under IPDS Data exchange
- (e) Calculated data
- (f) Pseudo-data (Manually entered data)
- (g) GIS land base data, network model using GIS engines/adaptors (Group A (Noida Town)Towns only)

All input data and parameters, whether collected automatically or entered by an user, shall be checked for reasonability and rejected if they are unreasonable. All intermediate and final results shall be checked to prevent unreasonable data from being propagated or displayed to the user. When unreasonable input data or results are detected, diagnostic messages, clearly describing the problem, shall be generated. All programs and all computer systems shall continue to operate in the presence of unreasonable data.

Each of the SCADA functions is described below.

1.2.1. Communication protocol.

SCADA system shall use the following protocols to communicate

- a) For RTU - IEC 870-5-104 protocol also 101 to communicate when acting as data concentrator with slave devices
- b) For FRTU- IEC 870-5-101 /104 protocol
- c) For FPIs - IEC 870-5-101 /104 protocol d) for MFTs – MODBUS
- e) For DR & Other any other SCADA system - ICCP/TASE.2 in specified format (OPC / CIM-XML / ICCP / ODBC Format) Model & Data Exchange over IEC 61968-1 Enterprise SOA Based BUS)
- f) For IT Systems - (in specified format (OPC / CIM-XML / ODBC Format) Model & Data Exchange over IEC 61968-1 Enterprise SOA

Based BUS)

- g) In case existing system uses DNP3.0 protocol, the same shall be used for integration of existing RTUs.
- h) IEC62056 (DLMS) SMART meters compliant in case of integration of SMART Meters in future

The protocol considerations shall be made in accordance to the system/ device to be interfaced. However, system shall have capability to interface using all necessary protocols as specified above for the devices that may be interfaced in future

1.2.2. Data Acquisition

SCADA system shall acquire data from Remote Terminal Units (RTUs) (Group A (Noida Town) , B, C, U Towns) ,FRTUs (Group A (Noida Town) , U Towns) & FPIs(Group A (Noida Town) , B,C, U Towns)

The type of data to be acquired through RTUs, FRTUs shall include analog values, digital status data (Double point and single point indications) and SOE data from the substation, RMUs etc.

Analog values like P, Q, F, each phase V, each phase I, each phase pf, and energy values (Export/Import KWh and KVARh) shall be collected by the RTU, FRTUs from the MFTs.

Analog values such as station battery voltage, oil temperature, winding temperature, tap changer, weather transducer data etc. shall also be acquired through RTU using analog input modules & suitable transducer, if defined in the RTU BOQ.

For FPIs, Digital status in the form Fault protection indication viz O/C & E/F & in case also analog data such as Fault settings are remotely .

The actual point counts & type of data acquired are given in the RTU, FRTU are specified in Annexure **for in I/O points** .

1.2.2.1. Polling method

Digital status data from RTU shall be reported by exception and shall be updated and displayed within 3 seconds. Digital status data from FRTU & FPI shall be also be reported by exception and shall be updated and displayed within 3 seconds. Digital status data shall have higher priority than the Analog data. The system shall have dead band for data by exception.

All analog values except energy values shall be reported by exception from the RTU, FRTU & FPI. The analog value, when reported by exception, shall be updated & displayed within 4 sec from S/S & 6 sec from RMU/Sectionalizers locations at the control center. An integrity scan of all status & Analog values shall also be made every 10 minutes (configurable).

The provision shall also be made to report analog values & status data periodically at every 10sec (user configurable), if required by the user.

The time skew at SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center, S/S , RMU,FPI shall not be more than 0.1sec at each location & latency shall not be more than 0.5sec for status. For analog data the time skew shall not be more than 1sec & latency shall not be more than 1sec for analog as per IEEE C37.1.

Energy values of 15 minute blocks shall be collected periodically from the RTU, FRTU at scan rate of 15 minute/1 hour (configurable up to 24 hours). Alternatively the energy values shall be calculated for each 15 minute/1 hour blocks at SCADA level from the acquired energy values of MFTs through RTU &FRTU.

The contractor must assess & take the network delay into consideration while designing the system so that the update time in normal & peak level of activities are met.

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION computer system shall also be able to collect any and all analog & digital data from its RTUs/FRTU/FPI on demand. Apart from the periodic integrity scan, the integrity scan shall also be initiated automatically for an RTU/ FRTU/ FPI whenever the following situations arise:

- i. Upon startup of the system
- ii. RTU/ FRTU/ FPI status change is detected such as RTU/ FRTU/ FPI restart, Communication Link restoration
- iii. On demand by SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions
- iv. On request by the user

The TCP/IP Communication for RTU, FRTU,FPI on public network shall be encrypted over SSL Security / VPN & the equipment should take control command from designated Master IP address only and no other IP. The RTU, FRTU, FPI & all TCP/IP devices that are on Public Network shall form a private VPN network with the SCADA Front End, through which encrypted data gets exchanged.

1.2.2.2. Telemetry Failure

If data is not received from an RTU/FRTU/ FPI after a user-adjustable number of retries, each affected point in the SCADA system shall be marked with a '**telemetry failure quality code**' and an alarm shall be generated. Telemetry failure of data can be due to failure of communication link, failure of complete RTU/, FRTU/FPI or RTU/ FRTU module or MFT etc. Only a single alarm shall be generated if an entire RTU/ FRTU or its communication channel fails.

In the event of telemetry failure, the last good value/status shall be retained in the database for each affected point. When telemetry returns to normal, the associated SCADA system shall automatically resume updating the database with the scanned data.

The user shall be able to substitute a value in the database for any point that is experiencing telemetry failure which shall be marked with **‘manual replaced’ quality code** in addition to the **‘telemetry failure’ quality code**. The user shall also be able to delete any point (or entire RTU/FRTU/FPI) from scan processing. All deleted points shall be marked with a **‘delete-from-scan’ quality code**.

Acquisition Modes

The following modes of data acquisition shall be supported:

a) Enable

When RTU/FRTU/FPI is enabled, the data is scanned in normal fashion and control command execution is allowed.

b) Disable

When RTU/FRTU/FPI is disabled, the data scanning & control execution is disabled. This is equivalent to” delete from scan “of complete RTU/FRTU/FPI

c) Test /Maintenance

Placing an RTU/ FRTU in test mode shall generate an appropriate event message. When an RTU/FRTU is in the test mode, the real-time database shall retain the last value from all points collected via the RTU/FRTU before it was placed in the test mode. The points shall be marked in the database with a quality code indicating that their source RTU/FRTU is in the test mode. All system displays, programs, data links, and other devices shall use this value. Supervisory control of points that are in the test mode shall not be permitted.

When an RTU/FRTU is removed from the test mode, a message shall be generated, the test mode quality code shall be removed from all points assigned to the RTU/FRTU, the database values shall resume updating on each scan, and any controls for the RTU/FRTU shall be enabled.

1.2.3. Time synchronization of RTUs

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system will be synchronized from the GPS based Time and frequency system. The SCADA system shall synchronize the time of all connected RTUs/FRTUs/FPI every 15 minutes (user configurable from 5 minutes to 24 hrs.) using time synchronization message in the IEC 870-5-104/101 protocol /NTP/SNTP. The servers /Workstations at SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center shall be synchronized using NTP/SNTP. The time of DR center shall also be synchronized from the GPS based system installed in one of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center in the DISCOM.

1.2.4. Data Exchange

Utility shall specify the external systems, if any with which data exchange of SCADA system is envisaged and shall specify interface and interoperability

parameters in the RFP. Utility shall also provide the required access & information of such existing systems to SIA for implementation

1.2.4.1. National Power Portal (NPP) & National Feeder Monitoring System (NFMS)

Machine to Machine data transfer to existing National Power Portal (NPP) & National Feeder Monitoring System (NFMS envisaged under PART A of the scheme separately. The data transfer shall be done in JSON object or any other format as finalized required, by creating suitable APIs at SCADA control Centre. The data primarily will be feeder wise SAIFI/SAIFI values on daily basis. Further, it shall be possible to transfer other telemetered data of interest of feeder also. The data & exchange format will be decided during design & Engineering phase.

Further , the real time SCADA/DMS/OMS AND SUB-STATION AUTOMATION status /reports in view only mode for cap building may be required to be linked with National SCADA Resource Centre (NSRC) or any common infra directed by MoP/ PFC

1.2.4.2. SCADA/DMS/OMS AND SUB-STATION AUTOMATION system with IT system (optional)

If specified requirement of specific parameters with IT system by utility in the RFP is envisaged then, SCADA/DMS/OMS AND SUB-STATION AUTOMATION System shall exchange data with ISR System & ISR System shall be the nodal interface with all IT System. The Data Center, DR Center and Customer Care Center under IT System, shall exchange data with the ISR System, using Open Standards like CIM/XML & IEC 61968 Series Standards for Power System ,OPC,ICCP/TASE.2., ODBC The GIS System shall exchange data with SCADA System over IEC 61968-1 SO Abased ESB/Bus using CIM/XML Models for Power System using GIS Engine / Adapters supporting the standard.

Direct SQL/ODBC interfaces should continue to be supported for report generation and ad-hoc queries.

If utility was having GIS/ billing/customer system prior to this scheme such as IPDS i.e. considered as legacy, then interfaces may be selected accordingly viz. ODBC/DDE etc. using ASCII files. However, they shall provide system in compliance of the data exchange requirement specified in this para.

Data to be exchanged with IT system is defined ISR section. For DR & SLDC, it is given below:

1.2.4.2 For data exchange between SCADA/DMS/OMS AND SUB-STATION AUTOMATION control centers & DR center, optional (SLDC):

If opted & requirement specified by utility in this RFP , then SCADA/DMS/OMS AND SUB-STATION AUTOMATION control centers shall also exchange data using ICCP with State Load Dispatch Centre (SLDC) of the state. Data exchange shall also allow other information to be transferred report by exception but also configurable periodically, or on demand. It shall be possible to exchange at least the following data:

- Real-time telemetered data of the interconnected network,

- Non-telemetered data of the interconnected network,
- Calculated data of the interconnected network,
- SOE data of the interconnected network
- Historical data of the interconnected network
- Scheduling data
- Operator messages.
- Event /alarm lists

It is envisaged that the utility shall get the load forecasting & drawl schedules from SLDC & versa in order to execute planning of load distribution. In addition, status /measurement of interconnected network shall be able exchanged in both directions.

For Group-A towns, Disaster recovery is replica of main control center and hence shall be in sync on daily basis or on demand also.

Whereas for Group B&C, the data exchange with DR is required all the data to be transferred from control center to DR which is required for system build in order to build a system from scratch. ICCP TASE.2 protocol or equivalent non-proprietary/ De-Facto protocol shall be used transfer network model / database changes on incremental /global basis automatically once a day & on demand It shall transfer all data /information which are required for system build in order to build a system from scratch.

1.2.5. Data Processing

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall prepare all data that they acquire for use by the power system operations and other applications. The data processing requirements shall apply to data collected from all specified sources.

Data acquired from RTUs/FRTUs/FPI/IT system, as well as data received from the DMS and the existing control centers (if any and specified by utility in this RFP), shall be processed and placed in the Real-Time Database as soon as it is received.

Data processing involves a value which has been converted to internal form and analyzed for violations of limits. The data processing shall set various data attributes depending on the results of the checks and shall trigger any additional processing or calculation. The SCADA /DMS system shall prepare all the acquired data for use by the power system applications. The SCADA system shall have capability to accept data from the following sources:

- a. Real-time (also referred as telemetered) data received from control centers /IT system (data center, customer care, DR center and RTUs/FRTU/FPI etc.)
- b. Calculated data
- c. Manually entered data
- d. Sequence of events data
- e. Alternate data sources

1.2.5.1. Analog Data Processing

Analog data processing shall be performed according to the requirements listed below.

(i) Conversion to Engineering Units

Analog points that are transmitted to SCADA system in raw data format shall be converted to engineering units before being stored in the database. This conversion function shall include, as a minimum, the capability to perform the following conversion algorithm:

$$\text{Value} = (A * \text{scanned valued}) + B,$$

Where A and B are programmer-adjustable constants assignable as database attributes on a per point basis.

(ii) Zero dead band processing

The SCADA system at control center shall process each analog input for dead band zone processing. The acquired value, if falls between the dead band range around zero then it shall be considered as clamped zero value else the actual value shall be considered.

(iii) Reasonability Limit Check

The reasonability limits shall represent the extremes of valid measurements for the point's value. All analog values shall be compared against defined high and low reasonability limits. The comparisons shall be performed at the scan rates of the analog values. An alarm shall be generated the first time a reasonability limit violation is detected. The last valid value of the variable shall be maintained in the database and marked with a quality code indicating the '**reasonability limit violation**'. When data returns to a reasonable value, the new value shall be accepted and a return-to-normal message shall be generated.

(iv) Limit Monitoring

For bi-directional quantities (positive or negative) there shall be a set of three limits for each direction. For unidirectional quantities there shall be a set of three limits in one direction. These limits will represent increasing levels of concern and shall be named as "**Operational**", "**Alarm**" and "**Emergency**" limits. These three limits shall be set within the boundaries of reasonability limit. Generally, any alarm can be assigned as audible alarm but emergency limit shall necessarily be assigned as audible alarm.

All telemetered and calculated analog point shall be compared against above sets of high and low limits each time the value is scanned or calculated. Whenever a monitored point crosses a limit in the undesirable direction a limit violation alarm message shall be generated. Whenever a monitored point crosses a limit in the desirable direction, an exit alarm message shall be generated. If multiple limits have been crossed since the last check, each limit

crossed shall be reported.

All limit monitoring shall preclude annunciation of multiple alarms when a value oscillates about an alarm limit by utilizing a programmer-adjustable alarm dead- band for each point.

The user shall be able to temporarily override any of the above limits (which are in use) by entering a new value. When the user overrides a limit, it shall be marked with a '**limit override quality code**' on all displays. The override value shall be recognized, and any display, report, or log containing the value of the overridden limit shall include it as such. An override value shall be used instead of the permanent value until the user removes the override condition or system is re- initialized. Any change in alarm states resulting from a change in limit value shall be reported. Contractor shall finalize & take approval from utility for limit values.

(v) Rate of change /Gradient

All telemetered and calculated analog points shall also be processed for rate of change / Gradient processing, if defined that point for such processing in the database. An Alarm for over shoot & event message for return to normal shall be generated.

The rate of change shall be calculated periodically for each assigned point, by dividing the point's values at the beginning and the end of the period into the length of the period. Filtering shall be applied so that single scan excursions do not cause an alarm. The result shall be saved as a non- telemetered database point. All the requirements that apply to calculated points, such as limit checking,

Alarming and availability for display and processing shall apply to the ROC points. There shall be a positive limit and a negative limit to catch excessive rises in the analog value.

vi) Sign Conventions

The sign conventions for the display, data entry and reporting of active and reactive power flow shall be used universally by all SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions. All imports to bus bars shall be represented with + sign and all exports from bus bars shall be with –ve sign.

Vii) Accumulator Processing

The system shall be able to store accumulator history. Storing accumulator history shall be provided with a method in which that stores data only once per hour and in other method that stores data each time new data enters the system.

It shall be possible to use the two methods concurrently for any pulse

accumulator, making it possible to maintain two records for data that are read more than once an hour.

1.2.5.2. Digital Input Data processing

Each state of a digital input point shall be associated with the state of an actual device. The number of bits that will be used to define the state of a device is defined in the RTU/FRTU Specification. A status point shall be defined as being either legal or illegal, and normal or abnormal:

- **Illegal state:** The first check on a new input to a digital status point is the legality check. If the new state is illegal, then the old value shall be left in the database and marked old with relevant quality code such as telemetry failure etc..
- **Abnormal state:** If the new state is legal, it shall be checked to see if it is among the normal states defined for the point. If not, the status point shall be marked as abnormal. While abnormal, it shall appear in the summary display of abnormal conditions/ off-normal summary
- **Alarm checking:** Each new value shall be checked to see if transitions into that state are to be alarmed. If so, and if no control action is pending on the status point, then an alarm action shall be triggered.

The following digital input data types shall be accommodated as a minimum:

- a. Two-state points: The following pairs of state names shall be provided as minimum :
 - (1) Open/Closed
 - (2) Tripped/Closed
 - (3) Alarm/Normal
 - (4) On/Off
 - (5) Auto/Manual
 - (6) Remote/Local
 - (7) On Control/Off Control
 - (8) Set/Reset
- b. Three-state points: Any of the state combinations listed in (a) above shall be supported with a third, typically, in-transit state which is the case for slow operating devices such as isolator. If a device remains in this state for a period more than a threshold value, the same shall be alarmed.
- c. Momentary change Detection (MCD): The input to capture the states of fast acting devices such as auto-reclosers.

Commanded changes initiated by supervisory control shall not be alarmed but shall generate an event message. All other status changes in the state of telemetered, calculated digital input points & un-commanded changes shall be alarmed. Each CB, isolator, switching device etc. shall have normal & off normal positions states defined. In the event of off normal positions, the same

shall be reflected in the off normal summary list

1.2.5.3. Calculated Data processing

SCADA system shall be capable of performing calculations and storing the result in the database as calculated data available for display. The database variables to be used for arguments and the mathematical/statistical/logical functions to be used as operations shall be definable interactively at a console as well as by the programmer using database creation and maintenance procedures.

Calculated analog values shall use database points as the arguments and mathematical and statistical functions as the operations. Functions such as addition, subtraction, multiplication, division, maximum value, minimum value and average value, count, integration, square root extraction, exponentiation, trigonometric functions, logarithms and logical & comparative operators etc. shall be provided.

It shall be possible to calculate running maximum value, minimum value and average value over a time interval (time interval configurable from 5 minutes to 60 minutes). The value shall be reset after the elapse of defined time interval. These values shall be stored with time of occurrence for maxima and minima and the time for averaging.

Calculated status values shall use database points as arguments and combi-national logic functions that include the logical, comparative operators such as AND, inclusive OR, exclusive OR, NOT, Less Than, Greater Than, Less Than or Equal To, Greater Than or Equal To, and Equal To ,If , else if etc. Suitable rules or operators (such as multi-level parentheses) shall be provided to indicate the sequence of operations in the calculation.

1.2.5.4. Substation Topology Processing

The SCADA /DMS system shall be provided with a Substation topology processor function. This function shall be capable of analyzing the open/closed status of switching devices, such as breakers and dis-connectors, in order to define the configuration of the substation for display. The energization of lines, transformers, bus sections and generating units shall be determined so that the associated displays may correctly show the status of these power system elements. The configuration shall be re-evaluated and updated whenever a switching device status change & analog value change beyond dead-band is detected.

1.2.5.5. Alternate source for data:

The system shall have capability to accept multiple data sources by defining as main & secondary. Normally, data from normal source will be considered. In the event of non-availability of primary source, data from secondary source shall be considered & once primary source is healthy, it shall switch back to primary source. There shall be an indication for primary /secondary source in displays, reports etc. Suitable alarm shall be generated in the event to change from primary

to secondary & vice versa. Alternate source of data can be defined for certain critical points in the database.

1.2.5.6. Quality Codes

Quality codes indicate the presence of one or more factors that affect the validity of a data value. All quality codes that apply to a data value shall be maintained in the database for that data value.

The quality of the calculated value shall be the quality of its "worst" component of its arguments. The presence of a quality code on any of the component data values shall not disrupt the calculation using that value. Results of calculations that are manually overridden by the user shall be denoted with a quality code that can be differentiated from the propagation of a manual replaced quality code from one of its component values.

At least the following data quality codes preferably as the following single letter code shall be provided. However, distinct symbols /shapes after approval from employer may also be used.

Quality code	Code	Reason
Telemetry Failure (RTU Link)	T	Telemetry has failed
Manual Replaced	M	Manual updation
Delete from Scan (RTU/point)	D	User disabled the scan of the of data/point
Questionable data	Q	Analog values of the de-energized elements
Calculated	C	Calculated data
Estimated	E	Estimated data from state estimator
Limit Override	L	Limits are overridden
Primary /secondary source	P/S	Primary or secondary source
Reasonability Limit Exceeded	R	Value beyond reasonability limit
Alarm Inhibit	A	Alarm processing is inhibited
Test or maintenance mode	X	Point is in test /maintenance mode

1.2.6. Continuous Real-time data storage and playback

All real-time data (Analog and status) shall be continuously stored in auxiliary memory for at least two weeks as and when it is received in the SCADA database from the RTUs/FRTUs/FPIs.

It shall be possible to playback above stored data on single line diagram and network diagram for a time window of at least 10 minutes (configurable in seconds /minutes) by defining Start and End date and time. It shall be possible to have tabular and graphical trends of the stored data. It shall be possible to set a different sampling rate for playback than the sampling rate for data storage.

The users shall be able to select the time window of interest for archival of data in the ISR system for future retrieval and playback in SCADA system. This archived data shall be transferable in RDBMS database tables of ISR system for generation of tabular displays and reports.

1.2.7. Sequence-of-Events data

Sequence-of-events (SOE) data shall be chronological listings of „status change events with time stamp“ acquired from RTUs /FRTUs/FPIs. The SOE data shall be collected from all RTUs/FRTU/FPI either in normal polling or periodically/on demand. SOE data collection shall have lower priority than supervisory control actions and normal data acquisition. The SOE data collected from different RTUs/FRTU/FPI shall be merged for chronological listings and stored for subsequent review. At least latest 1000 SOE data shall be available for display.

The SOE resolution of RTU/FRTU/FPI is defined in respective sections for RTU/FRTU. SCADA/DMS/OMS AND SUB-STATION AUTOMATION system at control center shall have 1ms SOE resolution. However, a s SOE time stamping is done at RTU/FRTU/FPI level, the same shall be in line with resolution defined for RTU/FRTU/FPI.

All SOE data collected from all RTU/ FRTU/FPIs shall be stored in daily RDBMS database of ISR system.

1.2.8. SCADA language

The SCADA system shall have capability to write various programs using IEC 61131-3 SCADA language or C/C++ or any non-proprietary language. It will facilitate user (programmer) to write various programs/ logics using points defined in the database.

1.2.9. Supervisory Control

The operator shall be able to request digital status control, set-point control and raise/lower control on selected points and analogs using Select check before operate (SCBO) Sequence.

Supervisory control shall allow the SCADA system to remotely control switching devices. A control action shall require a confirmation-of-selection-prior-to-execution response. Initiation of the control execute step shall occur after the dispatcher confirms that the correct point and control action have been selected.

After the dispatcher/DMS function initiates control execution, the RTU/FRTU shall be addressed for verification that the correct point has been selected at the RTU/FRTU and then the control action shall be executed. It shall also be possible to reset the flag in FPI through a command.

It shall be possible to issue control commands as a group control from SCADA where switching devices pertaining to different RTUs/FRTU or a RTU/FRTU may be controlled as a group. The SCADA system shall send the control commands

sequentially (without dispatcher intervention), if the commands pertain to switching devices in the same RTU/FRTU, using the Selection Check before operate (SCBO) of prior-to-execution. The control commands pertaining to different RTUs /FRTUs may be executed in parallel.

If, after selecting a point, the user does not execute the control action within a programmer-adjustable time-out period, or if the user performs any action other than completing the control action, the selection shall be cancelled and the user be informed. If the communication to the RTU /FRTU is not available, the control command shall be rejected and shall not remain in queue.

The user shall not be prevented from requesting other displays, performing a different supervisory control action, or performing any other user interface operation while the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system waits for a report-back on previously executed control actions.

The system shall process supervisory control commands with a higher priority than requests for data from the RTU /FRTU /FPI data acquisition function.

Functional requirements for the various types of supervisory control are given below. A supervisory control request shall be sent from control center only after the controlled point was checked for proper conditions. The request shall be rejected by the System if:

1. The requested control operation is inhibited by a tag placed on the device or maintenance tag
2. The device or S/S in local manual control mode
3. An Uninitialized, Telemetry failure, delete from scan, manual replaced , Test/maintenance , or Manually Entered data quality indicator is shown for the device;
4. The Operating Mode/ user permission of the workstation/console attempting control does not permit supervisory control
5. The device is already selected for control request or control execution is from another workstation / user/window /console or control request is progressing
6. Time out after selection
7. The device is not subject to supervisory control of the type being attempted

Rejection of a control request from control center shall occur before any transmission is made for control purposes. A control rejection message shall be displayed for the Dispatcher

1.2.9.1. Digital Status Control

A digital control output results in the activation of an output relay in a RTU/FRTU. Different commands shall be possible for these digital status controls. -

Successful completion of the control request shall be recorded as an event. Failures to complete shall be handled as specified in UI section. Control requests

shall be canceled and the selection of the point shall be terminated when the user cancels a request, does not perform the next step of the control procedure within the selection time-out period from the previous step of the procedure, or the request is rejected.

1.2.9.1.1. Breakers

The user shall be able to select and operate the two state controllable switching device i.e. Circuit breakers/ LBS/ in case of RMUs, Isolator also

1.2.9.1.2. Reset flag of FPI

The user shall be able to select and operate the reset flag of FPI as per utility SoP.

1.2.9.1.3. Capacitor Banks

The user shall be able to control capacitor devices. The procedure for controlling these devices shall be the same as that of a switching device except that any supervisory control action must be inhibited for a programmer-adjustable time period after the capacitor/ reactor device has been operated. A message shall appear if an attempt is made to operate the device prior to expiration of that time period & dispatcher is required to give command after expiration of inhibited time-period.

1.2.9.1.4. Tap Changing Transformers

SCADA system shall have the capability to raise and lower the on load tap position of the transformers from SCADA control center through supervisory commands.

Depending on system conditions, the user may raise or lower the tap positions of On Load Tap Changing (OLTC) transformers. OLTC's tap position needs to be monitored if supervisory control action is to be exercised. OLTC tap position input shall be acquired as an analog value. Tap excursions beyond user-specified high and low limits shall cause the master station to generate an alarm.

Supervisory control of OLTCs shall only be permitted when the transformer's control mode is Supervisory. All attempted invalid control actions shall be rejected.

For supervisory operations, the initial selection and control of the transformer for a raise/lower operation shall follow the (SCBO) Sequence. Upon receipt of the raise/lower command, the RTU will immediately execute the control action. It shall not be necessary for the user to re-select the transformer for additional raise/lower operations; the user shall only have to repeat the desired number of raise/lower commands, which shall be executed immediately. Normal scanning functions shall not be suspended between the times that repeated raise/lower commands are issued.

The user shall be able to cancel the operation or have it automatically cancelled by the master station after a programmer-adjustable time period elapses after the last

raise/lower command. This multi-step procedure as described below

1. The RAISE and LOWER push buttons shall be displayed.
2. The command shall be launched as soon as RAISE or LOWER is selected. The Raise and Lower buttons shall not be replaced by a single Execute button. The RAISE/LOWER push buttons shall continue to be displayed, and it shall be possible to initiate these controls repeatedly without re-selection of the controlled point, provided that the execution of the previous control command has successfully been completed.
3. The RAISE/LOWER push buttons shall remain available until either (a) the dispatcher clicks the CANCEL button or (b) the control times out due to inaction by the dispatcher.
4. A separate timeout period, adjustable in the range of up to 120 seconds, shall be provided for incremental control. The timer shall be reset and start counting again whenever a RAISE or LOWER command is issued.

Successful completion of incremental control shall be recorded as an event. However failure of incremental control, including failure to achieve the intended result, shall be alarmed.

1.2.9.2. Set point Control

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall provide the capability to issue set point control using SCBO procedure to field equipment. The SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall transmit a numerical value to the device being controlled, to indicate the desired operational setting of the device.

1.2.9.3. Auto execution sequence /Group control

The Auto execution sequence function shall permit multiple supervisory control commands to be programmed for automatic execution in a predefined sequence. The dispatcher shall be able to execute this sequence. Commands to be supported shall include:

- Time delayed
- Pause & until a user commanded restart or step execution
- Jump to other sequence on certain conditional logic
- Manual Entry.

After executing a supervisory control action, the SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall pause to obtain an indication of a successful control completion check. If the control completion check is not received, or does not have the expected value, the SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall terminate the execution of the sequence and shall declare an alarm. Apart from waiting for control completion checks, and unless there is an explicit command for a delay, such as a "Pause" or "Stop" command, the SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall not introduce any other delays in the execution of an sequence. No limit shall be placed on the number of Auto execution sequences, which may execute in parallel. At any time during the execution of a list, the user shall be able to stop further execution via a cancel feature.

1.2.9.4. Control Inhibit Tag

A user shall be able to inhibit or enable supervisory control on any device. A tag symbol indicating the control inhibit conditions shall be displayed next to the device on all displays where the device is presented.

The programmer shall be able to define up to 4 tag types with the following attributes for each:

- a) Type of controls that shall be inhibited by the tag (e.g. open only (Green tag) close only (Yellow tag), open and close (Red tag), or information only - no control inhibit (White tag). Tags shall be preferably identified by colors. However, distinct symbols /shapes after approval from employer may also be used.
- b) Tag priority

Further the user shall be able to place at least 4 tags per device. Only the highest priority tag shall be displayed. Any combination of tags shall be supported, including multiple tags of the same type. The combined effect of multiple tags shall be to inhibit a type of control if it is inhibited by any of the tags.

When a tag is placed on a device, the user shall be prompted to enter tag number and comment. An event message shall be generated each time a control inhibit tag is placed or removed with information on user ID, type of tag, time of placement or removal of tags.

1.2.9.5. Control Permissive interlocks

It shall be possible to define the interlocks at SCADA level as necessary for control actions. It shall also be possible for operator to bypass the interlock which shall be recorded as an event message with user ID information.

1.2.9.6. Control Action Monitor

The response to all control actions shall be verified by monitoring the appropriate feedback variable. A report-back timer (the duration dependent on the type of device) shall be initiated when the command is issued. At least ten timer periods of 1 to 60 seconds (adjustable in steps of one second) shall be supported, any of which may be assigned to any device.

The user shall be provided with an indication that a control action is in progress and, subsequently, a report of the result. If the control was unsuccessful, an alarm shall be generated that states:

- (a) The control message exchange was not completed successfully,
- (b) The device failed to operate, or
- (c) The device operated but failed to achieve the desired result (e.g., following a close control action, a three-state device operates from the open state, but remains in the transition state).

If the control was successful, an event message shall be generated.

For commands issued as part of a group control, DMS applications etc., the successful completion of all device control actions shall be reported via a single message. If the operation is unsuccessful, the user shall be informed of those devices in the group that failed to operate.

1.2.10. Fail-soft capability

The SCADA system shall be able to manage & prevent system from total shutdown / crash etc. in the event of system crosses mark of peak loading requirements through graceful de-gradation of non –critical functions & also relaxing periodicity / update rate of display refresh & critical functions by 50%.

1.2.11. Remote database downloading ,diagnostics & configuration :

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be able to download database run diagnostics & create/modify /delete configuration/ parameterization from centralized control center locations to RTU/FRTU/FPI etc. using ASDU/ messages of respective protocols or file transfer.

1.3. Information Storage and Retrieval

Information Storage and Retrieval (ISR) function shall allow collection of data from real-time SCADA/DMS/OMS AND SUB-STATION AUTOMATION system and storing it periodically in a Relational database management system (RDBMS) database as historical information (HI) data. This includes storing of data such as SOE, status data, Analog values, calculated values, Energy values etc. Programmer shall also be able to set storage mode as by exception in place of periodic storage.

Subsequently, the data shall be retrieved for analysis, display, and trending and report generation. All stored data shall be accessible from any time period regardless of changes made to the database after storage of that data (e.g., it shall be possible to retrieve stored data for a variable that no longer exists in the SCADA/DMS/OMS AND SUB-STATION AUTOMATION computer system through backups on storage medias viz. tapes /MO disks etc. and initialize study-mode DMS functions with stored data on the corresponding power system model).

The addition, deletion, or modification of data to be collected and processed shall not result in loss of any previously stored data during the transition of data collection and processing to the revised database.

It should be able to compress data, and should have 100% retrieval accuracy. However, the retrieval of compressed historical streams should be of the same performance levels as normal SCADA retrieval. The ISR should be able to interface over ICCP, OPC, ODBC and CIM/XML, JSON to external systems (**as defined by utility to interface with in the section “Data exchange”**) for analytics over SOA / ESB for Integration with IT Systems, over the Enterprise Services Bus & SOA Architecture provided as part of legacy system. The ISR system shall act as the real interface between SCADA and IT System, where-by the real-time operational system is not affected with a transaction processing system like IT, and the IT Integration efforts will not in any way effect the real-time operationally of SCADA/DMS/OMS AND SUB-STATION AUTOMATION System.

In ISR should also support ad-hoc queries, and define display and report formats for

selected data via interactive procedures from operator workstations. Formatted reports and responses to user queries shall be presented in alphanumeric or graphical format on either operator workstations or printers at the option of the user. Procedure definition facilities shall be provided for activities that will be frequently performed. SQL-based language shall be used for selecting, retrieving, editing, sorting, analyzing, and reporting ISR data stored. The selection and sorting criteria shall include time tags and ranges, station names, point names, equipment types, status values, text string matches on selected data fields etc. and combinations of these criteria.

It shall be possible to reload any IS&R archival media that has been removed from IS&R and access the archived data without disturbing the collection, storage, and retrieval of IS&R data in real-time.

The ISR system shall also be used for mass storage of data/files such as DMS application save-cases, Output results of DMS applications, Continuous real-time data of selected time window etc.

The online period of data tables is 24 months, however, there shall not be time restriction to online availability of logs, real time data based on the stored values..

The System Design Parameters of ISR system is given in the **section 8**

1.3.1. Circuit breaker status Table

The ISR function shall maintain a table in RDBMS database where real-time status of all Circuit breakers, in case of RMU -LBS, isolators & Sectionalizers switching also along with the associated quality codes shall be stored. The change of status of any breaker shall be updated in this table as soon as the change is detected by the SCADA system. This table shall contain additional information such as date & time of tripping, cause of tripping, Expected duration of outage etc. Some of the causes of tripping could be Supervisory control by user, Protection tripping, Tripping / closing by DMS applications. Information on expected duration of outage shall be taken from schedules for DMS application such as Load shed application etc. For expected duration of outages due to protection tripping, the same shall be user enter able field. Such daily tables for 24 months duration shall be stored on auxiliary memory (Online). Tables for the previous day shall be backed up to Magnetic tape/ or any offline storage device for this purpose by the user at 10AM daily.

The ISR function shall transfer the information available in the "Circuit breaker status table" as defined above, and may be used by existing Customer Care center /legacy system using SOA/Enterprise Service Bus, over ODBC/OPC/ICCP Adapters / Interfaces. The complete Circuit Breaker Information shall be transferred to Customer care center on demand & by exception along with the associated quality codes and additional information associated with the CB.

1.3.2. Real-time Database Snapshot Tables

At the end of each 5 minutes, the following real time snapshot data shall be stored in RDBMS in **Real-time Database Snapshot tables**:

- a) All telemetered analog values and Calculated values for all telemetered analog points (at least maxima & minima with associated time and average values). Energy values are not envisaged for storage in Data snapshot tables.
- b) All status values with time stamp

All the above values as specified above in (a) & (b) shall be stored along with their associated quality code. The periodicity of the snapshot shall be user adjustable to include 5, 15, 30, and 60 minutes. Data Snapshot tables shall be created on daily basis. Such daily tables for 24 months duration shall be stored on auxiliary memory (Online). Tables for the previous day shall be backed up to Magnetic tape/ or any offline storage device for this purpose by the user at 10AM daily.

The ISR function shall prompt the user through a pop-up window to inform the user for taking the backup. The pop-up window shall persist till user acknowledges the same. In addition to that data can be stored on offline storage device.

The user shall also be able to initialize the study-mode power system analysis functions from stored snapshot data.

1.3.3. Hourly Data tables

At the end of each hour information as defined below shall be included in the hourly data tables, in RDBMS database form:

- (a) Selected analog values along with their associated quality codes
- (b) Selected status values along with their associated quality codes
- (c) Results of hourly calculations for selected analog points (at least maxima & minima with associated time and average) along with their associated quality codes.
- (d) In addition to above a separate hourly energy data table exclusively for energy values (Export and Import Active and reactive Energy values for each feeder) shall be created in ISR along with their associated quality codes.

Hourly data tables shall be created on daily basis. Such daily tables for 24 months duration shall be stored on auxiliary memory (Online). Tables for the previous day shall be backed up to Magnetic tape/ or any offline storage device for this purpose by the user at 10AM daily.

. The ISR function shall prompt the user through a pop-up window to remind the user for taking the backup. The pop-up window shall persist till user acknowledges the same.

1.3.3.1. Missed Hourly Data Storage

The programmer shall be able to independently assign any one of the following processing for each hourly value to be executed when the value is missed and cannot be acquired prior to the storage of hourly values.

- a) Store zero and a telemetry failure quality code for each missed hour.
- b) Store the last good data value, with a questionable data quality code, for each missed hour.
- c) Temporarily store zero with a telemetry failure code for each missed hour. When the next good hourly value is obtained, divide that value by the number of hours since the last good value was obtained and insert this value, with a questionable data quality code, for all hours with missed data and the first hour that good data was obtained as is the case for energy values.

1.3.3.2. Hourly Data Calculations

The programmer shall be able to define calculated values using stored hourly data and constants as operands. The calculations shall allow the carry-forward of data from one day, week, or month to the next. The results of all calculations shall include quality codes derived from the quality codes of the operands. The following calculations shall be provided:

- (a) Addition, subtraction, multiplication, and division
- (b) Summation of an hourly value by day, week, and month: The running total of the summation for the current day, week, and month shall be updated each hour and made available for display.
- (c) Maximum and minimum of a value over a programmer-definable time period, and the time the maximum or minimum occurred
- (d) Average of a value over a programmer-definable time period

1.3.4. SAIDI/SAIFI table

SAIDI/SAIFI values of each feeder shall be stored on daily/ weekly/ monthly/ quarterly and yearly and user defined timeline basis. The values shall be determined from IEEE 1366 standard formula. In addition any customization as per Govt requirement may also be incorporated.

The SAIDI/SAIFI data shall be determined from outage and restoration time (breaker on & off /on cycle) and the time of outage. SAIDI /SAIFI shall be determined considering reason of outage in terms of planned and unplanned outage (Planned due to maintenance /operator command driven), Unplanned (Fault/Trip driven). In addition, the data consumer count and load connected on feeder on monthly basis shall be updated from user entry or export from IT system if any. There shall be suitable alarm/event message including user ID for such activity. Such tables on daily/ weekly/ monthly/ quarterly and shall be available

The data so captured shall also derive town wise SAIDI/SAIFI on daily/ weekly/ monthly/ quarterly, yearly and user defined timeline basis. Such daily tables for two years duration shall be stored on auxiliary memory (Online). Tables for the every year shall be backed up to Magnetic tape/ or any offline storage device for this purpose by the user.

1.3.5. Daily Energy Data table

The daily energy data table shall be generated for storage of daily energy values for 15 minute blocks / one hour blocks of a day & shall be stored for each feeder on daily basis along with quality codes. This daily energy data shall be exchanged with the Billing system in Data center/ legacy master billing center, if so defined to integrate in data exchange on daily basis and on demand. This table shall be

created on daily basis. Such daily tables for 24 months duration shall be stored on auxiliary memory. Daily Energy data table for the previous month shall be backed up to Magnetic tape by the user on the 10th of every month.

1.3.6. Load priority table

ISR system shall maintain a Load priority table containing information such as breaker name, number of consumers connected to each Breaker and Load priority of each Breaker. In addition, the priority of the feeders shall be updated from user entry or export from IT system if any on monthly basis or user defined time

There shall be suitable alarm/event message including user ID for such activity. The table information shall be used by various DMS applications.

1.3.7. SOE data table

ISR system shall maintain SOE data table which shall store the SOE data for complete distribution system. It shall be possible to sort the table by Time, Date, Substation name/, feeder/line name, device name etc. using SQL commands. This table shall be made on daily basis. Such daily tables for two y e a r s ~~months~~ duration shall be stored on auxiliary memory. For the purpose of sizing of table, daily 4 changes per SOE point may be considered. All CBs, protection and alarm contacts shall be considered as SOE. Tables for the previous day shall be backed up to Magnetic tape/ MO disks by the user at 10AM of every day.

1.3.8. Historical Information (HI) Data Retrieval

The data stored in the ISR system shall support the following retrieval capabilities:

- (a) The user shall be able to view and edit HI data on displays/Forms and reports.
The user shall be able to edit HI data, request recalculation of all derived values, and regenerate and print any daily, weekly or monthly HI report for the current and previous month.
- (b) The user shall be able to view tabular trend and graphical trend of multiple data points simultaneously by specifying the start date and time, the end date and time, and the time period between displayed samples. The duration of viewable tabular trend and graphical trend could be up to 24 hours. The features of Tabular/graphic trend are mentioned in the specification for User interface.
- (C) The HI retrieval shall expose the ISR Data over SOA / Enterprise Services BUS Supplied by ITIA, over CIM/XML, ICCP or OPC ODBC Interfaces / Adapters.
- (D) The retrieval shall provide 100% accuracy and fidelity of data

1.3.9. System Message Log Storage and Retrieval

System message log, which shall consist of the chronological listing of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION computer system alarm messages, event messages and user messages shall be stored for archival and analysis. Each entry shall consist of time tag and a text containing user and device identification as displayed on the Alarm Summary or Event Summary displays. The System message log data storage shall be sized for up to 20,000 entries per month.

System message log data shall be stored in daily tables & shall be available for minimum two months on auxiliary memory (online) System message log data for previous months shall be Backed up on Magnetic tapes/ MO disks by the user for which ISR function shall prompt the user every hour with suitable message to remind user for taking the backup on the 10th of every month. This message shall be disabled once the backup is taken.

Facilities to sort and selectively display and print the contents of the system message log shall be provided. The user shall be able to select the display of system message log entries based upon Alarm type, Events, User generated messages, Device, and Time period.

1.3.10. Mass storage of data/files

The ISR system shall be sized for mass storage of data/files for at least the following :

- a) 10 save-cases for each DMS application
- b) 10 Output results of each DMS applications

1.4. Load Shed Application (LSA)

The load-shed application shall automate and optimize the process of selecting the best combination of switches to be opened and controlling in order to shed the desired amount of load. Given a total amount of load to be shed, the load shed application shall recommend different possible combinations of switches to be opened, in order to meet the requirement. The Dispatcher is presented with various combinations of switching operations, which shall result in a total amount of load shed, which closely resembles the specified total. The Dispatcher can then choose any of the recommended actions and execute them. The recommendation is based on Basic rules for load shedding & restoration

In case of failure of supervisory control for few breakers, the total desired load shed/restore will not be met. Under such conditions, the application shall inform the dispatcher the balance amount of load to be shed /restore. The load-shed application shall run again to complete the desired load shed /restore process. The result of any LoadShed operation shall be archived in Information storage and retrieval (IS&R) system.

1.4.1. Basic rules for load shedding & restoration

The load shall be shed or restored on the basis of following basic rules:

(a) By load priority

The LSA shall have a priority mechanism that shall allow the user to assign higher priorities for VIP/ Critical loads or any other important load or feeders with high revenue or low AT&C losses. The load assigned with the higher priorities shall be advised to be shed later and restore earlier than load with relatively lower priorities. Each load priority shall be user definable over the scale of at least 1-10.

(b) By 24 Hrs. load shed /restore history

The loads of equal priorities shall be advised for restoration in such a way that loads shed first shall be advised to be restored first. The application shall ensure that tripping operations is done in a cyclic manner to avoid the same consumers being affected repeatedly, however, priority loads shall be affected least.

(c) By number of consumers affected

The consumer with equal priority and similar past load shed history shall be considered by the application in such a way that minimum number of consumers are affected during the proposed load shed. The data for number of consumers connected to a feeder /device shall be taken from computerized billing system.

1.4.2. Modes of operation

The load-shed application shall operate in the following modes:

- (a) Manual load shed
- (b) Manual load restoration
- (c) Auto load shed
- (d) Auto load restoration

Each mode of operation can be enabled or disabled by operator independently. The load can be shed & restore in possible combination i.e. manually shed & auto restore vice versa or both operations in the same modes.

1.4.2.1. Manual Load Shed

In this mode operator specifies a load to be shed in a project area. The software shall determine & propose all the possible combinations of switches to be operated for the requested load shed considering the basic rules for load shed & restoration.

In case more than one options are possible, then the application shall identify all such options with the priority of consumers along with the number of consumers are likely to be affected for the particular load shed option. The Dispatcher shall select & execute one of these options for affecting the load shed.

1.4.2.2. Manual Load Restoration

In this mode operator specifies the desired load to be restored. The software shall determine the switches to be operated for the requested load restore considering the basic rules for load shed & restoration.

In case more than one options are possible, then the application shall identify all such options with the priority of consumers along with the number of consumers are likely to be restored for the particular load restore option if chosen.

by Dispatcher. The Dispatcher shall select & execute one of these options for effecting the load restoration.

The Load shed Application shall maintain a load restore timer, which shall automatically start after tripping of CB due to manual load shedding. An alarm shall be generated to remind the operator to restore the loads when this timer expires. For manual mode of operation the dispatcher shall enter the value of load restore timer.

1.4.2.3. Auto Load Shed

This shall have two modes namely frequency based load shed & time of day based load shed as described below.

(a) Frequency based Load Shed

The function shall execute the tripping of breakers based on the system frequency automatically considering the basic rules for load shed & restoration.

The software shall automatically execute the switching operations as soon as system frequency reaches at load shed start (LSS_str) frequency threshold and it shall continue to do so unless system frequency crosses the load shed stop (LSS_stp) frequency limit. The frequency limits shall be Dispatcher assignable up to single decimal points. Once frequency crosses below LSS_stp limit, then load shed can only be started again when frequency attains LSS_str. Limit LSS_str shall be lower than LSS_stp & suitable protection to ensure that shall be provided in user interface such as discard, forbidden etc. if user accidentally enters LSS_str higher or equal to LSS_stp or LSS are entered higher than LSR.

(b) Time of day based Load Shed

The function shall operate to shed load at the predefined time of the day & load to be shed. The software shall automatically execute the switching operations considering the basic rules for load shed & restoration.

1.4.2.4. Auto Load Restoration

This shall have two modes namely frequency based load restoration & time of day based load restoration as described below:

(a) Frequency based restoration

The function shall execute the closing of breakers based on the system frequency automatically considering the basic rules for load shed & restoration.

The software shall automatically execute the switching operations as soon as system frequency attains load restore start frequency limit (LSR_str) and it shall continue to do so as long as system frequency is crosses below the mark load shed restore stop frequency limit (LSR_stp). The frequency limits shall be

Dispatcher assignable up to single decimal points. Once frequency crosses below LSR_stp limit , then load shed can only be started again when frequency attains LSR_str. Limit LSR_str shall be higher than LSR_stp & suitable protection to ensure that shall be provided in user interface such as discard ,forbidden etc. if user accidentally enters LSR _stp higher or equal to LSR_str or LSR limits or LSS _str higher or equal to LSS_stp or LSR limits, lower than LSS . The sequence of frequency limits shall be permitted as LSR str>LSR_stp>LSS _stp >LSS_str. Adequate protection as mentioned above shall be given if user tries to violate the same.

(b) Time of day based restoration

The function shall operate to restore load at the predefined time of the day & load to be restored. The software shall automatically execute the switching operations considering the basic rules for load shed & restoration.

1.4.3. Alarms/Events

All Load shed & restore operations executed shall be logged in the system as events. In case the supervisory control fails during the operation in predefined time, an alarm shall be generated with the possible reason for the failure.

1.4.4. Summary Report

Load shed application shall generate Summary Reports for project area on daily basis. These reports shall be available online for minimum period of two days. The following reports shall be made.

- (a) Daily Load shed report indicating, substation name, feeder/device name, date /time, duration of load shed and amount of load shed, Number of consumers affected based on consumer indexing information, mode of load shed including planned outages of feeders/network equipment.
- (b) Daily Alarm summary pertaining to LSA, substation wise.
- (c) Substation wise daily Served, un-served power & energy for every 5 minute time block
- (d) Served & un-served power for last seven days for every 5-minute time block to calculate Load forecast for the next day. The report shall contain a column to define weightage factor (multiplier) by Dispatcher to calculate Load forecast for the next day. The weightage factor is required to consider the type of the day such as holiday, festivals, rainy day, etc. Separate report for total load forecast of complete project area shall also be generated from above two reports.

1.5. Common Disaster Replica Recovery Centre (DRR)

The same shall be replica of SCADA DMS Control center for Group A (Noida Town) and with secured permission and upon non availability of main SCADA/DMS/OMS AND SUB-STATION AUTOMATION Control center, the operation of that town shall be possible from DRR. However, system shall remain in sync for data on daily basis and shall be suitable interlocks to avoid any accidental command.

1.6. Data recovery function (DR)

The DR function is a repository of system build up software of all towns Group B & Group C towns. One year online backup shall be available at this location with data pertaining to each town i.e. system build ups shall be available of each town separately so that the same can be utilized upon setting up newer system after disaster. The data related to network model of SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center of each town shall be sent to DR center periodically once a day & upon user request. The data shall be configured to be sent globally & incremental. All logs, data model etc. & necessary interfaces that are essential for complete system build up shall be stored at DR center . All requisite data which is build the system from scratch shall be transferred to DR. An alarm shall be generated & send to SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center upon attaining user defined threshold e.g. 80% for storage at DR center.

1.7. RT-DAS system

The RT-DAS system shall use control center of Group B towns and shall have SCADA features except control capability. However, the same may be upgraded for enabling control ,if need be without additional license and only by adding output cards and enabling in the configuration software.

End of Section 2, Chapter 1

SECTION -2 , CHAPTER 2

DMS FUNCTIONS & Supporting functions.

2.0 General Requirements

1.1.1 This Section describes the Distribution Management System (DMS) applications & other supporting applications that are required for SCADA/DMS/OMS AND SUB-STATION AUTOMATION System. The DMS applications shall utilize the data acquired by the SCADA application. Distribution management System Software shall include the following applications. Utilities shall select /all or certain applications according to the need & characteristic / profile of the electrical network in the project area. This section is applicable to Group A (Noida Town). However also applicable for B, C towns as per functional requirements mentioned explicitly in this chapter. For U category towns, the functions that are required sanctioned to be integrated, are applicable.

1. DMS functions

These functions are applicable to Group A (Noida Town) Towns only except LSA ,LFA, OM& DTS functions which are also applicable for GroupB ,C towns as pseudo SCADA functions limited to substation network))

- Network Connectivity Analysis (NCA)
- State Estimation (SE)
- Load Flow Application (LFA) (Group B,C) towns also as a pseudo SCADA feature also limited to Substation network)
- Voltage VAR control (VVC)
- Load Shed Application (LSA) (Group B,C) towns also as a pseudo SCADA feature also limited to Substation network).
- Fault Management and System Restoration (FMSR)
- Loss Minimization via Feeder Reconfiguration (LMFR)
- Load Balancing via Feeder Reconfiguration(LBFR)
- Operation Monitor (OM)) (Group B,C) towns also as a pseudo SCADA feature also limited to Substation network)

2. Other Supporting functions

- Dispatcher training Simulator (DTS)

3. Contractor's Standard product

The bidders are encouraged to supply standard, unmodified products that meet or exceed the Specification requirements. These products may be provided from the bidder's in-house baseline offerings as standard products from other established suppliers. Bidders shall describe all standard unmodified products proposed and shall highlight those features that exceed the Specification requirements. Although the bidder is encouraged to use as much standard hardware and software as possible, the proposal will be judged by its conformance to the Specification. Hence, a minimum level of customization in order functional requirement is permitted. The product CIM based interfaces to other enterprise applications shall be available. Bidder shall survey and collect network element parameters from utility and utility shall provide the same to run DMS functions.

2.3.1 Graphical & Tabular display requirements for DMS functions

A network overview display of the distribution system with substations, feeders color coded by voltage shall be provided. This display shall present the distribution system in a graphic format. Telemetered and calculated values like active and reactive power flows etc. shall be displayed with direction arrow. Lines, Loads, transformers etc. that have exceeded their loading limits shall be highlighted. Stations shall be depicted by suitable symbols which reflect the presence of alarms. Cursor selection of a station symbol shall result in display of the associated Single line diagram for that station. “What if “analysis shall be included to visualize network & verify the impact before an action is taken by dispatcher. For all switching actions which dispatcher have to execute manually/step by step shall have the option to simulate switching operations in order to visualize the effect on the distribution network using what if analysis

All DMS result tabular displays shall have capability for sorting by name and calculated parameters. The solution prescribed by DMS application shall consider & identify & sort the following as minimum.

1. Remote controllable circuit breaker with capability to interrupt fault currents.
2. Non-remote controllable circuit breaker with capability to interrupt fault currents.
3. Remote controllable circuit breaker with no capability to interrupt fault currents.
4. Non-remote controllable circuit breaker with no capability to interrupt fault currents.
5. Remote controllable dis-connector
6. Non remote controllable dis-connector.
7. Fuse
8. Ground/ Earth switch etc.
9. Sectionalizer
10. FPIs

4. Network Model

The DMS applications shall have a common model for the project area comprising of primary substation feeders, distribution network and devices with minimum 10 possible islands, which may be formed dynamically. All DMS applications shall be able to run successfully for the total distribution system with future expandability as envisaged under the specification. The following devices shall be represented in the model as a minimum:

- a) Power Injection points
- b) Transformers
- c) Feeders
- d) Load (balanced as well as unbalanced)
- e) Circuit Breakers
- f) Sectionizers
- g) Isolators
- h) Fuses
- i) Capacitor banks
- j) Reactors
- k) Generators
- l) Bus bars
- m) Temporary Jumper, Cut and Ground
- n) Ring, Meshed & radial network configuration.
- o) Line segments, which can be single-phase, two-phase or three-phase and makeup a distribution circuit.
- p) Conductors & Cables
- q) Grounding devices
- r) Fault detectors/FPI
- s) IEDs
- t) Operational limits for components such as lines, transformers, and switching devices

All DMS applications shall be accessed from graphic user interface through Operator consoles as defined in this specification. Reports, results and displays of all DMS applications shall be available for printing at user request.

Population and maintenance of the distribution network model should be possible by using the database maintenance tools to build the database from scratch. In case the required data already exists within the Employer's corporate Geographic Information System (GIS) as a legacy, the DMS database functions should leverage this effort by providing an interface/adaptor to extract GIS data using the CIM international standard IEC 61970/61968 and automatically generate the complete Network Operations Model. The data extracted should include network device information, connectivity, topology, nominal status and non-electrical data such as cable, land base data etc. Further Land base data can be sourced from GIS in Shape files or DXF. The utility shall provide all necessary details of legacy system for interface and to use this data. The extraction process should comply with the international standard CIM data descriptions. The CIM standard is maintained by the IEC (Technical Committee 57, Working Group 14) and is used for a wide range of purposes. The extraction process should be independent of the real-time network management system. Any GIS model should be extractable to build the network model regardless of the supplier or internal schema.

The extraction should also allow incremental updates & global transfer with no need to bring the system down or even fail over. The model should support extraction on a per-station basis

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and must be fully scalable from a single zone substation to the largest distribution networks. SCADA/ DMS should be able to present geospatial data even when the link to the source GIS at the data center/DR is not available. The user interface supporting the database will provide updated data directly to display geographic and/or schematic views of the network.

The model should support multiple geographic coordinate sets for each device so that, if available, the network can be displayed in custom geo- schematic formats. The network views may also include various levels of detail depending on the zoom level. Information such as land-based data (provided as a dxf file, shape file etc.) may also be displayed as required.

An interface with the already existing Geographical Information Systems shall be developed using interoperability features between the DMS and the installed GIS.

Each of the two systems shall keep its own specificity, and shall be used for what it has been designed: the SCADA for the real-time data acquisition, control and processing, the GIS for the maintenance of the network construction and geographic data.

The interface shall be developed in order to obtain a maximum benefit of the two systems use. It shall be implemented while maintaining the SCADA/DMS/OMS AND SUB-STATION AUTOMATION and GIS integrity as individual systems. It is of the utmost importance that the two systems remain able to operate separately.

The required functionalities for this interface shall cover the two following aspects:

The transfer of specific real-time data from the DMS into the GIS data-base the possibility to navigate easily from one system to the other through the user's interface

Data exchanges shall be made through the Control Center LAN/WAN.. Bidder shall demonstrate its incorporation capability to the main GIS Vendors through a dedicated reference list or provide and support standard interfaces to GIS.

In case of non-availability of the interface details of legacy system by utility. GIS adaptor shall tested to establish with sample database and the bidder shall run the same through, single line diagrams schema with network element parameters. Bidder shall survey and collect network element parameters from utility and utility shall provide the same to run DMS application.

5. Network Connectivity Analysis (NCA)

The network connectivity analysis function shall provide the connectivity between various network elements. The prevailing network topology shall be determined from the status of all the switching devices such as circuit breaker, isolators etc. that affect the topology of the network modeled.

NCA shall run in real time as well as in study mode. Real-time mode of operation shall use data acquired by SCADA. Study mode of operation will use either a snapshot of the real-time data or save cases.

NCA shall run in real time on event-driven basis. In study mode the NCA shall run on operator demand.

The topology shall be based on:

- (a) Tele-metered switching device statuses
- (b) Manually entered switching device statuses.
- (c) Modeled element statuses from DMS applications.

It shall determine the network topology for the following as minimum.

- (a) Bus connectivity (Live/ dead status)
- (b) Feeder connectivity
- (c) Network connectivity representing S/S bus as node
- (d) Energized /de-energized state of network equipment.
- (e) Representation of Loops (Possible alternate routes)
- (f) Representation of parallels
- (g) Abnormal/off-normal state of CB/Isolators

The NCA shall assist operators to know operating state of the distribution network indicating radial mode, loops and parallels in the network. Distribution networks are normally operated in radial mode; loops and/or parallel may be intentionally or inadvertently formed.

A loop refers to a network connectivity situation in which there exist alternative power flow paths to a load from a single power source. A parallel refers to a topological structure in which a load is fed from more than one power source. Parallel paths often result in circulating currents and such operating conditions need to be avoided. All loops/parallels in an electrical network shall be shown by different colors in such a way that each is easily identifiable.

The abnormal state of CB/Isolators means these devices are not in their Normal OPEN or CLOSED position.

Alarms shall be generated when presence of abnormal switches, De-energized components of network and of Network loops / parallels is detected.

2.5.1 Tracing

NCA function shall also have the capabilities of network tracing when requested by the dispatcher. Dedicated colors shall be used for feeder and circuit tracing and also when

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information available is not complete or inconsistent. The trace shall persist through subsequent display call-ups, until the operator explicitly removes it or requests another trace. In addition, at the bottom of the geographic view the number of transformers and customers passed by the trace are shown.

- (a) Feeder tracing - This feature shall aid dispatcher to identify the path from a source to all connected components by same color.
- (b) Circuit tracing- This feature shall enable operator to select any device and identify the source and path by which it is connected through the same color.
- (c) Between Tracing: This feature shall enable the operator to select any two components of the network and shall able to trace all components connected in between them.
- (d) Downstream Trace – from a selected circuit element the trace identifies all devices that are downstream of the selected element. In the case where a downstream trace is performed on a de-energized section of the network, the trace highlights all devices electrically connected to the element.

2.5.2 Temporary Modifications:

The NCA will allow temporary modifications at any point in the distribution network to change the network configuration, to isolate faults, restore services or perform maintenance. A Summary shall list the jumpers, cuts and grounds that are currently applied. The function is performed by the NCA and is implemented locally within the client software and has no effect on the operations model or other clients viewing the network.

2.5.2.1 Cuts:

Cuts facilitated in any line segment in the network. The cut may be applied to one or more available phases of the conductor. The cut could also be applied as a temporary switch inserted in the line.

- The cut must be given a name or id number for identification, which is displayed as a label on the geographic network view.
- It should be possible to select the position of the label relative to the cut symbol.
The position can be altered after the cut has been placed.

Once placed the cut symbol can be selected and switched on and off by the operator in the same way as a standard disconnect switch. Cuts can also be tagged.

2.5.2.2 Jumpers

Jumpers are a means of providing a temporary, switchable connection between two points on the network. The operator should be able to select two points and place the jumper with relevant details. The initial state of the jumper may be set to open or closed. The jumper popup automatically defaults to show the phases available for connection between the two points but other partial or cross-phase connections may be made if required. The popup shall warn the operator about abnormal connections such as not all phases being connected or the nominal voltage being different at the two connection points. Once the jumper has been placed the switch symbol in the center can be selected and switched open or closed. The topology of the network model is updated accordingly. There is no restriction on the placement of jumpers between lines connected to different feeders or different substations.

Temporary connections between phases on the same line segment, known as a phase jumper shall be supported. This can be used in conditions where one phase is de-energized and it is desired to restore customers by energizing the dead conductor from one of the live phases.

2.5.2.3 Temporary Grounds

Temporary grounds should only be placed, for obvious reasons, on De- energized sections of a line. These grounds represent the mechanical grounding of lines for safety purposes during maintenance or construction.

A temporary ground may be placed on one or more of the available phases. It must be given a name and additional information can be included in the description field.. If a line segment is re-energized while a temporary ground is still applied, the ground will be automatically removed.

2.5.3 Reports and Displays

The reports and displays shall be generated indicating the followings as a minimum:

- (a) Abnormal switches in tabular display
- (b) De-energized components of network in tabular display
- (c) Presence of loops & parallels on network displays
- (d) Un-served/ disconnected loads (loads affected due to tripping of CBs) in tabular displays
- (e) List of temporary jumpers/cuts /grounds

6. State Estimation

The primary function is to determine network state where SCADA system monitoring is directly envisaged. The State Estimation (SE) shall be used for assessing (estimating) the distribution network state. It shall assess loads of all network nodes, and, consequently, assessment of all other state variables (voltage and current phasors of all buses, sections and transformers, active and reactive power losses in all sections and transformers, etc.).

Firstly, the symmetrical (per phase) and asymmetrical (three-phase) load of all nodes in the radial or weakly meshed MV network, which are not remotely monitored, that is not directly covered by the SCADA System shall be using evaluated Load Calibration . **SE** represents the basic DMS function, because practically all other DMS Analytical Functions are based on its results.

This is the unique function dealing with the unobservable load of the actual network, which is not directly covered by the SCADA System. Function is used for balanced and unbalanced networks.

The function is based on an algorithm specially oriented towards distribution networks, with low redundancy of real time, remotely monitored data, The deficiency of real time data has to be compensated with historical data.

Beside the parameters of network elements, the real-time data consists of:

- Actual topology, transformers tap changer position, etc.
- Voltage magnitudes of supply point and other nodes in the network.
- Current magnitudes (active and reactive power) at feeder heads.
- Current magnitudes (active and reactive power) from the depth of the network.

The historical data of the network consists of:

- Daily load profiles – current magnitudes and power factors, or active and reactive powers for all load classes (types, for example: industrial, commercial, residential), for all seasons (for example: winter, spring, summer, autumn), for e.g. four types of days (for example: weekday, Saturday, Sunday and holiday).
- Peak-loads for all distribution transformers and/or consumers (peak-currents and/or peak powers) and/or monthly electric energy transfers across all distribution transformers

(consumers).

SE function shall run in all cases from the range of networks where all historical data are known, but also in networks with no historical data available (based on parameters of the network elements).

Also according to users setting, the **SE** function shall be able to run:

- With or without verification of telemetered measurements.
- With manual or automatically processing unobservable parts of network.
- With or without fixed measurements.

This shall have real time & Simulation mode both. In the first one, the function shall be used for estimation of the current state. In the Simulation mode, the function is used for estimation of the desired state (e.g. any state selected from the saved cases).

The **SE** algorithm shall consider into account the non-availability of real-time data and compensates them with historical data, pseudo and virtual measurements, to achieve the minimal set of input data necessary for running a consistent Load Flow.

The **SE** algorithm shall consist of the next important steps:

- Pre-estimation – It shall be based on the historical data of the network: daily load profiles, peak-loads for all distribution transformers and/or consumers, etc. This step shall give pre- estimated states of considered MV networks.
- Verification of measurements– It shall be obtained from artificial redundancy of measurements (too small number of measurements and notable main number of pseudo measurements obtained from first approximation). This step shall consider two sub-steps: (a) in sighting evidence bad measurements, (b) verification and/or correction all permanent measurements. In this step, incorrect measurements shall be corrected or discarded.
- Load calibration – The function shall distribute the load to the busbars of the MV network on the basis of the set of verified measurements and historical data. Also, Load calibration shall deal with consumers specified directly through their current/time diagrams i.e. load curves as well as with consumers with constant consumption. The function shall run even any of these data are not available. It shall be designed in such a way that the quality of results of the function running increases directly with the amount of given data.
- Load Flow calculation – This shall be the next function in the specification based on the loads assigned in the previous step.

2.6.1 Input/output

Beside the network element parameters, main inputs for the functions consist of above noted real time and historical data. In the case of the function running in the Simulation mode, the real time data must be replaced with the corresponding data from the saved cases or fore-casted ones.

Main outputs of the function are estimation of:

- Voltage magnitudes in the entire network.
- Current magnitudes and power factors for all network elements.
- Loads of all MV and LV consumption buses.
- Losses of active and reactive powers in the entire network, by each supply transformer or feeder.

Beside those results, output of **SE** function is tabular report, also. In this report measurement verification results are presented those results are:

- Pre-estimated and estimated values of measurements. Minimal and maximal expected values of measurement. Quality of each measurement.

- Deviation measured values from estimated and pre-estimated values.

7. Load Flow Application (LFA)

The LFA shall utilize information including real-time measurements, manually entered data, and estimated data together with the network model supplied by the topology function, in order to determine the best estimate of the current network state.

The Load Flow Application (LFA) shall determine the operating status of the distribution system including buses and nodes

The LFA shall take the following into consideration:

- a. Real time data
- b. Manual entered data
- c. Estimated data
- d. Power source injections
- e. Loops and parallels
- f. Unbalanced & balanced loads
- g. Manually replaced values
- h. Temporary jumpers/ cut/ grounds
- i. Electrical connectivity information from the real-time distribution network model
- j. Transformer tap settings
- k. Generator voltages, real and reactive generations
- l. Capacitor/reactor bank ON/OFF status value.
- m. Save case data

2.7.1 General Characteristics of LF application:

The following general characteristics/ capabilities shall be provided as minimum:

- The LF model shall support the different kind of lines such as cable feeders, overhead lines and different kind of transformers having various vector groups & winding configurations.
- Unbalanced & balanced three phase loads connected in radial and non-radial modes.
- Compute voltages and currents and power factor for each phase for every node, feeder and network devices.
- Compute each phase active and reactive loads and technical losses for the distribution system as a whole, for individual substations and feeder wise with in telemetered zone.
- Use previous save-case to make new save case or use new snapshots to set the base case for LF.
- The results of the LF application shall reasonably match with the operating condition in which the distribution system is stable.
- The LFA function shall be executed in real time & study mode.
- It shall be possible to model load either as a percentage of system load or profile base load modeling
- It shall be possible to model individual component of load i.e. Active and Reactive parts

2.7.2 Real Time Load Flow Execution:

The Real-Time LF function shall be executed:

- On event trigger
- On periodic basis
- On demand basis
- On initiation by other dms applications functions
- On placement of temporary jumper, cuts and ground

The Event Triggered LF execution shall always have the highest priority. The study mode LF function shall be executed on a snapshot or save case with user defined changes made to these cases. The study mode execution of LF Function shall not affect the Real-time mode execution of LF function.

(a) Event Triggered Real Time LF Execution:

The LF function shall be executed by pre-defined events that affect the distribution system. Some of the events the dispatcher may choose for triggers shall include:

- Power system Topology Change i.e. Alteration in distribution system configuration.
- Transformer Tap Position Change / Capacitive/reactor MVAR Change
- Feeder Over loadings
- Sudden change in feeder load beyond a set deadband

(b) Periodic Real Time LF Execution:

The real-time distribution system load flow application shall be executed periodically as configured by the dispatcher. The function shall be executed periodically even if there are no significant changes in the operating conditions, as some of the power flow outputs shall be required to provide aggregate summaries (losses, etc.)

(c) On Demand Real Time LF Execution:

Dispatchers may initiate the real-time LF function at any time through dispatcher command.

(d) Real Time LF Execution initiated by other DMS Applications:

Other DMS functions may initiate the real-time LF function at any time as desired for the execution of the respective functions.

2.7.3 Study Mode Load Flow Execution:

It shall provide dispatchers with estimates of kW, kVar, kV, Amps, power losses and the other information on the distribution system, but not necessarily reflecting its real-time state. In study mode the application should use the same data model and have direct access of the real time data as necessary. Study mode load flow shall be used to study contingency cases.

It shall be possible to prepare and store at least five cases along with the input parameters, network configuration and output results.

The dispatcher shall be able to select the saved Case to be used as a Base case for LF execution and modify the base case. Possible changes, which the dispatcher shall be permitted to make, shall include:

- (a) States of individual power system elements
- (b) Values of specific parameters including nodal loads, bus voltages, connected kVA, power factor etc.

The Study Mode shall calculate various values for each feeder and prepare summaries as LF output.

The Load Flow function shall provide real/active and reactive losses on:

- Station power transformers
- Feeders
- Sections
- Distribution circuits including feeder regulators and distribution

2.7.4 Load Flow Output:

The following output capability shall be provided:

- (a) Phase voltage magnitudes and angles at each node.
- (b) Phase and neutral currents for each feeder, transformers, section
- (c) Total three phases and per phase KW and KVAR losses in each feeder, section, transformer, DT substation & for project area
- (d) Active & reactive power flows in all sections, transformers List of overloaded feeder, lines, bus bars, transformers loads etc. including the actual current magnitudes, the overload limits and the feeder name, substation name
- (e) List of limit violations of voltage magnitudes, overloading. (f) Voltage drops
- (g) Losses as specified above

2.7.5 Display and Reports

All input and output data shall be viewed through tabular displays and overlay on the one line network diagram. Tabular displays shall consist of voltages, currents (including phase angles), real and reactive powers, real and reactive losses as well as accumulated total and per phase losses for each substation, feeder and project area. All the overloaded lines, busbars, transformers, loads and line shall start flashing or highlighted.

The LF outputs shall be available in the form of reports. The report formats along with its contents shall be decided during detailed engineering.

2.7.6 Alarms

The LFA shall warn the Dispatcher when the current operating limits are exceeded for any element or when lines are DE-energized. It shall also warn the Dispatcher when any abnormal operating condition exists.

Alarms generated during Study Mode shall not be treated as real-time alarms but shall be displayed only at Workstation at which the LF application is running in study mode.

8. Volt –VAR control (VVC)

The high-quality coordination of voltages and reactive power flows control requires coordination of VOLT and the VAR function. This function shall provide high-quality voltage profiles, minimal losses, controlling reactive power flows, minimal reactive power demands from the supply network.

The following resources will be taken into account for voltage and reactive power flow control:

- TAP Changer for voltage control.
- VAR control devices: switchable and fixed type capacitor banks.

The function shall propose the operator solution up on change in the topology of the network switching. The function shall consider the planned & unplanned outages, equipment operating limits, tags placed in the SCADA system while recommending the switching operations. The functions shall be based on user configurable objectives i.e. minimal loss, optimal reactive flow voltage limits, load balancing. These objectives shall be selectable on the basis of feeder, substation & group of substations or entire network.

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The Dispatcher shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltage profiles, load restored, system losses, number of affected customers. The solution shall identify /sort the different type of switches that are required for operation i.e. remote /manual etc.

2.8.1 Modes of operation

The VVC function shall have following modes of reconfiguration process:

- (a) Auto mode
- (b) Manual mode

The dispatcher shall be able to select one of the above modes. These modes are described below:

2.8.1.1 Auto mode

In auto mode, the function shall determine switching plans automatically and perform switching operations upon dispatcher validation automatically.

2.8.1.2 Manual mode

In manual mode, the function shall determine switching plans automatically and perform switching operations in step-by-step manner.

A filter for remote operable & manual switches shall be provided with switching plan.

2.8.2 Reports

Detailed reports of complete switching sequence for VVC operation, including voltage / VAR levels before switching & after switching shall be presented.

2.8.3 Displays

The User interface for VVC function shall have following summary displays as minimum:

- (a) Network & tabular display to VVC switching.
- (b) Tabular display giving chronological sequence for VVC operation.

9. Fault Management & System Restoration (FMSR) Application

The Fault Management & System Restoration application software shall provide assistance to the dispatcher for detection, localization, isolation and restoration of distribution system after a fault in the system. The FMSR function shall be initiated by any change in the network connectivity due to any fault. It shall generate automatic report on switching sequence depicting analysis of fault, location of fault & recommendations for isolation of faulty sections & restoration of supply.

2.9.1 Functional Requirement

The FMSR function shall include the following characteristics:

- 1) FMSR shall be capable of handling phase-to-ground and phase-to-phase faults and shall not be restricted by their time of occurrence on one or more feeders. Thus, the ability to handle multiple faults of different types, on multiple feeders, shall be provided. It shall be capable to carry out restoration of large area after a occurrence wide spread faults amounting to substantial outages in the town.

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- 1)
- 2) FMSR shall be capable of allowing the substitution of an auxiliary circuit breaker or line reclosers that may temporarily function in place of a circuit breaker or line reclosers that is undergoing maintenance.
- 3) The Operator shall be able to suspend FMSR restoration capabilities by activating a single control point. Otherwise, FMSR shall continue to operate for fault detection and isolation purposes. The Operator shall be able to resume FMSR's normal operation by deactivating the same point.
- 4) FMSR shall be capable of isolating faulty sections of network by opening any available line Circuit Breaker that may be necessary, however operating limitations on device such as control inhibit flag shall be respected.
- 5) FMSR application shall utilize the results of LF for recommendations of switching steps for restoration where in it should guide the operator for amount of overloading in lines ,bus voltage violations and amount of load that can be restored for various options of restorations ,the operator shall have the privilege of selecting the best restoration option suggested by FMSR before it starts restoration .The operator shall also be to simulate the LF for the recommended switching actions ,so that the necessary violations can be displayed on graphical display also. If an overload condition is expected as a result of the proposed switching, it shall be displayed to the operator on a graphical display and proposed alternative switching sequence to avoid or minimize the overload.
- 6) FMSR shall be capable of using data derived from substation RTUs/FRTUs /FPIs to recognize faults in substation transformer banks, any fault on the primary side of these banks that cause loss of outgoing feeder voltage and current or any fault occurred on 11KV network.
- 7) FMSR shall be capable to make Restoration plans with identification name and respective merit orders & its execution of Restoration plan using network Display and single line diagram of substation.
- 8) FMSR shall be capable to find delay in the restoration of network beyond specified time (Dispatcher configurable) and shall be able to report separately in the form of pending restoration actions.

2.9.2 Detection of fault

FMSR function shall detect the faulty condition of the network causing CB tripping due to protection operation or FPI indication. The Circuit breakers having auto-reclose feature, the FMSR application shall wait for programmer specified (settable for individual feeders) duration before declaring the network as faulty. On detection of fault in the network, an alarm shall be generated to draw attention of the dispatcher.

Switching device tripping caused by SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications shall not be considered as a faulty condition. FMSR application shall also not be initiated if the quality flags such as, manually replaced value , and Out of scan are set for a switching device.

To avoid potential difficulties during severe storm conditions, the Operator shall be able to suspend FMSR switching sequence of restoration capabilities by activating a single control point. Otherwise, FMSR shall continue to operate for fault detection and isolation purposes. The Operator shall be able to resume FMSR's normal operation by deactivating the storm- mode control point. When this occurs, FMSR shall be ready to restore power as well as detect and isolate faults following the next outage event. The same shall be recorded as an event.

2.9.5 Reports

2.9.3 Localization of Fault:

Wherever protection signal or FPI indication is not available, FMSR function shall determine the faulty section by logically analyzing the telemetered data (status of CBs, analog values etc.) as acquired through SCADA system. Besides this, for such cases an iterative method for determining fault shall be used e.g. In case of fault, upstream breaker is tripped & long stretch of multiple sections are having no intermediate fault indicators & intermediate switches are not capable to trip on fault upto the closest NO(Normal open) point, the dispatcher can open the last switch before NO point & try to close breaker, if trips again fault is on further upstream & the same method is to be repeated else fault is located in the downstream section only. For the sections where protection signal or FPI indication is available, the same shall be derived through these telemetered signals. Network diagram identifying the faulty sections/components shall be displayed identifying the relevant section. And various configurations of switch type etc.). Minimum of following switch types shall be considered by FMSR system:

- 1: Remote controllable circuit breaker with capability to interrupt fault currents
- 2: Non-remote controllable circuit breaker with capability to interrupt fault currents
- 3: Remote controllable circuit breaker with no capability to interrupt fault currents
- 4: Non-remote controllable circuit breaker with no capability to interrupt fault currents.
- 5: Remote controllable dis-connector
- 6: Non remote controllable dis-connector.
- 7: Fuse
- 8: Ground/ Earth switch etc.

2.9.4 System isolation & restoration

Once faulty section is identified, the FMSR function shall determine the switching plan to isolate healthy area from unhealthy area. FMSR function shall suggest switching plans for restoration of power to the de-energized healthy sections of the network. It may be done by closing NO switch to allow the power from alternate source. In case more than one feasible switching plan exist, the dispatcher shall be guided for most optimum plan based on the merit order i.e. minimum switching operations, minimum loss path, and system operation within the safe limits of various network elements. The dispatcher shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltage profiles, load restored, system losses, number of affected customers. The FMSR function shall have feature to attain the pre-fault configuration on dispatcher's request after repair of faulty sections.

The FMSR function shall have following modes of restoration process:

- (a) Auto mode of restoration
- (b) Manual mode of restoration

The dispatcher shall be able to select one of the above modes. These modes are described below:

(a) Auto mode of restoration

In auto mode, the FMSR shall determine switching plans automatically upon experiencing fault & proper isolation of unhealthy network from healthy part of the network and perform restoration actions upon dispatcher validation automatically.

(b) Manual mode of restoration

In manual mode, the FMSR shall determine switching plans upon experiencing faulty state & proper isolation of unhealthy network from healthy part of the network. The switching plans shall be presented to dispatcher for step by step restoration. Dispatcher shall be allowed to introduce new steps. A filter for remote operable & manual switches shall be provided with switching plan.

2.9.5 Reports

Detailed reports of complete switching sequence from outage to restoration, feeder-wise outage duration with Date & Time stamp, and quantum of served & un-served load, number of consumers interrupted & restored and network parameters limits violations shall be generated by FMSR application

2.9.6 Displays

The User interface for FMSR function shall have following summary displays as minimum:

- (c) Network & tabular display to identify faulty network.
- (d) Network & tabular display to identify remotely controllable devices
- (e) Network Display to show plan for Isolation of faulty sections from the network using single line diagram of substation or network as selected by the dispatcher.
- (f) Tabular display for Restoration plans with identification name and respective merit orders & execution of Restoration plan using network Display, and single line diagram of substation
- (g) Delay in the restoration of network beyond specified time (Dispatcher configurable) shall be reported separately in the form of pending restoration actions in Tabular display.
- (h) List of sections not restored with the reasons for non-restoration such as overloading and voltage limit violations etc. shall be shown in tabular display.

10. Loss Minimization via Feeder Reconfiguration (LMFR)

This function shall identify the opportunities to minimize technical losses in the distribution system by reconfiguration of feeders in the network for a given load scenario. The technical losses are the losses created by characteristics of equipment & cable such as efficiency, impedance etc.

The function shall calculate the current losses based on the loading of all elements of the network. The Telemetered values, which are not updated due to telemetry failure, shall be considered by LMFR application based on recommendations of LF Application.

Function shall advise the transfer of load to other elements of the network with an aim to minimize the loss. All such advises shall indicate the amount of loss reduction for present load condition. The LMFR application shall consider the planned & unplanned outages, equipment operating limits, tags placed in the SCADA system while recommending the switching operations. The dispatcher shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltage profiles, load restored, system losses, number of affected customers.

LMFR application shall run periodically at every 15 minutes and on demand. Short duration Power Interruption to the consumers during suggested switching operations may be permitted.

2.10.1 Modes of operation

The LMFR function shall have following modes of reconfiguration process:

- (a) Auto mode
- (b) Manual mode

The Dispatcher shall be able to select one of the above modes. These modes are described below:

2.10.1.1 Auto mode

In auto mode, the function shall determine switching plans automatically for minimal loss condition in the network and perform switching operations upon Dispatcher validation automatically.

2.10.1.2 Manual mode

In manual mode, the function shall determine switching plans automatically for minimal loss condition in the network based on which Dispatcher can perform switching operations in step-by-step manner.

A filter for remote operable & manual switches shall be provided with switching plan,

2.10.2 Displays & Reports

At the defined periodicity or on demand, the Dispatcher shall be presented with the tabular & graphical displays indicating feeder-wise, substation-wise, project area wide technical losses in % before & after the feeder reconfiguration.

The summary report shall also be generated periodically to display technical losses and possible reduction in losses if Dispatcher follows the LMFR recommended switching operations. The report shall also highlight violations that are occurring in the network with display layers before and after reconfiguration.

11. Load Balancing via Feeder Reconfiguration (LBFR)

The Load Balancing via Feeder Reconfiguration function shall optimally balance the segments of the network that are over & under loaded. This function shall help in better utilization of the capacities of distribution facilities such as transformer and feeder ratings.

The Feeder Reconfiguration Function shall be activated either by an overload condition, unequal loadings of the parallel feeders and transformers, periodically or on demand by the Dispatcher. It shall generate the switching sequence to reconfigure the distribution network for transferring load from some sections to other sections. The LBFR application shall consider the planned & unplanned outages, equipment operating limits, tags placed in the SCADA system while recommending the switching operations. The function shall distribute the total load of the system among the available transformers and the feeders in proportion to their operating capacities, considering the discreteness of the loads, available switching options between the feeder and permissible intermediate overloads during switching. The Dispatcher shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltage profiles, load restored, system losses, number of affected customers.

2.11.1 Modes of operation

The function shall have following modes of reconfiguration process:

- (a) Auto mode
- (b) Manual mode

The Dispatcher shall be able to select one of the above modes. These modes are described below:

2.11.1.1 Auto mode

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In auto mode, the function shall determine switching plans automatically for load balancing in the network and perform switching operations upon Dispatcher validation automatically.

2.11.1.2 Manual mode

In manual mode, the function shall determine switching plans automatically for load balancing in the network based on which Dispatcher can perform switching operations in step-by-step manner.

A filter for remote operable & manual switches shall be provided with switching plan,

2.11.2 Displays & Reports

The summary report shall cover the followings:

- (a) Loadings of feeders and transformers before and after reconfiguration.
- (b) Voltage profile of the feeders before and after reconfiguration.

The report shall also highlight violations that are occurring in the network with display layers before and after reconfiguration."

12. Operation Monitor

The Operations Monitoring function shall track the number of operations made by every breaker, capacitor switch, reclosers, OLTC, isolator and load break switch that is monitored by the System. Devices shall be identified by area of responsibility, substation, feeder, and device ID to provide the necessary information for condition-based maintenance of these devices.

Each monitored device shall be associated with a total operations counter. This counter shall be incremented whenever the associated device changes state. When a multiple change (such as a trip-close-trip sequence) is reported by an RTU/FRTU, each transition shall be counted separately. In addition, a fault operations counter is required. This counter shall be incremented only for uncommanded trip operations. The date and time of the last operation shall be saved for each device when one of the counters is incremented.

An Operator with proper authorization shall be able to enter total operations and fault operations limit for each counter. An alarm shall be generated when a counter exceeds its limits. No additional alarms shall be generated if the counter is incremented again before it is reset. For each counter, the System shall calculate the present number of operations expressed as a percent

(Which may exceed 100%) of the corresponding limit.

The ability to reset individual counters shall be provided. In addition, a user shall be able to inhibit operations counting for individual devices. Such devices shall be included in summaries based on areas of responsibility. Resetting and inhibiting counters shall be permitted only for devices that belong to the areas of responsibility and resetting shall require the console to be assigned to an appropriate mode of authority. The user info, date and time, when each counter was last reset shall be saved.

The counters and other related information shall be available for display and inclusion in reports. The user shall be able to view the date and time of a device's last operation together with its accumulated operations data by simply selecting the device on any display where it appears

13. Outage Management System

2.13.1 Outage Scheduling Management

The system shall enable utility to partially or completely deenergize an electric circuit. The system shall exhibit following features

- Planning, communications and performance of the work that involve best practices related to outage management:
 - Advance notifications
 - Priority Management of outage requests
 - Work permits
 - Generating switching plans to support the power outage requests
 - Status updates
 - Work order completion
- Notifies affected customers in advance so that they have adequate time to make appropriate decisions or alternate plans
- Allows for field crew to communicate delays in planned work and assists in providing a timely update to the expected time of restoration
- Allows for field crew to promptly provide notifications when their work is completed
- Crews can submit preliminary information about changes made to the energized system, and close the associated work orders or tasks

2.13.2 Trouble Call Management System

Customer outage related trouble call management system summarizes all of the ticket information and primarily used by the operator or dispatcher to analyze the location of any ticket (prediction or confirmed outage). The data of OMS regarding outages / tickets shall be shared with Customer Care Centre of DISCOM.

The system shall exhibit following features:

- Trouble call summary display provides an itemized summary of all trouble calls on the system in whole or by area.
- Switching devices operated by SCADA as a commanded change of state will generate an outage ticket which does not have to be confirmed by a crew.
- Telemetered protective devices operate automatically on a fault condition when they are tripped by relay. In this condition, outage prediction will 'walk' downstream to predict incident downstream of tripped protective device.
- If a telemetered protective device closes automatically, or under SCADA control, the system will close the outage ticket and commence with the call back process to inform the affected customers.

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- Trouble calls are organized into accounts and may be expanded by geographical, electrical or work areas:
 - Normal
 - Critical
 - Premium / VIP
 - Medical, etc.
- SCADA generated outages are logged as SCADA generated so as to differentiate them from trouble calls generated manually or by the prediction algorithm.
- Customer-centric information organized and displayed both graphically and in tabular form by area
- User friendly table organizes the calls into the following basic ticket groups which are filtered by type based on the user's area of responsibility:
 - Unassigned
 - Assigned
 - Incident
 - Trouble Calls
 - Outages
 - Completed Trouble Calls
 - Rejected
 - Closed

2.13.3 Crew Dispatch & Work Management Key Features

Crew & Work Order Management provides an organized and efficient way to manage the correlation of crews to Work Orders or Tickets. Crew Management user interface enhances the dispatcher and supervisor's situational awareness via an easy to use and visual progress of outage restoration or work resolution.

- Enables Operator / Dispatcher to monitor crews and assign crews to jobs
- Manage crews and activity related to daily work orders
- Schedule the work for independent creation, tracking and management of each job
- Work orders may be linked to Trouble Calls if the work order is related to the outage
- Dispatcher is able to monitor the crew workload and the crew's progress.
- Summary screens to monitor and manage Work Orders and Trouble Calls
- Crew workload can be balanced to handle changes in the personnel or resources

2.13.4 Outage Analytics & Reporting

Real-time dashboard summaries as well as detailed tabular and customizable graphic reports supporting drill-down and query capability shall be built up

- User-defined reports covering crew, trouble calls, outage, outage codes, call codes, failure codes, calculations, area reports, device operation, planned outages, etc.
- Create custom reports using drag and drop from the data model.
- Automatic calculation and reporting of several performance indices including IEEE 1366 continuity of service indices: SAIDI, CAIDI, SAIFI, MAIFI, etc.
- Quality of Service (QoS) reporting based on the logged events, times and degree of restoration for display and reporting.
- Reporting to crew through SMS about on configured feeder manager nos.

The following reports shall be minimum shall be defined apart from utility specific reports :

- Outage History
- Cause analysis
- KPI indices (Reliability, efficiency in closure of tickets)
- Recurring trouble summary
- Worst performing feeders/ devices
- Crew assignments
- Closed cases

2.13.5 Web Clients & Mobile Views

The Web-Based Solution offers an extended thin-client web-based application that allows users to visualize, simulate, and manage their electrical systems remotely from the web.

This tool applies to Real-Time operations as well as analysis, and optimization. It provides the user with a remote platform for executing “what-if” scenarios on existing operating conditions and predicts system responses using analysis calculations. Users can monitor single or multiple systems from a single web page; No software installation is required at the client machines.

Applications

- Predictive “What-if” Simulation using exiting operating conditions
- Remote Scenario Execution
- Review Results on the One-Line Diagrams & Reports

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- System Monitoring & KPI Views
- Geographical Power Distribution Views
- Alarms & Events
- Load Shedding System View
- Switching Sequence Management
- Customizable User Interface & Reporting

14. Dispatcher Training Simulator (DTS)

A Dispatcher Training Simulator (DTS) shall be provided for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system for training of operators/ dispatchers during power system normal, emergency/ disturbance and restoration activities. The DTS shall be installed at the at each SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center for Group A (Noida Town) towns and District Scada Control Centre for Group B towns, where it shall be used to train employer and other utilities dispatchers. The major DTS features shall include:

- a. The DTS model shall simulate the distribution power system in a realistic manner, including its response to simulated events, Instructor actions, and Trainee actions. The response shall be identical to the response observed by the dispatcher in the actual computer system environment.
- b. The consoles shall be assignable as trainee or instructor consoles. The DTS shall support at least one instructor & two trainees
- c. Instructor control features shall include the ability to set up, control, participate in, and review the results of a training session.
- d. Dispatcher control feature shall facilitate dispatchers to train dispatcher to use all SCADA, dispatcher & DMS functions under normal & disturbed conditions.
- e. An ability to obtain data from the SCADA/DMS/OMS AND SUB-STATION AUTOMATION systems automatically for DTS initialization. The initialization data shall include save cases, predefined & instructor defined scenarios.
- f. It shall prevent actions & keep insulated the actions performed by the Instructor and Trainee using the DTS from affecting the real-time system database or the actual power system.
- g. An ability to simulate actual system disturbances from historical data "snapshots" stored by the real-Time database Snapshots.
- h. DTS function shall have ability to establish the following training conditions as a minimum:
 - (1) Normal steady state
 - (2) Disturbed network conditions for distribution network
 - (3) High & Poor Voltage conditions
 - (4) Poor VAR conditions
 - (5) Indiscriminate tripping (6) islanding
 - (7) System blackout
 - (8) System restoration
 - (9) Conditions/functions included for SCADA/DMS/OMS AND SUB-STATION AUTOMATION real time system

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- i. Following features as minimum:
 - (a) All SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions as envisaged in the specification
 - (b) Cry wolf alarms
 - (c) Record/ Playback /slow/real-time/fast forward
 - (d) Record trainee actions

DTS Model features, functions & user interface shall be true replica of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system model for that project area. The DTS can be used in the following modes as minimum:

- 1. Instructor Control
- 2. Trainee Control

2.14.1 Instructor Control:

The Instructor shall be able to perform pre-session, session, and post-session activities. Each training session shall consist of executing a scenario (tailored to the simulated SCADA/DMS/OMS AND SUB-STATION AUTOMATION system) starting from a base case. The base case shall consist of a solved network output case from the NCA or load/power flow and one or more load curves.

Pre-session activities consist of scenario building and development of events that occur during the training scenario. A load/power flow function shall be provided in the DTS to support this feature.

Session activities performed by the Instructor include initiation, control, and participation in the training session.

Post-session activities shall consist of session review and evaluation of Trainee performance. The DTS shall maintain records of the training session so that the base case, scenario, Trainee actions, and other session activities may be reviewed. Instructor shall have all rights of trainee mode also as mentioned below:

2.14.2 Trainee control :

All activities, features, functions, user interfaces, which dispatcher can perform or use in real time shall be available to trainee in trainee control mode.

2.14.3 Pre-Session Activities

The Instructor shall be able to create a base case and to execute a power flow if desired to initialize the base case. The Instructor shall be able to build groups of events scheduled to occur during the training session. A training session shall be built by combining one or more event groups with a base case.

2.14.4 Scenario Construction

The following features shall be provided for building a training session:

- (a) Base Case Construction: shall allow Instructor to set conditions, parameters, and limitation for equipment in the network database. It shall be possible to initialize a base case from the following sources:
 - (1) A stored base case created in the DTS
 - (2) A power flow solution obtained in the DTS
 - (3) A power flow or NCA /SE solution obtained from real-time system.
 - (4) Output of real time DMS executed functions

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- (b) Base Case Store: shall allow instructor to save a base case for future use. It shall be possible to transfer saved base cases to auxiliary memory (e.g., magnetic tape) and to reload saved base cases from auxiliary memory.
- (c) Base Case Select: shall allow instructor to select a specific base case for modification or further processing. Base case selection may be indexed by title or subject.
- (d) Base Case Review: shall allow instructor to display the contents of the base case.
- (e) Base Case Editing: shall allow instructor to modify a base case and to store the updated version.
- (f) Event Group Construction: shall allow instructor to construct event groups containing one or multiple events. The Instructor shall be able to define the events within the event group to occur simultaneously or according to other parameters of time or system conditions. Checks shall be performed to assure that each event entered is one of the predefined set of events and that the equipment and parameters associated with the event are valid for the event specified.

The system shall provide an interactive means for specifying the device or point associated with each event.

- (g) Event Group Store: shall allow the Instructor to save the event group constructed for future use.
- (h) Event Group Select: shall allow the Instructor to select one or more event groups for incorporation into a training scenario.
- (i) Event Group Review: shall allow the Instructor to display events within an event group.
- (j) Event Group Editing: shall allow the Instructor to modify an existing event Group A (Noida Town) and to store the updated version.

2.14.5 Event Types

The Instructor shall be provided with a set of permissible event types that can be scheduled as part of a scenario. As a minimum, the following event types shall be included:

- i. Change of bus load
- ii. Change of system load
- iii. Fault application/FPI indication
- iv. Circuit breaker trip/close
- v. Circuit breaker trip with successful reclosers
- vi. Circuit breaker trip with unsuccessful reclosers
- vii. Isolators switching
- viii. Supervisory control disable/enable for specific device
- ix. Relay status enable/disable
- x. Loss of RTU /FRTU/FPI due to telemetry failure for specified period of time
- xi. Loss of single RTU /FRTU/FPI point

- xii. Replace value of telemetered point
- xiii. Messages to Instructor
- xiv. Pause simulation
- xv. Demand snapshot.
- xvi. Cry wolf alarms

2.14.6 Event Initiation

Events shall be executed at an Instructor-specified time, when Instructor-specified conditions occur, upon Instructor demand, and when protective relays operate. Event initiation shall include:

- (a) Time Dependent Events: These events shall be scheduled by the Instructor to occur at a specified simulated clock time or at time intervals relative to the start time of the scenario.
- (b) Conditional Events: Conditional events shall be based on simulated power system conditions obtained from DTS model. The Instructor shall be able to specify a conditional event by specifying a permissible events and a Boolean equation for the power system condition that will trigger the event. The Boolean equation shall allow the following triggers to be incorporated separately or in combination:
 - (1) A status variable equal to a defined state
 - (2) An analog variable above or below a defined threshold
 - (3) Change in analog variable from one DTS cycle to the next by more than a defined amount (positive or negative).
- (c) Demand Events: The Instructor shall be able to demand the immediate execution of an event without having to insert it in the events list.
- (d) Relay Initiated: The operation of a relay shall result in the execution of one or more Instructor-specified events.

2.14.7 Session Activities

The Instructor shall be able to monitor the training scenario and guide it toward a specific objective by inserting new events omitting scheduled events, and performing other actions. The following commands shall be provided to control a Trainee scenario:

- (a) Pause/Resume: Shall allow the Instructor to suspend or resume the training scenario without affecting the scenario. While in the Pause mode, the Trainee and Instructor shall be able to call all displays but perform no other functions. The Resume command shall resume the simulation from the point at which the pause occurred.
- (b) Slow/Fast Forward: shall allow the Instructor to move a training scenario forward at a Instructor-specified speed slower/faster than real-time.
- (c) Event Insertion: shall allow the Instructor to add new events when a training scenario is in progress without the need to interrupt the training scenario.
- (d) Event Demand: shall allow the Instructor to demand the immediate execution of an event.
- (e) Event Omission: shall allow the Instructor to omit a scheduled event from the training scenario in progress without interrupting the training scenario.

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- (f) Periodic Snapshot: shall allow the instructor to create a historical file that is periodically updated with session data necessary to resume simulation as it occurs during the simulation. The DTS shall not pause while the snapshots are being collected and saved. The snapshot save area shall be circular in nature where the oldest snapshot will be overwritten each time a new snapshot is saved when the save area is full.
- (g) Demand Snapshot: shall allow the Instructor to create a historical file, identical to that created by a periodic snapshot, on demand during the simulation. The DTS shall not pause while the snapshots are being collected and saved.

2.14.8 Post-session Activities

The DTS shall provide the following capabilities to assist the Instructor in reviewing a training session with the Trainee:

- (a) Snapshot Review: shall initialize the DTS with a snapshot saved during a training session. After a snapshot has been loaded, the Trainee and Instructor shall be able to call displays to examine any data available during a session.
- (b) Snapshot Resume: shall resume the simulation from a snapshot in the same manner as it would resume from a Pause.
- (c) Evaluation report : Based on the actions performed , timeliness & An evaluation report shall be created to review performance of trainee.

2.14.9 DTS Performance and Sizing

The DTS shall be sized the same in all respects as the SCADA/DMS/OMS AND SUB-STATION AUTOMATION control system. In addition, the capabilities of the DTS shall include the following items as minimum:

- (a) 20 DTS base cases
- (b) 20 scenarios
- (c) 250 event groups
- (d) 50 events per group
- (e) 50 session snapshots
- (f) 5-minute snapshot periodicity
- (g) 100 conditional events
- (h) 1000 variables in conditional events.
- (i) 2 Trainee (according to no. of DTS consoles) & 1 instructor

2.14.10 DTS Database and Displays

The DTS SCADA and Network model database must have the same functionality & displays as the real-time system database & displays. It must be possible to initialize the DTS with a copy of the database of real-time system in addition creation of database locally.

End of Section 2, Chapter 2

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SECTION -2, CHAPTER –3

User interface Requirements

3.0 General Requirements

This chapter describes the User Interface requirements for the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. All SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions shall have common user interface as user interaction shall be performed from Operator Consoles envisaged in this specification. This section is applicable to Group A (Noida Town), B,C towns as per functional requirements. All user interactions shall be from full graphics display. The sizing requirements are given in **the appendices in section 8**

3.1. System Users

The term "user" is applied to the personnel interacting with the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. These users shall be required to login in one or more of following **user modes**, which include:

- (a) Supervisor Personnel responsible for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system administration and management such as assigning the access area to users, creating users etc.
- (b) Dispatcher Personnel responsible for real-time Power system operations including real-time study as per assigned town /domain in AoR (Area of Responsibility)
- (c) Engineer Personnel having access to certain SCADA/DMS/OMS AND SUB-STATION AUTOMATION system functions and maintenance of database/ displays and responsible for support activities such as post fault analysis, report generation, regular backup of database
- (d) Programmer Personnel responsible for continuing development and maintenance of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system functions, databases, displays and report formats. Security system
- (e) Remote VDU user : Personnel having only monitoring access of real-time power system from SCADA/DMS/OMS AND SUB-STATION AUTOMATION system , reports..
- (f) DTS (Instructor & Trainee modes): The Consoles dedicated for DTS shall have instructor & trainee modes. The requirements are defined in section 2 chapter 2

The role, accessibility for each mode is defined as above, However, the Utility with login as supervisor shall be able to assign the operation of certain functions, or features of functions, to specific user modes. Utility shall maintain the privileges as specified to each user mode .Each individual user shall be assignable to anyone or more user modes. User access to all SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions shall follow a consistent set of common user access guidelines. A mechanism for defining and controlling user access to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be provided.

Password security shall be provided for access to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system, its operating system, layered products, and other applications. Each password shall be validated against the corresponding user information in the database. Users shall have the ability to change their own passwords.

3.2. Function and Data Access Security

After a user has successfully logged on, access to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions, displays, reports, and databases shall be restricted by pre-assigned operating jurisdictions. These operating area assignments shall be made when the function, display, report, or database element is defined.

The access security function shall compare the user's assigned operating jurisdiction against the operating jurisdictions assigned to the function, display, report, or database element each time a user attempts a console action, such as:

- (a) Calling a display
- (b) Entering or changing display data
- (c) Viewing, editing, or printing a report
- (d) Executing a supervisory control action

There shall be no restrictions on the assignment of multiple jurisdictions to a console & user or the assignment of a jurisdiction to multiple consoles & users. The access security function shall ensure that each jurisdiction is at all times assigned to a least one console. If a console failure or manual reassignment of jurisdiction results in one or more jurisdictions not being assigned to at least one console, the unassigned jurisdictions shall be automatically assigned to a pre- assigned default console and suitable alarms shall be generated.

SCADA/DMS/OMS AND SUB-STATION AUTOMATION users shall not require additional login (user name and password) to the other facility allowed as per operating jurisdictions such as ISR. "Single Sign-On" (SSO) technology be employed (i.e., a user logs on once to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION using individually defined user name and password which permits appropriate level of access to all SCADA/DMS/OMS AND SUB-STATION AUTOMATION facilities, including IS&R. Further, the facility should be compatible with enterprise-wide SSO capabilities.

Each log-on and log-off shall be reported as an event. Unsuccessful attempts to log-on shall also be reported as events.

3.3. Windows Environment

The user interface for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be web enabled. The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system displays shall operate within a windows environment and shall conform to the standards contained in the X Consortium's Inter-Client Communications Conventions Manual (ICCCM). The window system shall work with the graphical user interface provided and shall allow windows created on the workstations to communicate with processors equipped with X Windows- compatible software on their respective local area networks (LANs) and with future remote applications over the widearea network (WAN).

Alternatively, the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system can have the user Interface based on Microsoft Windows. The functionality in technical specification related to the GUI features of X-windows, shall be met by available features of Microsoft Windows.

It shall be possible to save window configuration in Rooms. Rooms shall allow each user to configure and save a preferred layout, size, and location of windows and displays. The World Display Features shall provide two-dimensional graphic world displays that a user shall be capable of panning, zooming and rubber banding.. The world display features such as Layers, Declutter levels, Overlays shall be supported. Displays & navigation on VPS shall be same as on the operator workstations.

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The user interface software shall be based on state-of-the-art web-based technology to present interactive, full-graphics views of system data via LAN, corporate intranet or the internet. The same displays shall be used.

It is essential that the same web-based user interface (same navigator, same tools) be available to the operator either for local use in the dispatching center or remotely.

Real-Time Dynamic Graphics and HMI Solutions for C/C++, C# / NET, Java and Web / Mobile is envisaged.

The web technology shall be natively supported by the SCADA & DMS product, which means that having the displays shown in the web browser shall not bring additional work to the maintenance engineer at display building time. Nor shall it require additional third-party software products like specific plug-ins.

C/C++, Java and C# .NET libraries for a variety of Windows, Linux/Unix and embedded platforms, with MFC, Qt and Gtk support. z Cross-platform support for a run-time choice of a graphics driver: hardware-accelerated Open GL or a native GDI. z Web deployment via a client-side HTML5 and JavaScript, or server-side (ASP.NET or JSP). Supported platforms: Windows, Linux, Solaris, AIX, HP-UX etc

A vast collection of pre-built widgets - real-time charts, graphs, dials, meters, process control symbols and others – to be provided with the Toolkit. The Graphics Builder may be used to modify widget drawings, create dashboards containing multiple widgets, as well as design custom widgets and add them to the Builder's palettes.

The web user interface shall support and enforce all security features including cyber security compliances.

3.4. Display interactions

Rapid, convenient, and reliable display requests shall be provided using the following methods:

3.4.1. Display Requests

- a) Selection of a display from a menu display
- b) Cursor target selection on any menu, graphic, or tabular display
- c) Selection of an alarm : in this case, it shall call up the one-line display containing the alarm's location,
- d) Selection of an alarm or event message on a summary display followed by a display request command.
- e) Selection of display by Entering a display name or number
- f) Forward and reverse paging in a page-based display.
- g) Selecting a previous display by re-call command.

- h) Selecting a point of interest from an Overview Display for viewing on full screen (such as viewing a SLD of a substation by selecting the Substation node from a Network diagram).
- i) Selecting function keys or cursor targets dedicated to displays.

3.4.2. Display navigation

Display navigation methods shall provide a consistent approach for moving within a display. The following methods shall be provided:

- a) Panning with cursor positioning device or scroll bars
- b) Zooming with cursor positioning device
- c) Navigation window for rapid movement between portions of a world display
- d) Rubber-band zooming.
- e) Tool tip
- f) Find & locate
- g) Drag & drop

Zooming shall affect the magnification level of the data displayed. Panning shall move the viewed portion of a world map space. The size of the viewed portion of the map relative to the whole display shall be indicated by the width of the sliders in the scroll bars of the window displaying the sector. When a display is first called up in a window, it shall be automatically scaled as per default zoom level.

Both continuous and discrete panning and zooming control shall be provided. Continuous panning and zooming shall be done in a convenient and intuitive way using the mouse; and the resulting changes in the screen contents shall be “smooth” and instantaneous without any noticeable delay. Discrete panning and zooming in larger steps shall be possible by dragging the mouse, using the keyboard, and clicking on push buttons on toolbars.

When only a part of the display is shown in the active window, the user shall be able to request a “navigation” window for orientation. This window shall show a small replica of the complete display, with the displayed sector of the display highlighted. The user shall be able to move the navigation window anywhere on the screen, and shall be able to close it.

A decluttering mechanism that defines the visibility of a graphic construct as a function of its magnification shall be provided. As zooming changes the magnification of data displayed, the declutter mechanism shall cause levels of detail to be shown or suppressed.

The magnification range corresponding to each declutter level shall be defined as system configuration parameter. Static and dynamic element within a display shall have associated with it a visibility designation as yes or no for each

In addition to reaching the various decluttering levels through zooming, users shall also be allowed to request a specific level from a dialog menu.

The user shall be able to scale (zoom) the image of a world co-ordinate space or display in a smooth fashion to any convenient scale factor. The scale factors shall allow the presentation of an entire world co-ordinate space or display on the full screen or a window.

Static and dynamic data shall be displayed and updated during a scaling operation, and display text shall be scalable to be consistent with the scaled image. At defined scale factors, levels of de-clutter shall be invoked.

The user shall be able to select an area of a world co-ordinate display by cursor manipulation.

("rubber-banding") and cause the display to be redrawn with the selected area centered in the display and with the selected area magnified to best fit the full window. The window dimensions shall not be changed by such an action.

A tool tip or equivalent method shall be provided for displaying information in English text & numeral upon moving cursor on the device etc.

Find & locate feature to take the user to the online/ network display where the component exists.

3.4.3. Permanent Indicators

Several indicators, including those listed below, shall be permanently shown on each SCADA/DMS/OMS AND SUB-STATION AUTOMATION Display screen as minimum:

- Date and Time: Date shall be presented in the format DD/MM/YY.
- Time shall be presented in the format HH:MM:SS with a resolution of one second, and shall be updated once per second.
- Username: Name of the user logged in the SCADA/DMS/OMS AND SUB-STATION AUTOMATION Name of the active server
- Name of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION display accessed
- Name of the display window

3.4.4. Default Screen Layout

It shall be possible for each user to define a personal layout (Rooms) for the screens displayed on the screen(s) of the workstation, i.e. to define a personal default setup of the position, size, and contents of the screens.

The user's default layout shall appear when the user logs on to a workstation. When a dispatcher takes over a new shift by logging on without the previous dispatcher logging off first, the current screen layout shall be preserved. It shall be possible to go to another room layout of the logged on user at any time.

3.4.5. Display Note pad

An user shall be able to place and edit a note on bays, devices etc. on any display. A symbol shall appear on the display indicating the presence of Note on that display. The content of the note shall be callable using a cursor target.

3.4.6. Quality Code and Tag Indication

All displays and reports containing telemetered analog values, device status and calculated values shall have a data quality code associated with each data field. The quality code shall reflect the condition of the data on the display or report. When more than one condition applies to the data, the symbol for the highest priority condition shall be displayed.

A separate indicator shall identify the devices that have supervisory control inhibit tags. When more than one tag is present on a device, the highest priority tag shall be displayed.

3.5. User Interaction Techniques

The user's interaction with the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system for power system operations shall primarily be accomplished using a menu item selection technique. The first step in the interaction will be selection of the item to be operated upon. The user shall then be provided a menu of operations applicable to the selected item. The required operation alternatives include:

- (a) Supervisory control
- (b) Data entry
- (c) Device status entry
- (d) Scan inhibit/enable
- (e) Tag placement/removal
- (f) Trend.

A set of parameters shall be presented appropriate to the item type and operation to be performed. For example, selecting a device for control shall cause a menu of control actions to be presented. Selecting an analog value for trending shall cause a menu of parameters, such as range and trend rate etc., to be presented.

As appropriate for the data and function requested, a menu containing output destinations such as screen, printer, or file shall be presented. When the destination is selected by the user, the requested action shall begin. It shall not be necessary to select an execute command to complete the interaction except for supervisory control actions.

The user shall be able to end the interaction sequence at any time by selecting a cancel command. The progress of all user operations shall be monitored. If the user does not complete to a step within a multi-step operation within a pre-defined time, the process shall reset, and the user shall be informed of the reset. A partially completed action shall be reset if the user begins another non-related sequence.

A programmer-adjustable time-out cancel shall also be provided.

3.5.1. User Guidance

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall respond to all user input actions indicating whether the action was accepted, was not accepted, or is pending. For multi-step procedures, the systems shall provide feedback at each step. User guidance messages shall be English text and shall not require the use of a reference document for interpretation. User shall be guided for multiple options. The use of mnemonics is prohibited, unless the mnemonics are industry-accepted or approved by employer. Provisions are required for administrators to edit the toolbars and menus, user guidance messages and to construct new ones through an interactive procedure and without programming.

3.5.2. User Help

In addition to the user guidance, general and specific context-sensitive on-line help shall be available to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION user. Context sensitive means that the help information provided shall be applicable to the next step or steps in the sequence being performed. The Help menu shall present a list of topics available for reference. The topics shall refer to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION user documents. The ability to scroll through the topic's explanatory text shall be supported.

The Help button in a dialog box and help key shall present the text of the user documents where use of the dialog box is explained. The user shall be able to scroll through this text. Exit from the help facility shall return the user to the same point in the sequence for which help was requested.

Context sensitive help facilities shall be provided for each application software package and operator display. The capability to easily edit or add additional help facilities in the future shall be provided.

The provided help facility shall also support:

- Search mechanism.
- Navigation links between related topics within the help documents
- select/copy mechanism.
- Print facilities.

3.5.3. Overlapping user access

The ability to queue multiple commands from different consoles shall be provided. In this regard, however, interlocks shall be provided to avoid overlapping user access to certain functions such as data entry and supervisory control as follows:

- (a) Data Entry: Although the same data entry field, device status entry or fields (in the case of full-page data entry) may appear concurrently in multiple windows at multiple consoles, data entry for the field or fields shall be restricted to one window at one console at a time. An attempt to initiate data entry for the field or fields from another window shall result in a user guidance message. Concurrent data entry on different areas of a world display, however, shall be allowed.
- (b) Supervisory Control: Although the same power system device, such as a circuit breaker, may appear concurrently in multiple windows at multiple consoles, control of the power system device shall be restricted to one window at a

3.5.4. Function Key Usage

Special functions shall be assigned to the 12 function keys on a standard keyboard. With extensions (e.g., Shift, Alt, Esc) this shall result in a minimum of 48 function key actions.

3.5.5. Trend

Trend shall be a display of series of values of parameters on a time axis. Both graphical trend and tabular trends shall be supported. The attributes of the trend display shall be user configurable. The trend application shall be able to show trends for any measurement type from more than one source, at least from real-time, historical and forecast sources. It shall be possible to combine this data showing data for comparison using a shared timeline simultaneously comparing for example yesterday (historic) and today (historic, actual and forecast) as two curves on the same time axis. It should be possible to trend different types of parameters (P, Q, V, I, F etc.) with associated Scales on the same display. The user shall be able to select a trend rate different than the sampling rate.

3.5.5.1. Graphical Trend

The user shall be able to select and configure trending on Graphical displays enabling user for entry of the following parameters:

- (a) Data value name
- (b) Trend header
- (c) Trend direction (horizontal or vertical)
- (d) Scale (unidirectional and bi-directional)
- (e) Zero offset
- (f) Trace number, color & texture
- (g) Trend data rate
- (h) Trend start time and date (historical data only)
- (i) Total trend duration (historical data only)
- (j) Reference lines or shading axes (With default to restrictive alarm limits)
- (k) Windows/chart to be used
- (l) Simultaneous trending of different parameters with associated scales.

Trending of at least four values simultaneously, on a common axis or separate axes shall be supported. All scales corresponding to the values selected shall be visible on the Trend Display simultaneously. There shall be automatic movement of data down or across the screen as new values are generated. When the number of real-time trend samples reaches the limit that can be displayed, the oldest value shall automatically be removed as the display is updated.

The magnitude & time of all the trended quantities at a particular time instant shall be displayed when the cursor is placed on the timescale on the trend display.

When historical data is selected for trending, the user shall be able to page forward and backward, or scroll by the use of a scroll bar, through a non-updating snapshot of the data within the constraints of the data stored in the historical files.

Shading between each trend value and user-definable axes shall be provided. Trend colour shall be changeable based on a comparison of the trend value against associated alarm limits.

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It shall be possible to have at least data samples corresponding to 2 months on line storage for each of the trended variables. The user shall be able to print the trend without interfering with the continuing trending process.

3.5.5.2. Tabular Trending

Tabular trending shall be a listing of the time-sequential values of a variable/ variable. The tabular trend shall present the data in a tabular form with one column for Date/time and additional columns for each of the trended variable. The tabular trend shall contain at least rows for samples corresponding to 2 months on line storage. Each row shall contain the values of the trended variables. It shall be possible to scroll up and down to see the rows. The sampling rate shall be individually definable for each tabular trend.

The historical tabular trends, which shall be produced from the previously stored values in trend files, it shall be possible to choose the start time, the end time, and the sampling rate independently of the sampled rate of historical data.

It shall also be possible to save trend output to an Excel, .csv ,ASCII file., with date and time information and the engineering unit value of the trended variables for each collection interval. The user shall be able to print the trend on a user-selected printer without interfering with the continuing trending process.

3.6. Alarms

Alarms are conditions that require user attention. All alarms shall be presented to the user in a consistent manner. Alarm conditions shall include, but not be limited to, the following:

- (a) Telemetered or calculated value limit violations
- (b) Values returning to normal from a limit violation state
- (c) Un-commanded changes of a power system device state
- (d) SCADA/DMS/OMS AND SUB-STATION AUTOMATION application program results
- (e) Data source communication errors resulting in loss of data
- (f) SCADA/DMS/OMS AND SUB-STATION AUTOMATION system hardware or software failures.

Each alarm shall be subjected to a series of alarm processing functions. A device or value's alarm able conditions shall be assigned to an alarm category and alarm priority levels. Alarms shall also be subjected to advanced alarm processing. The results of the alarm processing shall determine the console(s) that will receive and be authorized to respond to the alarm and the associated actions with the alarm.

All alarm messages shall be recorded on auxiliary memory of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system and archived in chronological order & reverse chronological order. It shall be possible to sort, display and print user selected alarm messages from any console by the user.

3.6.1. Alarm Categories

An alarm category provides the logical interface that connects an alarm condition to a specific Area of Responsibility (AOR) or operational jurisdiction as defined and accordingly alarm shall be reported to user. Every alarm shall be assignable to a category. Each category shall, in turn, be assignable to one or more users. A means shall be provided for changing operating shifts without reassignment of alarm categories at a console. Each log-on and log-off shall be reported as an event.

Each alarm shall be assigned to an alarm priority level. Up to 8 alarms priority levels shall be supported. Each alarm priority level shall be presented in separate display. For each alarm, it shall be possible for the programmer to independently configure the following actions:

- (a) Audible alarm tone type selection and its enabling/disabling.
- (b) Alarm messages to be displayed on an alarm summary
- (c) Alarm message deleted from alarm summary when acknowledged
- (d) Alarm message deleted from alarm summary when return-to-normal alarm occurs
- (e) Alarm message deleted from alarm summary when return-to- normal alarm is acknowledged
- (f) Alarm message deleted by user action.

This assignment shall determine how the alarm will be presented, acknowledged, deleted, and recorded.

3.6.3. User Interaction for Alarms

The User shall be able to perform the alarm interactions described below.

3.6.3.1. Alarm Inhibit/Enable

Inhibiting alarms for a value or device, including a complete RTU /FRTU/FPI or other data source, shall cause all alarm processing of that value or device to be suspended. The action shall be recorded in the event log. However, Scanning of the value or device shall continue and the database shall be updated.

3.6.3.2. Alarm Acknowledgment

An alarm shall be acknowledged by selecting an alarm acknowledge command when the item in alarm is selected on:

- (a) Any display showing the item in alarm
- (b) Any display showing the alarm message.

User shall be able to acknowledge alarm individually, by page, user selected manner. It shall be possible for the user to distinguish persistent & reset alarms under acknowledged & unacknowledged conditions. All alarms shall be stored by the system

3.6.3.3. Audible alarm silencing

User shall be able to silence alarm without acknowledgement and shall remain until the user enable the audible alarm. The silencing & enabling shall be recorded as event. The tones shall be definable on the console basis. For each console, multiple tones shall be available. Tones shall be of continuous & short duration type both. The former shall be of high priority condition & require operator intervention to stop. In case of short duration tone, it shall go off at its own.

3.6.3.4. Change Alarm Limits

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The user shall be able to change the alarm limits.. When the user selects an item to change its alarm limits, a menu showing the alarm limits currently in use and a data entry field for the revised limits shall appear. All changes to alarm limits shall be subjected to data entry error checking and recorded as events. The alarms shall be enunciated according to the changed alarm limits. The user shall be able to reset alarm limits to the limits set in the SCADA database. However, these shall be treated as temporary changes & if the system is re-initialized, the original limits defined in the SCADA database shall be operationalized.

3.6.3.5. Alarm Presentation

Alarm presentation shall be determined by the alarm's category and priority. Displays shall highlight every alarm condition using a combination of color, intensity, inverse video, blinking and audible sound. The alarm condition highlighting shall show whether the alarm has been acknowledged. The highlighted alarm condition shall appear on all displays containing that device or value at all consoles regardless of the alarm's category.

Alarm messages shall be a single line of text describing the alarm that has occurred and the time of occurrence. The alarm message shall be English text and shall not require the use of a reference document for interpretation.

3.7. Events

Events are conditions or actions that shall be recorded by the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system but do not require user action. Events shall be generated under the following conditions

- (a) User initiated actions
- (b) Conditions detected by application functions that do not require immediate user notification, but should be recorded.

Events shall be recorded in the form of an event message. The event message format shall be similar to the alarm message format. The same message format shall be used for displaying and printing events. Event messages shall be displayed on an events summary.

Event messages shall be stored on auxiliary memory of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system and archived in chronological order and reverse chronological order.. It shall be possible to sort, display, and print event messages from any console.

3.8. Hardcopy Printout

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall have features to produce a print out of a display, reports, Alarms, Events etc. from a menu. Any of the available printers shall be select-able by the SCADA/DMS/OMS AND SUB-STATION AUTOMATION users from menus for taking printout.

It shall be possible to print a complete display or a selected portion of a display. The options for printing shall include at least choice for orientation, background color, page size, color/ black & white and print preview. Also any of the available printers shall be select-able from the print Menu.

3.9. Report Generation

The contractor shall be required to generate the Daily, Weekly, Monthly reports formats for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The report formats shall be finalized during detailed engineering stage. The user shall be able to schedule periodic generation of reports, direct report to display, print report, and archive report using report-scheduling display. The report scheduling display shall enable entry of the following parameters, with default values provided where appropriate:

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- (a) Report name
- (b) Report destination (printer or archiving device)
- (c) Time of the system should produce the report.

The user shall be able to examine and modify the contents of reports for the current period and for previous report periods using displays. Any calculation associated with the revision of data in a report shall be performed automatically after data entry has been completed.

The report review displays shall accommodate formatted report pages up to 132 characters in width and 66 lines in length and shall contain headings that correspond to the printed report headings. For reports containing more columns or rows than the display, the system shall include a means to view the entire report in a graphic format. The report view and editing displays shall function with the initially supplied reports and all future reports added by employer.

3.10. System Configuration Monitoring and Control

The user shall be provided with the capability to review SCADA/DMS/OMS AND SUB-STATION AUTOMATION computer system configuration and to control the state of the configuration equipment using displays. The following operations shall be possible:

- (a) Failover of each server
- (b) Monitoring of servers, device, including workstations, RTUs, FRTUs, FPIs, status & loading of WAN LANs etc.
- (c) Monitoring of the processor resource, hard disk & LAN/WAN Utilization
- (d) Control & monitor of SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions

3.11. Dynamic Data Presentation

It shall be possible to present any item in the database on any display. All supervisory control and data control capabilities shall be supported from any window of a world display. Device status or data values shall be displayable anywhere on the screen, excluding dedicated screen areas such as the display heading.

Only standard X Window system or Microsoft windows standard fonts shall be provided with the SCADA/DMS/OMS AND SUB-STATION AUTOMATION. All fonts supplied shall be supported on the user interface devices and all printers supplied with the system. The types of fonts to be used in a particular display shall be selected at display definition time.

Status and data values shall be presented in the following formats as appropriate:

- (a) Numerical text that presents analogue values shall have the provision for the format definition of the text shall include the number of characters, number of decimal places, and the use of positive /negative sign or flow direction arrows, etc.
- (b) Normally the telemetered MW/Mvar values along with the sign/direction shall be displayed on the Single line diagram and Network diagram. However the user shall also be able to display all other telemetered and calculated/ estimated analog values (I, V, pf etc. for each phase) on the Single line diagram (SLD) and Network

diagram.

- (c) Symbols, including alphanumeric text strings for an item, based upon state changes e.g., circuit breaker (OPEN/CLOSE/ INVALID).
- (d) Symbols, including alphanumeric text strings for indicating the data quality flags.
- (e) Colors, textures and blink conditions based upon state or value changes or a change of data quality, e.g., alarm limits.

3.12. Element Highlighting

Element highlighting techniques shall be provided to draw the attention of Dispatcher to critical state of the system. The highlighting technique shall include change of color, color intensity, blinking, Character inversion, Line texture, appended symbols etc. This feature shall be used to highlight alarms, power system device and measurement status, data quality, data entry locations on a display and error conditions.

3.13. Display Types

The following indicative list describes the types of displays that are to be included in the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The user interface shall support the capabilities of all displays as specified. The User mode, Current Time and date shall be displayed on a screen-basis, not on a display basis, and shall be always visible.

3.13.1. SCADA/DMS/OMS AND SUB-STATION AUTOMATION System Display

A display shall be provided that lists all SCADA/DMS/OMS AND SUB-STATION AUTOMATION system directory displays. The displays shall be listed in alphabetical order with suitable separation in the list to enhance readability. Each entry in the list shall have a cursor target for display selection.

3.13.2. Distribution System Network Display

A graphic overview network display of the distribution system with substations, feeders. Distribution network color coded by voltage shall be provided. This display shall present the distribution system in a graphic format provided by employer. Telemetered and calculated data like Real and reactive power flows shall be displayed as a value with a direction. Lines that have exceeded their loading limits shall be highlighted. Substations and power stations shall be depicted by symbols that reflect the presence of alarms at that substation or power station. Cursorselection of a substation/ power station symbol shall result in the associated Single line diagram display for that substation/ power station.

3.13.3. Interchange Display

The interchange display shall be provided as a schematic diagram showing power transfers among various utilities. This diagram shall show each power system as a block with actual and scheduled net interchange values outside the block. Symbolic arrows shall indicate power flow directions. The diagram shall also show schedule deviations. This display shall show the frequency values collected from all substations having tie-lines.

3.13.4. Substation SLD displays Menu

A display shall be provided that lists all substations that can be viewed via a SLD display. The name of the SLD displays shall be listed in alphabetical order, according to substation name, with suitable separation in the list to enhance readability. Each entry in the list shall have a cursor target for graphic display selection.

3.13.5. Substation SLD Displays

SLD displays shall be provided for each substation, including those for which telemetry may not be available but are required for running the DMS applications. Each display shall present telemetered, manually entered, and calculated power system data on a Single line diagram that shows substation layout in terms of its buses, switches, lines, and transformers. The feeder names in the SLD shall have linkage with remote substation end SLD, distribution network associated with that feeder. It shall be possible to move to remote-end substations SLD by selecting this feeder. The user shall be able to perform any user interaction defined by the Specification on these displays.

3.13.6. Control panel displays

As utilities are presently using conventional panels at S/S for supervision & monitoring, The control panel displays giving look -alike feeling shall be provided for operator supervise & operate

3.13.7. Tabular Displays

Tabular displays shall be provided for each substation. These displays shall list the real-time values of telemetered, manually entered, and calculated data associated with the substation as well as related information such as alarm limits. The user shall be able to perform any user interaction defined by the Specification on these displays.

3.13.8. Alarm Summary Displays

Displays that list or summarize all unacknowledged and acknowledged alarms shall be provided. The summary shall separate acknowledged and unacknowledged alarms. Capacity shall be provided for at least 200 alarm messages for each alarm summary type. If an alarm summary display becomes full, the oldest messages shall be automatically deleted and the newest messages shall be added. It shall be possible to perform any alarm interaction from this display. The user shall be able to select between viewing events in chronological or reverse chronological order.

3.13.9. Event Summary Displays

Event summary displays shall list the most recent events and shall be organized by category for those categories assigned to a given console, as one summary display for all categories assigned to a console, or by all conditions system-wide without reference to the categories assigned to a console, as selected by the user. The user shall be able to select between viewing events in chronological or reverse chronological order.

3.13.10. Operating Information Summaries

The operating information summaries defined below shall be provided. Summary items shall be listed in reverse chronological order with the most recent item shown on the first page. All summary displays, except for Tag Summary shall be information-only displays; no user interaction, other than display call up, shall be associated with them. The Tag Summary shall be interactive, i.e., the user shall be able to place or remove tags on this summary.

3.13.11. Manual Override Summary

The manual override summary shall list all telemetered and calculated device status and data

3.13.12. Off-Normal Summary

The off-normal summary display shall list devices and values that are found to be abnormal, i.e., are not in their normal state. Telemetered, calculated, and manually entered status and data values shall be included.

3.13.13. Out-of-Scan Summary

The out-of-scan summary display shall list device status and data values that are not currently being processed by the system. If an entire telemetry source such as an RTU /FRTU /FPI is out-of-scan, the out-of-scan summary shall display the source without any of the individual device status or data values associated with the source

3.13.14. Alarm Inhibit Summary

This display shall list devices and data values for which the user has suspended alarm processing.

3.13.15. Tag Summary

This display shall list and describe all active device tags.

3.13.16. 3Graphical Trending Summary Displays

The summary display shall list all items being trended. The list shall include the item name, trace number or color, trend orientation, and trend range.

3.13.17. Tabular Trending Summary Displays

The summary display shall list all items being recorded for tabular trends. The list shall include the item name and the file name.

3.13.18. Notes Display

This display shall include a minimum of 5 pages on which a user at any console may enter and edit messages. The contents of these pages shall be accessible by any console. The user shall have the ability to clear any page of this display and to type over previous messages.

3.13.19. Computer system Configuration and Monitoring Displays

Graphic and tabular displays shall be provided that allow the user to:

- (a) Monitor and revise the configuration of the computer system
- (b) Monitor the system's resource utilization statistics

3.13.20. RTU/FRTU/FPI Communication Channel Monitoring and Control Display

This display shall show information on the status of the system's communication interface

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devices (including communication channels), the accessibility of each RTU/FRTU/FPI in a graphical form. The user shall be able to Enable/Disable any communication channel from this display. Such actions shall be recorded with User ID details

3.13.21. SCADA/DMS/OMS AND SUB-STATION AUTOMATION Application Program Displays

Application program displays shall be provided to satisfy the user interface requirements of the system functions stated throughout this Specification. Application program displays shall be based on a standard user interface design across all applications to provide a common look and feel. The application's information shall be presented in such a way as to facilitate user operations.

The required displays for all DMS Applications, as defined in Chapter 2 shall also be made available to the user.

3.13.22 SAIDI/SAIFI displays

There shall be suitable displays to visualize SAIDI /SAIFI (Planned, unplanned & total) feeder wise, Substation wise , Town wise, Distt. wise or any another logical boundary mentioned by utility on daily, weekly, month, quarterly, FY , Yearly basis with comparison with past years through suitable navigation

3.13.23 GIS integration

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION dynamic distribution network with GIS land base at the back ground shall be available for navigation. Operator shall be able to perform all functions & have features as envisaged in the specification. Suitable GIS adaptor shall be provided to import the distribution network model & GIS information from GIS system. Refer other GIS details as mentioned in chapter 1 &2 of this section.

3.13.24 Help Displays

Help displays shall be provided to aid the user in interpreting displayed information and to guide the user through a data entry or control procedure. Help displays shall be provided for each display that is provided with the system. Each display shall have a prominent cursor target that the user can select to request the associated help display. For standard displays, software aids (such as context sensitivity) shall be used to present pertinent help information in an expeditious manner. A programmer shall be allowed to modify and create help displays.

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SYSTEM SOFTWARE REQUIREMENTS

4.0 General

This section describes the characteristics of system software such as Operating system, RDBMS and support software (programming language compilers, database development and maintenance, display development, network services, report generation, diagnostics and backup utilities) to be provided by Contractor and the original software manufacturer as necessary to support the SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS/RT-DAS applications. This section also describes the standards to be followed for all supplied software. It is necessary that functional, availability & performance aspects are met. Bidder shall assess the adequacy of software specified & if any additional software is required to meet all the requirements of the technical specifications, the same shall also be included in the offer. This section is applicable to Group A (Noida Town), B, C towns as per functional requirements

4.1. Software Standards

All SCADA/DMS/OMS AND SUB-STATION AUTOMATION software provided by the Contractor, including the Operating system, RDBMS and support software, shall comply with the industry-accepted software standards produced by national and international organizations, such as ANSI, ISO, IEC, IEEE, ECMA in order to facilitate maintenance and enhancement of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION systems being supplied. In areas where these organizations have not yet set standards, the software shall comply with those widely accepted de- facto standards put forth by industry consortiums, such as OSF and X/Open or equivalent. The Contractor shall commit to meet the "open systems" objective promoted by industry standards groups by using software products that are based on open standards.

4.1.1. Design and Coding Standards for SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications.

All SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications shall be maintainable by employer using the supplied software utilities and documentation. The SCADA/DMS/OMS AND SUB-STATION AUTOMATION software design and coding standards shall also address the following:

- (a) Expansion/ scalability: software shall be dimensioned to accommodate the ultimate size of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system envisaged.
- (b) Modularity: software shall be modular to minimize the time and complexity involved in making a change to a program.
- (c) User-Directed Termination: Functions taking long execution times shall recognize and process user requests to abort the processing.
- (d) Programming languages: The software shall be written using ISO or ANSI or ECMA standard programming languages like FORTRAN, C, C++ and SQL and for Unix based systems the APIs shall be POSIX-conforming.
- (e) SOA architecture: Software shall conform to SOA.

- (f) Enterprise service bus (ESB): ESB based architecture is essential to enable interaction of applications from different product manufacturers, platforms etc.
- (g) Portability & Interoperability: The software shall be designed for hardware independence and operation in a network environment that includes dissimilar hardware platforms to the extent possible. The use of system services software shall be built on Open standards

4.2. Operating System

The contractor shall use Unix /Linux / Microsoft Windows™ operating system servers. The servers based on of Unix O/s, shall generally comply with the evolving set of POSIX standards defined by IEEE.

4.3. Time and Calendar Maintenance

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall maintain Time and date for use by various software applications. The GPS based time receiver shall be used for synchronizing the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system time. All Servers and O p e r a t o r workstation clocks shall be synchronized within the accuracy of +/-100 milliseconds. The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall not be dependent on a particular server for time /calendar maintenance. . The SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall include two redundant time and frequency standards. Failure of the online unit shall result in automatic switching to the redundant unit. The SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall periodically check if the backup unit is operational and failure of either unit shall be alarmed.

The frequency reading shall be accessible by SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications with three post-decimal digits resolution .The system shall support communication protocols such as NTP and SNTP. The time and frequency standard unit shall support a common time code output format such as IRIG-B.

A surge protection system shall be included to prevent the time and frequency standard equipment from lightning.

4.4. Network Software

The network software for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall include software for network communication, security and services.

4.4.1. Network Communication

Users and various applications shall be able to communicate within the SCADA/DMS/OMS AND SUB-STATION AUTOMATION local area network and operate as described in this Specification. The network communications software shall use a standard network protocol such as TCP/IP. The software shall link dissimilar hardware nodes, including local and remote workstations, application servers, communication servers, and various peripherals (such as printers) into a common data communication network allowing communications among these devices.

4.4.2. Network Security

A user authentication scheme consisting at least of a user identification and password shall be required for the user to request a connection to any network node.

The design & configuration , parameterization, placement of DMZ shall be such that SCADA /DMS system shall be protected from intrusion /vulnerabilities from outside world as per IEC62443, IEC 62351-3, ISO/IEC27001. The cyber security same shall certified on SAT by CERT.IN empanelled agency/ NCIIPC or any GoI agency before

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Operational acceptance by SIA. The same shall be required to be verified at least once annually or Major upgrade or change on the system or data of validity of certification which ever earlier during the FMS period also and maintain required performance and functional requirements/SLA

4.4.3. Network services

The following network services shall be provided for the users of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system:

- (a) Network file management and transfer, for files containing text, data, and/or graphics information
- (b) Network printing management
- (c) Network time synchronization
- (d) Network backup over LAN
- (e) Task-to-task communications to external computers
- (f) LAN global naming facilities.
- (g) Remote procedure call
- (h) Remote terminal session

4.4.4. Security Services

The security solution shall comprise of comprehensive solution for secured zone Firewalls i.e LAN Firewall & Gateway Firewall, intrusion Prevention system IPS (Network based & Host based) & Strong Authentication (multi layered), LDAP , Encryption mechanism. The contractor shall provide a tightly integrated intrusion detection system to detect and prevent intrusion

Followings are the functional requirement from the security system:

- System shall have Multi-layer (at least network, application layer) firewall which shall protect the complete system network from unwanted users. Further the separate firewall of different OEMs shall be provided to take care the security of all the servers& shall have High Availability architecture with No Single Point of Failure (NSPOF).
- Gateway Firewall should be capable of load balancing multiple links from different service providers.
- LAN Firewall shall provide isolation/security services between the subsystems installed under SCADA system
- Firewalls deployed should not become a bottleneck. It shall be Robust, Secure, Scalable and future-proof with Centralized Management.
- Two type of IPS Host based & Network based shall be deployed with minimum hardware & they should not go blind in peak traffics.
- IPS should have hybrid technology to detect attacks. It should detect through a combination of Protocol Anomaly and Signature matching.
- Shall have Gateway antivirus which will protect from inflow of virus from the Internet and other WAN locations at the gateway itself with content filtering without any lag in data transmission.

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- Shall have strong authentication containing user name and passwords which shall be very difficult to compromise.
- SSL over VPN to provide secured link over public network such as with RTU/FRTU/FPI

4.4.4.1. Features

Followings are the features specific to each component of security system

4.4.4.1.1. Firewall

The Firewall shall be hardware box Firewall system with following features.

- Firewall speed >250 Mbps
- Data encryption supported DES (56 bits) 3 DES (168 bits) and hashing algorithm like MD5 and SHA-1
- Encryption to offload the main CPU
- It shall have minimum 8 Ethernet 10/100 /1000 ports (4ports for connectivity to two web servers & 4 Ports for connectivity to LAN
- Support NAT and PAT
- Capability of working in Load sharing and hot standby mode
- Denial of service prevention.
- DNS guard features
- JAVA and Active X blocking
- Radius integration
- Web based management interface
- Stateful inspection for web, mail, SQL application etc.
- Detailed system logging and accounting feature
- No. of concurrent TCP Sessions supported shall be more than 5000.

4.4.4.1.2. Intrusion Prevention System (IPS)

The contractor shall provide a tightly integrated intrusion detection & prevention system Capable for detecting the intrusion attempt that may take place and intrusion in progress and any that has taken place.

Both Network based and Host based IPS should have centralized Management Console system which will be either the application server with NMS or any of the workstation. The Centralized management console shall have integrated event database & reporting system & it must be able to create and deploy new policies, collect and archive audit log for post event analysis. The system shall have Integrated Event Database & Reporting System.

Automated Update of the signature for contract period shall be provided and there should be provision for creating customized signature

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(A) Intrusion Prevention System (Network Based)

After detecting any intrusion attempt there should be provision to configure to perform the following functions:

- Capability for Detecting the intrusion attempt that may take place, intrusion in progress and the intrusion that has taken place
- Reconfigure the firewall provided in this package.
- Beep or play a .WAV file
- Send an SNMP Trap data gram to the management console.
- The NMS server envisaged under the specification shall be used as management console also.
- Send an event to the event log.
- Send E-mail to an administrator to notify of the attack.
- Save the attack information (Timestamp, intruder IP address, victim IP address/port, protocol information).
- Save a trace file of the raw packets for later analysis
- Launch a separate program to handle the event
- Forge a TCP FIN packet to force a connection to terminate.
- Detect multiple forms of illicit network activity: -Attempted
- Vulnerability Exploits -Worms -Trojans -Network Scans -Malformed
- Traffic -Login Activity
- The System shall support monitoring of multiple networks. The system shall also support the monitoring of additions or changes to addresses of devices on the network.

The system shall have detection rules for monitoring faults, dangerous and malicious activity related to IP based protocols. The Contractor shall also apply its power control and security experience to enhance these detection rules for specific issues within the system.

(B) Intrusion Prevention System (Host Based)

Host based IPS shall run on the servers. After detecting any intrusion attempt there shall be provision to configure the IPS to perform following actions

- Send an SNMP Trap datagram to the management console. The NMS server envisaged under the specification shall be used as management console also.
- Send an event to the event log. Send e-mail to an administrator to notify of the attack.
- It should be capable of creating audit trail for user and file access activity, including file accesses, changes to file permissions, attempts to install new executable and/or attempts to access privileged services,
- In an event where user accounts are added, deleted, or modified changes to key system files and executable is done in by unauthorized account or there is unauthorized attempt to overwrite vital system files, to install Trojan horses or back-doors, suitable action shall be taken such as :
 - Terminate user Login (intruder)
 - Disable user Account (intruder)
 - Administrator can define the action to be taken
 - Forge a TCP FIN Packet to force a intruder connection to terminate.
- Should provide events check for suspicious file transfers, denied login attempts, physical messages (like an Ethernet interface set to promiscuous mode) and system reboots.

4.4.4.1.3. Gateway Antivirus

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This shall be used for Gateway scanning of viruses. Gateway antivirus shall have Centralized-user Administration which will Communicate directly with centralized user directories such as LDAP. It shall have the all the essential/standard features of Latest version of Gateway antivirus, some of the features are as following:

- It shall have Policy-based URL filtering and Dynamic Document Review.
- It shall protect web traffic with high-performance, integrated virus scanning and web content filtering at the gateway
- It shall ensure protection by combining list-based prevention with heuristic content analysis for both virus protection and web content filtering
- It shall eliminate unwanted content and malicious code & Scan all incoming and outgoing HTTP and FTP traffic etc.

The Security System shall use the best practices to prevent the System itself being a source of security compromise. The System shall be hardened, patched, tested, and designed with security as a primary objective. Communication with (GUI and notifications) and within (agent reporting and updates) the System shall use encryption and authentication.

4.4.4.2. Other aspects of security

4.4.4.2.1. Application Security Monitoring

The standard operating system shall support the monitoring of security on host installed applications. The system shall support or allow the creation of monitoring for:

- Application Software Error Conditions
- Application Software Performance Issues
- Application Configuration Changes
- Application Logins, etc.

4.4.4.2.2. Application Security Monitoring

The system shall be capable of annunciation, to include audible and visual alarms and remote paging whenever a security event takes place and shall support the following:

- Instant notification through email or pager
- Logical grouping of security events by time, location, and device, etc
- Interactive dashboard window for viewing and acknowledgement

4.4.4.2.3. Analysis and Reports

- The system with the stored information shall be able to produce analyses and reports to meet security compliance requirements. The system shall be equipped with best practices ad-hoc reports widely used in the industry.
- The employer's personnel shall be trained to be capable of creating new custom analysis and reports, and revising existing, without requiring external consultation.

4.4.4.2.4. Log Archiving

The security system shall archive, record, and store all security related events in raw form for at least one year. As a minimum, the event logger shall record all security related events from the perimeter security devices and the host IPS. Graphical trend displays of each event shall be available along with specific information on the type of intrusion, the area affected and the source via IP address.

4.4.4.2.5. Data Access through intranet

The Web server at Control Center is to function as source of information on the distribution network. It will be accessed by utility intranet user. Any additional client software, if required, at external clients/users ends, the same shall be made dynamically available from Web server for its downloading by these external clients. There shall not be any restriction to the number of clients downloading this software (i.e. Unlimited number of client downloads shall be provided).

The external users shall be licensed users of the employer. The following features are required:

- a) The Web servers shall be sized to support atleast 50 concurrent external intranet clients/users for providing access to real-time data.
- b) External intranet clients/users shall be connected to the web servers through secure authentication such as VPN access. These users shall be denied direct access to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION protected LAN.
- c) Internal SCADA/DMS/OMS AND SUB-STATION AUTOMATION users shall not have any dependency on the availability of the Web servers.
- d) For the purpose of transfer of data/displays/ from the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system to the Web server system, the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall initiate a session with the Web server and any attempt to initiate a session by the Web server shall be terminated by the Firewall in SCADA/DMS/OMS AND SUB-STATION AUTOMATION system LAN. Interface between Web server and SCADA/DMS/OMS AND SUB-STATION AUTOMATION zone shall preclude the possibility of external clients defining new data/Report/Displays.

For any sessions initiating from the DMZ LAN into the protected LAN, the servers shall be located in a separate DMZ LAN that will be isolated from common applications connected directly to ISP such as email. The Access to these servers from the external web will be through authorization of Virtual Private Network.

- e) The web server shall provide access to allowable real time data and displays, at defined periodicity, for viewing by external clients/users. The access to each display shall be definable on per user type basis. It shall be possible to define up to 100 users. Further the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system administrator shall exercise control over the real-time displays which can be accessed through the Web server.
- f) The Web server at Control Center shall also facilitate exchange of email messages from ISP (Internet Service Provider) and other mail servers supporting SMTP.
- g) Suitable load balancing shall be provided among the web servers where each shall serve proportionate number of clients. However, in case of failure of one of the servers, all the clients shall automatically switch to the other web server(s).

Typical displays/pages for Intranet access shall be same as that on the SCADA/DMS/OMS AND SUB-STATION AUTOMATION. Real time SCADA data on web server shall be refreshed every minute. The access to Web server/site shall be controlled through User ID and password to be maintained /granted by a system administrator. Further, different pages/data access shall be limited by user type (i.e. CMD, Mgmt. user, in-charge etc.). The access mechanism shall identify and allow configuration of priority access to selected users.

Further, tools shall be provided for maintaining the website, web server configuration, E-mail configuration, FTP configuration, Mailing lists setup and customer support. Latest protections against viruses shall be provided.

4.4.4.2.6. Signature Updating Requirements

The system shall be able to accept timely updates. The updates shall keep the threat signatures current, providing the latest detection and protection. The updates shall also incorporate the latest security enhancements into the Security Management System. These enhancements shall increase security and functionality, without requiring redesign or reengineering efforts.

4.4.4.2.7. Network Management system (NMS)

A network monitoring and administration tool shall be provided. The interface of this tool shall show the DMS hardware configuration in form of a map. The network- monitoring tool shall automatically discover the equipment to construct the map. It shall support management of multi-Vendor network hardware, printers, servers and workstations.

It shall support remote administration of network devices, management of thresholds for monitoring performance and generation of alarm and event notifications. It shall be possible to send these notifications to maintenance personnel through e-mail

The Network management system shall manage the interfaces to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION servers, workstations, devices, communication interface equipment, and all SCADA/DMS/OMS AND SUB-STATION AUTOMATION gateways and routers ,switches etc

The network management software shall be based on the Simple Network Management Protocol (SNMP-Internet latest RFC) over TCP/IP (CMOT), with additional proxy software extensions as needed to manage SCADA/DMS/OMS AND SUB-STATION AUTOMATION resources.

The NMS software shall provide the following network management capabilities:

- (a) Configuration management
- (b) Fault management
- (c) Performance monitoring.

The network management software shall:

- (a) Maintain performance, resource usage, and error statistics for all of the above interfaces (i.e. servers, workstation consoles, devices, telephone circuit interface equipment, and all SCADA/DMS/OMS AND SUB-STATION AUTOMATION gateways , routers etc.) and present this information via displays, periodic reports, and on-demand reports.

The above information shall be collected and stored at user configurable periodicities i.e. upto 60 minutes. The Network Management System (NMS) shall be capable of storing the above data for a period of one year at periodicity of 5 minutes.

- (b) Maintain a graphical display of network connectivity to the remote end routers
- (c) Maintain a graphical display for connectivity and status of servers and peripheral

- (d) Issue alarms when error conditions or resource usage problems occur.
- (e) Provide facilities to add and delete addresses and links, control data blocks, and set data transmission and reception parameters.
- (f) Provide facilities for path and routing control and queue space control.

4.4.4.2.8. Central Cyber security Monitoring & Detection

The Contractor shall implement a **unified cyber security Application platform** purpose built to **monitor, manage & maintain** the security posture of the overall control system network. The system shall establish mechanisms & processes for detection of cyber security threats, to ensure cyber security threats or incidents can be responded promptly to. These shall include key security technologies like central security policy management for host machines, capturing and & analyzing security event logs from all security/networking assets and continuous threat detection systems adopted for an **operational technology** environment.

The proposed deployment shall be based on a **vendor agnostic** platform, natively supporting the said cyber security services, while offering **flexibility and scalability** to provide additional functionalities needed in the context of security improvement plan.

The software platform shall be designed in conformance to key global standards like IEC 62443 and IEC 62351 while supporting compliance to the country specific guidelines/frameworks.

The central security management server shall be deployed in the De-Militarized zone inside the control room segregated by suitable firewalls and shall act as an IT/OT interface

All hosts machines shall implement advanced end point protections including anti-malware, application whitelisting, data loss prevention, HIPS etc. The whitelisting and application control shall allow only list of permitted applications, services and processes to run on each host; no other processes shall be permitted to be executed on the host. It shall not be possible for users to circumvent the malicious code protection on a host device.

The Host based IPS shall monitor the characteristics of a host and the events occurring within that host for suspicious activity. The characteristics which need to be monitored include network traffic, system logs, running processes, file access & modification, and system & application configuration changes.

The central policy Orchestrator shall be deployed to enable operators/security administrators to centrally monitor and manage the security policy for all host workstations. The application shall allow creation of automated workflows, support creation of reports, customized dashboards to analyze the performance of each security setting while tracking the deployment of signature (DAT files) updates date from a single location.

Continuous (24/7) anomaly & threat detection shall be implemented to detect and alert for all known & unknown threats including Zero days, MITM attacks, DDoS attacks, unauthorized behavior or malicious activities on the network. The system shall support a wide range of IT & OT communication protocols including the proprietary protocols, and able to discover information from the network passively using Deep Packet Inspection by connecting to the Mirror Port / SPAN port on a backbone switch(s).

The proposed system shall support the following capabilities:

- **Real time network visualization** of the entire ICS network, including asset inventory information, communication patterns, connections, protocols and topology.

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- Discover detailed **asset inventory information** (like Manufacturer, Model, Firmware, serial no etc.) from network devices including nested devices to enable enhanced visibility, segmentation, and vulnerability management. Additionally, it should be capable of automatic asset grouping to help visualize a micro-segmentation view of the network primarily based on asset behavior.
- Automated **identification of vulnerabilities** in the environment, correlated with operational context to provide detailed insights and rapid remediation.
- The system shall learn typical behavior through **Dynamic learning via artificial intelligence** to automatically learn nodes, devices, connections, etc. to accurately profile normal process behavior and engage a "protection mode" where variants and risks from the learned process behavior are alerted.
- Create detailed behavioral profiles for every device according to the process state thereby identifying/alerting users for anomalies on the network such as new or unusual assets, communication patterns, configuration changes, malfunctions etc. based on extensive learned baselines using **Deep Packet Inspection (DPI) into the OT protocols**.
- System should be able to calculate a **granular Risk score** for each identified threat based on the context it has about the network, the assets and the events that occurred.
- Automatically capture network traffic associated with the alert to **analyze and identify** what happened before and after the Incident.
- **Integrates with firewalls** to inject rules associated with an alert or policy

The security monitoring application shall encompass collecting security logs from various devices in the system (Hosts, IED's, Firewalls, routers, IDS, AV Servers etc) over standard protocol formats i.e. syslog/SNMP/WMI etc. and provide dashboards for real-time situational security awareness and alerts. The application must be compliant to international standards IEC 62443-3-3 (for providing syslog server and audit trail capabilities) and IEC 62351-14 (for central management functionalities).

The system shall have a capability to archive, record and store all security related events. The logs of the system shall be analyzed for exceptions and the possible incident of intrusion/trespass shall be presented to the employer in the form of alerts/notifications. The audit log function must be enabled and protected against tampering. The Bidders shall put in place audit trail and logging mechanism to ensure security logs are available for upto 12months.

The entire system shall use a uniform system time which can be synchronized with an external time source (GPS).

The tool must be open and customizable with dashboards as per the local infrastructure requirements and business KPI's. Typically it should support basic used cases like:

Application Security Monitoring

The standard operating system shall support the monitoring of security on host installed applications. The system shall support or allow the creation of monitoring for:

- Application Software Error Conditions
- Application Software Performance Issues
- Application Configuration Changes
- Authentication activities - login, logout, failure access

Host Security Monitoring:

- Security policy changes.
- Anti-malware activities - alerts provided by antivirus or whitelist solutions
- Mobile drive activities - USB connection in the system
- Windows event logs from Windows Machine System - Windows patches and activities,

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Network monitoring alerts and events:

- Configuration update activities - settings and parameters changes in systems
- Unauthorized access attempts events from Security appliances

Application must be simple and intuitive to support OT operators with limited IT skills to quickly identify the security issues or any unauthorized access to the system and respond to it before it becomes a major threat to the system. Employer's personnel shall be trained to be capable of creating new custom analysis and reports.

The contractor shall propose a centralized patch management solution to securely execute and manage all necessary systems, security mitigation and signature-related patching in timely manner. All host machines shall be configured via domain policy to contact patch servers and check for missing updates. These updates shall be installed manually to avoid cause unscheduled disruptions.

All the security appliances (Firewalls, Antivirus, central cyber security monitoring & detection appliances etc) being supplied under this project shall have definition updates for virus/signatures and updates for software patches for the warranty and complete FMS period. The signature and patches shall then be deployed to all the respective devices. These enhancements shall increase security and functionality, without requiring redesigning or re-engineering efforts.

4.5. Database structure

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION RTDB (Real Time Data Base) shall be an active process model. i.e. It shall initiate actions or events based on the input it receives. The RTDB shall describe the state of the power system at a given point in time and the events that move the system to a new state at the next point in time. This database is required to support the data access to real time information and to allow efficient integration and update.

A library of event routines may encapsulate or interface the RTDB with other components of the system. These event routines shall be the preferred means for application programs to interact with RTDB. This way, application programs (and programmers) only need to concern themselves with callable interface (API) of these routines. Each application shall interact with the RTDB through the event library. These event routines shall serve as generic APIs for database access thereby eliminating proprietary database function calls at the application level.

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall include a single logical repository for all data needed to model the historical, current, and future state of the power system and SCADA/DMS/OMS AND SUB-STATION AUTOMATION – the Source Database (SDB). All information needed to describe the models on which the SCADA/DMS/OMS AND SUB-STATION AUTOMATION operates, shall be defined once in the SDB and made available to all SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications, real-time database, and user interface maintenance tools that need the information.

Any database update, whether due to local changes or imported network model changes, shall be able to be placed online in a controlled manner without causing undue interruption to network operations, including without losing any manually entered data. For example, a network model update to introduce a new substation shall not interrupt the ability to perform supervisory control actions or receive telemetry to view the network state. It shall be possible the changes, local or imported, to be placed online either automatically or under manual control with proper validation. It shall be possible to easily revert to an earlier database

Version, again without undue interruption to network operations.

The capability to import & export the CIM compliant network model data including the corresponding telemetry and ICCP data reference in XML format to send it to other parties shall be provided. The capability to import the CIM compliant network model data from other parties in XML format shall also be provided.

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall provide a consistent interface to accept XML format data for updates

4.5.1. Software Maintenance and Development Tools

4.5.1.1. General requirements

A set of software shall be provided to enable maintenance of application software and development of new software in software development mode.

All hardware and software facilities shall be provided to allow creation, modification and debugging of programs in all languages that are supplied.

The following shall thus be possible:

- Program and data editing
- Program compiling and assembling
- Linking
- Loading, executing and debugging program. Version management
- Concurrent development

The following features shall be provided:

- Library management
- Programs allowing to copy and print any data or program file
- Backup and restore File comparison Sort and merge
- Programs that allow to partially save and recover volumes
- Core and memory dump.

In addition tools shall have the following:

4.5.1.2. Command language

A complete command language shall be provided that allows interactive use of any console to interactively create, modify and debug programs in all languages provided. It should also be possible to create and save command procedure file and to execute it sequentially.

4.5.1.3. Linkage Editor and Loader

Compilers and assemblers, linkage editor and loader shall be provided to link object modules from an assembly or compilation to produce an executable module and load it in system. As far as possible, the loader shall accept object modules issued from various language compilers.

4.5.1.4. Symbolic Debugger

A language-independent, interactive symbolic debugger shall be provided to enable the user to test new software and inspect the characteristics of existing software. The execution of a program shall be under the control of the debugger according to parameters entered by the user. The following features shall be supported:

- (a) Program execution break point control.
- (b) Program execution sequence tracing.
- (c) Display and modification of program variables.
- (d) Attachment of specifically written debug code to the program under test.

The debugger shall allow halting execution of a program at predefined points, reading and modifying the registers and memory locations and executing step by step a program. Tender shall describe the features of debuggers for each type of equipment.

4.5.1.5. System Integration

System integration services shall be provided for adding new programs to the set of active software after the programs have been tested. These services shall include commands to substitute one program for another, to set up or modify operating system tables, and to schedule and activate a new program with a minimum of interference with the normal running of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions. The capability to restore the system to its status prior to the new program integration shall be provided.

4.5.1.6. System Generation

System generation software and procedures shall be provided to generate an executable object code of all software, databases, displays, and reports. Employer personnel shall be able to perform a system generation on site, using only equipment, software, procedures, and documentation supplied with the SCADA/DMS/OMS AND SUB-STATION AUTOMATION. It shall not be necessary to return to the Contractor's facility or rely on the assistance of Contractor personnel.

The procedures necessary to perform a complete system generation shall be provided as interactive or batch commands maintained on auxiliary memory and on archive storage, source listings, and detailed manuals. System generation shall be accomplished without programming; only directives or control commands described in the procedures shall be required.

4.5.1.7. Code Management

A code management utility shall be provided for documenting and controlling revisions to all SCADA/DMS/OMS AND SUB-STATION AUTOMATION application programs. The utility shall maintain a library of source, object, and executable image code and provide a controlled means for changing library files containing this code.

The code management utility shall include inventory, version, and change control and reporting features. Program dependencies shall be included in the library for user reference. The code management facility shall retain a complete history of additions, deletions, and modifications of library files.

An integrated source code development subsystem supporting C, Fortran, Java, and C++, other programming languages used in the SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall provide a software configuration management system to define the elements and the associated attributes of the applications provided in the SCADA/DMS/OMS AND SUB-STATION AUTOMATION. Source definitions for all elements of an application shall be maintained in disk files under a code management system. As a minimum, the code management system shall:

- 1) Manage source code and binary images
- 2) Allow tracking of code changes by date, author, and purpose
- 3) Manage documentation modules and associate them with source code, binary images, and other documentation
- 4) Support multiple teams of programmers working concurrently on the same modules
- 5) Provide an efficient link between modules

4.6. Database Development software

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The databases organization shall be designed to meet the following major functional requirements:

- Data consistency,
- Compliance with the system performance requirements including both response times and expansion capabilities,

A Database development software shall be provided which shall contain database structure definitions and all initialisation data to support the generation of all relational , real time database (RTDB) non-relational run-time databases required to implement the functions of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. All the facilities required for generating, integrating and testing of the database shall be provided with the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The delivered SCADA/DMS/OMS AND SUB-STATION AUTOMATION database shall be sized for the ultimate system as described in this Specification. The database development facility shall be available on development system comprising of server & workstation. Once the database creation/ modification activity is over, the compiled runtime executable shall be downloaded to all respective machines. Executing the database generating functions shall not interfere with the on-line SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions.

The database development function shall locate, order, retrieve, update, insert, and delete data; ensure database integrity; and provide for backup and recovery of database files. The database development function shall generate and modify all SCADA/DMS/OMS AND SUB-STATION AUTOMATION data by interfacing with all database structures. The location of database items shall be transparent to the user performing database maintenance.

Extensive reasonability, integrity, and referential integrity checks shall be made on user entries to detect errors at the time of entry. Invalid entries, such as entering an invalid data type or attempting to define contradictory characteristics for a database item, shall be detected and reported to the user in an error message. All error messages shall be in plain English. The user shall not be required to repeat steps that were correctly executed prior to the erroneous action. Help displays shall be available to provide additional, detailed information to the user on request.

All newly defined points shall be initially presented to the user with default values for all parameters and characteristics where defaults are meaningful. It shall also be possible to initialise a new database point description to an existing database point description. The user shall be guided to enter new data, confirm existing data, and change default values as desired.

All required entries for any database item selected for changes shall be presented to the user. When parameters are entered that require other parameters to be specified, the additional queries, prompts, and display areas required to define the additional parameters shall be presented automatically.

- (a) Add, modify, and delete telemetered, non-telemetered, or calculated database items and data sources such as RTUs/ FRTUs / FPI, data links, and local I/O.
- (b) Add, modify, and delete application program data
- (c) Create a new database attribute or new database type
- (d) Resize the entire database or a subset of the database
- (e) Redefine the structure of any portion of the database.

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The database tool for creation, editing, generation, export, import of ICCP database including complete definition, association, bilateral tables, objects etc. shall be provided.

4.6.1. Run-Time Database Generation and Maintenance

The database development software shall generate incremental database changes as well as run-time (loadable) databases from the global source database (user entered database) Incremental structure changes in the source database such as addition of a bay or a substation shall not require regeneration of the entire run-time database. Based on the nature of the change, the database development software shall determine which portion of the database must be regenerated and which displays, reports, and software functions must be re- linked.

All errors that were not detected during data entry time but are encountered during run-time database generation shall be flagged. The database generation routines shall continue processing the database in an effort to detect all errors present in the database before terminating the generation task.

4.6.1.1. Data Retention

The database generation process shall retain and utilize data from the current SCADA/DMS/OMS AND SUB-STATION AUTOMATION database in the newly generated database, even when a newly generated database contains structure changes. Data to be retained across database generation cycles shall include, but not be limited to, quality codes, manual entries, tags, historical data, and tuning parameters.

4.6.1.2. Making Database Online

After an error-free database generation, the user shall be able to test the data- base in an off-line server prior to its use in an on-line server. The previous run- time database of the server shall be archived such that it is available to replace the new database upon demand. The archived database shall be deleted only when directed by the user.

Newly generated run-time databases shall only be placed on-line by user command. Following the assignment of a new database to a server and on user demand, the database management software shall access each SCADA/DMS/OMS AND SUB-STATION AUTOMATION server to ensure that all databases are consistent. Inconsistencies shall be annunciated to the user.

4.6.1.3. On-Line Database Editing

Selected database management functions and changes to a run-time database shall be possible without requiring a database generation. These shall be limited to viewing functions and changes to the contents, but not the structure of the database. On-line changes shall be implemented in all applicable SCADA/DMS/OMS AND SUB-STATION AUTOMATION run-time databases without system downtime. Changes shall also be implemented in the global database to ensure that the changes are not lost if a database regeneration is performed. On-line database editing shall not affect the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system's reaction to hardware and software failures nor shall it require suspension of exchange of data among servers for backup purposes.

4.6.1.4. Tracking Database Changes

The database manager utility shall maintain Audit trail files for all changes made by all users. The audit trails shall identify each change including date and time stamp for each

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change, and identify the user making the change. An audit trail of at least last 2 months shall be maintained and another audit trail maintaining records of who/when performed the edit operation shall be maintained for a period at least 2 months.

4.6.1.5. Initial Database Generation

The initial database shall contain all data required by the SCADA/DMS/OMS AND SUB-STATION AUTOMATION systems. Default values shall be used in consultation with the employer for data that is not provided by employer. Population and maintenance of the distribution network model should be possible by using the database maintenance tools to build the database from scratch.

4.7. Display Generation and Management

SCADA/DMS/OMS AND SUB-STATION AUTOMATION displays shall be generated and edited using interactive display generation software delivered with the system. The display generator shall be available on development system & once the display/ displays creation/ modification activity is complete, the compiled runtime executable shall be downloaded on all workstations/servers.

The display editor shall support the important construction options like:

- Copy/move/delete/modify,
- Building at different zoom level,
- Linking of any defined graphics symbol to any database point, Pop-up menus,
- Protection of any data field on any display against user entry based on log- on
- identifiers
- Activation of new or modified displays for any application or across all applications of the system by a simple command that causes no noticeable interruption of on-line DMS system activity.

All displays, symbols, segments, and user interaction fields shall be maintained in libraries. The size of any library and the number of libraries shall not be constrained by software. The display generator shall support the creation, editing, and deletion of libraries, including copying of elements within a library and copying of similar elements across libraries. A standard set of libraries and libraries of all display elements used in the delivered SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be provided.

Displays shall be generated in an interactive mode. The user shall be able to interactively:

- (a) Develop display elements
- (b) Link display elements to the database via symbolic point names
- (c) Establish display element dynamics via database linkages
- (d) Define linkages to other displays and programs
- (e) Combine elements and linkages into display layers
- (f) Combine display layers into displays.

The display generation, compilation & loading shall not interfere with the on line SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions. All user interface features defined in this Specification shall be supported by the display generator.

4.7.1. Display Elements

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The elements available to create a display shall consist of graphic primitives symbols, segments, User Interaction Field and layers. These elements shall be available to be linked to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions and dynamically transformed on the display as governed by linkages to the database.

4.7.1.1. Segments

The display generator shall support the construction of display segments consisting of symbols, primitives, and dynamic linkages to the database and user interface. Typical uses of display segments are pull-down menus, bar charts, and common circuit breaker representations. The display generator shall be able to save display segments in segment libraries for later use. The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall include a base library of segments commonly used by display builders.

The display generator shall support the addition, deletion, and modification of segments, including the merging of one segment with another to create a new segment. Segment size shall not be limited. Segments shall be defined at an arbitrary scale factor selected by the user.

4.7.1.2. Dynamic Transformation Linkages

Dynamic transformations shall be performed on symbols and display segments based upon dynamic linkages to database variables. All linkages to the database shall be defined via symbolic point names. Each symbol or segment stored in a library shall include its dynamic transformation linkages, although the specific point names shall be excluded. Dynamic transformation linkages shall support the dynamic data presentation.

4.7.2. Display Generation and Integration

The displays shall be constructed from the display elements described above. The display definition shall allow displays to be sized to meet the requirements of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION application for which they are used; displays shall not be limited by the size of the viewable area of the screen. The display generation software shall allow unbroken viewing of the display image being built as the user extends the size of the display beyond the screen size limits. Each display shall include the display coordinates definition that will permit a user to navigate successfully to the portion of the display that is of interest.

It shall be possible for a user to build a new display starting with a blank screen or an existing display. The definition of each layer shall include a range of scale factors over which the layer shall be visible. The display generator shall also support manual control of layer visibility, where the user of the display shall determine the layers on view. Each display may incorporate manually and automatically (by scale factor) displayed layers. The user shall also define the periodic update rate of the dynamic information on the display and any programs called before or after presentation of the display.

The display generator shall support the integration of new and edited displays into the active display library. During an edit session, the display generation software shall allow the user to store and recall any display. To protect against loss of display work when computer fails, the current work shall be automatically saved every 5 minutes (user adjustable) to an auxiliary memory file.

The display generator shall verify that the display is complete and error-free before integrating the display into the active display library. A copy of previous display library shall be saved & protected and it shall be brought back on line or can be deleted upon user request.. It shall not be necessary to regenerate any display following a complete or partial system or database generation unless the database points linked to the display have been modified or deleted.

4.8. Report Generation Software

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION /OMS system shall include report generation software to generate new report formats for SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS and edit existing report formats. The user shall be guided in defining the basic parameters of the report, such as the report database linkages as symbolic point names, the report format, the report activation criteria, the report destination (workstation, printer, or text file), and the retention period for the report data.

The user shall be able to construct periodic reports and ad-hoc queries via interactive procedures. The capability to format reports for workstations and printers shall be provided. The user shall be able to specify the presentation format for periodic reports and ad-hoc query reports as alphanumeric display format, graphical display format, or alphanumeric printer format. The user shall be able to specify that processing functions, such as summations and other arithmetic functions, be applied to portions of the report data when the report is processed for display, printing, or file storage. The software shall provide for generation of reports that are the full character width of the printers and that use all of the printer's capabilities, such as font sizes and styles and print orientation. For report data editing, the user shall be able to obtain the data from a retained report, modify the data, repeat the inherent data calculations, reprint the report, and save it in a report retention file on auxiliary memory without destroying the original report.

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The user shall also be able to access a retained report, modify its point linkages to the database, modify its format, and save it in a report retention file on auxiliary memory as a new report without destroying the original report.

Executing the report generating functions shall not interfere in any server of the system with the on-line SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions.

4.9. System Generation and Build

System generation includes the activity of generating an executable object code of all databases, displays, and reports as required for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. System build is the process under which all the above executable and the executable provided for SCADA/DMS/OMS AND SUB-STATION AUTOMATION application software are ported to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system hardware and configuring to make it operational.

The contractor shall do the complete system generation and build as required for successful operation of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The contractor shall also provide the complete backup of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system in electronic media such as tapes, CDs, MO disks etc. Employer personnel shall be able to restore the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system at site by using above backup tapes/CDs etc. The contractor shall provide the procedures necessary to restore the system from the backup tapes/CDs etc. The DR system shall always have updated set of system build. It shall be synchronized with the SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center .

4.10. Software Utilities

All software utilities used to maintain SCADA/DMS/OMS AND SUB-STATION AUTOMATION software, whether or not specifically required by this Specification, shall be delivered with the system.

The software utilities shall operate on-line (in background mode) without jeopardizing other SCADA/DMS/OMS AND SUB-STATION AUTOMATION application functions that is running concurrently. This utility software shall be accessible from workstations, programming terminals, and command files on auxiliary memory. Multiple users shall have concurrent access to a utility program task, provided there are no conflicts in the use of peripheral devices.

4.10.1. File Management Utility

File management utilities shall be provided that allocate, create, modify, copy, search, list, compress, expand, sort, merge, and delete program files, display files, and data files on auxiliary memory and archive storage.

4.10.2. Auxiliary Memory Backup Utility

A utility to backup auxiliary memory of server and workstation files onto a user- selected auxiliary memory or archive device shall be supplied. The backup utility shall allow for user selection of the files to be saved based on:

- (a) Server and workstation
- (b) File names (including directory and wildcard designations)
- (c) File creation or modification date and time
- (d) Whether or not the file was modified since the last backup.

A backup utility that can backup all server and workstation auxiliary memories on to a single target auxiliary memory or archive device shall be provided. The backup utility must ensure that the source auxiliary memory files are captured properly regardless of caching activity.

4.10.3. Failure Analysis Utility

Failure analysis Utility shall be provided to produce operating system and application program status data for analyzing the cause of a fatal program failure. The failure information shall be presented in a condensed, user-oriented format to help the user find the source of the failure. The information shall be presented on displays and recorded for historical records and user-requested printed reports.

4.10.4. Diagnostic Utility

The system shall have suitable auto diagnostic feature, online & offline diagnostic Utility for on-line and off-line monitoring for equipment of SCADA/DMS/OMS AND SUB- STATION AUTOMATION system shall be provided.

4.10.5. System utilization Monitoring Utility

Software utility shall be provided in each server and workstation to monitor hardware and software resource utilization continuously and gather statistics. The monitoring shall occur in real-time with a minimum of interference to the normal SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions. The period over which the statistics are gathered shall be adjustable by the user, and the accumulated statistics shall be reset at the start of each period. The statistics shall be available for printout and display after each period and on demand during the period.

4.10.6. Other Utility Services

Online access to user and system manuals for all software/Hardware products (e.g., Operating System and Relational Database Software/hardware) and SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications shall be provided with computer system.

End of Section 2, Chapter 4

Section -2, Chapter -5

**HARDWARE REQUIREMENTS FOR
SCADA/DMS/OMS AND SUB-STATION
AUTOMATION**

5.1 Introduction

This section articulates the hardware requirements for the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The conceptual hardware configuration diagram of SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center is indicated in Figure-1 of section 1 chapter 1. The bidders are encouraged to optimize the hardware for servers where SCADA, DMS & ISR applications can be combined or distributed in any combination with adequate redundancy. However quantity of servers shall be as per detailed bill of quantities for SCADA/DMS/OMS AND SUB-STATION AUTOMATION defined in section 8. Bidder shall assess the adequacy of hardware specified in the BOQ & if any additional hardware is required to meet all the requirements of the technical specifications, the same shall also be included in the offer. The Bidder shall offer the minimum hardware configuration as specified here for various equipment, however if required, higher end hardware configurations shall be offered to meet all the requirements of the technical specification. The redundant hardware such as servers (Except DTS, development server) , CFE, etc. shall work in hot standby manner. It is necessary to ensure that the functional requirements, availability & performance aspects are met as per SCADA/DMS/OMS AND SUB-STATION AUTOMATION system specification. This chapter is applicable to Group A (Noida Town),B,C towns as per functional requirements

5.2 General Requirements for Hardware

All hardware shall be manufactured, fabricated, assembled, finished, and documented with workmanship of the highest production quality and shall conform to all applicable quality control standards of the original manufacturer and the Contractor. All hardware components shall be new and suitable for the purposes specified. All hardware such as computers, computer peripherals/accessories etc. and networking products proposed and implemented shall conform to latest products based on industry standard. All hardware shall be of reputed make.

All servers and workstations shall include self-diagnostic features. On interruption of power they shall resume operation when power is restored without corruption of any applications.

The hardware shall be CE/FCC or equivalent international standard compliance. The specification contains minimum hardware requirement. However, the contractor shall provide hardware with configuration equal or above to meet the technical functional & performance requirement. Any hardware /software that is required to meet functional, performance & availability requirement shall be provided by Contractor & the same shall be mentioned in the BOQ at the time of bid . If not mentioned at the time of bid, contractor shall provide the same without any additional cost to the owner The proposed system shall be designed for an open & scalable configuration, to ensure the inter-compatibility with other systems of the Utility, the future smooth expansion as well as the easy maintainability. The proposed hardware configuration should be extended by adding either CPU processors / memory boards / disks etc.in delivered units or additional units for capacity extension.

The configuration of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION shall comprise a distributed computing environment with an open systems architecture. The system architecture shall be open internally and externally to hardware or application software additions, whether supplied by the original supplier of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION or obtained from third party vendors, both for capacity expansion

and for upgrading functionality, without affecting existing SCADA/DMS/OMS AND SUB-STATION AUTOMATION components or operation.

To be recognized as a true open computer system, all internal communications among the SCADA/DMS/OMS AND SUB-STATION AUTOMATION Servers and all external communications between the SCADA/DMS/OMS AND SUB-STATION AUTOMATION and other computer systems shall be based on widely accepted and published international or industry standards which are appropriate and relevant to the open systems concept or should have a field proven acceptance among utilities. This applies to the operating system, database management system, and display management system, as well as to APIs providing standardized interfacing between System software and application software.

The contractor should ensure that at the time of final approval of hardware configuration/BOQ, all the above hardware are current industry standard models and that the equipment manufacturer has not established a date for termination of its production for said products. Any hardware changes proposed after contract agreement shall be subject to the following: -

- a) Such changes/updates shall be proposed and approval obtained from Employer along with the approval of Drawings/documents.
- b) The proposed equipment shall be equivalent or with better features than the equipment offered in the Contract.
- c) Complete justification along with a comparative statement showing the original and the proposed hardware features/parameters including technical brochures shall be submitted to the Employer for review and approval.
- d) Changes/updates proposed will be at no additional cost to the Employer.

5.2 Hardware Configuration

In this technical specification all hardware has been broadly classified as server and Peripheral device. The term "server" is defined as any general-purpose computing facility used for hosting SCADA, DMS & ISR application functions as defined in the specification. The servers typically serve as the centralized source of data, displays and reports. The term "Peripheral Device" is used for all equipment other than servers. Peripheral device includes Operator Workstations, WAN router, LAN, Printer, Time and Frequency system, External Auto loader, External Cartridge Magnetic tape drive, VPS, RTU/FRTU etc.

5.2.1 Servers

The OEM of servers shall be member of TPC/SPECMARK. can be broadly classified into the following categories:

A) Application server

- SCADA
- DMS (Group A (Noida Town) ONLY)
- OMS (Group A (Noida Town) ONLY)
- ISR
- NMS
- Web server

B) Communication server

- Front –End server (Communication Front End) FEP(CFE)
- ICCP /Inter control center communication server

C) De –militarized server (DMZ)

- Web server with load balancing

D) Training & development system server

- DTS #
- Developmental server #

E) Data recovery

DR/ Communication server ^

The minimum hardware configuration of the servers shall be:

- 2.8 GHZ each processor-*Min 2X8 Core or min 1x16* (in case the offered server is RISC & EPICbased processor speed shall be at least 2GHz)
- Minimum 2 Processors
- 64GB Main memory (RAM)
- *Hard disk - SAS HDD with 1 TB or better configuration (For ISR Server SSD type hard disk with Min. 4 TB*
- 19" LED color monitor
- Keyboard & Mouse
- 4 nos. of 10/100/1000Mbps Ethernet ports (2 nos. for DTS & Developmental server #)
- One hot plug-gable port for external STORAGE drive
- TPC/ Spec mark performance compliance
- redundant power supply
- redundant fan

SCADA/DMS/OMS AND SUB-STATION AUTOMATION and other servers shall be RISC (Reduced Instruction Set for Computation) or Non-RISC e.g. EPIC/CISC etc.

Contractor shall provide cubicle mounted servers. The main & standby servers shall be provided with separate cubicles where each cubicle can be provided with one set of LED monitor, keyboard, and mouse through KVM switch with re-traceable tray.

5.2.1.1 Application servers

Redundant SCADA/DMS/OMS AND SUB-STATION AUTOMATION servers shall house SCADA/DMS/OMS AND SUB-STATION AUTOMATION application. Redundant ISR application shall be provided with common external memory for mass historical data storage and retrieval. The external memory shall comprise of multiple hot pluggable type hard disks configured in RAID configuration. (Except RAID-0) The external memory shall be connected either directly to the ISR server through SATA/ SCSI /SAS interface or directly on the LAN (Network Attached Storage). Alternatively, the bidder may offer RAID with each server to meet the mass storage requirement in place of common external memory.. The minimum requirement for external RAID for ISR servers is as below. The SCADA shall include historical data storage configured to store historical data at the storage rates, for the required period of time, and for the Ultimate historical database sizes given in section8.

- Storage Array
- Controller Cache: 512 MB per controller standard
- Integrated RAID controller with an LCD/LED status display and 256 MB
- read/write battery-backed cache (expandable to 512 MB per controller).
- Host Interface: Fiber Channel connection per controller from the host side
- Host Ports per Controller: Dual 2 Gb/s RAID Levels (EXCEPT RAID 0)
- Redundant Controller: Yes

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Redundant Web / Active Directory Services Server shall host Web Applications for SCADA/DMS/OMS AND SUB-STATION AUTOMATION LAN and the DNS configuration

Redundant NMS server shall be provided to host NMS application

5.2.1.2 Communication Servers:

5.2.1.2.1 FEP (CFE) Server

The redundant FEP server shall be a functional unit that offloads the task of communication & pre-processing between RTUs/FRTUs/FPIs & SCADA/DMS/OMS AND SUB-STATION AUTOMATION servers. All RTUs/FRTUs/FPIs shall be connected to CFE through IEC 60870-5-104/101 link.. For any existing RTUs/FRTU/FPI that are to be integrated, interface must be available to use existing protocols. Free slots shall be made available inside the FEP server, so as additional communication boards can be plugged-in to meet the network future expansion. Each channel shall be assigned a different protocol and the front-end shall be able to manage several protocols in parallel.

The redundancy of front-end servers shall allow handling of RTUs/FRTUs/FPIs connected either through single channel or redundant channels. In both cases, one FEP server shall be able to take control of all RTUs/FRTUs/FPIs channels. In order to meet network's expansion behind the full capacity of a pair of FE servers, it shall be possible to connect additional FE servers' pairs to the LANs. Each communication line shall be able to support its own communication protocol. The CFE shall comply VPN / SSL based security for connecting with IEC 60870-5-104 & 101 nodes on public networks. Further the nodes and CFE shall be self-certified by manufacturers as NERC/CIP compliant to comply with future smart grid requirements.

All FEPs shall not have open ports other than needed for protocol traffic / SCADA traffic, and shall have an audit trace of all login attempts / connection attempts. This FEP shall exchange data through secured SSL / VPN and encryption of protocol traffic whether it is a public network or a dedicated one. The equipment should take control command from designated Master IP address only and no other IP.

All RTU/FRTU/FPI shall be connected to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION Control Center.

RTU Communication Card / Module shall support VPN / SSL Security / Encryption of data coming to it through Public network, and then send over private & secure Utility network to the SCADA Control Center.

The Communication Servers shall be able to process time – stamped data and can be directly connected to GPS device for time synchronization

5.2.1.2.2 ICCP Server /inter control center communication server

Depending upon the protocol i.e ICCP or other inter-control center protocol used as permissible as per this specification for , the server shall be called as ICCP or inter control center communication server. The redundant ICCP//*inter control center communication server* servers shall be installed at each SCADA/DMS/OMS AND SUB-STATION AUTOMATION control centers of eligible towns of the state and DR center & shall be used to retrieve, transmit and process data to and from remote sources

i.e. remote control centers. Data retrieved and processed from remote sources may be stored in communication servers, which then distributes the data to other servers periodically or on demand. The server may also be used by utility to exchange data with State Load Dispatch Centers (SLDC) of the state where scheme will be implemented for exchange of scheduling

data.

5.2.1.2.3 Network Management System (NMS) Servers

Redundant NMS servers shall be used for configuration management, fault management & performance monitoring of servers, workstations, routers & LAN equipment etc. Part of the above functions may be performed by other servers as per the standard design of offered product.

5.2.1.2.4 Web servers with Active directory:

Redundant Web servers with active directory LDAP, DNS shall be provided.

5.2.1.3 Demilitarized/ Security servers

5.2.1.3.1 Web servers with Firewalls and IPS:

Redundant Web servers shall be provided to allow the access of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system data, displays by outside users. One router shall be provided which shall be connected to the external LAN/WAN communicating SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The external LAN/WAN users shall be able to access SCADA/DMS/OMS AND SUB-STATION AUTOMATION data through the Web server system through this router.

Web servers shall also be provided with host based Intrusion prevention & detection system (IPS). The host-based IPS will be installed in both the Web-servers. The Network based IPS shall be supplied for both the SCADA/DMS/OMS AND SUB-STATION AUTOMATION dual LAN and DMZ dual LAN.

All necessary hardware & software for Web Servers with firewalls and IPS shall be supplied by the contractor.

The design & configuration, permertization, placement of DMZ shall be such that SCADA /DMS system shall be protected from intrusion /vulnerabilities from outside world as per IEC62443, IEC 62351-3, ISO/IEC27001. The cyber security same shall certified on SAT by CERT.IN empanelled agency/ NCIIPC or any GoI agency before Operational acceptance by SIA . The same shall be required to be verified at least once annually or Major upgrade or change on the system or data of validity of certification which ever earlier during the FMS period also and maintain required performance and functional requirements

5.2.1.3.2 Firewall:

Two firewalls shall be provided, one between Web servers & SCADA/DMS/OMS AND SUB-STATION AUTOMATION dual LAN and another between Web servers & Web server dual LAN. Specification of the firewall is given in the chapter for software requirements.

Contractor shall provide equivalent tools such as Apache etc. for Web servers if UNIX or LINUX O/s is used to meet the security requirement as envisaged in the specification.

5.2.1.4 Training & development system server

5.2.1.4.1 DTS server;

A non - redundant server to host DTS applications shall be provided to impart the training.

5.2.1.4.2 Development server

A non- redundant server to host Developmental applications shall be provided

5.2.1.5 Data recovery cum communication server

Redundant DR server shall be provided with common external memory for mass historical data storage and retrieval. The external memory shall comprise of multiple hot pluggable type hard disks configured in RAID configuration. (Except RAID-0) The external memory shall be connected either directly to the ISR server through SCSI/SAS interface or directly on the LAN (Network Attached Storage). Alternatively, the bidder may offer RAID with each server to meet the mass storage requirement in place of common external memory.. The minimum requirement for external RAID for ISR servers is as below. The SCADA shall include historical data storage configured to store historical data at the storage rates, for the required period of time, and for the Ultimate historical database sizes given section 8.

- Storage Array
- Controller Cache: 512 MB per controller standard
- Integrated RAID controller with an LCD/LED status display and 256 MB read/write battery-backed cache (expandable to 512 MB per controller).
- Host Interface: Fiber Channel connection per controller from the host side
- Host Ports per Controller: Dual 2 Gb/s FC enabled
- RAID Levels(EXCEPT RAID 0)
- Redundant Controller: Yes

5.2.2 Operator Workstations

The operator Workstation console shall be used as a Man Machine Interface (MMI) by Dispatcher for interacting with all SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. Operator Workstation consoles shall also be used as development console to take up developmental/ maintenance activities such as generation/updation of database, displays etc.& to impart training through DTS workstation consoles.

Each workstation shall consist dual monitors & single keyboard and a cursor positioning device/mouse.

Workstation consoles for development system shall also be available with single TFT monitor. Operator workstation consists of a console driving single/ dual monitors as defined in the BOQ.

The user shall be able to switch the keyboard and cursor-positioning device as a unit between both monitors of console. The minimum hardware configuration of operator workstation shall be:

- 2.4 GHz processor (in case RISC & EPIC it shall be at least 1.2GHz)
- 2 GB Main memory (RAM)
- 1TB Auxiliary memory (Hard disk drive)
- 21 TFTcolour monitors
- Graphic adaptor cards
- Two speakers for audible alarms with configurable tones
- Keyboard & Mouse
- Dual 10/100/1000Mbps Ethernet ports

The specification of Remote VDU is same as of workstation for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system mentioned above, except, it shall have suitable software & hardware to facilitate remote VDU user to monitor remotely, the real time power system from SCADA/DMS/OMS AND SUB-STATION AUTOMATION system & have facility to generate report. The additional associated hardware is mentioned in the BOQ.

5.2.3 LED color monitor

The LED monitor shall have flat panel color screen. The following is the minimum characteristics of LED color monitors

S. No	Specification	For 19" monitor	For 21" monitor
1	Diagonal Viewable size	19"	21"
2	Viewing angle	Sufficiently wide horizontal & vertical viewing angles	Sufficiently wide horizontal & vertical viewing angles
3	Response time	5ms or better	5ms or better
4	Resolution	1920x1080 (Full HD)	1920x1080 (Full HD)
5	On screen control	Yes	Yes
6	Anti glare & anti static	Yes	Yes
7	Tilt , Swivel	yes	Yes

Monitor shall have inbuilt audio and speaker

5.2.4 WAN router

WAN router shall be required for data exchange of SCADA /DMS control centers with other systems (Other Data center, SLDC etc. if envisaged in the RFP), remote VDUs and LDMS & SLDC optional. Further, data exchange between RTU and SCADA control center is also envisaged over MPLS using routers. The data exchange between the two centers shall be over TCP/IP using Ethernet based communication network on various mediums viz FO, radio etc. The router shall have the following features:

- Working on G.703 interface & support the OSI and TCP/IP protocols
- support X.21/V.35/G.703 interface for interfacing communication links

The data exchange between the two centers shall be primarily over MPLS based secured network using TCP/IP on various mediums as per the requirement and availability in the respective project area viz FO, radio, V-SAT etc. by network bandwidth service provider (NBSP) part of SIA team. The router shall support the OSI and TCP/IP protocols.

The Wide Area Links are planned for 2Mbps or higher Bandwidth capacity from ISPs (BSNL, MTNL or any other NBSP)

The Router offered shall deliver high performance IP/MPLS features and shall support Layer 3 MPLS VPN connection. It shall support PPP/Frame Relay transport over MPLS.

The Routers shall be configurable and manageable through local console port, http

The Router shall provide built-in monitoring and diagnostics to detect failure of hardware. The Router shall be provided with LED/LCD indication for monitoring the Operational status.

The configuration changes on the Router should take effect without rebooting the router or modules.

- 1) Memory Flash: Minimum 8MB and upgradable up to 72MB SDRAM: Minimum 64MB and upgradable up to 320MB
- 2) Console Port: 01 No. for configurations and diagnostic tests
- 3) LAN/WAN Port: The router shall support variety of interfaces as per the concerned utility's requirement at site like V.24, V.35, E1, Channelized E1 etc. along with following minimum number of ports:
 - Two fixed 10/100M high speed Ethernet ports
 - Two fixed Serial ports with synchronous speed up to 2 Mbps and with interface support for V.35, V.24 ports
 - Two fixed ports of G.703 E1 (2 Mbps) interface
 - One AUX port

Total no of ports shall be determined by the connectivity requirement.

All the interface cables for interconnecting all LAN/WAN ports as well as connection to SCPC/MCPC/ leased E1 – V.35 ports etc. shall be in the scope of bidder.

- 4) Scalability: Should have provision of at least 100% additional number of free ports for future scalability
- 5) Network Protocol: TCP/IP and support for IP version 6. Shall provide IP address Management.
- 6) Routing Protocols:

RIP v1 (RFC 1058), RIPv2 (RFC 1722 AND 1723), OSPFv2 (RFC1583 & RFC 2328), OSPF on demand (RFC 1793), BGP4 with CIDR implementation as per RFC 1771. The implement should be compliant as per RFC1745 that describes BGP4/IDRP IP OSPF interaction. It shall provide Policy routing to enable changes to normal routing based on characteristics of Network traffic. IS-IS protocol support (RFC 1195).
- 7) WAN Protocols:

Frame Relay (LMI & Annexed & ITU Annex A), PPP (RFC1661), Multi-link PPP (RFC1717), HDLC/LAPB, Frame Relay support shall include Multi-protocol encapsulation over Frame relay based on RFC1490, RFC 1293 for Inverse ARP/IP, DE bit support
- 8) High Availability:

Shall support redundant connection to LAN

For high availability, the router should support the standards based RFC 2338 Virtual

9) Network Management:

SNMP, SNMPv2 support with MIB-II and SNMP v3 with Security authentication. Implementation control configuration on the Router to ensure SNMP access only to SNMP Manager or the NMS work Station.

- RMON 1 & 2 support using service modules for Events, Alarms, History.
- Should have accounting facility.
- Shall support multilevel access.
- Shall be Manageable from any Open NMS platform.
- Shall support for telnet, ftp, tftp and http & https enabled Management.
- Should have debugging facility through console.
- AAA Authentication support shall be provided via RADIUS (Remote Authentication Dial-IN User Service) and/or TACACS, PAP/CHAP authentication for P-to-P links, 3DES/IPsec encryption with hardware based encryption services.

10) Optimization feature:

Data Compression for both header and payload to be supported for Frame Relay and Leased/Dial-up WAN Links. Dial restoral on lease link failure Dial on demand or congestion, Load Balancing.

Support for S/W downloads and quick boot from onboard Flash. Online software re-configuration to implement changes without rebooting. Should support Network Time Protocol for easy and fast synchronization of all Routers.

11) QOS Support:

RSVP (Resource Reservation Protocol as per RFC 2205), IGMP v1, v2 (Inter Group Management Protocol Version 2 as per RFC 2236), Multicast Routing support like PIM- SM (RFC 2362), PIM-DM etc.

Policy based routing (It shall be possible to affect the normal routing process for specific mission critical traffic through specified alternate routes in the network).

A class based scheduling, Priority Queuing mechanism that shall provide configurable minimum Bandwidth allocation to each class and IP Precedence.

Congestion Avoidance –Random Early Detection (RED). Support for Differentiated Services as per RFCs 2474, 2475, 2598 & 2597.

12) Switching Performance: 200 Kbps or higher as per utility requirement at site

The following routers will be required as minimum, The minimum port requirement is specified above. However, bidder shall determine no. of ports requirement on the basis the interface & performance, availability & functional requirements & shall provide additional features/ ports over and above minimum requirement specified:

- SCADA/DMS/OMS AND SUB-STATION AUTOMATION router
- Intranet router at/DMZ
- DR router
- Router at S/S & remote VDUs locations

5.2.5 Local Area Network (LAN) and Device Interfaces

Servers, consoles and devices are connected to each other on a local area network (LAN), which allows sharing of resources without requiring any physical disconnections & reconnections of communication cable. Four LAN shall be formed namely SCADA/DMS/OMS AND SUB-STATION AUTOMATION OR SCADA, DTS, developmental system & DMZ. Dual LAN is envisaged each for the SCADA /DMS system & DMZ system & Single LAN is envisaged each for DTS & development system. At DR center also redundant LAN is envisaged. LAN shall have the following characteristics:

- Shall conform to the ISO 8802 or IEEE 802 series standards.
- Shall preclude LAN failure if a server, device, or their LAN interface fails.
- Shall allow reconfiguration of the LAN and the attached devices without disrupting operations
- Shall be either controlled LAN such as Token passing or uncontrolled LAN such as CSMA/CD
- Shall have minimum of twenty four (48) ports of 10/100/1000Mbps per LAN switch for SCADA/DMS/OMS AND SUB-STATION AUTOMATION LAN & (24)ports be considered for DMZ system, DTS & development system & DR system each,)

5.2.6 Printers

Except for the output capabilities unique to any printer type (such as extended character sets, graphic print and colouring features), there shall be no limitations on the use of any printer to perform the functions of any other printer. All the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system printers shall have dual LAN interface either directly or through internal/external print servers. Printers for DTS & development system shall have single LAN interface. The characteristics for each type of printer are described below:

a) Color inkjet printer

Color inkjet printer shall be used to take colored hardcopy printout. The Printer shall have the following features:

- Shall be suitable for printing on A4 & A3 size normal paper.
- The printout shall match to object/content to be printed in color & size.
- Shall have resolution of at least 1200 X 1200 dots per inch.
- Print time shall be less than 60 seconds per page for a colour printout in normal mode for A4 size of printing.
- Shall have suitable port for connectivity with Remote VDU.
- Shall have input & output trays
- Shall have landscape and portrait print orientation

B) Black & White Laser Printer

It is a multipurpose printer used to take prints of displays, reports etc. The laser printer shall have the following features:

- Shall be black & white laser printer
- Have speed of at least 17 pages per minute

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- minimum resolution of 1200 dots per inch
- Landscape and portrait output orientation
- Memory buffer of at least 48 mbyte
- Shall be suitable for a4 size normal paper

C) Colour Laser Printer

It is a multipurpose printer used to print displays, reports etc . The color laser printer shall have the following features:

- shall be color laser printer.
- have speed of at least 10 pages per minute for A3 & 17 pages for 20pages per minute
- in color
- 600 X 600 dpi
- Landscape and portrait output orientation.
- Duplex printing
- Memory buffer of at least 128 Mbyte

5.2.7 Time and Frequency system

GPS based time facility, using Universal Time Coordination (UTC) source, shall be provided for time synchronization of computer system at SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center. The time receiver shall include an offset adjustment to get the local time. It shall have propagation delay compensation to provide an overall accuracy of ± 1.5 microsec. The GPS system shall have dual 10/100/1000Mbps LAN interface. The GPS receiver shall be provided in redundant configuration

The time receiver shall detect the loss of signal from the UTC source, which shall be suitably indicated. Upon loss of signal, the time facility shall revert to its internal time base. The internal time base shall have a stability of 2ppm or better.

The GPS system shall include digital displays for time and date in the format DDD: HH:MM:SS (the hour display shall be in 00 to 23 hour format)

GPS system shall also be used to drive separate time, day & date indicators which shall be wall mounted type. The display for time shall be in the 24-hour, HH:MM:SS format. The display for the day & date shall be xxx format (MON through SUN) & DD:MM:YYYY respectively.

Contractor shall provide wall mounted type digital display units for time, day, date & frequency indication. The display of frequency shall be in the xx.xx Hz format. The frequency shall be derived from 230V AC supply.

Each digit on the time, day and frequency indicators shall be at least 7.5 cm in height and shall be bright enough for adequate visibility in the control room from a distance of 15 meters.

The offered GPS clock shall also provide at least one 2 MHz (75 ohm interface confirming to ITU-T G.703) synchronization interface to meet the time synchronization requirement of the communication system. This interface shall confirm to the requirements specified in ITU-T G.811 for accuracy, jitters, wander etc. Alternatively, a separate GPS clock for synchronization of communication system is also acceptable.

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5.2.9 Digital Light Processing (DLP) or LED based Video Projection System

The contractor shall provide a video projection system based on modular DLP (Digital Light Processing) or LED technology. All the screen modules of the VPS system, shall be suitable to form combined high resolution projection images. The VPS system will be used to project displays of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system independently of workstation console monitors. All the operations envisaged from workstation console (dispatcher) shall be possible from VPS also.

The Contractor shall supply all necessary hardware and software, including the multi- screen drivers, adapters and memory to seamlessly integrate the video projection system with the user interface requirements described in the specification.

The video projection systems shall be rear projection systems and shall be complete with all projection modules, supporting structures and cabling. Design & installation of the video projection systems shall be coordinated with the Employer during project implementation. The requirement for each modular video display system include:

- a) VPS screen with 2x3 matrix with each module minimum 67" diagonal
- b) VPS screen shall form a seamless rectangular array, using modules. (0.5mm) max
- c) VPS Graphics controller shall be interfaced to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system through dual LAN connectivity.
- d) Each projector shall provide a minimum resolution of 1920x1080 pixels per module. The rear projection screens shall be capable of displaying full resolution of the LED source.
- e) The VPS shall be capable of supporting multiple display modes in which one or more modules show one or more SCADA/DMS/OMS AND SUB-STATION AUTOMATION displays concurrently as selected by the user.
- f) This system shall provide the same functional display capability as the full graphics workstations.
- g) The VPS shall have a horizontal & vertical viewing angle of approximately 160 degrees minimum .The half gain angle shall be at least 40 degrees with a tolerance of ± 5 degrees for both horizontal & vertical directions.
- h) The overall brightness of individual projector shall be at least 550 ANSI lumens. The luminance measured at the screen shall be minimum 100 candelas/sqm.
- i) The projection bulb (lamp) shall have an average operating life of 6,000 hours (typical).
- j) Centre to corner brightness shall be generally uniform.
- k) The configuration of the VPS (no. of screens and size of each screen) is defined in the BOQ.
- l) The VPS controller shall have audio-video signal input module to interface with video conferencing equipment

Utility can also VPS based on LED technology with relevant parameters for LED type VPS from the above mentioned features

5.2.10 Furniture

Utility shall provide necessary furniture & shall look aesthetically pleasing. It is not in the scope of contractor.

5.3 Auxiliary Power Supply for Computer systems

The computer system should be suitable for operation with single-phase, 230 $\pm 10\%$ Vac, 50 $\pm 5.0\%$ Hz power supply. To ensure uninterrupted & regulated power supply to computer system, suitable rating UPS are envisaged under auxiliary power supply specification. All cables supply, laying & their termination between UPS panel & computer system shall be in the scope of contractor.

The input circuit breakers are provided in the UPS for protection against short circuits, any additional fuses, switches and surge protection if necessary to protect the hardware shall also be supplied by the Contractor.

The auxiliary power to all computer system hardware shall be fed from parallel operating UPS system. On interruption of input AC power to UPS, the load shall be fed through UPS inverter through it's batteries. In case of battery capacity low conditions (due to prolonged failure of input supply to UPS), the computer system shall go for orderly shutdown to avoid corruption of any applications. The orderly shutdown of computer system can be implemented either through RTU (where UPS alarms shall be wired to RTU) or through suitable interface with UPS Supplier software.

5.4 Environmental Conditions

Equipment to be located in the SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center building shall operate over an ambient temperature range of 16 C to 32°C, with a maximum rate of change of 5 C per hour. Relative humidity will be less than 80% non-condensing. In case of Altitude of 2000MSL or more, the same may be specified by utility

5.5 Acoustic Noise Level

The noise level of any equipment located in the control room shall not exceed 60dbA measured at three feet from equipment especially for the printers.

5.6 Construction Requirements of panels

In case the equipment are mounted in panel type of enclosures, then such enclosures shall meet the following requirements:

- a) shall be free-standing, floor mounted and shall not exceed 2200 mm in height.
- b) Enclosures shall be floor mounted with front and rear access to hardware and wiring through lockable doors.
- c) Cable entry shall be through the bottom. No cables shall be visible, all cables shall be properly clamped, and all entries shall be properly sealed to prevent access by rodents.
- d) 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.
- e) All enclosures shall be provided with, 230 VAC 15/5A duplex type power socket & switch for maintenance purpose.
- f) All panels shall be provided with an internal maintenance lamp and space heaters, gaskets.

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- g) All panels shall be indoor, dust-proof with rodent protection, and meet IP41 class of protection.
- h) There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.
- i) Document Holder shall be provided inside the cabinet to keep test report, drawing, maintenance register etc.
- j) Cooling air shall be drawn from the available air within the room.
- k) All materials used in the enclosures including cable insulation or sheathing, wire troughs, terminal blocks, and enclosure trim shall be made of flame retardant material and shall not produce toxic gasses under fire conditions.
- l) Suitable sized terminal blocks shall be provided for all external cabling.

5.7 Assembly and Component Identification

Each assembly in the system, to the level of printed circuit cards, shall be clearly marked with the manufacturer's part number, serial number, and the revision level. Changes to assemblies shall be indicated by an unambiguous change to the marked revision level. All printed circuit card cages and all slots within the cages shall be clearly labelled. Printed circuit cards shall be keyed for proper insertion orientation.

5.8 Interconnections

All signal cabling between component units of the computer systems shall be supplied by the Contractor. Plug-type connectors shall be used for all signal interconnections. The connectors shall be polarized to prevent improper assembly. Each end of each interconnection cable shall be marked with the cable number and the identifying number and location of each of the cable's terminations. Each cable shall be continuous between components; no intermediate splices or connectors shall be used. Terminations shall be entirely within the enclosures.

5.9 Consumables

The Contractor shall supply, at its own expense, all consumables required for use during all phases of the project through completion of the system availability test. The consumable items shall include as minimum :

- (a) Printer paper
- (b) printer toner, ink. Ribbons and cartridges
- (c.) storage devices like bluray disc /CD in line with storage device of Server or Workstation

5.10 Certain criteria for Hardware /Configuration

1. Each SCADA /DMS control center and ZSCC shall have 1 DTS at control center .
2. Each DISCOM can have maximum 1 common or Disaster Recovery center for SCADA/DMS/OMS AND SUB-STATION AUTOMATION cities (Group A (Noida Town)) . However, as per availability of infrastructure by utility , the same may corresponding to each control center .
3. Each DR for ZSCC (Group B&C) or combined can be considered as per infrastructure availability by utility

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4. Workstation

1 PER 20 S/S OR 3 WHICHEVER IS HIGHER
1 PER 100 FRTU locations OR 2 WHICHEVER IS HIGHER

5. Remote VDUs shall be required at one each at Circle, Division, Sub-division office, HQ (Common for all towns) , control center in-charge.

End of Section 2, Chapter 6

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CONFIGURATION & SYSTEM AVAILABILITY

6.0 General

This chapter describes the requirement of monitoring and managing the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system with regard to its configuration and availability under normal conditions and under hardware and software failure conditions. This section is applicable to Group A (Noida Town), B, C towns as per functional requirements

6.1 System Redundancy

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS system envisages some functions as critical functions and others as non-critical functions as defined in Chapters 1 and 2. The critical functions shall have sufficient hardware and software redundancy to take care of hardware or software failure condition whereas non-critical functions may not be provided with hardware and software redundancy.

The redundancy requirement for hardware of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be as follows:

- a) Servers: The servers for SCADA/DMS/OMS AND SUB-STATION AUTOMATION, OMS, ICCP, Communication servers, ISR application, servers for DMZ/ security system systems, DR and shall be configured as redundant system. (Except for DTS , development server)
- b) LAN and device interface: LAN shall be configured as redundant. All equipment, except DTS, development system shall have single LAN)
- c) Printers: All Printers shall be non- redundant devices.
- d) Operator workstations/ Remote VDUs: These shall be configured as non-redundant devices.
- e) Time and frequency system: The GPS receiver of time and frequency system shall be configured as a redundant device at SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center.
- f) Communication front end (CFE): Communication front end shall be configured as redundant system.
- g) WAN Router: The WAN router connected to dual LAN shall have channel redundancy. Video Projection System (VPS) shall be non-redundant.

Every critical function must be supported by sufficient hardware redundancy to ensure that no single hardware failure will interrupt the availability of the functions for a period exceeding the automatic transfer time.

Non-critical functions are those that support maintenance and development of database, application software and training of users. No hardware redundancy is envisaged for these functions.

6.2 Server and Peripheral Device States

Server and peripheral device states represent the operating condition, of each server and peripheral device. The various states have been defined below: The system's reaction to restart/failover operations shall be governed by the state. Server and peripheral device states shall be assigned by the function restart, server and device failover functions, and by user command.

6.3 Server States

Each server shall be assigned to one of the following states:

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- (a) Primary State: In primary state, a server performs any or all of the on-line functions described in this specification and is referred as primary server. A primary server shall concurrently perform maintenance functions (e.g. update of database, display and reports).
- (b) Backup State: A server in backup state is referred as backup server. A backup server replaces a primary server/primary server group in the event of primary server/primary server group failure or upon user command. It shall communicate with the primary server(s) to maintain backup databases and monitor the state of the primary server(s). A backup server shall concurrently perform maintenance functions.
- (c) Down State: A server in down state shall not communicate with the computer system and is not capable of participating in any system activity

6.4 Peripheral Device States

Each peripheral device shall be assigned to one of the following states:

- (a) Primary state: A device in primary state is referred as primary device. The primary device is logically attached to a primary server or primary server group. If the primary server or primary server group fails and its functions are reassigned to a backup server or backup server group, the device shall follow the reassigned functions.
- (b) Backup state: A device in backup state is referred as backup device. A backup device is used to replace a primary device in the event of primary device failure. It shall communicate with the primary server or primary server group to inform its readiness for its assignment as a primary device. A device may be assigned to the backup state by the server function and by user action.

A backup device may participate in on-line activity along with the primary device as can be the case with LAN s. For such cases, failure of any one device shall cause other device to take up the role of both devices.

- (c) Down state: A device in down state is referred as down device.
A down device cannot be accessed by the computer system.

6.5 Functional Redundancy

Every critical function must be supported by sufficient hardware redundancy to ensure that no single hardware failure will interrupt the availability of the functions for a period exceeding the automatic transfer time.

Non-critical functions are those that support maintenance and development of database, application software and training of users. No hardware redundancy is envisaged for these functions.

6.6 Backup Databases

Copies of all databases shall be maintained on the Backup server so that system operations may continue in the event of Primary server, peripheral device or software failure. The backup databases shall be updated with the current contents of the primary databases such that all changes to a primary database are reflected in the backup database within 60 seconds of the change. The backup databases shall be maintained in such a manner as to be protected from corruption due to server and device failure. Backup databases shall be preserved for system input power disruptions of any duration.

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The information maintained in the backup databases shall include:

- a) Telemetered, calculated, and manually-entered values and their attributes, including quality codes, control inhibit state, and tag data
- b) Data and associated attributes maintained by the Information storage and Retrieval function
- c) Alarm, event, and summary displays (such as off-normal, control inhibit, and alarm inhibit displays) or sufficient information to rebuild the displays in their entirety (including the time and date of the original data entries, not the time and date the display is newly created)
- d) Application function execution, control, and adaptive parameters and input and output data, including DMS functions save cases.
- e) Changes resulting from the addition or deletion of items and restructuring of databases in an existing database shall be automatically accommodated in the backup database.

6.7 Error Detection and Failure Determination

All servers, peripheral devices, on-line software functions, and maintenance functions in SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be monitored for fatal error and recoverable errors. All errors shall be recorded for review by maintenance personnel. Each type of error (e.g., server failure, memory access violation, device reply time-out, or message checksum error) shall be recorded separately with a date and time tag.

6.8 Server and peripheral device Errors

The Server/Device shall be declared as failed in case of fatal error. Server and peripheral device failure shall be detected and annunciated to the user within 10 seconds of the failure. For each type of recoverable error the programmer shall assign a threshold. When the count of consecutive recoverable errors exceeds this threshold, a warning message shall be issued to the operator.

6.9 Software Errors

Execution errors in on-line and maintenance functions that are not resolved by program logic internal to the function shall be considered fatal software errors. Examples of errors that may be resolved by internal program logic include failure of a study function to achieve a solution due to violation of an iteration limit or arithmetic errors (such as division by zero) which are caused by inconsistent input parameters or data. These errors shall produce an alarm informing the user of the error but shall not be considered fatal software errors. Fatal software errors shall result either in termination of the function or shall be handled as a fatal Server error. The action to be performed shall be defined by the programmer for each on-line function and each maintenance function. If the function is to be terminated, future executions of the function shall also be inhibited until the function is again initiated by the programmer.

On the occurrence of each fatal software error, Server and operating system error codes and messages shall be recorded in the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system.

6.10 Server Redundancy and Configuration Management

Each server or server group supporting the CRITICAL functions described in the specifications, shall include at least one redundant server. The redundant server shall normally be assigned to the backup state and shall take the role of a primary server in the event of failure or upon user

command.

When a failure of a primary server in a redundant group is detected, the SCADA/DMS/OMS AND SUB-STATION AUTOMATION computer system shall invoke the appropriate failover and restart actions so that on-line functions assigned to the failed server are preserved. The on-line functions of the failed primary server shall be assigned to the backup server by execution of a function restart within 30 seconds after detection of server failure, except for ISR function. For ISR server function the corresponding time shall be within 120 seconds after detection of server failure in case of failure of ISR server, the ISR data shall be stored in the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system till the failover of ISR server is completed to avoid data loss. This stored data shall be transferred to the ISR server automatically after restoration of ISR server.

If on-line functions are restarted in a backup server, the server's state shall be changed to primary. If backup servers are not available to perform the required functions, the SCADA/DMS/OMS AND SUB-STATION AUTOMATION computer system shall attempt to restart the failed primary server. A complete restart of the System, including full update from the field, shall not more than the stipulated time as specified above. No data shall be lost during the transfer of operation.

A failover (transfer of critical functions) to an alternate Server shall occur, as a minimum, under any one of the following situations:

- Non-recoverable failure of a server performing a critical function
- User request for a transfer of servers
- Failure of a periodic / scheduled function to execute on schedule.
- Violation of a configurable hardware device error counter threshold.

Failure of non-critical function shall not cause server failover. Functions assigned to a failed server in a non-redundant group may be lost until the failed server is restored to service. Failure of server operating in the backup state shall not initiate failover action.

Failed server shall be switched from down to any other state by user command only. All server reinstatement actions shall result in operator message. The messages shall identify the server(s) affected, all server state changes, and the success or failure of any restart operations.

6.11 Server Startup

Server startup shall be performed when commanded by a user, when server input power is interrupted and restored such that the operating environment of the server is established prior to restarting the on-line functions. Establishment of the operating environment may include execution of self-diagnostics, reloading the operating system and system services, and connection to and verification of communications with all nodes on the SCADA/DMS/OMS AND SUB-STATION AUTOMATION computer system LAN. Subsequent to server startup, a function restart shall bring the server(s) to the appropriate server state.

Server Startup requirements are as follows:

Cold Start: In which default values are used for entire database. A cold start would be used only to build the initial SCADA/DMS/OMS AND SUB-STATION AUTOMATION and to recover from extraordinary failure conditions. Server startup shall be completed within 15 minutes and all applications shall be operational within 20 minutes of applying power except for ISR server and its database initialisation, which can be up to 60 minutes.

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Warm Start: In which a previously saved version of the database shall be used to initialise all real time data values. Server startup shall be completed within 10 minutes and all applications shall be operational within 15 minutes of application of power.

Hot Start: In which the memory resident version of database shall be used for continued operation. No reload of saved data shall be performed, although application software restarts. The intent is that after hot restart, only the operations being performed at the time of failure may be lost. All on line applications shall be operational not more than failover time.

6.12 Peripheral Device Redundancy and Configuration Management

The device failover shall result in an orderly transfer of operations to a backup device in the event of failure of primary device. The device failover function may replace a failed device with an identical backup device or with a backup device that is different from the normal device.

Device failover actions shall be completed and the backup device shall be operating within 30 seconds of detection of the device failure. All device failures shall be annunciated by alarms.

6.13 System Configuration Monitoring and Control

Required displays shall be provided for the user to review the system configuration and to control the state of the equipment. The following operations shall be possible:

- Fail-over, switching of states and monitoring of Servers and peripheral devices.
- Control of the resource usage monitoring function and display of server resource utilization
- The user shall be provided with the capability to interact with all functions using displays. It shall be possible to at least Stop, Start, inhibit /enable and Restart any of the functions.
- Displays to view and control the status of backup databases shall also be provided.

End of Section 2, Chapter 6

Section 2, Chapter 7

TESTING & DOCUMENTATION

7.0 General

This section describes the specific requirements for testing and documentation of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The general requirements of testing and documentation are covered in **Section 7**. This section is applicable to Group A (Noida Town), B, C, U towns as per functional requirements.

7.1 Type testing –

Equipment wherever mentioned in the specification for type testing shall conform to the type tests listed in the relevant chapters. Type test reports of tests conducted in NABL accredited Labs or internationally accredited labs with in last 5 years/ or validity except GIS and Hybrid switchgear, for GIS and Hybrid switchgear will 15 years/or validity of test of certificate whichever is lower from the date of bid opening may be submitted. In case, the submitted reports are not as per specification, the type tests shall be conducted without any cost implication to employer before approval during design & engineering. Further, the equipment indicated in the MoP order no 12/34/2020-T&R dtd. 08.06.21 & CEA/PLG/R&D/MII/2021 dtd. 11.06.21 and any amendment from time to time shall be adhered to. If there is a difference between the type test requirement mentioned above specification and type test requirement mentioned in the respective, the above shall prevail

7.2 Factory Acceptance Tests (FAT)

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system including DR center (DR is part of the project area) shall be tested at the Contractor's facility. All hardware and software associated with the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system and at least two RTUs along with, LDMS, 1 type of numerical relays and one SCADA enabler each (if part of supply under this project) & 10 FRTUs & all Remote VDUs, shall be staged for the factory testing and all remaining RTUs/FRTUs/FPIs shall be simulated for the complete point counts (ultimate size). The requirements for exchanging data with other computer systems like DR (if DR is not a part of the project area), data exchange with other envisaged shall also be simulated.

Each of the factory tests described below (i.e. the hardware integration test, the functional performance test, integrated system test and unstructured tests) shall be carried out under factory test for the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The factory tests, requiring site environment, shall be carried out during the Field Tests after mutual agreement for the same from owner.

7.2.1 Hardware Integration Test

The hardware integration test shall be performed to ensure that the offered computer hardware, conforms to this Specification requirements and the Contractor-supplied hardware documentation. All the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system hardware shall be integrated and staged for testing. Applicable hardware diagnostics shall be used to verify the hardware configuration of each equipment. The complete hardware & software bill of quantity including software licenses & deliverables on electronic media shall also be verified.

7.2.2 System Build test

After completion of hardware integration test, the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be built from the backup software on electronic media (CDs/ Tapes) to check the completeness of backup media for restoration of system in case of its crashing/failure. The software deliverables shall include one copy of backup software on electronic media.

7.2.3 Functional Performance Test

The functional performance test shall verify all features of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION hardware and software. As a minimum, the following tests shall be included in the functional performance test:

- a) Testing of the proper functioning of all SCADA/DMS/OMS AND SUB-STATION AUTOMATION & other software application inline with the requirements of various sections of technical specification.
- b) Simulation of field inputs (through RTU/FRTU/FPI) from test panels that allow sample inputs to be varied over the entire input range
- c) Simulation of field input error and failure conditions
- d) Simulation of all type of sample control outputs
- e) Verification of RTU /FRTU/FPI communication Protocol IEC-60870-5-104 /101 etc
- f) Verification of MFT communication Protocol MODBUS etc
- g) Verification of compliance of supporting interfaces such as IEC61850, IEC60870-5-103 etc.
- h) Verification of Security & Encryption using SSL for all FRTU/FPI Connectivity.
- i) Confirmation of cyber security compliance of products through software and RTU/FRTU and networking devices to be carried out by Cyber Crisis Management plan (CCMP) & its implementation during SAT by CERT.IN empanelled agency. CISO designated by DISCOM shall be available during these verification
- j) Verification of Integration between GIS using adapter
- k) Verification of data exchange with other systems
- l) Verification of interoperability profile of all profiles of all protocols being used.
- m) Verification of RTU /FRTU/FPI communication interfaces
- n) Verification of LAN and WAN interfaces with other computer systems
- o) Testing of all user interface functions, including random tests to verify correct database linkages
- p) Simulation of hardware failures and input power failures to verify the reaction of the system to processor and device failure
- q) Demonstration of all features of the database, display, and report generation and all other software maintenance features on both the primary and backup servers. Online database editing shall also be tested on primary server.

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- r) Logic verification of SAIDI/SAIFI reports and API for transfer of data to NPP
- s) Demonstration of the software utilities, libraries, and development tools.
- t) Verification that the SCADA/DMS/OMS AND SUB-STATION AUTOMATION computer system meets or exceeds employer's performance requirements (as per table for peak & normal loading in section 8 Verification of Design parameters as mentioned in section 8 & wherever defined in the specification.
- u) Verification that ultimate expansion requirements are met. (p) Verification of DTS
- v) Verification of Development system
- w) Verification of data transfer of main to back up SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. (s) Functions of DR system, if it is in the project area.
- x) Unstructured testing of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system by employer. The unstructured tests shall include the test, which are not in the approved test procedures and may be required to verify the compliance to the specification. (Max 20% of total testing)

7.2.4 Continuous operation Test (48 hours)

This test shall verify the stability of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION hardware and software after the functional performance test has been successfully completed. During the test, all SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions shall run concurrently and all Contractor supplied equipment shall operate for a continuous 48 (forty eight) hour period with simulated exchange with other interconnected system IT system envisaged etc. The test procedure shall include periodic repetitions of the normal and peak loading scenarios defined. These activities to be tested may include, but shall not be limited to, database, display, and report modifications, configuration changes (including user-commanded processor and device failover), switching off of a primary server and the execution of any function described in this Specification. During the tests, uncommanded functional restarts or server/device failovers are not allowed; in case the problems are observed, the Contractor shall rectify the problem and repeat the test.

7.3 Field Tests (Site Acceptance tests -SAT)

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be tested at the site. All hardware and software associated with the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system along with all RTUs/FRTUs/FPIs along with all field devices including MFTs connected shall be tested under the field tests.

7.3.1 Field Installation Tests

The equipment which has undergone the factory testing shall be installed at site and integrated with the RTUs /FRTU/FPI and other computer systems through the communication medium.

The field installation test shall include the following:

- (a) Proper installation of all delivered hardware as per approved layout.
- (b) Interconnection of all hardware
- (c) Interconnection with communication equipment
- (d) Interconnection with power supply
- (e) Diagnostic tests to verify the operation of all hardware
- (f) Random checking of SCADA/DMS/OMS AND SUB- STATION AUTOMATION software basic functions

The Contractor shall be responsible for performing the field installation tests and Employer may witness these tests.

7.3.2 End-to-End Test

After the field installation tests, the Contractor shall carry out end-to-end test to verify:

- a) the communication of RTUs/FRTUs/FPIs/MFTs with SCADA/DMS/OMS AND SUB-STATION AUTOMATION system
- b) the RTU /FRTU/FPI communication channel monitoring in the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system.
- c) the mapping of SCADA database with RTU /FRTU/FPI database for all RTU/FRTU/FPI points
- d) the mapping of SCADA database with displays and reports

The Contractor shall provide the details of all the variances observed and corrections carried out during end to end test.

7.3.3 Field Performance Test

The field performance test shall concentrate on areas of SCADA/DMS/OMS AND SUB-STATION AUTOMATION operations that were simulated or only partially tested in the factory (e.g., system timing and loading while communicating with a full complement of RTUs/FRTU/FPI and data links and system reaction to actual field measurements and field conditions). Further the validity of factory test results determined by calculation or extrapolation shall be examined.

After the end to end test, the Contractor shall conduct the field performance test to verify the functional performance of the system in line with the technical specification which includes the following:

- a) the communication of other system envisaged, if any e.g. IT , SLDC, DR system with SCADA/DMS/OMS AND SUB-STATION AUTOMATION system
- b) Mapping of SCADA/ISR database with other system database e.g. IT , SLDC, DR system , NPP (SAIFI ,SAIDI data) with SCADA/DMS/OMS AND SUB-STATION AUTOMATION system
- c) Verify that all the variances observed during the Factory test are fixed and implemented.
- d) Conduction of the Factory tests deferred (tests requiring site environment)
- e) Functional tests of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system
- f) Verify the execution rates of all SCADA/DMS/OMS AND SUB-STATION AUTOMATION application
- g) Verify update rate & time for data update & control command execution as per specification requirements
- h) Verify the response time of all SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications.
- i) Verify the response time for User interface requirements
- j) Testing of all features of the database, display, and report generation and all other software maintenance features on both the primary and backup servers. Online database editing shall also be tested on primary server.
- k) Conduction of unstructured tests as decided by the Employer

7.3.4 Cyber security compliance

Compliance of cyber security without threatening vulnerabilities by CERT.IN empanelled agency shall be carried out. DISCOM CISO shall also be available during this verification. Further, the equipment indicated in the MoP order no 12/34/2020-T&R dtd 08.06.21 & CEA /PLG/R&D/MII/2021 dtd 11.6.21 and any amendment from time to time shall be adhered to.

7.4 System Availability Test (360 hours)

Contractor shall provide & approve theoretical and practical figures used for this calculation at the

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time of detailed engineering. The calculation shall entail reliability of each individual unit of the System in terms of Mean Time between Failures (MTBF) and a Mean time to Repair (MTTR) as stated by OEM. Reliability figures of existing equipment shall be supported by evidence from operational experience at similar types of installation / figure given by OEM.

From those data, the unavailability of each sub-system shall be calculated taking in account each item redundancy. The global availability shall then be calculated from those different unavailability data. This calculation shall lead to the failure probability and equivalent global MTBF data for the control center system.

The overall assessment of System availability shall be provided in the form of an overall System block diagram with each main item shown, complete with its reliability data. The calculation of overall availability shall be provided with this diagram.

System availability tests shall be conducted after completion of the field tests. The system availability test shall apply to the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system (hardware and software) integrated with its RTUs/FRTU/FPIs and legacy system envisaged. However, the non-availability of RTUs/Data Concentrators/ FRTU/FPI , legacy IT system etc. & Communication System shall not be considered for calculating system availability. However, RTU/FRTU, communication equipment's auxiliary power supply shall be tested as per the provisions given in their chapters.

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system (hardware and software systems) shall be available for 99.5% of the time during the 360 hours (15 days) test period. However, there shall not be any outage/down time during last 85 Hours of the test duration. In case the system availability falls short of 99.5%, the contractor shall be allowed to repeat the system availability test after fixing the problem, failing which the system shall be upgraded by the contractor to meet the availability criteria without any additional cost implication to the owner.

Availability tests of RTUs/FRTUs shall be conducted along with System availability test for 360 hours. Each RTU/FRTUs shall exhibit minimum availability of 98%. In case the RTU/FRTU availability falls short of 98%, the contractor shall be allowed to repeat the RTU/FRTU availability test (for failed RTU/FRTU only) after fixing the problem, failing which the equipment shall be upgraded by the contractor to meet the availability criteria without any additional cost implication to the owner.

In the event of unsuccessful reruns of the availability test, employer may invoke the default provisions described in the General Conditions of Contract.

The system availability tests will be performed by the owner by using the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system and RTUs/FRTU/FPI for operation, control and monitoring of distribution system and using Contractor supplied documentation. The owner will also be required to generate daily, weekly and monthly reports. The supplied system shall be operated round the clock.

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be considered as available if

- a) one of the redundant hardware is available so that all the SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications are functional to ensure the design & performance requirement as envisaged in the specification
- b) At least one of the operator console is available
- c) At least one of the printers is available (off-lining of printers for change of ribbon, cartridge, loading of paper, paper jam shall not be considered as downtime)
- d) All SCADA applications are available
- e) All DMS applications are available
- f) All SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions described in the specification are executed at periodicities specified in the specification. without degradation in the response times
- g) Requests from available Operator Consoles & VPS are processed

- h) Information Storage and Retrieval applications are available
- i) Data exchange with other system is available

However each device, including servers, shall individually exhibit a minimum availability of 98%.

The non-availability of following Non-Critical functions shall not be considered for calculations of system availability; however these functions should be available for 98% of the time.

- (a) Database modification and generation
- (b) Display modification and generation
- (c) Report modification and creation
- (d) DTS

During the availability test period, employer reserves the right to modify the databases, displays, reports, and application software. Such modifications will be described to the Contractor at least 48 hours in advance of implementation to allow their impact on the availability test to be assessed, except where such changes are necessary to maintain control of the power system.

The successful completion of system availability test at site shall be considered as **“Operational acceptance”** of the system.

7.4.1 Downtime

Downtime occurs whenever the criteria for successful operation are not satisfied. During the test period, owner shall inform the Contractor for any failure observed. For attending the problem the contractor shall be given a reasonable travel time of 8 hours. This service response time shall be treated as hold time and the test duration shall be extended by such hold time. The downtime shall be measured from the instant, the contractor starts the investigation into the system and shall continue till the problem is fixed. 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. Contractor shall be allowed to use mandatory spares (on replenishment basis) during commissioning & availability test period. However it is the contractor's responsibility to maintain any additional spares as may be required to maintain the required system availability individual device/ equipment availability. All outage time will first be counted but if it is proven to be caused by hardware or software not of Contractor's scope, it will then be deducted.

7.4.2 Holdtime

During the availability test, certain contingencies may occur that are beyond the control of either employer or the Contractor. These contingencies may prevent successful operation of the system, but are not necessarily valid for the purpose of measuring SCADA/DMS/OMS AND SUB-STATION AUTOMATION availability. Such periods of unsuccessful operation may be declared "holdtime" by mutual agreement of employer and the Contractor. Specific instances of holdtime contingencies could be Scheduled shutdown of an equipment, Power failure to the equipment, Communication link failure.

7.5 Documentation

The complete documentation of the systems shall be provided by the contractor. Each revision of a document shall highlight all changes made since the previous revision. Employer's intent is to ensure that the Contractor supplied documentation thoroughly and accurately describes the system hardware

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and software.

The contractor shall submit the paper copy of all necessary standard and customized documents for SCADA/DMS/OMS AND SUB-STATION AUTOMATION in 2 sets for review/approval by the Employer for necessary reference which includes the following:

- a) System overview document
- b) Cross Reference Document
- c) Functional design document
- d) Standard design documents
- e) Design document for customization
- f) System Administration documents- software utilities, diagnostic programs etc.
- g) Software description documents
- h) Bill of Quantity & List of software and hardware deliverable
- i) protocol implementation documents
- j) point address document
- k) IP addressing plan document
- l) Software User document for dispatchers
- m) Software Maintenance document
- n) Training documents
- o) Real time & RDBMS documents
- p) Database settings, Displays and Reports to be implemented in the system
- q) Test procedures
- r) Test reports
- s) Hardware description documents
- t) Hardware User documents
- u) Hardware Maintenance documents
- v) Data Requirement Sheet (DRS) of all Hardware
- w) Site specific Layout, Installation, GA, BOQ, schematics and cabling details drawings/documents
- x) SCADA & IT Integration Plan Document using GIS Adapters & Messaging Interfaces.
- y) Cyber Security Plan & Mitigation document (or Cyber Crisis Management Plan (CCMP)) for the system if Public Networks are used.
- z) Interoperability profiles/ Tables

After approval two sets of all the above documents as final documents shall be delivered to site by the Contractor. In case some modifications/corrections are carried out at site, the contractor shall again submit as built site specific drawings in three sets after incorporating all such corrections as noticed during commissioning. Any software modifications/updates made at site shall also be documented and submitted in three sets to site and one set to Employer.

In addition to paper copies, two sets of final documentation shall be supplied on Electronic media to employer. The contractor shall also submit two sets of the standard documentation of Operating system and Databases in electronic media. Paper copies of these may be submitted, if the same are available from the OEM as a standard part of delivery. One copy of the software packages used for accessing & editing the final documentation in electronic media shall also be provided.

After successful completion of System availability test, the contractor shall take the software backup of complete SCADA/DMS/OMS AND SUB-STATION AUTOMATION system on electronic media and two copies of these backup software shall be submitted to the owner.

SECTION 3

CHAPTER-1

TECHNICAL REQUIREMENTS OF RTU

1.0 General

The Remote Terminal Unit (RTU) shall be installed at primary substation to acquire data from Multifunction Transducers (MFTs), discrete transducers & status input devices such as CMRs etc. RTU & shall also be used for control of Substation devices from Master station(s). The supplied RTUs shall be interfaced with the substation equipment, communication equipment, power supply distribution boards; for which all the interface cables, TBs, wires, lugs, glands etc. shall be supplied, installed & terminated by the Contractor. Further, the equipment indicated in the MoP order no 12/34/2020-T&R dtd 08.06.21 & CEA /PLG/R&D/MII/2021 dtd 11.6.21 and any amendment from time to time shall be adhered to. This section is applicable to Group A (Noida Town), B, C towns as per functional requirements

1.1 Design Standards

The RTUs shall be 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.

The RTU shall be designed around microprocessor technology. For easy maintenance the architecture shall support pluggable modules on backplane. The field wiring shall be terminated such that these are easily detachable from the I/O module. The RTU shall comply to IEC62351-3/IEC62443 standard for cyber security

1.2 RTU Functions

All functional capability described herein shall be provided by the Contractor even if a function is not initially implemented.

As a minimum, the RTU shall be capable of performing the following functions:

- (a) Acquiring analog values from Multifunction Transducers or alternatively through transducer-less modules and the status inputs of devices from the substation, processing and transmitting to Master stations. Capability to acquire analog inputs from analog input cards receiving standard signals viz current loops 4-20mA standard signals such as 0-5Vdc etc. for RTD, transducer etc.
- (b) Receiving and processing digital commands from the master station(s)
- (c) Data transmission rates - 300 to 19200 bps for Serial ports for MODBUS. and 10/100 mbps for TCP/IP Ethernet ports
- (d) IEC 60870-5-104 protocol to communicate with the Master station(s) at least 2, IEC 60870-5-101 for slave devices & MODBUS protocol over RS485 interface, to communicate with the MFTs.
- (e) RTU shall have the capability of automatic start-up and initialization following restoration

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of power after an outage without need of manual intervention. All restarts shall be reported to the connected master stations.

- (f) Remote database downloading of RTU from master station/SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center
 - (g) Act as data concentrator on IEC60870-5-101/103/104/MODBUS(h) Internal battery backup to hold data in SOE buffer memory & also maintaining the time & date.
 - (i) As the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system will use public domain such GPRS/CDMA etc., therefore it mandatory to guard the data/ equipment f r o m intrusion/damage/breach of security & shall have SSL/VPN based security.
 - (j) Shall have SNMP
- (K) Conformance to IEC62351-3/ IEC62443 standard for cyber security

Support Feature:

All support feature as mentioned below will not be used now & may require in future . However, the same shall be tested in routine /Factory Tests. Further, it should be possible to have following capabilities in the RTU by way of addition of required hardware limited to addition of I/O modules & communication card or protocol converter & using the same firmware at later date:

- a) Support for Analog output in form of standard current loops viz 4-20Ma etc
- b) Support for IEC 62056 protocols /IEC61850 /protocols & ability to act as a gateway for Numerical relays/ Smart Meters may have to be interfaced if .
- c) Have required number of communication ports for simultaneous communication with Master station(s), /MFTs and RTU configuration & maintenance tool.
- (d) PLC support
- (e) Communication with at least two master stations simultaneously on IEC] 60870-5-104
- (f) Receiving and processing analog commands from master station(s) and Capability of driving analog output card.
- (g) RTU shall be capable of acquiring analog values through transducers having output as 4-20 mA, 0-10 mA, 0-+10 mA or +/- 5 volts etc. using analog input modules.
- (h) Capability of time synchronization with GPS receiver which may be required future.

1.3 Communication ports

The RTUs shall have following communication ports to communicate with master station, existing /MFTs and configuration & maintenance terminal.

- a) RTU shall have two TCP/IP Ethernet ports for communication with Master station(s) using IEC 60870-5-104.
- b) RTU shall have required number of RS 485 ports for communication with MFTs to be connected in daisy chain using MODBUS protocol. Minimum 15 analog values (including 4 energy values) to be considered per energy meter The RTU shall be designed to connect maximum 5 MFTs. Further , bidder to demonstrate during testing that all analog values updated within 2 sec. The updation time shall be demonstrated during FAT(routine) & SAT testing . The bidder can offer MFT on IEC 60870-101/104 protocol to communicate with RTU.
- c) In addition, if weather transducer & DC transducers are also having RS485
- d) MODBUS port., the same can be also added in the daisy. However, total devices including MFT connected on one port shall not exceed
- e) RTU shall have one port for connecting the portable configuration and maintenance tool for RTU.

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- f) RTU as a data concentrator, then RTU shall have additional communication ports Ethernet or serial for IEC60870-5-104/101 using SSL/VPN

It shall be possible to increase the number of communication ports in the RTU by addition of cards, if required in future. The RTU shall support the use of a different communication data exchange rate (bits per second) and scanning cycle on each port & different database for each master station. FRTUs & FPIs shall be communicating to SCADA/DMS/OMS AND SUB-STATION AUTOMATION Master control using IEC60870-5-104 /101 protocol over MPLS/GPRS.

1.3.1 Master Station Communication Protocol

RTU shall use IEC 60870-5-104 communication protocol for communicating to master station. The RTU communication protocol shall be configured to report analog (except energy values) & status changes by exception to master stations. However, RTU shall support periodic reporting of analog data and periodicity shall be configurable from 2 sec to 1 hour. Digital status data shall have higher priority than the Analog data. The dead-band for reporting Analog value by exception shall be initially set to 1% (user configurable) of the full scale value. In addition, analog values shall also be reported to Master station by exception on violation of a defined threshold limit. All the analog values and status data shall also be assigned to scan groups for integrity check by Master stations at every 10 minutes configurable up to 60 minutes RTU wise.

RTU shall report energy values to master station periodically. The periodicity shall be configurable from 5 minutes to 24 hours (initially set for 15 minutes)

1.3.2 Communication Protocol between RTU & MFTs

The RTU shall acquire data from the MFTs using the MODBUS protocol. In addition, usage of IEC 60870-5-101/104 protocols is also permitted. The MFT will act as slave to the RTU. The RTU shall transmit these values to the master station in the frame of IEC 60870-5-104/101 protocol. As an alternate approach the utility/contractor may use RTU as a data concentrator & acquire all the required analog data from DCU installed & connected to energy meters using MODBUS /DLMS as legacy system . However, performance, functional, availability & update time requirement shall be met in this case also. It is the responsibility of utility /contractor to assess this option & only opt in case it is found feasible,

1.4 Analog Inputs

The real time values like, Active power, Reactive Power, Apparent power three phase Current & Voltage and frequency, power factor & accumulated values of import /export energy values will be acquired RTU from the following in the given manner:

1. MFTs installed in substations
2. RTU shall also take 4-20 mA, 0-20mA, 0- -10mA, 0-+10mA, 0-5V etc.as analog inputs to acquire transformer tap position, DC power supply voltage, weather transducer etc.

The RTU analog-to-digital (A/D) converters shall have a digital resolution of at least twelve (12) bits plus sign. The overall accuracy of the analog input system shall be at least 0.2% (i.e. 99.8%) at 25 °C of full scale . Mean accuracy shall not drift more than 0.002% per degree C within the temperature range of –5 to +55 degree Linearity shall be better than 0.05%. The RTU shall be designed to reject common mode voltages up to 150 Vac (50 Hz). For dc inputs, normal mode noise voltages up to 5 Vac shall be rejected while maintaining the specified accuracy. Each input shall have suitable protection and filtering to provide protection against voltage spikes and residual current at 50 Hz, 0.1 ma (peak-to-peak) and overload. Loading upto

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150% of the input value shall not sustain any failures to the RTU input.

The ability of the RTU to accommodate dc inputs shall include the following signal ranges:
Unipolar Voltage: 0-0.5V, 0-1V, 0-5V, 0-10V, Unipolar Current: 0-1mA, 0-10mA, 0-20mA, 4-20mA, Bipolar Voltage: 0.5V, 2.5V, 5V, -20-0-20mA (- to +)

The total burden imposed by the RTU/DC analog input circuit shall not exceed 0.5 volt-ampere for current and voltage inputs. As an option, contractor may also provide transducer less solution to connect direct CT/PT secondaries.

1.5 Status input

RTU shall be capable of accepting isolated dry (potential free) contact status inputs. The RTU shall provide necessary sensing voltage, current, optical isolation and de-bounce filtering independently for each status input. The sensing voltage shall not exceed 48Vdc.

The RTU shall be set to capture contact operations of 20 ms or more duration. Operations of less than 20 ms duration shall be considered no change (contact bounce condition). The RTU shall accept two types of status inputs i.e. Single point Status inputs and Double point status inputs.

To take care of status contact chattering, a time period for each point and the allowable number of operations per time period shall be defined. If the allowable number of operations exceed within this time period, the status change shall not be accepted as valid

Single point status input will be from a normally-open (NO) or normally-closed (NC) contact which is represented by 1-bit in the protocol message.

The Double point status input will be from two complementary contacts (one NO and one NC) which is represented by 2-bits in the protocol message. A switching device status is valid only when one contact is closed and the other contact is open. Invalid states shall be reported when both contacts are open or both contacts are closed.

All status inputs shall be scanned by the RTU from the field at 1 millisecond periodicity.

1.6 Sequence of Events (SOE) feature

To analyze the chronology or sequence of events occurring in the power system, time tagging of data is required which shall be achieved through SOE feature of RTU. The RTU shall have an internal clock with the stability of 10ppm or better. The RTU time shall be set from time synchronization messages received from master station using IEC 60870-5-104 protocol. In addition, the message can be transmitted using NTP/SNTP. SOE time resolution shall be 1ms or better.

The RTU shall maintain a clock and shall time-stamp the digital status data. Any digital status input data point in the RTU shall be assignable as an SOE point. Each time a SOE status indication point changes the state, the RTU shall time-tag the change and store in SOE buffer within the RTU. A minimum of 1000 events can be stored in the SOE buffer. SOE shall be transferred to Master Station as per IEC 60870-5-104 protocol. SOE buffer & time shall be maintained by RTU on power supply interruption.

1.7 IED pass through

The Master Station user shall be able to perform a virtual connection with any IED connected to

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the RTU/DC, provided the communication protocol functionality, to support the information transfer from and to the IEDs. For example, the Master Station shall gather on-demand IED data, visualize IED configuration parameters, and IED source code depending upon the IED capabilities. On the other hand, the Master Station shall be able to download to the IEDs configuration parameters, code changes, etc. depending upon the IED capabilities. This feature is a support function considering in future implementation. The capability can be demonstrated with the upload & download of data from master station with IEDs connected to the RTUs using the support of protocols specified in this chapter. Numerical relays Analog data viz voltage, current, sag swell instantaneous, momentary, temporary, over voltage, under voltage, over current, phasor measurement, THD, current TDD & current unbalance ratio etc. at numerical relays if installed at bay of S/S

1.8 PLC capability

The RTU shall be provided with programmable logic capabilities supported by easy to use editor facilities. The programmable logic capability shall enable the RTU to perform control functions using ladder logic language conforming IEC 1131.

1.9 Control Outputs

The RTU shall provide the capability for a master station to select and change the state of digital output points. These control outputs shall be used to control power system devices such as Circuit breakers relay disable/enable and other two-state devices, which shall be supported by the RTU.

A set of control outputs shall be provided for each controllable device. On receipt of command from a master station using the select check-before-execute operate (SCBO) sequence, the appropriate control output shall be operated for a preset time period which is adjustable for each point from 0.1 to 2 seconds.

Each control output shall consist of one set of potential free NO contact. The output contacts shall be rated for at least 0.2 Amp. at 48 Vdc. These output contact shall be used to drive heavy duty relays. In case Control output module of RTU does not provide potential free control output contact of this rating, then separate control output relays shall be provided by the contractor. These relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils & shall conform to the relevant IEC requirements.

1.9.1 Heavy duty control output relays

The control output contact from the RTU shall be used for initiating heavy duty relays for trip/close of switching devices and energizing relays of OLTC raise lower. The contractor shall provide heavy duty relays. Each control output relays shall consist of atleast 2 NO contacts. The output contacts shall be rated for at least 5 Amps Continuous at 220Vdc and shall provide arc suppression to permit interruptions of an inductive load. Relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de- energizing of the relay coils. The relays shall conform to the IEC255-1-00 and IEC 255-5 requirements.

1.9.2 Control Security and Safety Requirements

The RTU shall include the following security and safety features as a minimum for control outputs:

- (a) Select- check-before-operate operate (SCBO) sequence for control output. (b) No more than one control point shall be selected/executed at any given time. (c) The control selection shall be automatically cancelled if after receiving the "control selection" message, the "control execute" command is not received within the set time period.
- (d) No control command shall be generated during power up or power down of RTU.

1.9.3 Local/Remote selector switch

A manual Local/Remote selector switch shall be provided for each RTU to disable all control outputs by breaking the power supply connection to the control output s. When in the "Local" position, the Local/Remote switch shall allow testing of all the control outputs of RTU without activating the control outputs to field devices. A status input indication shall be provided for the Local/Remote switch to allow the SCADA system to monitor the position of the switch.

1.9.4 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 RTU to open and close, and shall provide the correct indication response through a single point status input.

1.10 Contact Multiplying Relays (CMRs)

Contact Multiplying Relays (CMRs) are required to multiply the contacts of breaker, isolators and protection relays etc. The contacts of these relays shall be used to provide status inputs to the RTUs.

The relays shall be DC operated, self-reset type. The rated voltage for relay operation shall be on 24/48/110/220V DC depending on the station DC supply. The relay shall be able to operate for +/-20% variation from nominal voltage.

The relay shall have a minimum of two change over contacts, out of which one shall be used for telemetry purposes. The contacts shall be rated to carry minimum current capacity of 5A.

The relay shall conform to following requirement.

- a) Power Frequency withstand voltage–2KV for 1 minute as per IEC 255-5. b) Insulation Resistance of 100M ohms measured using 500V DC megger. c) 5KV Impulse test as per IEC 255-5

The relays coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils. The relays shall conform to the IEC 255-1-00 and IEC 255-5 requirements. The relays must be protected against the effects of humidity, corrosion & provide with a dust tight cover. The connecting terminals shall be screw type & legibly marked. The relays may optionally have a visual operation indicator. The relays are to be mounted in Control & Relay (C&R) panels and therefore shall be equipped with suitable mounting arrangements. In case suitable space is not available in C&R panel the same shall be mounted in RTU panel or suitable panels, which shall be supplied & mounted on the top of the C&R panel by the contractor.

1.11 Time facility

The internal RTU time base shall have a stability of 10 ppm. The RTU shall be synchronized through synchronization message from master station at every 15 minutes (configurable from 15 minutes to 24hrs) over IEC 60870-5-104/101/NTP/SNTP. The RTU shall also carry out time stamping of the events which are not received as time stamped from connected IEDs/ FPIs etc.

1.12 Diagnostic Software

Diagnostic Software shall be provided to continuously monitor operation of the RTU and report RTU hardware errors to the connected master stations. The soft- ware shall check for memory, processor, and input/output ports errors and failures of other functional areas defined in the specification of the RTU.

1.13 SCADA language based on IEC61131-3

RTU shall have capability to write various programs based IEC 61131-3 SCADA language. It will facilitate user to write various programs using points defined in the database .

1.14 Input DC Power Supply

The RTU will be powered from a 48 V DC power supply system. The RTU shall not place additional ground on the input power source. The characteristics of the input DC power supply shall be

- (a) Nominal voltage of 48 Vdc with variation between 40.8 and 57.6 Vdc.(i.e. 48(+20%/-15%)
- (b) Maximum AC component of frequency equal to or greater than 100 Hz and 0.012 times the rated voltage peak-to-peak.

The RTU shall have adequate protection against reversed polarity, over current and under voltage conditions, to prevent the RTU internal logic from being damaged and becoming unstable causing mal-operation. The specification for DCPS is given in respective section of MTS. Utility may opt any other voltage level such as 12, 24, 110 ,125 VDC etc. and permissible ranges and applicable standards specified shall be adhered . The interface components like CMRs , HDRs MFT etc. may also be selected accordingly.

1.15 Environmental Requirements

The RTU will be installed in control room buildings with no temperature or humidity control. The RTUs shall be capable of operating in ambient temperature from -20 to +70 degree C with rate of temperature change of 20 degree C/hour and relative humidity less than 95%, non-condensing. For RTUs to be installed in the hilly region with the history of snowfall, the lower ambient temperature limit shall be -10 degree C. Utility may specify location with altitude more than 2000m above MSL for compliance of RTUs to be installed in that project area

1.16 RTU Size and Expandability

RTU shall be equipped for the point counts defined in the BOQ (Basic+20% spare (wired & hardware). It shall be possible to expand the RTU capability for additional 100 % of the basic point counts by way of addition of hardware such as modules, racks, panels, , however, RTU software and database shall be sized to accommodate such growth without requiring software or database regeneration.

1.17 RTU Panels

At least 50% of the space inside each enclosure shall be unused (spare) space that shall be reserved for future use. The Contractor shall provide required panels conforming to IEC 529 for housing the RTU modules/racks, relays etc. and other required hardware. The panels shall meet the following requirements:

- (a) shall be free-standing, floor mounted and height shall not exceed 2200 mm.
All doors and removable panels shall be fitted with long life rubber beading. All non load bearing panels/doors shall be fabricated from minimum 1.6 mm thickness steel sheet and all load bearing panels, frames, top & bottom panels shall be fabricated from minimum 2.0 mm thickness steel sheet
- (b) shall have maintenance access to the hardware and wiring through lockable full height doors.
- (c) shall have the provisions for bottom cable entry
- (d) The safety ground shall be isolated from the signal ground and shall be connected to the ground network. Safety ground shall be a copper bus bar. The contractor shall

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connect the panel's safety ground of to the owner's grounding network. Signal ground shall be connected to the communication equipment signal ground.

- (e) All panels shall be supplied with 230 Vac, 50 Hz, single-phase switch and 15/5A duplex socket arrangement for maintenance.
- (f) All panels shall be provided with an internal maintenance lamp, space heaters and gaskets.
- (g) All panels shall be indoor, dust-proof with rodent protection, and meet IP41 class of protection.
- (h) There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.
- (i) Document Holder shall be provided inside the cabinet to keep test report, drawing, maintenance register etc.
- (j) All materials used in the enclosures including cable insulation or sheathing, wire troughs, terminal blocks, and enclosure trim shall be made of flame-retardant material and shall not produce toxic gasses under fire conditions.

1.18 Wiring/Cabling requirements

The RTU panels shall gather all signals from and to the devices located in Control & Relay panels in the substation control room. 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 ferrules or by color 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.

Shielded cables shall be used for external Cabling from the RTU panels. The external cables (except communication cables) shall have the following characteristics:

- a) All cables shall have stranded copper conductor.
- b) Minimum core cross-section of 2.5 mm² for PT cables, 4 mm² for CT cables, if applicable and 2.5 mm² for Control outputs and 1.5mm² for Status inputs
- c) Rated voltage U_o/U of 0.6/1.1KV
- d) 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.
- e) Shielding, longitudinally laid with overlap.
- f) Dielectric withstand 2.5 kV at 50 Hz for 5 minutes
- g) External marking with manufacture's name, type, core quantity, cross- section, and year of manufacture.
- h) Armored Cables shall be used in the area where cable will pass through open area which may experience loading.

- i) The Communication cable shall be of shielded twisted pairs and of minimum 0.22sq mm size.

1.19 Terminal Blocks (TBs)

Terminal blocks shall be having provision for disconnection (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.

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. TBs for CT circuits shall have feature for CT shorting (on CT side) & disconnection (from load side) to facilitate testing by current injection. Similarly, TBs for PT circuit shall have feature for disconnection to facilitate voltage injection for testing.

1.20 RTU Architecture

Bidder has the option to offer RTUs having following architectural design:

- a) Centralized RTU design where all I/O modules are housed in RTU panels and communicating with master station through communication port.
- b) Distributed RTU design where distributed I/O modules/processor with I/O modules are housed in respective bay panels/RTU panel. All these distributed I/O modules / I/O modules with processor shall be connected to a central processor for further communication with master station. The bidder shall assess the requirement of RTU panels for such design and supply panels accordingly.

In both cases the RTU requirements as envisaged in this specification shall be followed.

1.21 LOCAL DATA MONITORING SYSTEM (LDMS)

The LDMS is a client workstation of main SCADA/ DMS control center connected on 2Mbps or 64kbps leased line for local monitoring of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The hardware & software specification, features shall be same as of remote VDU defined for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system.

SECTION 3

CHAPTER-2

TECHNICAL REQUIREMENTS OF FRTU

2.0 General

The Feeder Remote Terminal Unit (FRTU) shall be installed at Ring Main Units (RMUs) , Sectionalizers locations FRTU shall also be used for control of switching devices such as breaker, isolator switches etc. inside RMU panel , Sectionalizers etc. from Master station(s). The supplied FRTUs shall be interfaced with the RMUs, FPI, communication equipment, power supply distribution boards; for which all the interface cables, TBs, wires, lugs, glands etc. shall be supplied, installed & terminated by the Contractor. Further, the equipment indicated in the MoP order no 12/34/2020-T&R dtd 08.06.21 & CEA /PLG/R&D/MII/2021 dtd 11.6.21 and any amendment from time to time shall be adhered to. This section is applicable to Group A (Noida Town) towns as per functional requirements

2.1 Design Standards

The FRTUs shall be 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. The FRTU shall comply to IEC62351-3/ IEC62443 standard for cyber security

2.2 FRTU Functions

All functional capability described herein shall be provided by the Contractor even if a function is not initially implemented.

As a minimum, the FRTU shall be capable of performing the following functions:

- a) Acquiring analog values from Multifunction Transducers or alternatively through transducer-less modules and the status inputs of devices from the substation, processing and transmitting to Master stations. Capability to acquire analog inputs from analog input cards receiving standard signals viz current loops 4-20Ma , RTD etc.
- b) Receiving and processing digital commands from the master station(s)
- c) Data transmission rates - 300 to 19200 bps for Serial ports for MODBUS and 10/100 mbps for TCP/IP Ethernet ports
- c) Use of IEC 60870-5-104/101 protocol to communicate with the Master station(s) at least 2 Use of MODBUS over RS485 interface , Protocol to communicate with the MFTs.
- d) Have required number of communication ports for simultaneous communication with Master station(s), MFTs and FRTU configuration & maintenance tool.
- e) FRTU shall have the capability of automatic start-up and initialization following restoration of power after an outage without need of manual intervention. All restarts shall be reported to the connected master stations.
- f) Remote database downloading of FRTU from master station from SCADA/ DMS control center.
- g) Internal battery backup to hold data in SOE buffer memory & also maintaining the time & date.
- h) As the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system will use public domain such GPRS/CDMA etc, therefore it mandatory to guard the data/ equipment from intrusion/damage/breach of security & shall have SSL/VPN based security.

- i) Shall support SNMP
- j) Conformance to IEC62351-3/ IEC62443 standard for cyber security
- k) Further it should be possible to have following capabilities in the FRTU by way of addition of required hardware limited to addition of I/O modules & communication card or protocol converter & using the same firmware at later date
- l) Communication with at least two master stations simultaneously on IEC 60870-5-104 /101
- m) RTU shall be capable of acquiring analog values through transducers having output as 4-20 mA, 0-10 mA, 0-+10 mA etc. using analog input modules.

2.3 Communication ports

The RTUs shall have following communication ports to communicate with master station MFTs and configuration & maintenance terminal.

- a) FRTU shall have one TCP/IP Ethernet port for communication with Master station(s) using IEC 60870-5-104/101 protocol or serial port in case IEC60870-101
- b) FRTU shall have required number of RS 485 ports for communication with
- c) MFTs/ to be connected in daisy chain using MODBUS protocol . Minimum
- d) 15 analog values (including 4 energy values) to be considered per energy meter. The RTU shall be designed to connect maximum 5 MFT per port. Further, bidder to demonstrate during testing that all analog values updated within 2 sec. The updation time shall be demonstrated during testing.
- e) FRTU shall have one port for connecting the portable configuration and maintenance tool for FRTU.
- f) Support for IEC 62056 protocols /IEC61850 /protocols & ability to act as a gateway for Numerical relays/ Smart Meters may have to be interfaced.
- g) SSL/VPN ,NERC/CIP complaint
- h) Ability to communicate over dual SIM
- i) Ability to auto changeover incase configured for single SIM configuration at a time

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 (bits per second) and scanning cycle on each port & different database for each master station.

2.3.1 Master Station Communication Protocol

FRTU shall use IEC 60870-5-104/101 communication protocol for communicating to master station. The FRTU communication protocol shall be configured to report analog (except energy values) & status changes by exception to master stations. However, FRTU shall support periodic reporting of analog data and periodicity shall be configurable from 2 sec to 1 hour. Digital status data shall have higher priority than the Analog data. The dead-band for reporting Analog value by exception shall be initially set to 1% (in %) of the full scale value. In addition, analog values shall also be reported to Master station by exception on violation of a defined threshold limit. All the analog values and status data shall also be assigned to scan groups for integrity check by Master stations at every 10 minutes configurable up to 60 minutes FRTU wise.

FRTU shall report energy values to master station periodically. The periodicity shall be configurable from 5 minutes to 24 hours (initially set for 15 minutes).

2.3.2 Communication Protocol between FRTU & MFTs

The FRTU shall acquire data from the MFTs using the MODBUS protocol. In addition, usage of IEC 60870-5-101/104 protocols is also permitted. The MFT will act as slave to the FRTU. The FRTU shall transmit these values to the master station in the frame of IEC 60870-5-101/104 protocol.

2.4 Analog Inputs

The real time values like, Active power, Reactive Power, Apparent power three phase Current & Voltage and frequency, power factor & accumulated values of import /export energy values will be acquired FRTU from the following in the given manner:

1. MFTs installed in RMU/DTs
2. RTU shall also take 4-20 mA, 0-20mA, 0- -10mA, 0-+10mA, 0-5V etc.as analog inputs to acquire DC power supply voltage etc.

The FRTU analog-to-digital (A/D) converters shall have a digital resolution of at least twelve (12) bits plus sign. The overall accuracy of the analog input system shall be at least 0.2% (i.e. 99.8%) at 25 °C of full scale . Mean accuracy shall not drift more than 0.002% per degree C within the temperature range of –5 to +55 degree Linearity shall be better than 0.05%. The FRTU shall be designed to reject common mode voltages up to 150 Vac (50 Hz). For dc inputs, normal mode noise voltages up to 5 Vac shall be rejected while maintaining the specified accuracy. Each input shall have suitable protection and filtering to provide protection against voltage spikes and residual current at 50 Hz, 0.1 ma (peak-to-peak) and overload. Loading upto 150% of the input value shall not sustain any failures to the FRTU input.

The ability of the FRTU to accommodate dc inputs shall include the following signal ranges:

- Unipolar Voltage: 0-0.5V, 0-1V, 0-5V, 0-10V,
- Unipolar Current: 0-1mA, 0-10mA, 0-20mA, 4-20Ma, Bipolar Voltage:
- 0.5V, 2.5V, 5V, -20-0-20mA (- to +)

The total burden imposed by the FRTU analog input circuit shall not exceed 0.5 volt-ampere for current and voltage inputs. As an option, contractor may also provide transducer less solution to connect direct CT/PT secondaries.

2.5 Status input

RTU shall be capable of accepting isolated dry (potential free) contact status inputs. The RTU shall provide necessary sensing voltage, current, optical isolation and de-bounce filtering independently for each status input. The sensing voltage shall not exceed 48 Vdc/220VAC.

The RTU shall be set to capture contact operations of 20 ms or more duration. Operations of less than 20 ms duration shall be considered no change (contact bounce condition). The RTU shall accept two types of status inputs i.e. Single point Status inputs and Double point status inputs.

To take care of status contact chattering, a time period for each point and the allowable number of operations per time period shall be defined. If the allowable number of operations exceed within this time period, the status change shall not be accepted as valid

Single point status input will be from a normally-open (NO) or normally-closed (NC) contact which is represented by 1-bit in the protocol message.

The Double point status input will be from two complementary contacts (one NO and one NC) which is represented by 2-bits in the protocol message. A switching device status is valid only when one contact is closed and the other contact is open. Invalid states shall be reported when both contacts are open or both contacts are closed.

All status inputs shall be scanned by the FRTU from the field at 1 millisecond periodicity.

2.6 Sequence of Events (SOE) feature

To analyze the chronology or sequence of events occurring in the power system, time tagging of data is required which shall be achieved through SOE feature of RTU. The RTU shall have an internal clock with the stability of 100ppm or better. The RTU time shall be set from time synchronization messages received from master station using IEC 60870-5- 104 protocol. SOE time resolution shall be 10 ms or better

The RTU shall maintain a clock and shall time-stamp the digital status data. Any digital status input data point in the RTU shall be assignable as an SOE point. Each time a SOE status indication point changes the state, the RTU shall time-tag

The change and store in SOE buffer within the RTU. A minimum of 300 events can be stored in the SOE buffer. SOE shall be transferred to Master Station as per IEC 60870-5-104 protocol. SOE buffer shall be maintained by FRTU on power supply interruption.

2.7 Control Outputs

The FRTU shall provide the capability for a master station to select and change the state of digital output points. These control outputs shall be used to control power system devices such as Circuit breakers, isolator, reset, relay disable/enable and other two-state devices, which shall be supported by the RTU.

A set of control outputs shall be provided for each controllable device. On receipt of command from a master station using the select check-before-execute operate (SCBO) sequence, the appropriate control output shall be operated for a preset time period which is adjustable for each point from 0.1 to 2 seconds.

Each control output shall consist of one set of potential free NO contact. The output contacts shall be rated for atleast 0.2 Amp. at 48 Vdc. These output contact shall be used to drive heavy duty relays. In case Control output module of FRTU does not provide potential free control output contact of this rating, then separate control output relays shall be provided by the contractor. These relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils & shall conform to the relevant IEC requirements.

2.7.1 Heavy duty control output relays

The control output contact from the FRTU shall be used for initiating heavy duty relays for trip/close of switching devices. The contractor shall provide heavy duty relays. Each control output relays shall consist of atleast 2 NO contacts. The output contacts shall be rated for at least 5 Amps Continuous at 220Vdc and shall provide arc suppression to permit interruptions of an inductive load. Relay coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils. The relays shall conform to the IEC255-1-00 and IEC 255-5 requirements.

2.7.2 Control Security and Safety Requirements

The FRTU shall include the following security and safety features as a minimum for control outputs:

- a) Select- check-before-operate operate (SCBO) sequence for control output.
- b) No more than one control point shall be selected/ executed at any given time.
- c) The control selection shall be automatically cancelled if after receiving the "control selection" message, the "control execute" command is not received within the set time period.
- d) No control command shall be generated during power up or power down of FRTU.

2.7.3 Local/Remote selector switch

A manual Local/Remote selector switch shall be provided for each FRTU to disable all control outputs by breaking the power supply connection to the control outputs. When in the "Local" position, the Local/Remote switch shall allow testing of all the control outputs of FRTU without activating the control outputs to field devices. A status input indication shall be provided for the Local/Remote switch to allow the SCADA system to monitor the position of the switch.

2.7.4 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.

2.8 Contact Multiplying Relays (CMRs)

Contact Multiplying Relays (CMRs) are required to multiply the contacts of breaker, isolators and protection relays etc. The contacts of these relays shall be used to provide status inputs to the RTUs.

The relays shall be DC operated self-reset type. The rated voltage for relay operation shall be on 24/48/110/220V DC depending on the station DC supply. The relay shall be able to operate for +/-20% variation from nominal voltage.

The relay shall have a minimum of two change over contacts, out of which one shall be used for telemetry purposes. The contacts shall be rated to carry minimum current capacity of 5A.

The relay shall conform to following requirement.

- a) Power Frequency withstands voltage—2KV for 1 minute as per IEC 255-5.
- b) Insulation Resistance of 100M ohms measured using 500V DC megger.
- c) 5KV Impulse test as per IEC 255-5

The relays coils shall be shunted with diodes to suppress inductive transients associated with energizing and de-energizing of the relay coils. The relays shall conform to the IEC 255-1-00 and IEC 255-5 requirements. The relays must be protected against the effects of humidity, corrosion & provide with a dust tight cover. The connecting terminals shall be screw type & legibly marked. The relays may optionally have a visual operation indicator. The relays are to be

mounted in junction /termination box and therefore shall be equipped with suitable mounting arrangements. In case suitable space is not available in junction /termination box the same shall be mounted in FRTU panel.

2.9 Time facility

The internal FRTU time base shall have a stability of 100 ppm. The RTU shall be synchronized through synchronization message from master station at every 5 minutes (configurable from 5 minutes to 60 minutes) over IEC 60870-5-104/101/NTP/SNTP

2.10 Diagnostic Software

Diagnostic Software shall be provided to continuously monitor operation of the FRTU and report RTU hardware errors to the connected master stations. The soft- ware shall check for memory, processor, and input/output ports errors and failures of other functional areas defined in the specification of the RTU.

2.11 Input DC Power Supply

The FRTU will be powered from a 48 V DC power supply system. The RTU shall not place additional ground on the input power source. The characteristics of the input DC power supply shall be

- (a) Nominal voltage of 48 Vdc with variation between 40.8 and 57.6 Vdc.(i.e. 48(+20%/-15%)
- (b) Maximum AC component of frequency equal to or greater than 100 Hz and 0.012 times the rated voltage peak-to-peak.

The FRTU shall have adequate protection against reversed polarity, over current and under voltage conditions, to prevent the RTU internal logic from being damaged and becoming unstable causing mal-operation. Utility may opt any other voltage level such as 12, 24, 110 VDC etc. and permissible ranges and applicable standards specified shall be adhered . The interface components like CMRs , HDRs MFT etc. may also be selected accordingly.

2.12 Environmental Requirements

The FRTU will be installed in inside RMU Panel or in open environment with no temperature or humidity control. The RTUs shall be capable of operating in ambient temperature from -20 to +70 degree C with rate of temperature change of 20 degree C/hour and relative humidity less than 95%, non-condensing. FRTUs to be installed in the hilly region with the history of snowfall, the same the lower ambient temperature limit shall be -20 degree C. Utility may specify location with altitude more than 2000m above MSL for compliance of FRTUs to be installed in that project area

2.13 FRTU Size and Expandability

FRTU shall be equipped for the point counts defined in the BOQ (Basic+20% spare (wired & hardware). It shall be possible to expand the FRTU capability for additional 100 % of the basic point counts by way of addition of hardware such as modules, racks, panels, , however, FRTU software and database shall be sized to accommodate such growth without requiring software or database regeneration.

2.14 FRTU Panels

At least 50% of the space inside each enclosure shall be unused (spare) space that shall be reserved for future use. The Contractor shall provide required panels conforming to IEC 529 for housing the FRTU modules/racks, relays etc. and other required hardware. The panels shall meet the following requirements:

- (a) shall be pole/ wall mounted compact size cabinet. The size shall be preferably in the order of 400 mm. All doors and removable panels shall be fitted with long life rubber beading. All non-load bearing panels/doors shall be fabricated from minimum 1.6 mm thickness steel sheet and all load bearing panels, frames, top & bottom panels shall be fabricated from minimum 2.0 mm thickness steel sheet
- (b) shall have maintenance access to the hardware and wiring through lockable doors.
- (c) shall have the provisions for bottom cable entry
- (d) The safety ground shall be isolated from the signal ground and shall be connected to the ground network. Safety ground shall be a copper bus bar. The contractor shall connect the panel's safety ground to the owner's grounding network. Signal ground shall be connected to the communication equipment signal ground.
- (e) All panels shall be supplied with 230 Vac, 50 Hz, single-phase switch and 15/5A duplex socket arrangement for maintenance.
- (f) All panels shall be provided with an internal maintenance lamp, space heaters and gaskets.
- (g) All panels shall be outdoor, dust-proof with rodent protection, and meet class of protection. IP41 if housed in RMU panel & IP54 in case of in open outdoor.
- (h) There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.
- (j) All materials used in the enclosures including cable insulation or sheathing, wire troughs, terminal blocks, and enclosure trim shall be made of flame retardant material and shall not produce toxic gasses under fire conditions.

2.15 Wiring/Cabling requirements

The FRTU panels shall gather all signals from and to the devices located in Control & Relay panels in the substation control room. 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 ferrules or by color 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.

Shielded cables shall be used for external Cabling from the FRTU panels. The external cables (except communication cables) shall have the following characteristics:

- a) All cables shall have stranded copper conductor.

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- b) Minimum core cross-section of 2.5 mm² for PT cables, 4 mm² for CT cables, if applicable and 2.5 mm² for Control outputs and 1.5mm² for Status inputs
- c) Rated voltage U₀/U of 0.6/1.1KV
- d) 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.
- e) Shielding, longitudinally laid with overlap.
- f) Dielectric withstand 2.5 kV at 50 Hz for 5 minutes
- g) 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 minimum 0.22sq mm size.

2.16 Terminal Blocks (TBs)

Terminal blocks shall be having provision for disconnection (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.

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. TBs for CT circuits shall have feature for CT shorting (on CT side) & disconnection (from load side) to facilitate testing by current injection. Similarly, TBs for PT circuit shall have feature for disconnection to facilitate voltage injection for testing.

SECTION 3

CHAPTER-3

3.0 Transducer & Weather Sensor Requirements:

All transducers including weather sensor shall use a 48 Vdc auxiliary power supply as provided for the RTU/FRTU. Optionally, MFTs can also be self-powered. All transducers shall have a maximum power consumption of 10 watts. Transducer shall be din rail or wall/plate mounted. Further, the equipment indicated in the MoP order no 12/34/2020-T&R dtd 08.06.21 & CEA /PLG/R&D/MII/2021 dtd 11.6.21 and any amendment from time to time shall be adhered to. This section is applicable to Group A (Noida Town), B, C towns as per functional requirements.

The input, output and auxiliary circuits shall be isolated from each other and earth ground. The transducer output shall be ungrounded and shall have short circuit and open circuit protection. The transducers shall comply to the following requirements, in addition to the requirement of IEC 60688, without damage to the transducer.

Voltage:

Voltage test and other safety requirement compliance as specified in IEC 60688 or 60687 and IEC 414.

(c) Impulse Withstand:

IEC 60688 or 60687 compliance is required.

(d) Electromagnetic Compatibility:

IEC 60688 or 60687 and IEC 801-3, level 1 compliance is required.

(e) Permanent Overload Protection:

IEC 60688 or 60687 compliance is required.

(f) Temporary Overload Protection:

IEC 60688 or 60687 compliance is required.

(g) High Frequency Disturbance:

IEC 60688 or 60687 compliance is required.

The transducers shall comply with the following general characteristics:

(a) Shock Resistance:

Minimum severity 50 A, IEC 68-2-27 requirements

(b) Vibration Strength:

Minimum severity 55/05, IEC 68-2-6 requirements.

(c) Input Circuit Consumption:

Less than or equal to 0.2 VA for voltage and 0.6VA for current circuits.

(d) Reference Conditions For Accuracy Class:

IEC 60688 or 60687 compliance is required.

(e) Temperature Rise:

IEC 60688 or 60687 compliance is required.

(f) Operating Temperature: 0 ° C to + 60 ° C (-5 ° C to + 55 ° C for project area with snowfall history)

3.1 Multi-Function Transducers (MFTs)

The contractor shall provide the multi-function transducers for acquiring the real time analog inputs through 3 phase 3 wire CT/PTs circuits/ 3 phase 4 wire CT/PTs circuits (Based on the field requirement). Based on the CT/PT secondary rating , the multi-function transducer shall be designed for nominal 110 V (Ph-Ph voltage) and 1A/5A (per phase current). The MFT shall be suitable for 20% continuous over load and shall be able to withstanding 20 times the normal current rating for a period one second. The MFT shall be able to accept the input voltages upto 120% of the nominal voltage. The MFT shall have low VA burden. MFTs shall be mounted in the interface cabinet to be supplied by the contractor.

Multi-function transducers shall provide at least phase voltage, phase current active/reactive power , import & export energy (active & reactive) , pf , frequency with class 0.5 accuracy or better.

The parameters to be acquired from multi-function transducers shall be select-able. MFT shall provide the 15 minute values (configurable 15 minute/1 hour) of Active Energy Import, Active Energy Export, Reactive Energy Import and Reactive Energy Export.

Multi-function transducers shall accept nominal 48 V DC as auxiliary power supply. Optionally, MFT can be self-powered also. Multi-function transducer shall be provided with RS485 interface to communicate with RTU over Modbus protocol in multi-drop mode. Optionally, the MFT with IEC60870-5-101/104 can be used.

The MFTs shall be suitable for mounting on DIN rails. The MFT terminals shall accept upto two 2.5 mm² / 4 mm² for PT/CT circuit terminations as applicable.

The MFT shall be programmable with password protection thru suitable facia mounted key pad arrangement so that the configuration parameters such as CT

/PT ratio , integration time of energy , reset, communication parameters setting (Address, baud , parity) can be set up at site also. The device shall have LCD displays to visualize all parameters being monitored & configuration etc. have configurable at site for CT/PT ratio etc.

3.2 DC Transducer

The DC transducer (DCT) are following types.

- I. Voltage
- II. Current
- III. Winding Temp
- IV. Oil temp

The Dc Transducer are required to measure battery charger current & voltage shall be suitable for 20% continuous over load and shall be able to withstanding 20 times the normal current rating for a period one second. The DCT shall be able to accept the input upto 120% of the nominal voltage. The DCT shall have low VA burden. DCT shall be mounted in the interface cabinet to be supplied by the contractor. The input range for current & voltage are site specific & hence the same shall be specified RFP floated by utility/state Output of the device shall preferably be 4-20ma or MODBUS in order to optimize the BOQ. However, as specific cases the output in line ranges specified in analog input card in clause for analog input shall be selected. The accuracy of transducer shall be $\pm 0.5\%$

3.3 Transformer Tap Position Transducer

The transformer tap position indications shall be either of two types based on field requirement..

- (i) Variable resistance type
- (ii) Lamp type

The Contractor shall provide suitable resistance tap position transducers which shall have the following characteristics

- (a) The input measuring ranges shall be from 2 to 1000 ohms per step, which is tuneable at site with at least 25 steps.
- (b) Dual output signal of 4 to 20 mA DC, 0.5% accuracy class as per IEC 688 shall be provided. One output will be used for driving a local digital indicator (to be provided by the contractor) and the other will be used for interfacing with the RTU. Alternatively for RTU,MODBUS link may be used. In case of lamp type, additional resistance/potentiometer unit shall be provided to convert the dry type contacts to a variable resistance as defined in (a) above, suitable for the remote indication.

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3.4 Modems	
1.	The modem shall have suitable interface facility to connect with the meter by using the RS232 /485 cable.
2.	<p>The offered modems should be capable of operating on Three phase supply drawn from the FPI input itself. Auxiliary Power supply will not be acceptable form Modem at FPI The operating voltage range for the modem should be 90 V ac P-P to 440 V ac P-P. However the modem should also be capable of operating on single phase 230 V, 50 Hz power supply. The modem voltage surges. Modem at FRTU locations should be capable of operating on 24V/48Vdc The offered Modem should be capable to transfer the entire data as per the FRTU data requirement of FRTU/FPI at control center shall be suitably protected against</p> <p>The offered Modem should be capable to transfer the entire data as per the FRTU data requirement of FRTU/FPI at control center 4G /5G as per site signal condition</p>
3.	The offered Modem should be supplied with power cable, antenna with co-axial cable of length, RS 232 /485 connecting suitable cable, mounting adopter etc. and should be complete in all respects.
4.	Sealing :- The modem cover and body should have arrangement for sealing. In addition to this, the SIM card holder cover should also have arrangement for sealing.
5.	<p>Antenna :- The Modem should have flexible external antenna to enable placement of the antenna at the location of strongest signal inside the Metering Cubicle. Bidders are requested to quote separately for multiple gain antenna, such as OdBi/3dBi/10dBi with screw mount / Wall mount arrangement. The actual requirement of these Modem Antennas of various gains may vary as per the requirement at site Bidder will be required to supply the exact requirement as per site conditions and will be paid as per the separate unit rated quoted for different Gain Antennas.</p> <p>Before supply of GSM/CDMA modem, the bidder is requested to ensure the availability of appropriate signal and operation of GSM/CDMA Modem in all the areas to be covered by making physical survey or otherwise. Before making the actual supply of Modems for FPI & FRTU locations , the Bidder is requested to assess the exact requirement and should supply a high gain antenna or any other suitable alternate communication network for collecting data in such area.</p>
6.	<p>Outage Notification :-</p> <p>In the event of an outage, the modem should be able to initiate separate call or send SMS to predefined number to notify the outage event with data and time of occurrence and restoration.</p>
7.	<p>Other requirements:-</p> <p>A) The Modem should act a completely transparent channel i.e. the Commands received from SCADA/DMS/OMS AND SUB-STATION AUTOMATION Control center should be conveyed to FRTU/FPI and data from FRTU/FPI should be conveyed to SCADA/DM control center without any changes in the modem.</p>

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	<p>B) Data collection from FRTU/FPI should take place only after connection is established between Control center and FRTU/FPI. Data should not reside in the modem before the time of transmission to Control center, to avoid chances of tampering of data at Modem end.</p> <p>C) The Modem should be capable of operating with SIMs of local GSM/CDMA Service provider in the area.</p> <p>D) Data enabled SIM card will be provided by the utility and monthly SIM charges will be borne by the utility.</p> <p>Modem should be capable for continuous working for 24 hours every day under field conditions</p>
8	GSM Modem shall be suitable for long duration data transmission and shall be protected from external interference of systems working at different bands.
9	<p>Mechanical Specifications :- Modem should be a compact model housed in a polycarbonate /engineering plastic / Metallic enclosure. The modem should comply with IP55 degree of protection for FPI locations & IP41 for FRTU as the same shall be housed in the FRTU panel.</p>
10	<p>Environmental Specifications :- The Modem shall meet the following environmental specifications : - Storage Temperature : -20 degrees to +70 degree Celsius Operating Temperature: -10 degrees to +60 degree Celsius Humidity:- 95% RH (Non - Condensing) Utility may specify location with altitude more than 2000m above MSL for compliance of FRTUs to be installed in that project area</p>
	<p>Communication Capabilities: - Modem should be Dual Band modem capable of operating at 900 and 1800 MHz transmission. GSM Modem should support both Data and SMS transmission. It should have both GSM and GPRS/EDGE features.</p>

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5	<p>Interface :-</p> <p>Modem should have an RS232 Interface through a 9 pin or 15 pin D type Connector for connection to FRTU/FPI. The SIM interface should be a 3 V Interface in accordance with GSM 11.12 phase 2 with a retractable SIM cardholder, which should be fully inserted inside the modem. The holder opening should have a sliding cover with provision for sealing after placing of the SIM card. The modem shall accept the standard SIM Card. Modem should have a SMA Antenna connector</p>
6	<p>Power :-</p> <p>Maximum Power Output should be 2 W at 900 MHz (Class 4) and 1W at 1800 MHz (Class 1).</p> <p>The RF functionalities should comply with the GSM phase II/II+ compliant, EGSM 900/GSM 1800 recommendation.</p> <p>VA Burden of the Modem should not exceed 3.5 VA during data communication.</p>
7	<p>Sensitivity :- GSM 900 : <-100 dBm GSM 1800 : <-100 dBm</p>
8	<p>Data Features: -</p> <p>Modem should use standard AT Command set (GSM 07.05, GSM07.07) for settings of the modem.</p> <p>TCP/IP stack access via AT commands</p> <p>Internet Services : TCP, UDP, HTTP, FTP, SMTP, POP3</p> <p>Max. Baud Rate: for GSM</p>

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	<p>Operation - 9600 bits/sec,</p> <p>CSD Data transmission features:- Data circuit asynchronous, and non-transparent upto 14.4</p> <p>GPRS Data transmission features :- GPRS Class B Multi slot class 12 or class B Multi slot class 10 Packet channel support : PBCCH Coding Schemes: CS1 to CS4 compliant with SMG32 (Release 97)</p>
9	<p>EDGE Data transmission features:- EDGE (EGPRS) Multi slot class 12 or Multi slot class 10 Mobile station Class B Modulating and coding schemes : MCS 1 to 9 Packet channel support : PBCCH</p> <p>SMS Features: - Text and PDU Point to point (MT/MO) Cell broadcast</p>
10	<p>Operational Indicator :- The Modem should have LED indications for transmit data, received data, carrier detects and Power ON, etc. to indicate Power on position and to indicate the availability of signal at the place of installation.</p>

3.7 WAN router

RTU shall communicate with control center through MPLS network . The router specification shall be suitable to communicate with Control center. Specification of router in Control center hardware may be referred .

SECTION 3, CHAPTER –4

TEST EQUIPMENT FOR RTU/FRTU

4.0 RTU/FRTU Configuration and Maintenance Tool

Test equipment for RTU/FRTU shall have Configuration and maintenance tool consisting of the followings:

4.1 RTU/FRTU Data base configuration & Maintenance software tool

The RTU/FRTU database configuration & Maintenance software tool shall be required to perform the database modification, configuration, compilation and documentation. The database compiler shall provide error detection services. It shall also perform the downloading of the compiled database into the RTU database.

4.2 Master station-cum-RTU/FRTU simulator & protocol analyzer software tool

The Master station cum RTU/FRTU simulator tool shall be used to test the communication interfaces of Master station, RTU/FRTU and Electronic MFT. The Master station simulator tool shall be capable of emulating the master station for IEC 60870-5-104,101 and MODBUS protocols. The RTU/FRTU simulator shall be capable of emulating the slave protocols for both the IEC 60870-5-104,101, and MODBUS protocols for MFTs. It shall also be possible to prepare illegal messages for transmission, such as messages having invalid checksum.

The protocol analyzer shall be used to monitor all communication traffic on a channel (between Master station & RTU/FRTU and between RTU/FRTU & MFT without interfering channels operation. Channel traffic captured in the active or passive modes of operation shall be displayed.

The Master station simulator and protocol analyzer tool shall also have following features:

- Each received message shall be checked for validity, including the check sum. The tool shall
- maintain and display error counters so that the number of errors during a period of
- unattended testing can be determined.
- All fields of a message shall be displayed. A pass/fail indication for the message shall be included.

In case of usage of IEC 103/61850/ IEC62056 for data acquisition, the feature of the same also be provided with same or additional tool

4.3 Laptop PC for above software tools along with interfacing hardware

A laptop PC shall be used for the above mentioned software tools. The laptop PC shall be provided with all hardware accessories including cables, connectors etc. required for interfacing with Master station, RTU/FRTU and MFT. A suitable Hub shall be provided to use the tool in monitor mode. A carrying case and a suitable power adaptor (input 230VAC, 50Hz) for laptop PC shall also be supplied.

SECTION 3. CHAPTER –5

TESTING, TRAINING & DOCUMENTATION

5.0 RTU/FRTU Testing

This chapter describes testing, training & documentation requirement for RTU/FRTU

(a) Type Testing:

RTU/FRTU including Transducers shall conform to the type tests listed in the relevant table. Type test reports of tests conducted in NABL accredited Labs or internationally accredited labs within last 5 years from the date of bid opening may be submitted. In case, the submitted reports are not as per specification, the type tests shall be conducted without any cost implication to employer. A complete integrated unit shall be tested to assure full compliance with the functional and technical requirements of the Specification including functional requirement. The testing sample shall include one of each type of cards/modules and devices. The list of Type tests to be performed on the RTU/FRTU is mentioned in **Table-1** & type test requirements are mentioned in **Table-2 of this chapter**. For other items also such as MFT, sensor etc. the requirements are mentioned in the respective sub sections of specification. However, the type tests shall be only be limited to the specification of that item only & not as specified for RTU/FRTU.

(b) Routine Testing or Factory acceptance test (FAT):

Each complete unit shall undergo routine testing. The list of Routine tests to be performed in the factory is mentioned in **Table-2**.

(c) Site Acceptance Test (SAT)

(i) Field Tests

After RTU/FRTU panel installation, interface cabling with C&R panels/Termination boxes, communication panel and interface cabling with field & communication equipment, the Contractor shall carry out the field- testing. The list of field tests for RTU/FRTU is mentioned in **Table-2**

(ii) Availability Tests

After field testing, RTU/FRTU shall exhibit 98% availability during test period. Availability tests shall be performed along with Master station. The RTU/FRTU shall be considered available only when all its functionality and hardware is operational. The non-available period due to external factors such as failure of DC power supply, communication link etc., shall be treated as hold-time & availability test duration shall be extended by such hold time.

5.1 TRAINING

The contractor shall provide training to the Employer's personnel. The training program shall be comprehensive and provide for interdisciplinary training on hardware and software. The training program shall be conducted in English. RTU/FRTU training course shall cover the following:

- a) RTU/FRTU operation including data flow.
- b) Troubleshooting, identification and replacement of faulty Modules.
- c) Preventive maintenance of the RTU/FRTU
- d) Use of RTU/FRTU configuration and Maintenance tool
- e) All functional and Diagnostic testing of RTU/FRTU
- f) Database modification and configuration of RTU/FRTU

5.2 DOCUMENTATION

The Contractor shall submit 3 sets of all the standard and customized RTU/FRTU documents for review and approval which includes the following:

- a) RTU/FRTU Function design document
- b) RTU/FRTU Hardware description document & all the documents referred therein to meet all the clauses of the specification.
- c) RTU/FRTU Test equipment user documents d) RTU/FRTU user guide
- d) RTU/FRTU Operation & Maintenance document f) RTU/FRTU Training documentation
- e) RTU/FRTU database document h) RTU/FRTU I/O list
- f) RTU/FRTU Test procedures
- g) Data Requirement Sheet (DRS) of all items
- h) Protocol documentation including implementation profile etc.
- i) RTU/FRTU installation and Layout, GA, BOQ, schematics and internal wiring drawings for each RTU/FRTU site
- j) RTU/FRTU to C&R panels/ field device cabling details for each RTU/FRTU Site
- k) Cyber security compliance certificate /document by manufacturer incl international agencies like KEMA / TuV etc.

After approval of all the above documents, the Contractor shall submit three sets as final documents. The site-specific drawings as indicated at item (i) and (j) above shall be submitted in three sets for each site before installation of RTU/FRTU. In case some modifications/corrections are carried out at site, the contractor shall again submit as built site-specific drawings in three sets after incorporating all such corrections as noticed during commissioning of the RTU/FRTU.

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AUTOMATION, system under RDSS - Govt. of India
Model Technical specification

Table-1: List of Tests on RTU/FRTU

Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine test	Field test
A	FUNCTIONAL TESTS FOR RTU/FRTU			
1.	Check for BOQ, Technical details, Construction & Wiring as per RTU/FRTU	√	√	√
2.	Check for database & configuration settings	√	√	√
3.	Check the operation of all Analog inputs, Status input & Control output points of RTU/FRTU	√	√	√
4.	Check operation of all communication ports of RTU/FRTU	√	√	√
5.	Check for communication with master stations including remote database downloading from master station	√		√
6.	Check for auto restoration of RTU/FRTU on DC power recovery after its failure	√		√
7.	Test for self-diagnostic feature	√		√
8.	Test for time synchronization from Master	√		√
9.	Test for SOE feature	√		√
10.	End to end test (between RTU/FRTU & Master station) for all I/O points			√
11.	Test for MODBUS protocol implemented for acquiring data from MFT/ transducers and updation time demonstration in daisy chain configuration	√		√
12.	Test for IEC 60870-5 -104,101 protocol implemented	√		√
13.	Test for supporting other protocol	√		
14.	Test for operation with DC power supply voltage variation	√		
15.	Test for internal Clock stability	√		
16.	Test for Noise level measurement	√		
17.	Test for Control Security and Safety for Control outputs	√		
18.	Test for functionality/parameters verification of , CMRs & Heavy duty trip relays	√	√	√
19.	Test for data concentrator	√*		
20.	Test for IED pass through	√*		
21.	Test for SOE buffer & time data back up	√		
22.	Other functional tests as per technical specification requirements including features in support/ capability (for future)	√		
23.	Test for DCPS of FRTU	√**		
24.	Test for compliance of standards for bought items viz. CMRs, Heavy duty trip relays , MFT, weather sensor etc.	√		
25.	Test for functionality/parameters for bought items viz. CMRs, Heavy duty trip relays , MFT , weather sensor etc.	√	√	
26.	Test for test tools		√	√
27.	Test for LDMS functioning		√**	√**
B	EMI/EMC IMMUNITY TESTS FOR RTU/FRTU			
28.	Surge Immunity Test as per IEC 60870-2-1	√		
29.	Electrical Fast Transient Burst Test as per IEC-60870-2-1	√		
30.	Damped Oscillatory Wave Test as per IEC 60870-2-1	√		
31.	Electrostatic Discharge test as per IEC 60870-2-1	√		
32.	Radiated Electromagnetic Field Test as per IEC 60870-2-1	√		
33.	Damped Oscillatory magnetic Field Test as per IEC-60870-2-1	√		
34.	Power Frequency magnetic Field Test as per IEC-60870-2-1	√		
C	INSULATION TEST FOR RTU/FRTU			
35.	Power frequency voltage withstand Test as per IEC 60870-2-1	√		
36.	1.2/50 μs Impulse voltage withstand Test as per IEC 60870-2-1	√		
37.	Insulation resistance test	√		
D	ENVIRONMENTAL TEST FOR RTU/FRTU			
38.	Dry heat test as per IEC60068-2-2	√		
39.	Damp heat test as per IEC60068-2-3	√		
E	Other test			
40.	Product cyber security compliance IEC 62443 /IEC62351-3 certificate of RTU/FRTU from labs incl. international accredited labs like KEMA/TuV/ DNV etc	√		

Note: 1) Test levels for above type tests mentioned in B, C & D above are elaborated in Table 2 of this Chapter

2) * For RTU only & ** For FRTU only

- 3) Contractor can provide test certificates for the type tests mentioned in B,C,D & supporting protocols from Govt of India/NABL/International accredited Labs. If not provided, the same needs to be conducted at Govt of India/NABL/International accredited Labs
- 4) Transducer type test requirements are mentioned in the respective sub section of specification.

Table--2
RTU/FRTU Type Test Requirements

Test Name	EUT Status	Test Level	Power Supply Points		I/O Points	Passing Criteria
			CM	DM	CM	
Surge Immunity Test (Test 28)	ON	Level 3	2 Kv	1 kV	2 kV	A
Electrical Fast Transient Burst Test (Test 29)	ON	Level 3	2 KV	-	1 kV	A
Damped Oscillatory Wave Test (Test 30)	ON	Level 3	2.5 kV	1 kV	2.5 kV	A
Electrostatic Discharge (Test 31)	ON	Level 3	+/- 6 kV in Contact discharge mode or +/- 8 kV in Air discharge mode			A
Radiated Electromagnetic Field (Test 32)	ON	Level 3	10 V/m electric field strength			A
Damped Oscillatory Magnetic Field test (Test 33)	ON	Level 3	30 A/m at 1MHz of magnetic field strength			A
Power frequency magnetic field (Test 34)	ON	Level 3	30 A/m of magnetic field strength (Continuous duration sine wave)			A
Power frequency voltage withstand (Test 35)	OFF	-	1 KVrms for 1 minute			No break down or flashover shall occur
1.2/50µs impulse voltage withstand (Test 36)	OFF	-	2 kVp			No break down or flashover shall occur
Insulation Resistance Test (Test 37)	OFF	-	Measure Insulation resistance using 500 V DC Megger before & after Power Freq & Impulse voltage withstand tests			As per manufacturer standard
Dry heat test (Test 38)	ON	-	Continuous operation at 55 ⁰ C for 16 hrs			0
Damp heat test (Test 39)	ON	-	at 95% RH and 40 ⁰ C			0

SECTION- 4

AUXILIARY POWER SUPPLY SYSTEM

SECTION- 4

AUXILIARY POWER SUPPLY SYSTEM

4.0 General

This section describes the technical requirements for Auxiliary Power Supply System. The BOQ for Auxiliary Power Supply system equipment required for SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center, RTU/Data Concentrator, FRTU Communication equipment & remote VDU locations. The components of Auxiliary Power Supply system are Uninterruptible Power Supply (UPS), 48V DC power supply (DCPS), the batteries for UPS and DCPS. The technical requirements for all the above components are described in the various subsequent clauses.

The Bidder is encouraged to offer their standard products and designs. The UPS, DCPS, Battery shall be manufactured & tested as per the relevant IS/IEC/ EN/BS standards. However, the Bidder shall conform to the requirements of this specification and shall provide any special interface equipment necessary to meet the requirements stated herein.

All equipment except Batteries shall be designed for an operating life of not less than 15 years, however, batteries shall have a minimum expected operating life of 5 years under normal operating conditions or 1200 charge/discharge cycles (whichever is earlier). The Contractor shall demonstrate the functionality of the equipment during tests in the factory. After the equipment is installed, the Contractor shall demonstrate all of the functions during well-structured field tests. This section is applicable to Group A (Noida Town), B, C towns as per functional requirements

4.1 Uninterruptible Power Supply (UPS)

The technical requirements for the Uninterruptible Power Supply (UPS) System and associated equipment to be provided by the contractor are described below.

The UPS system shall include the following:

- UPS equipment supplying load at 0.8 lagging power factor
- VRLA batteries for UPS system with backup duration
- UPS input and output AC Distribution Boards.
- Power, control and network cables

4.1.1 UPS Functions

The UPS shall be designed for continuous-duty, on-line operation and shall be based on solid-state design technology to provide uninterrupted power supply for computer system and associated items. The control of the UPS system shall be microprocessor based providing monitoring and control of rectifier/charger, Inverter, static switches, firing and logic control.

Each UPS system provided by the Contractor shall include all of the following sub-systems as well as any other components and support hardware necessary for complete and proper operation of the UPS:

- a) Rectifier/charger unit Inverter unit
- b) Battery Low Voltage Disconnect device
- c) Static bypass switches
- d) Manual maintenance bypass switches
- e) Isolation transformer
- f) Load transformer and filters
- g) Control panels including source selection equipment & ACDBs, automatic controls and protection
- h) Hardware and software as required for parallel operation of two no of UPS
- i) Systems
- j) All necessary cables, MCCBs/MCBs/ switches/ fuses

In the event of a loss of AC source, the UPS equipment shall provide uninterrupted power to the critical loads from the output of the UPS inverter subsystems through batteries.

4.1.2 UPS Operation

The UPS systems with associated batteries shall operate in parallel redundant configuration sharing the connected load. The conceptual diagram for UPS is shown in figure 4-1.

The UPS shall primarily use the inverter subsystem to deliver AC power to the computer loads. In case of failure of any one of UPS, the other healthy UPS shall continuously supply the power to the computer loads without any interruption. If the other healthy UPS also fails then automatically Static bypass of UPS shall start supplying the connected load through AC mains without any interruption.

The Manual Maintenance Bypass shall be provided for each of the UPS separately to extend AC raw power supply to computer systems in case of complete failure or shutdown of UPS systems.

The facilities shall also be provided to manually control the UPS through its control panel.

4.1.3 UPS Equipment Design

The design of the UPS shall have the capability to isolate any failed piece of equipment viz. Rectifier/charger unit, inverter and battery for maintenance. UPS equipment design shall consider the following electrical parameters:

- UPS equipment shall comply with IEC 62040 or equivalent. EN/BS standards for design, performance and EMC requirements.
- The input mains AC supply to the UPS shall be 415 volt AC, 3-phase, 4-wire 50 Hz. The input supply voltage may vary +10% to -15% from nominal and the frequency may vary from 47.5 to 52.5 Hertz.

- The UPS shall be suitable for operation on Mains input AC on phase sequence reversal. The UPS shall provide 3-phase four wire output plus ground. The UPS shall Supply power to the connected loads at 415 volt AC, 3-phase, and 50 Hz. 0.8-lagging power factor.
- The UPS shall provide continuous regulated sine wave AC power to the connected loads.
- The overall efficiency of the UPS, input to output, shall be a minimum of 90 percent with the batteries fully charged and operating at full load and unity power factor.
- Noise generated by the UPS under normal operating condition shall not exceed 78 dB measured five (5) feet from the front of the cabinet surface. The requirements of each sub-system of UPS are detailed below.

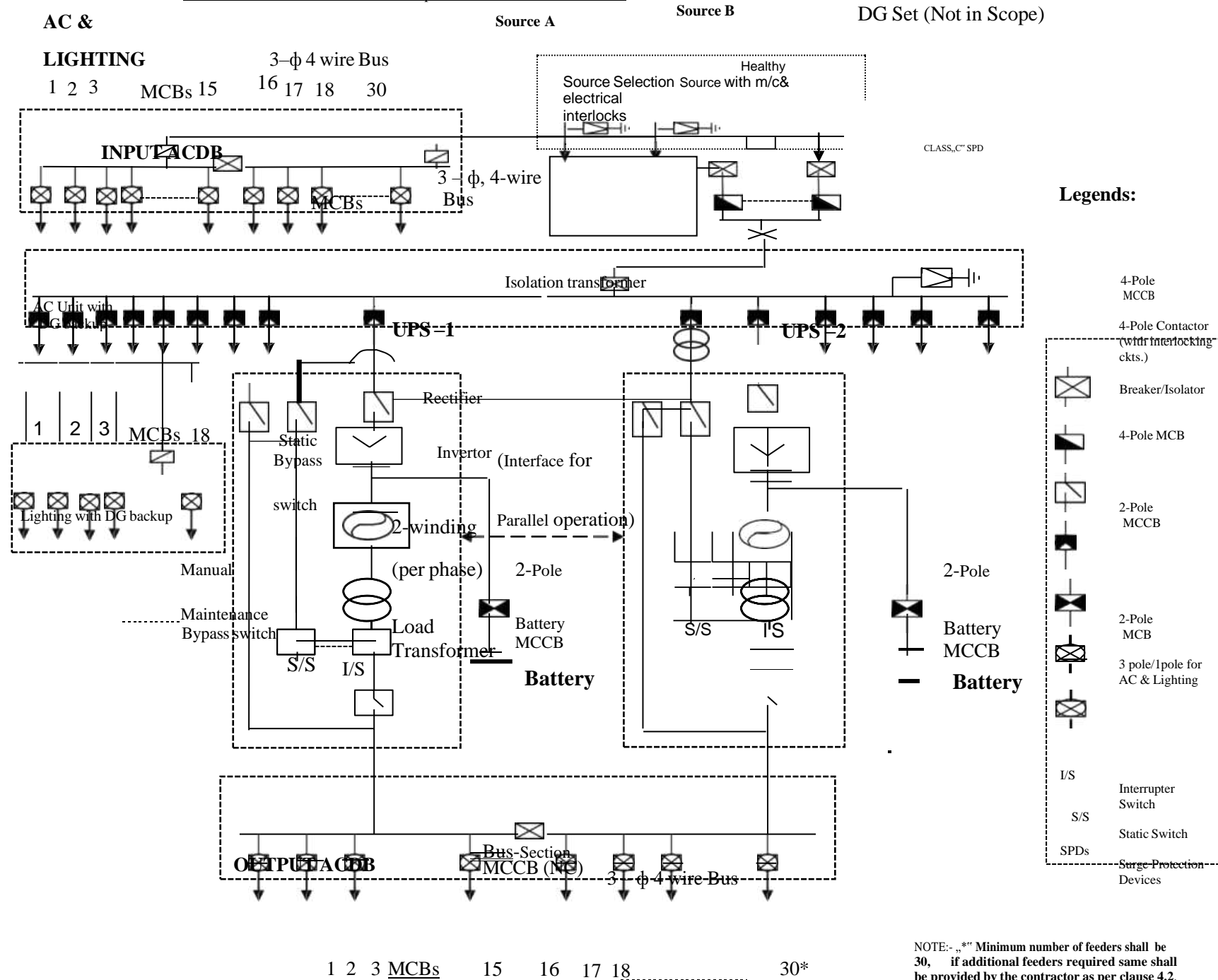
4.1.4 Rectifier/Charger Units

Each rectifier/charger unit output voltage shall be regulated to match the characteristics of the batteries and inverter. The rectifiers/chargers shall provide voltage regulated DC power to the invertors while also charging and maintaining the batteries at full capacity.

The rectifier/charger units shall have the following characteristics:

- Input Voltage and frequency characteristics as per clause 4.1.3 above.
- Input current limit of 125 percent of the nominal full load input current
- Maximum input current total harmonic distortion of 5 percent at nominal input voltage and under full load.
- The output shall be current limited to protect the rectifier/charger unit circuitry and to prevent the batteries from over-charging.
- Capacity to recharge the batteries to 90% of its capacity (from fully discharged state i.e. ECV of 1.75) within 8 hours while carrying full load.
- Automatic equalizing after partial discharge of the batteries.
- Temperature dependent battery charging with temperature sensing probes mounted on the battery banks.
- Automatic float cum boost charging feature.

FIG 4.1: CONCEPTUAL AUXILIARY POWER SUPPLY SYSTEM CONFIGURATION



CLASS_B&C™ SPD



CLASS_B&C™ SPD

To Computer Loads

To Computer Loads

4.1.5 Invertors

The invertors shall normally operate in synchronism with the mains AC power source. Upon loss of the mains AC power source or its frequency deviating beyond a preset range, the invertors shall revert to their own internal frequency standard. When the mains AC source returns to normal, the invertors shall return to synchronized operation with the mains AC source. Such reversal of operation of inverters from synchronous to free running mode and vice-versa shall not introduce any distortion or interruption to the connected loads. A suitable dead band for frequency may be provided to avoid unnecessary frequent reversal of inverter operation between free running mode and synchronized mode under fluctuating frequency conditions.

The invertors shall have the following characteristics:

- (a) Inverter unit shall be based on Pulse Width modulation (PWM) technique.
- (b) The nominal output voltage shall be 415 Volt $\pm 1\%$, 3-phase, 4-wire AC up to rated load.
- (c) The transient voltage response shall not exceed $\pm 4\%$ for the first half-cycle recovering to $\pm 1\%$ within ten cycles for a 100 percent step load application or removal.
- (d) The free running frequency shall not deviate by more than $\pm 0.1\%$ for the rated frequency of 50 Hz.
- (e) The invertors shall be synchronized to the main AC source unless that source deviates from 50 Hz by more than 1% (adjustable to $\pm 1/2/3/4/5\%$).
- (f) The output voltage harmonic distortion shall not exceed 5% RMS and no single harmonic component shall exceed 3%.
- (g) The invertors shall be capable of resistive load operation & deliver at least 80% of the nominal capacity at the rated power factor and be capable of operation with loads ranging from the rated through unity power factor. Inverter shall also accept 100% load at crest factor of at least 3:1 for Switching Mode Power Supply (SMPS) load of computer system equipment without de-rating.
- (h) The invertors shall provide protection logic to automatically shut down and isolate itself from the load when the battery voltage drops below a preset voltage.
- (i) The invertors shall provide interrupter switch to isolate the unit from the load on failure of the unit. The interrupter switch shall be rated to carry full continuous load and to interrupt the inverter under full fault load.
- (j) The invertors shall be capable of supporting a start-up surge or overload of 150 percent of rated output for up to 60 seconds.

In case the inverter subsystem does not include an internal load transformer, an external load transformer of delta-wye configuration, 3-phase, 50Hz, 415 V AC, suitable for the inverter shall be provided.

4.1.6 Static Bypass Switches

Each UPS system shall include static bypass switch to facilitate automatic transfer of loads from the inverter sub-system output to bypass AC source through isolation transformer. Isolation transformer shall be rated for at least two times the rating of single UPS sub system. However, in case of parallel-redundant UPS systems, the transfer to Static bypass must occur only when the inverter of both the UPS systems have failed.

The transfer to Static Bypass from the inverter shall take place under the following fault conditions:

- (a) The inverter load capacity is exceeded
- (b) An over- or under-voltage condition exist on the inverter output
- (c) Inverter failure.

The static bypass switches shall be high-speed devices rated to transfer and carry full rated load. The static bypass switches shall provide protection to prevent out of phase transfers. The switching speed of the static bypass switches shall be less than 1 millisecond. During the changeover, the output voltage should not fall below 205V A.C, 50Hz $\pm 5\%$, in order to avoid any disruption to computer load supply. An automatic transfer back to the inverter subsystem shall occur if the transfer from the inverter subsystem was caused by a temporary overload and the load has returned to normal or by a temporary over/under voltage condition on inverter output and the voltage has returned to normal.

The transfer back to the inverter subsystem, both automatic and manual, shall be inhibited under the following conditions:

- a. The frequency of bypass AC source is outside the frequency band of $\pm 1\%$ of 50Hz (adjustable to $\square 1/2/3/4/5$ percent).
- b. The inverter output voltage and frequency are beyond the preset range.
- c. An overload exists.

4.1.7 Manual Maintenance Bypass Switches

Manual bypass switches are provided to facilitate maintenance of the UPS system and shall provide transfer of the connected load from one UPS output to the other UPS system. These switches shall be rated to transfer and carry continuous full rated load.

4.1.8 Batteries

UPS system shall have a set of storage batteries designed for continuous UPS application. The battery set shall have sufficient capacity to maintain output at full rated load for the specified backup duration after 8 hour charging. The backup duration of the battery shall be as specified in the BOQ. The battery set shall be maintenance free VRLA type Batteries. The detailed requirement of batteries is given under clause 4.4.

4.1.9 Battery Breaker for UPS system

A 2-pole MCCB of suitable rating shall be provided near the battery bank (at suitable location on the frame of the battery bank) to allow disconnection of the batteries from the rectifier/charger unit and inverter. This shall also provide over-current protection to the battery circuits.

4.1.10 UPS Control/Monitoring

The Contractor shall supply control panel to permit automatic & manual operation of UPS, display of associated alarms and indications pertaining to the UPS. In each UPS system, a local display of the following analog and status/alarm signals/indications as a minimum shall be included Analog signals for the following measurements:

AC input voltage (to display each phase)

- i. AC output voltage (to display each phase)
- ii. AC output current (to display each phase)
- iii. AC input mains Frequency
- iv. AC UPS Output Frequency
- v. DC voltage (battery subsystem)
- vi. DC current (battery subsystem) Status/Alarms signals for the following indications:
 - a) Parallel operation of inverters
 - b) Inverters running in synchronized / free running mode
 - c) Battery Low voltage alarm (battery subsystem)
 - d) Load on battery alarm
 - e) Battery Circuit Breaker Open alarm
 - f) Overload trip alarm
 - g) High-temperature alarm
 - Equipment failure alarm

For remote monitoring a wall mounted type panel consisting of audio visible alarm or PC based monitoring system shall be provided in the control room. For PC based monitoring system required computer hardware and software shall be provided by the contractor. The monitor of PC shall be 15" TFT type.

4.1.11 Internal Wiring

All internal wires shall be of stranded copper conductor, sized according to the current requirements with minimum insulation rating of 1100 VAC. Extra-flexible wire shall be used for all circuits mounted on door or swing panels within the UPS.

4.1.12 Enclosures/Panels design

The UPS electronic equipment and associated circuitry & all devices shall be housed in a freestanding enclosures/panels. Modules and sub-assemblies shall be easily replaceable and maintainable. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). The applicable degree of protection of enclosures shall be IP20 however, suitable protection shall be provided against vertical dripping of water drops. UPS shall be installed with the necessary base frame including anti-vibration pad. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for front & rear, sides, bottom and top covers shall be minimum 1.6 mm. For other requirement of enclosure/panel, clause 4.2.3.4 may be referred.

4.1.13 Equipment / Panel Earthing

Each enclosure shall include suitable signal & safety earth networks within the enclosure. The signal-earthing network shall be separate & terminated at a separate stud connection, isolated from safety earth network. Each earth network shall be a copper bus bar, braid or cable. The contractor shall connect safety and signal earths of each enclosure to the earth grid/earth riser through suitable 50X6 sq. mm. GI strips. For other requirement of enclosure/panel earthing, clause 4.2.3.5 may be referred.

4.1.14 External Power Connections

All breakers/switches shall be suitably rated to match the requirement of external power connections.

4.1.15 Testing of UPS

4.1.15.1 Type Test of UPS

The Contractor shall supply type tested UPS equipment. The Contractor shall submit the UPS type test reports of earlier conducted tests (including performance & EMC requirements) on the same make, model, type & rating as offered, as per IEC 62040 or equivalent EN/BS standards. For type testing requirements in addition to provisions of section 7 is also to be complied.

4.1.15.2 Factory Acceptance Test of UPS

A factory acceptance test shall be conducted on all the equipment and shall include, but not be limited to the following, appropriate to the equipment being tested:

- (a) Verification of all functional characteristics and requirements specified
- (b) Voltage drop and transients generated during switching operations
- (c) System efficiency tests
- (d) Verification of all features and characteristics included in all the delivered equipment and also as per specification requirements.
- (e) Inspection and verification of all construction, wiring, labeling

4.1.15.3 Documentation, and completeness of the hardware

Before the start of factory testing, the Contractor shall verify that all change orders applicable to the equipment have been installed. As a part of the factory tests, unstructured testing shall be performed to allow Employer representatives to verify proper operation of the equipment under conditions not specifically tested in the above structured performance test. A minimum of 8 hours of the factory test period shall be reserved for unstructured testing. The Contractor's test representative shall be present and the Contractor's technical staff members shall be available for consultation with Employer personnel during unstructured test periods. All special test facilities used during the structured performance test shall be made available for Employer's use during unstructured testing.

The respective factory acceptance tests for UPS are listed in Table 4.1

4.1.16 Environmental Conditions

UPS & all other hardware and components shall be capable of continuous operation at rated load without failures in the following environmental conditions:

Temperature/humidity - Ambient temperature of 0⁰ to 50⁰C and upto 95 percent humidity, non-condensing. However, air conditioned environment shall be provided for VRLA batteries.

Table 4.1 LIST OF FACTORY & SITE TESTS FOR UPS

Sl. No.	T e	Factory Acceptance Tests	Site Tests
1.	Interconnection Cable Check	√	√
2.	Light Load Test	√	
3.	UPS Auxiliary Devices Test	√	√
4.	A.C. input failure Test	√	√
5.	A.C. input return Test	√	√
6.	Simulation of parallel redundant UPS fault	√	
7.	Transfer Test	√	√
8.	Full Load Test	√	√
9.	UPS Efficiency test	√	
10.	Unbalanced Load test	√	
11.	Balanced Load test	√	
12.	Current division in parallel or parallel redundant	√	
13.	Rated stored energy time test (Battery test)		√
14.	Rated restored energy time test (Battery test)		√
15.	Battery ripple current test		√
16.	Overload capability test	√	
17.	Short circuit test	√	
18.	Short-circuit protection device test	√	
19.	Restart test	√	√

Sl. No.	T e	Factory Acceptance Tests	Site Tests
20.	Output Over voltage test	√	
21.	Periodic output voltage variation test	√	
22.	Frequency variation test	√	
23.	Harmonic Components test	√	
24.	Earth Fault test	√	
25.	On site ventilation test		√
26.	Audible noise test	√	
27.	Parameter/Configuration settings	√	√
28.	Phase Sequence Test	√	√
29.	Coordination and discrimination of Tripping of associated breakers (MCCB/MCBs) in upstream		√

4.2 AC DISTRIBUTION BOARDS

AC distribution boards shall be provided for UPS input and output power distribution. The distribution boards shall distribute power and provide protection against failures on feeder circuits, to the equipment. The Contractor shall be responsible for design, engineering, manufacturing, supply, storage, installation, cabling, testing & commissioning of AC distribution boards required for distribution of power. The nominal input frequency is 50 Hz, which may vary from 47.5-52.5Hz. The phase to neutral input voltage shall be (Nominal 240V) varying from 190V to 265 V.

The Input ACDB will cater for the load requirements of DC power supply system, air-conditioning alarm system, fire protection alarm system, lighting loads and one spare of 20A minimum, in addition to UPS system load. The Output ACDB shall cater for only critical loads in the control center. The number of feeders and their ratings in the output ACDB shall be decided during detail engineering. At least five spare feeders in the output panel shall be provided.

All MCCBs shall conform to IEC-60947-2 & IS 13947-2/IEC 947-2, IEC-60898 and IS8828 and shall be of Four (4) Pole type of requisite rating. MCBs used for load feeders in output ACDB shall be of minimum curve B characteristics. The load feeders shall be coordinated with requirement of loads of computers and other loads.

4.2.1 Enclosures/Panels

The equipment of ACDBs shall be physically mounted in freestanding enclosures/panels. MCCBs and sub-assemblies shall be easily replaceable and maintainable. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). The Contractor shall state the type, size and weight of all enclosures and indicate the proposed manner of installation. The applicable degree of protection of enclosures shall be at least IP21. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for front & rear, sides and top covers shall be minimum 1.6 mm. For wall mounted type of output ACDB the above requirements shall not be applicable.

4.2.2 Equipment/Panel Earthing & Surge Protection

Each enclosure shall include suitable safety earth networks as per clause 4.2.3.5. . Surge protection devices shall be installed in the input ACDB to provide adequate protection against current and voltage transients introduced on input AC due to load switching surges. These protection devices shall be in compliance with IEC- 61312, IEC- 61024 and VDE 0100-534 for following surges:

a) Low Voltage Surges (Class C)

Between	Requirement
R, Y, B & N	$I_n \geq 10 \text{ kA}, 8/20 \mu\text{S}$ for each phase
N & PE	$I_n \geq 20 \text{ kA}, 8/20 \mu\text{S}$
I_n = Value of Nominal Discharge Current.	

4.2.3 CABLING REQUIREMENTS

The contractor shall supply, install and commission all power cables, control cables, network interface cables and associated hardware (lugs, glands, cable termination boxes etc.) as required for all equipment. The contractor shall be responsible for cable laying and termination at both ends of the cable. The Contractor shall also be responsible for termination of owner supplied cables if any at contractor's equipment end including supply of suitable lugs, glands, terminal blocks & if necessary cable termination boxes etc. All cabling, wiring and interconnections shall be installed in accordance with the following requirements.

4.2.3.1 Power Cables

All external power cables shall be stranded aluminum/Copper conductor, armoured XLPE/PVC insulated and sheathed; 1100V grade as per IS 1554 Part-I. The conductor for the Neutral connection from UPS to Output ACDB shall be sized 1.8 times the size of the Phase conductors to take care of the non-linear loads. However, the cable between UPS & Battery bank shall be of copper conductor (armoured type).

4.2.3.2 Cable Identification

Each cable shall be identified at both ends, which indicates the cable number, and the near-end and far-end destination. All power cables shall have appropriate color for identification of each phase/neutral/ground. Cable marking and labelling shall comply with the requirements of the applicable standards.

4.2.3.3 Cable and Hardware Installation

The Contractor shall be responsible for supplying, installing, and terminating all cables and associated hardware (lugs, glands, etc.), required to mechanically and electrically complete the installation of facilities for the project.

4.2.3.4 Enclosures/Panels design

Enclosures/panel shall be of freestanding type of design. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). The

enclosures shall not have doors that are wider than 80 cm and doors shall be hinged with locking as per standard design of the manufacturer. Keyed locking is required with identical keys for all enclosures. The enclosures shall not exceed 220 cm in height. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for others shall be minimum 1.5 mm. The panels/boards shall be equipped with necessary cable gland plates. The Contractor shall state the type, size and weight of all enclosures and indicate the proposed manner of installation.

Wiring within panel shall be neatly arranged and securely fastened to the enclosure by non-conductive fasteners. Wiring between all stationary and moveable components, such as wiring across hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wire. Conductors in multi-conductor cables shall be individually color coded, and numbered at both ends within enclosures.

The enclosures shall be painted inside and outside. The finish color of all enclosures shall be aesthetically pleasing and shall be approved by the owner. Further, finish color of external surfaces shall be preferably of same color for all enclosures/panels.

Maintenance access to the hardware and wiring shall be through full height lockable doors. Each panel shall be supplied with 240 VAC, 50Hz single-phase sockets with switch. Each ACDB and equipment within ACDB enclosures shall be clearly labelled to identify the enclosure/equipment. All labelling shall be consistent with Contractor-supplied drawings.

4.2.3.5 Enclosure/Panel Earthing

Each enclosure shall include suitable earth networks within the enclosure. Earth network shall be a copper bus bar, braid or cable inside enclosures.

The safety earth network shall terminate at two/more studs for connecting with the earthing grid. Safety earthing cables between equipment and enclosure grounding bus bars shall be of minimum size of 6 mm², stranded copper conductors, rated at 300 volts. All hinged doors shall be earthed through flexible earthing braid.

For all enclosures requiring AC input power, the green earthing wire from the AC input shall be wired to the safety-earthing stud. The Contractor shall provide all required cabling between enclosures for earthing. The contractor shall connect safety and signal earths (as applicable) of each enclosure to the nearest earth grid/earth riser through suitable 50X6 sq. mm. GI/25x3 Cu strips. The contractor may use the existing grid wherever available. In case the suitable earthing grid is not available the same shall be made by the contractor.

The signal earthing network shall terminate at a separate stud connection, isolated from safety ground. The stud connection shall be sized for an external earthing cable equipped with a suitable lug.

All earthing connections to equipment shall be made directly to each equipment chassis via earthing lug and star washer. Use of the enclosure frame, skins, or chassis mounting hardware for the earthing network is not acceptable.

4.3 DC POWER SUPPLY SYSTEM

The DC Power Supply system shall be capable of meeting the load requirements for various Telecom equipment, RTUs and other associated equipment located at indoor, i.e. at the substations, the control centers and customer care system. The AC input to the ACDB shall be provided from the ACDB described under clause 4.2 at control center. At other locations the AC input to the DCPS system shall be single phase AC which will be provided from the existing system. At these locations the class B & C level of surge protection (between phase-neutral and neutral – protective earth) as specified under and conforming to IEC 61312, IEC 61024 and VDE 0100-534 shall be installed in the DCPS system.

Surge protection devices shall be installed in the DCPS panel to provide adequate protection against current and voltage transients introduced on input AC due to load switching and low energy lightning surges. These protection devices shall be in compliance with IEC- 61312, IEC- 61024 and VDE 0100-534 for following surges:

a) Lightning Electromagnetic impulse and other High Surges (Class B):

Between	Requirement
Ph & N	$I_{imp} \geq 25 \text{ kA}, 10/350 \mu\text{S}$ for each phase
N & PE	$I_{imp} \geq 100 \text{ kA}, 10/350 \mu\text{S}$
I_{imp} = Value of Lightning Impulse Current	

b) Low Voltage Surges (Class C)

Between	Requirement
Ph & N	$I_n \geq 10 \text{ kA}, 8/20 \mu\text{S}$ for each phase
N & PE	$I_n \geq 20 \text{ kA}, 8/20 \mu\text{S}$
I_n = Value of Nominal Discharge Current.	

4.3.1 General Technical Requirements for SMPS based DC power supply units

SMPS based DC power supply system is to be used in Auto Float-cum-Boost Charge mode as a regulated DC Power source. DCPS system is to be installed indoors and shall be provided with IP21 panels. The System shall consist of the following:

- (a) SMPS modules
- (b) Controller module to control and monitor all DCPS modules.

The number and rating of SMPS modules shall be provided as per the Employer's requirements stipulated in the BOQ. The Panel, Distribution/Switching arrangement shall be provided for the ultimate system capacity. Ultimate System capacity is defined as 150% of the present capacity specified. The ultimate capacity is over and above the requirement of redundancy wherever specified. All factory wiring for the panel shall be for the ultimate capacity so that only plugging-in of SMPS module shall enhance the DC power output. The size of fuses, MCBs, switch, bus etc. shall be suitable for the ultimate capacity.

The system shall be sufficiently flexible to serve any load depending on manufacturer's design, rating and number of SMPS modules used in panel and system configuration. To cater for higher load requirements, same type of SMPS modules mounted in the same rack or different racks shall be capable of working in parallel load sharing arrangement. The DCPS system shall be suitable for operation from single phase A.C. mains.

4.3.2 Operational/Component Requirements

The basic modules shall operate at specified ratings and conform to requirements stipulated in this specification. The DCPS system shall meet requirement of the latest TEC specification / IEC/BS for other parameters not specified in this specification. The component parts of the equipment shall be of professional grade of reputed manufacturer to ensure prompt and continuous service and delivery of spare parts. The component shall conform to relevant IEC/IS standards. The contractor shall obtain Employers approval of major component before procurement of the same. Conceptual diagram for DCPS is shown in figure 4-2.

The DCPS shall be suitable for operation at ambient temperature of 0-50 deg and relative humidity up to 95 %. Utility may specify requirements

4.3.3 Wiring

All insulated conductors except those within the confines of a printed circuit board assembly shall be of the rating enough to withstand the maximum current and voltage during fault and overload. All insulated conductors/cables used shall conform to IS1554 or equivalent international standard.

All wiring shall be neatly secured in position and adequately supported. Where wires pass through any part of metal panel or cover, the hole through which they pass shall be suitably secured.

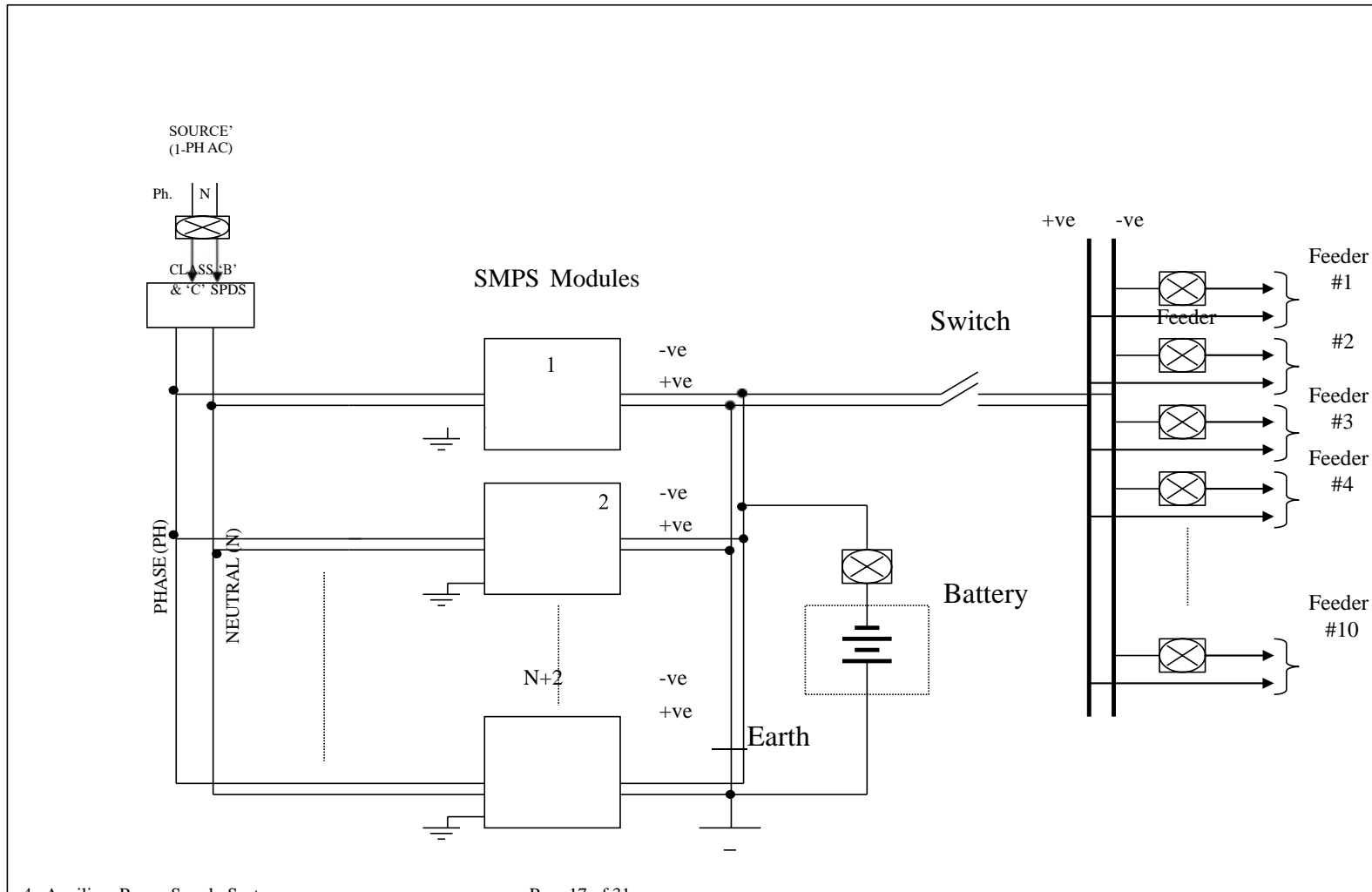
4.3.4 Bus Bars

High conductivity Cu bus bar shall be provided and shall be sized to take care of the current of ultimate DCPS system capacity for which it is designed. However, it shall not be less than 25mm X 5mm.

4.3.5 Earthing

Two earth terminals shall be provided in the frame of the system. The Contractor shall connect these earth terminals to the earth bus. All modules and devices shall be connected to these earth terminals. The hinged door shall be connected to the panel with braided Cu at two points at least.

FIG. 4-2 : CONCEPTUAL CONFIGURATION OF DC POWER SUPPLY (DCPS) SYSTEM



4.3.6 Finish and Painting

The finish of Steel/Aluminum alloy structure and panels shall conform to relevant IS specification (or equivalent international specifications). The color scheme for panel, Door and Modules shall be decided during detailed engineering.

4.3.7 Marking and Labelling of Cables

The Contractor shall propose a scheme for marking and labeling the inter panel cables and get it approved from the Employer. A cabling diagram, screen printed or any other better arrangement ensuring better life expectancy shall be placed in the inside of the front door or any other convenient place for ready reference of the maintenance staff.

4.3.8 Name Plate

A name plate etched, engraved, anodized or any other better arrangement ensuring better life expectancy shall be suitably fixed on each panel /module and contain at least the following information :

- (a) Type of the Unit / Model No
- (b) Manufacturer's Name and identification
- (c) Unit serial No
- (d) Year of manufacture
- (e) Input voltage and phase
- (f) Output Voltage and Current

4.3.9 System and Panel Configuration

The mechanical and electrical requirements of the Panel are described as below:

4.3.10 System Configuration

The SMPS modules shall be accommodated in panels. The system shall employ a modular configuration to provide flexibility, keeping in view the future load requirements of DC Power. The system shall be configured for ultimate capacity as brought out in Section 4.3.1 General Technical Requirements. The control, Monitoring, Alarm arrangement and DC & AC distribution shall be provided suitably in the panel.

The number of SMPS modules to be provided in the DCPS system shall be provided in $N+2$ configurations, where N is the number of SMPS modules to meet the battery charging current (10% of C10 AH Capacity) of the offered battery plus the load requirement stipulated in the BOQ. The current rating of each module shall be considered as output current of the SMPS module at nominal voltage (48V).

It shall be possible to easily mount/remove the modules from the front side of the panel. The SMPS modules/SMPS module sub-racks shall be designed to slide into the panels and fixed securely by a suitable mechanical arrangement.

4.3.11 Constructional Features of Panel

Panel (Enclosure) shall be freestanding type of design. Cable entry shall be from the bottom/top of the enclosures (to be finalized during detailed engineering). The enclosures shall not have doors that are wider than 80 cm and doors shall be hinged with locking as per standard design of the manufacturer. Keyed locking is required with identical keys for all enclosures. The enclosures shall not exceed 220 cm in height. The thickness of the structural frames and load bearing members shall be minimum 2.0 mm and for others shall be minimum 1.5 mm. The panels/boards shall be equipped with necessary cable gland plates. The Contractor shall state the type, size, and weight of all enclosures and indicate the proposed manner of installation.

Wiring within panel shall be neatly arranged and securely fastened to the enclosure by non-conductive fasteners. Wiring between all stationary and moveable components, such as wiring across hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wire. Conductors in multi conductor cables shall be individually color coded, and numbered at both ends within enclosures.

The enclosures shall be painted inside and outside. The finish color of all enclosures shall be an aesthetically pleasing and shall be approved by the owner. Further, finish color of external surfaces shall be preferably of same color for all enclosures/panels.

Maintenance access to the hardware and wiring shall be through lockable, full height, from doors.

Each panel shall be supplied with 240 VAC, 50Hz single-phase sockets with switch and lighting lamp for panel illumination.

The manufacturer so as to ensure the uninterrupted use of the equipment shall do proper thermal engineering of hardware design. The Panel shall be designed to allow cooling preferably by natural convection. The Bidders shall submit detail design of proposed Panel/enclosure and heat dissipation calculations during detailed engineering. Forced cooling is permitted (DC Fans are permitted in the Panel or SMPS module) for equipment mounted indoors (buildings/rooms/shelters). If cooling is provided at Panel level it shall be provided with additional fan with facility for manual switch over. Proper filtering shall be provided to control dust ingress. There shall be an arrangement for automatic Switching-OFF of fans during AC input failure. The required individual modules may be separated by air baffle to provide effective convection. The manufacturer shall also ensure that the failure of fan does not cause any fire hazards. The failure of any of the fans shall draw immediate attention of the maintenance staff.

4.3.12 Electrical Requirements:

AC input supply: The nominal input frequency is 50 Hz, which may vary from 47.5-52.5Hz. The input voltage shall be single phase (Nominal 240V) varying from 190V to 265V.

There shall be an automatic arrangement for shutting off of the SMPS module whenever the input voltage is beyond the specified operating limits with suitable alarm indication. The SMPS module shall resume normal working automatically when the input is restored within the working limits. Hysteresis within specified working limits shall not cause shutting down of the SMPS. A tolerance of $\pm 5V$ may be acceptable for protection & alarm operation.

4.3.13 DC output Characteristics of Modules

The module shall be capable of operating in “Auto Float-cum-Boost Charge” mode depending on the condition of the battery sets being sensed by the Control unit.

- a) The float voltage shall be continuously adjustable & pre-settable at any value in the range of -48 to $-56V$ either at the module or may be set from the common controller configuration. Further, the prescribed float voltage setting shall be based on recommendations of the VRLA battery supplier.
- b) In Boost charge mode SMPS shall supply battery & equipment current till terminal voltage reaches set value, which is normally $2.3V/cell$ ($55.2V$) or as recommended by the VRLA battery supplier & shall change over to constant voltage mode
- c) The DC output voltage variation shall not be more than 2% for load variation from 25% load to full load.

4.3.14 Current Limiting (Voltage Droop)

The current limiting (Voltage Droop) shall be provided in DCPS modules in float and boost charge modes of operation. The float/boost charge current limiting shall be continuously adjustable between 50 to 100% of rated output current for output voltage range of -44.4 volts to -56 Volts.

The float and boost charge current limit adjustment shall be provided in the DCPS system. The SMPS modules shall be fully protected against short circuit. It shall be ensured that short circuit does not lead to any fire hazard.

4.3.15 Soft/Slow Start Feature:

Soft/Slow start circuitry shall be employed such that SMPS module input current and output voltage shall reach their nominal value within 10 seconds.

The maximum instantaneous current during start up shall not exceed the peak value of the rectifier input current at full load at the lowest input voltage specified.

4.3.16 Voltage overshoot/Undershoot:

The requirements of (a) to (c) given below shall be achieved without a battery connected to the output of SMPS module.

- (a) The SMPS modules shall be designed to minimize DC output voltage

Overshoot/Undershoot such that when they are switched on the DC output voltage shall be limited to $\pm 5\%$ of the set voltage & return to their steady state within 20 ms for load variation of 25% to 100%.

- (b) The DC output voltage overshoot for a step change in AC mains as specified in clause 4.3.12 Electrical Requirements shall not cause shut down of SMPS module and the voltage overshoot shall be limited to $\pm 5\%$ of its set voltage and return to steady state within 20ms.
- (c) The modules shall be designed such that a step load change of 25 to 100% and vice versa shall not result in DC output voltage Overshoot/Undershoot of not more than 5% and return to steady state value within 10 ms without resulting the unit to trip.

4.3.17 Electrical Noise:

The Rectifier (SMPS) Modules shall be provided with suitable filter at output with discharge arrangements on shut down of the modules. The Psophometric Noise and ripple shall be as per relevant standards.

4.3.18 Parallel Operation

SMPS modules shall be suitable for operating in parallel with one or more modules of similar type, make and rating, other output conditions remaining within specified limits.

The current sharing shall be within $\pm 10\%$ of the average current per rectifier module individual capacity of each rectifier module in the system (mounted in the same or different Panels) when loaded between 50 to 100% of its rated capacity for all other working conditions.

4.3.19 Protection

The SMPS module, which has failed (for any reason) shall be automatically isolated from the rest of the modules and an alarm shall be initiated for the failure.

4.3.19.1 DC Over voltage protection

DCPS shall be fitted with an internal over voltage protection circuit.

In case output DC voltage exceeds $-57V$ or as per the recommendations of the manufacturer of batteries, the over voltage protection circuit shall operate & shut off the faulty module. A tolerance of $\pm 0.25V$ is permitted in this case.

Shutting off of faulty SMPS module shall not affect the operation of other SMPS modules operating in the Panel. Operation of over voltage shut down shall be suitably indicated and extended monitoring/control unit. The circuit design shall ensure protection against the discharge of the Battery through the SMPS module in any case. The over voltage protection circuit failure shall not cause any safety hazard.

4.3.20 Fuse/Circuit Breakers

Fuses or miniature circuit breakers (MCB) shall be provided for each SMPS module as follows:

1. Live AC input line
2. Control Circuit

All fuses/circuit breaker used shall be suitably fault rated.

4.3.21 AC Under/Over Voltage Protection

AC input Under/Over voltage protection shall be provided as per clause 4.3.12 for Electrical Requirements.

4.3.22 Over Load/Short Circuit Protection

The SMPS shall be protected for Over load/Short circuit as per clause 4.3.14 Current Limiting (Voltage Droop).

4.3.23 Alarms and indicating lamps

Visual indications/display such as LEDs, LCDs or a combination of both shall be provided on each SMPS module for detection of SMPS module failure.

4.3.24 Termination

Suitable termination arrangements shall be provided in the panel for termination of inter cubicle cables from other equipment such as owners ACDB, Telecom and other associated equipment and alarm cables. All the termination points shall be easily accessible from front and top. AC and DC terminals shall be separated by physical barriers to ensure safety. All the terminals except AC earth shall be electrically isolated.

4.3.25 DC Terminations

All terminations including through MCBs shall be through lock and screw type terminations. Load and batteries shall be connected to DCPS through appropriate MCBs. The isolation of any of the battery from the load shall create an alarm. DC distribution shall be provided with adequate no of feeders (with three no of spare) with appropriate MCBs (6 Amp thru 32 Amp) for termination of the loads. Actual rating of the MCBs and no of feeders shall be finalized during the detail engineering.

DC distribution may be done either on wall mounted panel or on the DCPS panel. The proper rated MCB shall be provided at the combined output of the SMPS modules (if not provided at each SMPS module). All the AC, DC and Control/alarm cabling shall be supplied with the Panel. All DC +ve and -ve leads shall be clearly marked. All conductors shall be properly rated to prevent excessive heating.

4.3.26 Power Cables

All power cables shall be stranded copper conductor XLPE/PVC insulated and PVC sheathed, single core/two core/three core/four core, 1100V grade as per IS 1554 Part-I.

4.3.27 Earthing Cables

Earthing cables between equipment and grounding bus bars shall be minimum size 70 mm² stranded conductors copper/copper strip, rated at 300 volts. All hinged doors shall be earthed through flexible earthing braid. Signal and Safety earthing shall be provided separately.

4.3.28 Alarms

Following Visual indications/display such as LEDs, LCDs or a combination of both shall be provided to indicate:

Functional Indications for local monitoring:

- a) Mains available (not mandatory if provided at module level)
- b) DCPS/SMPSs in Float
- c) DCPS/SMPSs in Charge Mode

Alarm Indication for local monitoring:

- a) Load Voltage High /Low b)
DCPS module/SMPS fail c)
Mains out of range
- d) System Over Load
- e) Mains “ON”/Battery Discharge
- f) Temp. Compensation fail g)
Battery fail/isolated

All the protections/alarms shall be within tolerance of 0.25V in case of DC voltage, 1% in case of DC current and $\pm 5V$ for AC voltage

Alarm Indication for remote monitoring:

- a) Input AC mains supply fail alarm
- b) Battery low voltage (Pre cut off) alarm c)
c) DCPS module fail

Potential free Contacts in two numbers for each of the above remote monitoring alarms (one for remote alarm interfaced through RTU and one redundant for local monitoring at suitable location) shall be provided. All these potential free contacts are to be wired and terminated at the suitable location for termination to RTU.

4.3.29 Temperature Compensation for Battery

There shall be provision for monitoring the temperature of battery and consequent arrangement for Automatic temperature compensation of the SMPS output voltage to match the battery temperature dependant charge characteristics. The output voltage of the rectifier in Float/Charge operation shall decrease or increase at the rate of 72 mV (24 cell battery) per degree increase or decrease in temperature over the set voltage or as maybe recommended by the VRLA Battery supplier. The output voltage shall decrease till the

open circuit voltage of the battery is reached. The open circuit voltage range shall be settable between 2.1V/cell to 2.2V/cell. The increase in output voltage due to decrease in temperature has been taken care of by the tripping of the unit due to output voltage high (57V) protection. Failure of temperature compensation circuit including sensors shall create an alarm and shall not lead to abnormal change in output voltage.

4.3.30 Digital Meters/Display Unit

There shall be provision to monitor the following parameters through digital meters or digital display units:

- (a) Input AC voltage.
- (b) Output DC voltage
- (c) Output DC current of charger
- (d) Battery current
- (e) Load current.

The Digital display of meters or display unit shall be with minimum 3 1/2 digital display of height 12mm and shall have accuracy 1.5% or better.

4.3.31 Type Testing of DCPS

The contractor shall supply DCPS System, which was already type tested. The test reports for immunity, Emission and surge must be in accordance with relevant IEC/CISPR standards shall be submitted. The Contractor shall submit the DCPS type test reports of earlier conducted tests on the same make, model, type & rating which shall include the following tests. For type testing requirements in addition to provisions of this section 7 is also to be complied.

Type Tests on DCPS

- 1 Surge immunity (Level 4- as per IEC 61000-4-5)
- 2 Electrical Fast Transients/Burst (Level 4 – as per IEC 61000-4-4)
- 3 Electrostatic Discharge (Level 4 – as per IEC 61000-4-2)
- 4 Radiated Electromagnetic Field (Level 3 – as per IEC 61000-4-3)
- 5 Conducted disturbances induced by radio-frequency field
(Level 3 – as per IEC 61000-4-6)
- 6 Damped oscillatory magnetic field (Level 3 – as per IEC 61000-4-10)
- 7 Voltage dips, short interruptions and voltage variations
(Level 2 – as per IEC 61000-4-11)
- 8 Conducted Emission (Level - Class A, Group 1 as per IEC CISPR 11)
- 9 Radiated Emission (Level - Class A, Group 1 as per IEC CISPR 11)
- 10 Verification of Protection class (IP 21) for enclosure
- 11 Safety Tests (as per IEC 60950)
- 12 Burn in test for 72 hours at maximum operating temperature

4.3.32 Factory/Site Testing of DCPS

The factory/site tests to be carried out on DCPS system/module in the factory and site are listed respectively in Table below. The manufacturer shall conduct routine tests on all the systems/modules and submit the report before offering for FAT. The routine test shall include at least the tests mentioned under FAT.

Sl.No.	Test	FAT	SAT
Tests on DCPS System			
1.	Mechanical & Visual Check Tests	√	√
2.	Insulation Test.	√	
3.	High Voltage Withstand Test	√	
4.	Switch On Test	√	√
5.	DCPS Low voltage & High voltage limits check Test	√*	√
6.	Pre-alarm test for Battery Voltage Low	√*	√
7.	Battery Low Voltage Disconnect Level Test	√*	√
8.	AC Input Low and High voltage limits check Test	√*	
9.	Rectifier Fail Alarm Test	√*	√
10.	Voltage Regulation Test	√*	√
11.	Current Sharing Test	√*	
12.	Total Output Power Test	√*	√
13.	Hot Plug In Test	√*	√
14.	Calibration & Parameter settings	√*	√
15.	Automatic Float cum Boost Charge Mode Change Over Test	√*	√
16.	Battery Path Current Limiting Test	√*	√
17.	Battery Charging and full load Current Test	√*	√
18.	Battery Temperature Compensation Test	√*	
19.	Total Harmonic distortion Test	√*	
20.	Burn in Test for 8 hours at max operating temperature	√*	
Tests on SMPS module			
21	Mechanical & Visual Check Test	√*	
22	Module-On Test	√*	
23	Input low/high voltage cut-off test	√*	
24	Voltage Droop Test	√*	
25	Voltage Regulation Test	√*	
26	Power Output & Current Limit Test	√*	
27	DC High Voltage Test	√*	
28	O/P Voltage Ripple Test	√*	
29	Psophometric Noise Test	√*	
30	Efficiency Test	√*	
31	Power Factor	√*	
32.	Input Current Limit	√*	

Sl.No.	Test	FAT	SAT
33.	Input AC Frequency Range Test	√*	
34.	Rectifier Dynamic Response	√*	
35.	Output Short Circuit Test	√*	
36.	Hold up Time Test	√*	

Note* : These tests (Sl. No. 5-36) shall be conducted on 10% samples of the offered batch and other tests (Sl. No 1-4) shall be conducted on each equipment during the FAT.

4.4 BATTERY REQUIREMENTS

The contractor shall supply Valve Regulated Lead Acid (VRLA) maintenance free Battery for UPS & DCPS system. Each battery set shall have sufficient capacity to maintain output at full rated load for duration as defined in **BOQ**. The Bidder shall furnish detailed battery sizing calculations along with all arrangements and supporting structures, for UPS and DCPS system being proposed, along with the bid. In all cases the battery is normally not allowed to discharge beyond 80% of rated capacity (80% DOD) at 10 hours rate of discharge.

The contractor supplying the cells/batteries as per this document shall be responsible to replace/repair free of charge, the battery/cell becoming faulty, owing to defective workmanship or material as per the provisions of the bid document.

Battery sizing calculation for UPS shall be done considering the actual charging achieved in eight hours i.e. in case 100% charging is not achieved in eight hours the Ah of the battery shall be enhanced by the ratio of charging actually achieved in eight hours.

4.4.1 Constructional Requirements

The design of battery shall be as per field proven practices. Partial plating of cells is not permitted. Paralleling of cells externally for enhancement of capacity is not permitted. Protective transparent front covers with each module shall be provided to prevent accidental contact with live module/electrical connections. It shall be possible to easily replace any cell of the battery at site in normal working condition.

4.4.2 Containers

The container material shall have chemical and electro-chemical compatibility and shall be acid resistant. The material shall meet all the requirements of VRLA batteries and be consistent with the life of battery. The container shall be fire retardant and shall have an Oxygen Index of at least 28%. The porosity of the container shall be such that so as not to allow any gases to escape except from the regulation valve. The tensile strength of the material of the container shall be such that so as to handle the internal cell pressure of the cells in the worst working condition. Cell shall not show any deformity or bulge on the sides under all working conditions. The container shall be capable of withstanding the rigors of transport, storage and handling. The containers shall be enclosed in a steel tray.

4.4.3 Cell Covers

The cell covers shall be made of suitable material compatible with the container material and permanently fixed with the container. It shall be capable to withstand internal pressure without bulging or cracking. It shall also be fire retardant. Fixing of Pressure Regulation Valve & terminal posts in the cover shall be such that the seepage of electrolyte, gas escapes and entry of electro-static spark are prevented.

4.4.4 Separators

The separators used in manufacturing of battery cells, shall be of glass mat or synthetic material having high acid absorption capability, resistant to sulphuric acid and good insulating properties. The design of separators shall ensure that there is no misalignment during normal operation and handling.

4.4.5 Pressure Regulation Valve

Each cell shall be provided with a pressure regulation valve. The valve shall be self re- seal able and flame retardant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

4.4.6 Terminal Posts

Both the +ve and –ve terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both +ve and –ve posts shall be clearly and unambiguously identifiable.

4.4.7 Connectors, Nuts & Bolts, Heat Shrinkable Sleeves

Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably lead coated to withstand corrosion due to sulphuric acid at a very high rate of charge or discharge.

Nuts and bolts for connecting the cells shall be made of copper, brass or stainless steel. Copper or brass nuts and bolts shall be effectively lead coated to prevent corrosion. Stainless steel bolts and nuts can be used without lead coating.

All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

4.4.8 Flame Arrestors

Each cell shall be equipped with a Flame Arrestor to defuse the Hydrogen gas escaped during charge and discharge. Material of the flame arrestor shall not affect the performance of the cell.

4.4.9 Battery Bank Stand

All batteries shall be mounted in a suitable metallic stand/frame. The frame shall be properly painted with the acid resistant paint. The suitable insulation shall be provided between stand/frame and floor to avoid the grounding of the frame/stand.

4.4.10 Capacity Requirements

When the battery is discharged at 10-hour rate, it shall deliver 80% of C (rated capacity, corrected at 27°Celsius) before any of the cells in the battery bank reaches 1.85V/cell.

All the cells in a battery shall be designed for continuous float operation at the specified float voltage throughout the life. Float voltage of each cell in the string shall be within the average float voltage/cell $\pm 0.05V$ band.

The capacity (corrected at 27°Celsius) shall also not be less than C and not more than 120% of C before any cell in the battery bank reaches 1.75V/cell. The battery voltage shall not be less than the following values, when a fully charged battery is put to discharge at C/10 rate:

- a) After Six minutes of discharge: 1.98V/cell
- b) After Six hours of discharge : 1.92V/cell
- c) After 8 hours of discharge : 1.85V/cell
- d) After 10 hours of discharge : 1.75V/cell

Loss in capacity during storage at an average ambient temperature of 35° Celsius for a period of 6 months shall not be more than 60% and the cell/battery shall achieve 85% of its rated capacity within 3 charge/discharge cycles and full rated capacity within 5 cycles, after the storage period of 6 months. Voltage of each cell in the battery set shall be within 0.05V of the average voltage throughout the storage period. Ampere-hour efficiency shall be better than 90% and watt-hour efficiency shall be better than 80%.

4.4.11 Expected Battery Life

The battery shall be capable of giving more than 1200 charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27° Celsius. DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity. The battery sets shall have a minimum expected operational life of 5 years at normal operating conditions or 1200 charge / discharge cycles (whichever is early).

4.4.12 Routine Maintenance of Battery system

For routine maintenance of battery system, the contractor shall supply 1 set of following tools:

- a. Torque wrench.
- b. Tool for opening /closing of pressure regulation valve of battery.
- c. Hand held digital Multimeter for measurement of resistance, AC/DC Voltages.

4.4.13 Testing of Battery

The contractor shall supply type tested battery as required for DCPS and UPS system. The Contractor shall submit the Battery type test reports of earlier conducted tests on the same make, model, type & rating as offered as per the IEC 60896 or equivalent IS/EN/BS standards. These Type test reports shall be submitted for the highest rating battery to be supplied under the contract. For type testing requirements in addition to provisions of this section 7 is also to be complied. The tests mentioned in the Table 4.2 shall be conducted on the battery at site and factory.

TABLE 4.2 LIST OF FACTORY & SITE TESTS FOR BATTERY

S. No.	Test	Factory Tests	Site Tests
1.	Physical Verification	√	√
2.	C/10 Capacity test on the cell	√	
3.	8 H r s . Charge and 30 minutes (duration as Specified) discharge test at full rated load for UPS.		√

4.5 Testing Requirements

The requirements for type tests, factory acceptance tests and field acceptance testing have been specified under the respective clauses. After completion of field acceptance testing the auxiliary power supply system shall be put under availability test for fifteen (15)days. Availability test shall be carried out by the employer/owner. During the availability test the APS shall be used as required to be used for rest of the life. In case of any failure Normal-operation during this period the contractor shall take all necessary action to rectify the problems. The APS shall be accepted only after rectification of the problems by the contractor in a manner acceptable to the employer.

4.6 2KVA UPS

Two KVA UPS shall be supplied for bill collection centers as per the quantity specified in the BOQ. The technical particulars of these UPS shall be as mentioned below:

Technical Specification for 2 KVA (1.6 KW) UPS

	Parameter	Requirements
INPUT	Voltage	230±15% V AC, 50Hz, Single phase
	Frequency	50 ± 5% Hz
OUTPUT	Power	2 kVA / 1.6 kW (at 0.8 pf)
	Voltage	230V AC Single phase (±1 %)

	Parameter	Requirements
	Frequency	50 Hz & $\pm 0.2\%$ (Free Running)
	Regulation	$\pm 1\%$
	Transient Response	$\pm 5\%$ for 100% load change and recovers to normal within 10 milliseconds
	Waveform	Pure Sine wave, THD $< 2\%$ (linear load)
	Short term overload	110% for 15 minutes and 150% for 10 seconds
	Efficiency (Peak)	$> 90\%$
	Supported load pf	0.6-unity
	Change Over	Transfer time (in Sync Mode) less than 5 msec
BATTERY	Type	SMF/lead Acid tubular
	Backup time	4 hours
	Recharge Time	Maximum 12 hours*
	Life	Minimum 3 years (SMF)/ 8 years (LATB)
GENERAL	LED Indicators	Mains ON, Converter / Inverter faults, O/P high/low, Bypass mode, Inverter ON/OFF
	Audible Alarm	Main Failure, Low Battery, Overload
	Isolation	UPS output isolated from Mains Input
	Protection class	IP-21
	Temperature	0-45° C (Battery shall be sized at an average Temp. Of 27 Deg C.)
	Humidity	Upto 95% RH (Non condensing)

* **Note:** Battery shall be sized to deliver rated load for specified duration after charging for 12 hours from fully discharged state of battery (1.75V for VRLA).

4.7 Documentation

The following specific document for items covered under this section shall be submitted which shall be in addition to the applicable general document required under section 7.

- Data Requirement Sheets (DRS)
- Battery sizing calculations
- Cable sizing calculations
- Inventory of the hardware
- Panel General Arrangement drawing
- Panel Internal General Arrangement drawing indicating modules, major devices/components location etc.
- Installation drawings
- Schematic drawings
- Type Test reports
- FAT plan & procedure
- SAT plan & procedure
- External cable laying & termination schedule details
- Availability test plan & procedure

4.8 Mandatory Spares

List of mandatory spares for UPS, DCPS are mentioned in the BOQ

SCADA ENABLERS

SECTION – 5

CHAPTER-01

**TECHNICAL SPECIFICATION FOR IMPLEMENTATION OF MOTORIZED
SCADA RMUs / SCADA AUTO RECLOSERS/ SCADA SECTIONALIZERS/ SCADA
FPIs (COMMUNICABLE)**

5.0 STANDARDS:

- a) The equipment delivered shall be new and of high quality, suitable for the purpose it is intended for, free from defects and imperfections and of the classifications listed herein, or their equivalents, subject to acceptance by the Utility.
- b) Materials used in the manufacture of the specified equipment shall be of the kind, composition and physical properties best suited to their various purposes and in accordance with the best engineering practices.
- c) The equipment design shall be suitable to render satisfactory operation under the conditions prevailing at site, and the equipment shall operate satisfactorily under normal load and voltage variations and frequency variations (50 Hz \pm 3%) ensuring the safety, further include all necessary provisions ensuring the safety of the operating and maintenance personnel.
- d) As part of customization, Utility may change control voltage 24/48 Vdc as per site requirement but shall be uniform across state and vendor neutral and also the ambient /operational requirement as per site conditions such as high altitude over 2000m and low temperature , environment conditions Utility may specify location with altitude more than 2000m above MSL for compliance of in that project area
- e) However, the same shall be vendor neutral and serving objective of the scheme. Further, utility may opt RMUs / sectionalizer /AR with built in FRTU. In that case, The Quantity of the same shall be deducted from BOQ of FRTU and space for FRTU in the equipment may not be mandatory. The FRTU optionally can be housed in separate enclosure suitable for outside installation.
- f) The applicable standards of various equipment for the DMS project is as specified here below:

5.1 11kV 5, 4way & 3 way Ring Main unit

Description	Standard
<u>11kV 5 way .4 way & 3 way Ring Main unit</u>	
AC metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV	IS 3427
Classification of degrees of protection provided by enclosures of electrical equipment	IS 12063
High Voltage Switches	IS 9920 (Parts 1 to 4)
Specification for AC dis-connectors and earthing switches for voltages above 1000 V	IS 9921 (Parts 1 to 5)
HV AC Circuit Breakers	IS 13118
Dimensions of terminals of HV Switchgear and Control gear	IS 10601
General requirements of switchgear and control gear	IS 12729

Description	Standard
for voltages exceeding 1000 V	
High voltage/Low voltage prefabricated substations	IEC 1330
Common clauses for MV switchgear standards	IEC 62271-100/200
Monitoring and control	IEC 6081
Current Transformers	IS 2705
Voltage transformers	IS 3156
Specification for Static Protective Relays	IS 8686
Standards for high voltage metal clad switchgear up to 52 KV.	IEC 62271-200

5.2 Key RMU Configurations of RING MAIN UNIT

- **3 WAY RMU – Left or Right side extensible** Two (2) Motor operated load break switches (LBSs) **with manual operated** earthing switches **in SF6** and **1 vacuum circuit breaker** with Electrical closing and tripping along with dis-connector and earthing switches WITH BUS PT metering module and base channel and suitable space for mounting FRTU, battery charger , Auxiliary PT of suitable rating inside metering cubical. The Battery charger along with batteries required for Electrical operations of RMU is in the scope of the Bidder.
- **4 WAY RMU – Left or Right side extensible** Two (2) Motor operated load break switches (LBSs) **with manual operated** earthing switches **in SF6** and **2 vacuum circuit breaker** with Electrical closing and tripping along with dis-connector and earthing switches WITH BUS PT metering module and base channel and suitable space for mounting FRTU, battery charger , Auxiliary PT of suitable rating inside metering cubical. The Battery charger along with batteries required for Electrical operations of RMU is in the scope of the Bidder.
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- **5 WAY RMU - Left or Right side extensible** Two (2) Motor operated load break switches (LBSs) **with manual operated** earthing switches **in SF6** and **(3) vacuum circuit breakers** with Electrical closing and tripping along with dis-connector and earthing switches WITH BUS PT metering module and base channel suitable space for mounting FRTU, battery charger , Auxiliary PT of suitable rating inside metering cubical. The Battery charger along with batteries required for Electrical operations of RMU is in the scope of the Bidder.

1.0 Technical parameters

11 kV 5 way , 4 way and 3 way Motorized RMUs

5.1 **Scope of Work**

- The Package scope of work shall include design, manufacture, testing, delivery installation commissioning of **SCADA Compatible Ring Main Units** capable of being monitored and controlled by the SCADA/DMS/OMS AND SUB-STATION AUTOMATION. This also includes supply of relevant 11 kV cable termination kits including the jointing as per this tender specification

- Where relevant, the RMU scope of work shall be coordinated with the work to be carried out like providing of UG cable under the project's other construction packages.
- Each RMU shall include its own power supply unit (including auxiliary power transformer, batteries, and battery charger), which shall provide a stable power source for the RMU. The RMUs will be connected to the FRTU including the power supply required will be procured, supplied and installed by SIA. Each new RMU shall be equipped with main-line load break switches and a fault passage indicator (FPI). Furthermore, to protect each of its lateral / transformer feeders, it shall be equipped with a corresponding set of circuit breakers and self-powered numerical relays. The RMU shall include potential-free contacts so as to connect to SCADA/DMS/OMS AND SUB-STATION AUTOMATION via FRTUs, so as to:
 - Monitor and control the open/closed status of the RMU circuit breakers and load break switches.
 - Monitor the local/remote position of RMU manually-operated switches that can be used to enable and disable remote monitoring.
 - Monitor the health of the power supply, which will include battery failure and low voltage indications.
 - Monitor the open/closed status of RMU earthing switches.
 - **Facility for remote reset of FPI.**
 - Monitor for low SF6 gas pressure indication.
 - Monitor for circuit breaker relay operations.
 - Monitor for indication of main-circuit fault detected by the RMU's FPI.
 - The civil works, **foundations works** including providing of Earth pits and earth flat and their connectivity to earth pits for erection and commissioning of the RMU's are in the scope of the Bidder.
 - **Any site/ equipment/ statutory approvals at site etc. required shall be in Utility scope.**

5.1.1 Environmental Conditions

All materials supplied shall be capable of operating under relevant environmental conditions are listed as follows:

- Maximum ambient air temperature: - 55 °C
- Minimum ambient air temperature : - 0 °C
- Average ambient air temperature : - 40 °C
- Maximum relative humidity: - 0-100 %
- Average thunder storm days per annum: - 10
- Average rainfall per annum: - 400 mm
- Maximum wind speed: - 119 km/hr
- ☐ Utility may specify location with altitude more than 2000m above MSL for compliance of in that project area

5.1.2 Distribution Network Electrical Parameters

The main parameters of the distribution network are as follows:

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

5.1.3 Testing

The specified RMUs shall be subject to type tests, routine tests, and acceptance tests. Where applicable, these tests shall be carried out as per the standards stated above. Prior to acceptance testing, the supplier shall prepare and submit a detailed test plan for review and approval by the Utility.

5.1.4 11 kV 5 way ,4 way and 3 way RMU TECHNICAL PARAMETERS

- 5.1.4.1** The scope of supply is 11 kV 5 Way RMU, 4 Way RMU and 3 Way RMU suitable for outdoor application. The complete RMU i.e primary parts, gas tank, Outdoor enclosure , Vacuum Interrupter, Bus PT modules etc to be manufactured, inspected & offered from RMU manufacturer's own works.
- 5.1.4.2** The RMU to be supplied shall be compact and shall meet the following requirements:
- Easy to install
 - Safe and easy to operate
 - Compact
 - Low maintenance
- 5.1.4.3** It shall include, within the same metal enclosure number of MV functional units required for connection,
- Power supply including the battery bank for controlling the LBS and breakers
 - Load break switches,
 - Earthing Switches
 - Breakers
 - Relays
 - BUS PT metering module, FPI's and other allied equipment.
 - Space for FRTU
- 5.1.4.4** Equipment and material conforming to any other standard, which ensures equal or better quality, may be accepted. In such case copies of English version of the standard adopted shall be submitted.
- 5.1.4.5** The electrical installation shall meet the requirement of Indian Electricity Rules, 1956 as amended up to date; relevant IS code of practice and Indian Electricity Act, 1977. The Electricity Act, 2003 and Amendment if any shall also apply. In addition other rules and regulations applicable to the work shall be followed. In case any discrepancy the most stringent and restrictive one shall be binding.
- 5.1.4.6** The high-tension switchgear offered shall in general comply with the latest issues including amendments of the following standards but not restricted to them.
- 5.1.4.7** All design features of the proposed RMU, as described in the supplier's bid and in the bid's reference materials, shall be fully supported by the equipment actually delivered. The key design features include those that relate to:
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- Maintainability, expandability, and life span
- Ability to operate in severe outdoor environmental conditions.
- Immunity to electrical stress and disturbance.
- Acceptable insulation properties.
- Convenient FRTU interconnection features.

5.2 Maintainability, Expandability, and Life Span

5.2.1 Maintainability

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

5.2.2 Expandability

The whole switchgear (RMU) should be suitable for extension on at least one side either left or right.

5.2.3 Life Span

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

5.3 Outdoor Features

5.3.1 General

- The RMUs shall be designed specifically for outdoor installation with ingress protection degree of IP54. They shall also be suitable for conditions in which they will be exposed to heavy industrial pollution, and high levels of airborne dust.
 - The Outdoor RMU shall be conformably/ suitably coated/painted to meet these climatic conditions. In this respect, standards such as IEC 62271-200, covering equipment, systems, operating conditions, and environmental conditions shall apply. In particular, the RMU
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equipment shall have been type tested for IP54 from a national NABL aggregated laboratory. Failure to conform to this requirement shall constitute grounds for rejection of the proposal

- In addition to the above, materials promoting the growth of fungus or susceptibility to corrosion and heat degradation shall not be used, and steps shall be taken to provide rodent proofness.

5.3.2 Corrosion Protection

The main SF6 tank, housing the on-load break switches and the **vacuum circuit breakers** should be of **2.0 mm thick (minimum) stainless steel tank (SS 304 grade)** so as to have high corrosion resistance, non-magnetic and ensure high longevity. This tank containing SF6 to a **minimum pressure of 1.2 bars @ 20 deg C** should be hermetically robotic welded and sealed for life, ensuring a leakage rate not more than 0.1 % per annum. Except for stainless steel, all steel surfaces that are not galvanized shall be treated to protect against corrosion. As a minimum, corrosion treatment shall include the following procedures:

- The surface shall be cleaned to bare material by mechanical or chemical means.
- Must be powder coated by means of seven tank process
- **All outdoor metal enclosures shall be treated in 7 tank Pre-treatment process & should be painted with UV Resistant Pure Polyester Powder coating. The powder coated sheet steel fabrication shall fulfill 700 Hrs of Salt spray test. The thickness of Painting/Powder coating shall be of 100+/-25 microns to withstand tropical heat and extremes of weather.**

5.3.3 Immunity to Electrical Stress and Disturbance

The electrical and electronic components of the RMU shall conform to relevant standards concerning insulation, isolation, and **the product shall comply with IEC 60270 Immunity** to electrical stress & disturbance. The ability to meet these requirements shall be verified by type tests carried out by accredited test laboratories that are independent of the bidder and/or the manufacturer of the RMU components. Certified copies of all available type test certificates and test results shall be included as part of the bidder's proposal.

5.3.4 Minimum Insulation of Equipment

- The RMUs shall be of SF6 gas-insulated type with a minimum gas operating pressure of **1.2 BAR @ 20 deg C**.
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5.4 Nameplate Information

RMU nameplate information shall be determined in agreement with the Employer.

This information may include for example:

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

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

5.5 Interconnecting Cables, Wiring, Connectors, and Terminal Blocks

- The Contractor shall provide all interconnecting wires, cables, connectors, terminations and other wiring accessories such as terminal blocks required by the RMU.

5.5.1 Metallic Cables

- All metallic cables and wiring shall be of required cross-section solid or multiple strands of round copper conductors and have flame retardant insulation. All wiring shall be neatly laced and clamped.
 - All wire and cable connectors and terminators shall be permanently labeled for identification. All connection points for external cables and wires shall be easily accessible for connection and disconnection and shall be permanently labeled. Conductors in multi- conductor cables shall be individually color-coded.
-

5.5.2 Connectors

- **Nuts & Bolts type terminal blocks shall be provided in LV compartment for SCADA connectivity and to accommodate FRTU.**

5.5.3 RMU-FRTU Connectors

- For ease of installation and maintenance, the interconnection between the RMU and the FRTU, (FRTU to be installed by **SCADA Implementing agency (SIA)** in a separate enclosure shall be supported by having heavy-duty terminal blocks with **Nuts & Bolts type** terminals shall be provided by the supplier for necessary cable terminations. In using a terminal block, no more than two cables or wires shall be connected to any of its individual terminals.
- Making strips shall be used to identify all external connection blocks. Marking tags shall be read horizontally. All terminals to which battery or other high voltages are connected shall be provided with fireproof covers.
- All individual status input, AC voltage input, and control output points shall be isolatable without the need to remove wiring by means of individual terminal blocks of the removable link type. In order to avoid open circuits on the secondary side of CTs, termination blocks with by-pass bridges shall be provided for all AC current inputs.
- Terminal blocks shall comply with IEC 60947-7-1 (2009): Low-voltage Switchgear and Control Gear, Part 7-1: Ancillary Equipment, Terminal Blocks for Copper Conductors.

5.6 RMU Characteristics

- As a minimum, the RMUs shall be equipped with on-load break switches and a fault passage indicator (FPI), circuit breakers, and **self-powered** numerical relays for the protection of transformer feeders, and provision for wiring for multifunction transducer (MFT is not in the scope of the bidder, to be provided by **SCADA Implementing agency (SIA)**) for monitoring voltage, current, power, energy, and power factor readings and tripping and protection functionalities from the Communicable Numerical relay to be provided on the RMU. The Load Break Switches and earthing switches shall be housed in SF6 and the CircuitBreakers used in the RMU shall be **vacuum interrupter type (must be RMU manufacturer's own make)**.
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- In addition, each RMU shall be equipped with all necessary connectors, terminal blocks, and other accessories that will allow it to be connected to the FRTU, which in-turn will send required indications and measurements to the DMS via the communications system.

5.7 General Requirements

- Each RMU shall include its own power supply, including battery and battery charger. In addition, RMU should have a bus connected PT panel (air insulated), which shall serve as the power supply's 230 V AC input.
- Within this context, the general requirements of the RMU shall include, but shall not be limited to provision of the following monitoring and control features:
 - Positions of local/remote switches as used to control local and remote access to circuit breakers and load break switches
 - Power supply indications including battery failure and voltage alarms
 - Open/closed position of load break switches, circuit breakers, and earthing switches
 - SF₆ gas-pressure low indication.
 - Circuit breaker relay indications
 - Indications of fault in the RMU's main feeder circuit as detected by the FPI
 - Load break switch and circuit breaker open/close control
 - FPI remote reset.
 - Earth switch open/Close status for remote.
 - Door open potential free contact for SCADA.

5.8 *Parameter Requirements*

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

Table 1: System Parameters

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

Table 2: Circuit Breaker Parameters

Parameter	Value
Lightning Impulse Withstand Voltage Phase-to-Phase & Phase-to- Earth:	75 kV (peak)
Power Frequency Withstand Voltage to Earth, Between Poles, & Across Opening Span	28 kV rms for 1 minute
Rated Short Time Withstand/Breaking Current:	21 kA (rms)
Rated Duration of Short Circuit:	3 seconds
Rated Normal Current:	630 Amps (rms)

Table 3: Load Break Switch Parameters

Parameter	Value
Rated Short Circuit Making Capacity	52.5 kA peak at rated voltage (both LBS & Earthing Switch)
Rated Load Interrupting Current	630 Amps
Rated Cable Charging Interrupting Current	25 Amps

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

The equipment offered shall be as per the standards specified in the bid specification and if the offered equipment is tested with any other international standards which is superior to the standards specified they can also be considered and the bidder has to submit the documentary evidence for the same to Utility

5.9 Design Details

- The RMU shall be designed to operate at the rated voltage of 12 kV.
 - It shall include, within the same metal enclosure, On-load break switch, circuit breakers and earthing switches for each Load Break Switch/Circuit Breaker.
 - Suitable fool-proof interlocks shall be provided to the earthing switches to prevent inadvertent or accidental closing when the circuit is live and the concerned Load Break Switch/Circuit Breaker is in its closed position.
 - The degree of protection required against prevailing environmental conditions, including splashing water and dust, shall be not less than IP 54 as per IS 12063.
 - The active parts of the switchgear shall be maintenance free. Otherwise, the RMU shall be of low-maintenance type.
 - **The tank shall be made of minimum 2.0 mm thickness of stainless steel (SS304 grade)**
 - The Stainless Steel tank should be completely welded so as to ensure IP 67 degree of protection and shall be internal arc tested.
 - The RMU shall be suitable for mounting on its connecting cable trench.
 - For each RMU enclosure, a suitably sized nameplate clearly identifying the enclosure and the electrical characteristics of the enclosed devices shall be provided.
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- The access to the **cable compartment should be from the front** of the switchgear only to have minimum operating & maintenance space at site.
- The RMU design shall be such that access to live parts shall not be possible without the use of tools.
- The design shall incorporate features that prevent any accidental opening of the earth switch when it is in the closed position. Similarly, accidental closing of a Circuit Breaker or Load Break Switch shall be prevented when the same is in an open position.
- The RMU tank must be equipped with a suitable pressure relief device. The pressure relief must ensure that the escaping gases are dissipated to the rear / top/ bottom of the switchgear.
- The complete RMU shall be tested in an accredited INDIAN or FOREIGN laboratory and designed for an Internal Arc i.e. IAC AFLR 21 KA for 1 sec for Both Tank & Cable Compartment.

5.10 Earthing

- There shall be continuity between metallic parts of the RMUs and cables so that there is no dangerous electric field in the surrounding air and the safety of personnel is ensured.
 - The RMU frames shall be connected to the main earth bars, and the cables shall be earthed by an Earthing Switch having the specified short circuit making capacity.
 - The Earthing Switch shall be operable only when the main switch is open. In this respect, a suitable mechanical fail-proof interlock shall be provided.
 - The Earthing Switch shall be provided with a reliable earthing terminal for connection to an earthing conductor having a clamping screw suitable for the specified earth fault conditions. The connection point shall be marked with the earth symbol. The flexible connections between the earthing blade and the frame shall have a cross-section of at least 50 mm² copper or equivalent in GI
 - The Earthing Switch shall be fitted with its own operating mechanism. In this respect, manual closing shall be driven by a fast acting mechanism independent of the operator's action.
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5.11 Incomer Load Break Switches

- The Load Break Switches shall be maintenance free. With outdoor canopy doors open, the position of power contacts and earthing contacts shall be clearly visible from the front of the RMU through the Mimic facia.
- The position indicator shall provide positive contact indication in accordance with IS 9920. In addition, the manufacturer shall prove the reliability of indication in accordance with IS 9921. These switches shall have three positions (or states), i.e., Open, Closed, and Earthed, and shall be constructed in such a way that natural interlocking prevents unauthorized operations.
- The switches shall be fully assembled, tested, and inspected in the factory.
- In case of Manual operation without motors, opening and closing shall be driven by a fast-acting mechanism independent of manual operator action.
- The Load Break Switches shall be provided with a motorized operating mechanism suitable for SCADA control.
- A facility shall be provided with an electrical operating mechanism allowing an operator at the RMU site to operate the Load Break Switches without any modification of the operating mechanism and without de-energizing the RMU.
- The switch and earthing switch mechanisms shall have a mechanical endurance of at least 1,000 operations.

5.12 Circuit Breakers

- The Circuit Breakers shall be maintenance free and, when standing in front of the RMU with outdoor canopy doors open, their positions shall be clearly visible, through the Mimic facia. The position indicator shall provide positive contact indication in accordance with IS 9920. The breakers shall have three positions (or states), i.e., Open, Closed, and Earthed, and shall be constructed in such a way that natural interlocking prevents unauthorized operations. They shall be fully assembled, tested, and inspected in the factory.
 - An operating mechanism shall be used to manually close the Circuit Breaker and charge the mechanism in a single movement. It shall be fitted with a local system for manual tripping. There shall be no automatic reclosing. The Circuit Breaker shall be capable of closing fully
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and latching against the rated making current. Mechanical indication of the OPEN, CLOSED, and EARTHED positions of the Circuit Breaker shall be provided.

- Each Circuit Breaker shall operate in conjunction with a suitable protection relay under transformer feeder/ circuit phase and earth fault conditions. In addition, the Circuit Breaker shall be provided with a motorized operating mechanism that can be remotely controlled by the SCADA.
- The circuit breaker shall have a mechanical endurance of at least 1,0000 CO operations. The Circuit breaker Operating sequence must be O-0.3sec-CO-3Min-CO.

5.13 Cable Termination

- Bushings shall be conveniently located for working with the specified cables and shall allow for the termination of these cables in accordance with the prevailing practice and guidelines of cable manufacturers. The dimensions of the terminals shall be in accordance with IS 10601.
- A non-Ferro-magnetic cable clamp arrangement shall be provided for each cable to be terminated in the RMU.
- A suitable arrangement for the Circuit Breakers, Earthing Switches, and Load Break Switches shall be provided so that these devices can be padlocked in the "Open" and "Closed" positions.
- A permanent "Live Cable" indication as per IEC 61958 shall be provided for each cable using a capacitor voltage divider.
- It shall be possible to test the core or sheath insulation of the cables without disconnecting the cables in the cable compartment, after accessing the cable compartment. The cable end kits including the supply and erection is in the scope of the successful bidder.
- Two earth pits of 10 ohms each shall be provided diagonally and earthing to the equipment shall be done as detailed in the scope of supply.

5.14 Safety of Equipment

- With respect to the RMU's SF6-filled equipment, any accidental overpressure inside the sealed chamber shall be limited by the opening of a pressure-limiting device in the enclosure so that the gas will be released away from the operator and to the rear bottom or top of the
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tank without endangering the operator or anyone else in the vicinity of the RMU.

- All manual / motorized operations, monitoring of open/close position of switches/breakers, live line indicators, FPI indication, SF6 gas pressure indication and **access to the cable compartment shall be carried out from the front of the RMU only.**

5.15 Current and Voltage Transformers.

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

5.15.1 Current Transformers

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

5.15.1.1 CTs for Metering:

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

5.15.1.2 CTs for Protection:

- Material : Epoxy resin cast/ Tape wound
 - Burden : 2.5VA
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- Ratio : 200-100/1 A
- Accuracy Class : 5P10
- The RMU's other CTs / sensors, i.e., those used by Fault Passage Indicators (FPIs), shall be supplied by the FPI manufacturer. These CTs/sensors shall be an integral part of the FPI's design to ensure that they properly match the requirements of the FPI.

5.15.2 Voltage Transformers

- A 3 phase single or 3 nos. single phase potential transformers shall be provided. These should be housed in a separate air insulated PT Panel, directly connected to the RMU through main bus. The burden per transformer shall not be more than 50 VA and the voltage ratio shall be $11000 \text{ V} / \sqrt{3} / 110 \text{ V} / \sqrt{3}$. The accuracy class shall be 0.5.
- HRC fuses shall be provided on the HV side.
- The PTs shall be of cast epoxy-resin construction, and they shall conform to IS 3156. Their design and construction, in particular, shall be sufficiently robust to withstand the thermal and dynamic stresses during short circuits.

5.16 Fault Passage Indicator for RMU

- The FPI shall facilitate quick detection of faulty section of line. The fault indication may be on the basis of monitoring fault current flow through the device. The FPI should be self-powered and should have internal lithium battery for external indication and setting of FPI in the absence of current.

5.16.1 The FPIs shall include:

- Fault detection - Phase to phase and Phase to earth faults.
 - One potential-free output contacts for hardwiring to FRTUs. On this basis, the SCADA/DMS/OMS AND SUB-STATION AUTOMATION will be able to monitor phase / earth fault condition.
 - Local fault indications - LCD display on FPI front panel along with LED indication on front
-

panel of RMU enclosure.

- Multiple reset option –
- End of time delay (Adjustable from 2 to 16 Hrs)
- Remote reset (Via potential free input contact of FPI)
- Manual reset (Reset button on front panel of FPI)
- Automatic reset on current restoration.

5.16.2 The characteristics of the FPIs shall include:

- Phase fault thresholds configurable from at least 100 to 800 A
- Earth fault thresholds configurable from at least 20 to 200 A
- Multiple number of steps for adjusting phase and earth fault thresholds.
- Fault current duration range configurable from at least 40 ms to 100 ms in 20 ms steps and further 100 ms to 300 ms in 50 ms steps.
- Variations with respect to these characteristics may be acceptable as long as they prove applicable and provide the same or better flexibility.

5.16.3 Protection Relay

- The RMU shall be equipped with self-powered numerical relays (**Communicable relays shall be with auxiliary power which shall be given from battery but the tripping shall be self-powered philosophy**) communicable to trip the RMU circuit breakers

5.17.1 General

5.17.1.1 The Circuit Breaker in the RMU shall be fitted with a communicable-type, self-powered numerical relay, i.e., one for each outgoing circuit breaker. The protection relay's auxiliary contacts shall be provided for hardwiring to the FRTU. The relay shall also interface with the FRTU via an RS 232/485 port in order to send, as minimum, real-time readings using the MODBUS protocol.

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

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

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

5.17.2 Features and Characteristics

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

- It shall be housed in a flush mounting case and powered by the RMU power supply unit.
 - It shall have three phases over current elements and one earth fault element.
 - IDMT trip current settings shall be 50-200% in steps of 1% for phase over current and 10-80% in steps of 1% for earth fault.
 - Instantaneous trip current settings shall be 100-3000% in steps of 100% for phase over current and 100-1200% in steps of 100% for earth fault.
 - Selectable IDMT curves shall be provided to include, for example, Normal Inverse, Very Inverse, Extreme Inverse, Long Time Inverse, and Definite Time. Separate curve settings for phase over current and earth fault shall be supported.
 - For IDMT delay multiplication, the Time Multiplier Setting (TMS) shall be adjustable from 0.01 to 0.1 in 0.01 steps.
 - The relay shall also be provided with:
 1. Alphanumeric Liquid Crystal Display (LCD) for relay setting.
 2. Communications via a MODBUS RS232/RS485 port to provide the FRTU (and hence the DMS) with phase current measurements. It is also desirable
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that this same means of communication can be used by the FRTU to send setting and control commands to the relay.

3. Parameter change capability that is password protected.
4. LED indication on front panel eg battery , cable test. FPI shall have at least 2000 hours of flashing hours and support site Test functions.

5.17 Power Supply and auxiliary power transformer

Each RMU shall be fitted with a power supply, including batteries and battery charger, suitable for operating the motors of the On-load Isolators and Circuit Breakers. On this basis, the following operational specifications shall apply:

- The power supply unit shall conform to the following requirements:
 - 1) Input: 230 V AC nominal from the RMU's auxiliary power transformer allowing for possible variations from 190 to 300 V AC
 - 2) Output: Stable 24 V DC.
 - 3) Batteries: 24 V DC (2 Nos of 12 V DC each) SMF VRLA.
 - The auxiliary power transformer shall be of suitable rating as per the load calculation and the Auxiliary power transformer inputs shall be equipped with surge protection devices in accordance with IEC 62305.
 - The 24 V DC batteries shall have sufficient capacity to supply power to the following devices with a nominal backup of 4 hours:
 - 1) RMU's motors for a minimum of five (5) operations
 - 2) RMU's trip coils, close coils, FPI.
 - **The batteries shall be of sealed lead acid VRLA and shall have a minimum life of five (5) years at 25°C.**
 - The battery charger shall be fully temperature compensated.
 - To prevent deep discharge of the batteries on loss of AC power source, the battery charger shall automatically disconnect all circuitry fed by the batteries following a user-adjustable time period or when the battery voltage falls below a preset value. If the battery voltage falls below the preset value, the time to fully recharge all batteries shall not exceed twenty-four (24) hours.
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- An automatic battery checking device shall be provided to check the battery's health and initiate a battery-failed alarm signal in case battery deterioration is detected. Such detection may be based on comparing measurement values with set values (e.g., internal resistance, voltage, etc.).
- The battery charger shall be provided with an alarm displayed at the local control panel and remotely at the DAS to account for any of the following conditions:
 - 1) Low battery voltage
 - 2) Charger failed

5.18 Multi-Function Transducer (MFT)

The RMU main incoming On-load switches circuits shall be equipped with Communicable Numeric relays and the multi-function transducers to be supplied by SCADA Implementing agency (SIA) capable of providing distribution system voltage, current, power factor, power, and energy readings and is in the scope of the bidder. The wiring from metering current transformer shall be made available for connecting to MFT that is being provided by the SCADA Implementing agency (SIA). The data from Communicable Numeric relay regarding the tripping functionalities shall be provided and data shall be integrated with the FRTU.

5.19.1 Each MFT shall have the following minimum features:

- Measurement, display, and communications capability of up to 31 parameters
 - True rms measurement
 - Digital communications
 - Simple menu driven interface
 - High quality LED display
 - Able to monitor:
 - a) Voltage: line-to-line and line-to-neutral
 - b) Current: phase and neutral
 - c) Frequency d) Power factor
 - d) Power (active, apparent, and reactive)
 - e) Energy (active and reactive)
 - f) Total harmonic distortion
-

5.19 Construction

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

5.20 Enclosures

- All supplied enclosures shall be sized to provide convenient access to all enclosed components. It shall not be necessary to remove any component to gain access to another component for maintenance purposes or any other reason.
 - The enclosures shall also be designed to ensure that the enclosure remains rigid and retains its structural integrity under all operating and service conditions with and without the enclosure door closed.
 - The thickness of all enclosure panels shall be at least **2 mm (minimum)**. **The appropriate corrosion treatment and finish requirements shall apply to both inside and outside enclosure surfaces. Other required features are as follows:**
 - Constructed of mild steel according to IEC 60529 with IP rating 54 or better. Must be grit/shot blasted, thermally sprayed with Zinc alloy, phosphate, and subsequently painted with polyurethane based powder paint, the overall paint layer thickness including Zinc spraying shall be of the order of 80 to 90 microns
 - A metal pocket attached to the inside of the front door to hold documentation, maintenance log sheets, and other such information.
 - Door opening mechanism with built-in key-lock facility suitable for padlocking. An opening mechanism that is less prone to breaking than a projecting door handle is preferred, e.g., a push-button opening mechanism.
 - A grounding terminal including grounding bolt and lock washer for connecting a 50 mm² copper or galvanized steel grounding conductor. The grounding bolt and lock washer shall be made of stainless steel.
 - Means of preventing moisture from condensing on electronic components mounted inside the enclosure proposed for housing the FRTU. If necessary, heaters providing adjustable thermostat-control within the range 20 to 60 °C shall be installed in the enclosure for this purpose.
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- Means of protection against rain water, and high levels of airborne dust, should be provided.
- Means of enabling the SCADA to monitor the open/closed status of the enclosure door. A SCADA equipment alarm shall be produced whenever the enclosure door is open.
- The outdoor RMU shall include having a minimum protection class of IP 54. It shall be tested in accordance with the latest IEC 60529 standard.
- The outdoor canopy shall have a hinged front access door with a two-point latch locking system with a latch operating lockable handle. The door shall be fitted with a perimeter flange and gasket (rubber or neoprene) to prevent the entrance of water. In addition, a means of monitoring and indicating that the door is open shall be provided.

5.21 Motors

- The RMU shall be fitted with spring charging **24V DC** motors of high insulation class allowing the circuit breakers and load break switches to be operated without manual intervention.
- In addition to allowing circuit breaker tripping by the RMU's protection relays, the motorized operating mechanism shall be suitable for remote control by the SCADA.
- The motors along with the supplied control card and push buttons shall allow Utility's personnel to electrically operate the circuit breakers and load break switches at site without any modification of the operating mechanism and without de-energizing the RMU.

5.22 Inspection and Test

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

5.23.1 Inspections

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

5.23.2 Test Procedures

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

5.23.3 Test Reports

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

- A formal factory acceptance test shall be conducted to ensure that the RMUs have been designed to meet the utility's functional requirements in all respects. Utility representatives shall witness the test on a representative RMU, and the test shall be carried out in accordance with the supplier's test plan and procedures as approved by the Utility. Should the factory acceptance test prove unsatisfactory in any way, the Utility reserves the right to have further tests conducted and, if applicable, request further improvements in the supplier's RMU design.
- The Factory acceptance test of complete RMU to be done at RMU OEM's own factory.

5.23.5 Routine Factory Tests

- These tests shall be carried out during RMU manufacture as a quality control measure, i.e., to ensure each RMU to be delivered meets the Employer's minimum requirements including all relevant standards. Recording and reporting the routine test results shall be the responsibility of the Supplier.
- At the Utility's discretion, Utility representatives will witness such testing. This may include requesting the Supplier to perform tests on RMUs selected at random from each batch of RMUs that the Supplier deems ready to be delivered to site. Should any such test prove unsatisfactory, the Utility reserves the right to have further tests conducted and for delivery not to take place until a mutually agreed course of action has been reached.
- Further for additional reliability of the manufactured RMU it is mandatory to have the complete assembled tank tested for partial discharge.
- The routine test of complete RMU to be done at RMU OEM's own factory.

5.23 Operating Manuals

- The Supplier shall submit, operating manuals for all RMU components including items such as FPI, Relay, and other equipment provided by the bidder. These manuals shall be in English. They shall include the RMU operating instructions. Context sensitivity shall be used to go directly to the appropriate place in the manual.
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- The manuals shall be organized for quick access to each detailed description of the operator procedures that are required to interact with the RMU functions. This shall include the procedures to define, build, edit, and expand all data points provided with the RMU.
- The manuals shall present in a clear and concise manner all information that operators, including maintenance personnel, need to know to understand and operate RMUs satisfactorily. The manuals shall make abundant use of diagrams and/or photographs to illustrate the various procedures involved.

5.24.1 As-Built Documents and Drawings

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

2.3.1 11 KV AUTO-RECLOSER

Description	Standard
11 kV Auto recloser	
Requirements for overhead, pad mounted, dry vault, and submersible automatic circuit recloser and fault interrupters for AC systems (RI993)	ANSI/IEEE C37.60 -1981 IEC 62271-111
Electrical relays	IEC 60255
High-voltage alternating-current circuit breakers. Amendment No. 1:1 992.	IEC 60056:1987
Degrees of protection provided by enclosures (IP Code).	IEC 60529:1989

Standard	Description	Level
IEEE C37.60 IEC 62271-111	Requirements for overhead, pad mounted, dry vault, and submersible automatic circuit recloser and fault interrupters for AC systems	

IEC 60255	Electrical relays	
IEEE C37.60.6.13	Control element surge withstand	
IEC 60529	Degrees of protection provided by enclosures (IP Code). -Electronic modules -Control enclosure - Dangerous voltage screening	IP65 IP44 IP2X
IEC 68-2-5	Temperature rise due to Solar radiation 1.1kW/m ²	
IEC68-2-6	Vibration in 3 axes	
IEC 61000-4-2	Electrostatic Discharge	4
IEC 61000-4-3	Radiated Electromagnetic Field	3
IEC 61000-4-4	Fast Transient	4
IEC 61000-4-5	Surge	4
IEC 61000-4-6	Conduced Disturbances	3
IEC 61000-4-8	Power Frequency Magnetic Field	5
IEC 61000-4-11	Voltage Dips and Interruptions	3
IEC 61000-4-16	Conducted Common mode disturbances 0-150kHz	4
IEC 61000-4-18	Damped Oscillatory Wave	3

6.0 Auto reclosers

6.1 Scope of Work

- The Package scope of work shall include design, manufacture, testing delivery, installation commissioning of **SCADA Compatible (built-in FRTU) Auto Reclosers** along with Lightning Arrestors capable of being monitored and controlled by the SCADA/DMS/OMS AND SUB-STATION AUTOMATION.
 - Where relevant, the Auto recloser scope of work shall be coordinated with the work to be carried out under the project's other construction packages.
 - Each Auto recloser shall include programmable protection features and integrated remote operation capability and that are intended for installation on 11kV Feeders on distribution networks to implement complete overhead network automation. Auto recloser should have own power supply unit (including auxiliary **11000V / 230V Dry Type Resin Cast Power**
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Transformer, batteries, and battery charger), which shall provide a stable power source for the controller of the Auto recloser including the FRTU.

- The Auto-recloser shall be connected to its controller by means of umbilical cable using suitable connector.
- A primary objective of this specification is to foster modularity and a maximum level of interchangeability and integration to a central SCADA system by supporting IEC 60870-5-104 communications protocol.
- The auto-reclosure shall be fixed on the existing **MS pole** or **if additional pole is required, one 9.1 M (height) Steel Girder Pole / Rail Pole or MS Box 175 X 85 mm X 2 Nos. back to back box pole** with all the hardware and clamping structures conductor, concreting and earthing of the equipment etc., is in the scope of the Bidder.

6.2 APPLICABLE STANDARD

The following standards contain provisions that, through reference in the text, constitute requirements of this specification at the time of publication the revisions indicated were valid. All standards are subject to review and parties to purchasing agreements based on this specification are encouraged to investigate the possibility of applying the most recent revisions of the standards listed below.

Description	Standard
Auto reclosers	
Requirements for overhead, pad mounted, dry vault, and submersible automatic circuit reclosers and fault interrupters for AC systems (RI993)	ANSI/IEEE C37.60-1981/ IEC 62271-111
Electrical relays	IEC 60255
High-voltage alternating-current circuit breakers. Amendment No. 1:1 992.	IEC 60056:1987/ IEC 62271-1
Degrees of protection provided by enclosures (IP Code).	IEC 60529:1989

6.3 DEFINITIONS AND ABBREVIATIONS

6.3.1 Automatic Protection Group Selection (APGS):

An automated feature to determine and activate a pre-programmed group of protection settings based on the direction of power flow.

6.3.2 Auto-recloser (AR):

A mechanical switching device that, after opening, closes automatically after a predetermined time. Several reclosers could occur before lockout.

6.3.3 Cold load pick-up (CLP) feature:

A feature that allows modification of the over-current protection characteristics in order to prevent nuisance tripping under conditions of system energization.

6.3.4 Dead time:

Also referred to as "Reclosing Interval". This is the time between the instant that the current is interrupted by the AR and the instant the contact of the AR closes as a result of an automatic reclose operation. [IEC 50-448-04-09]

6.3.5 Definite time lag (DTL) protection element:

A protection element with a settable time delay that is constant above the pick-up current setting.

6.3.6 Delayed protection operation:

The protection functionality enabling delayed circuit-breaker operation, whether this is due to an IDMTL or DTL protection element.

6.3.7 Effectively earthed system:

An earthed system in which the healthy phase power frequency phase-to-earth over voltages associated with earth faults are limited to 80% of the highest phase-to-phase voltage of the system.

6.3.8 Fast curve protection element:

A family of curves with operating times approximately constant (slightly inverse) relative to the multiple of pick-up setting.

6.3.9 Instantaneous protection element:

An element with no intentional time delay active above a pre-determined pick-up current setting.

6.3.10 Inverse definite minimum time (IDMT) protection element:

A protection element of which the minimum operating time is adjustable and is inversely proportional to the fault current.

6.3.11 Lockout:

Where the recloser remains open and will not reclose automatically.

6.3.12 Pole-mounted remote terminal unit (PMRTU):

A remote terminal unit that is designed for pole mounting and that operates specific pole-mounted equipment remotely.

6.3.13 Rapid protection operation:

The protection functionality enabling rapid circuit-breaker operation, whether this is due to an instantaneous, fast curve, or a definite time delay protection element with relatively short definite time delay.

6.3.14 Reset time:

The time duration after a circuit-breaker close operation for which the measured currents are below a fault detecting level. On the expiry of this time the protection sequence resets.

6.3.15 Secure control:

A single mechanically non-latching switch that effects one state of a control function only. An example of which is either a non-latching switch or two separate push buttons that effect one state of a control function only in each position. If a control is activated repeatedly it only effects that state and does not change the state of the control.

6.3.16 Sensitive earth fault (SEF) relay:

A relay that is sensitive to very low earth fault currents and in which the operating settings are for current magnitude and definite time delay.

6.3.17 Supervisory:

Remote control and indications of an AR or a PMRTU by means of a telecommunications link.

6.3.18 Toggled control:

A single mechanically non-latching switch/push-button that enables a single control function on the first operation of the switch/push-button and disables the function on the second operation of the same switch/push button.

6.3.19 Sequence co-ordination:

The feature that allows protection devices to maintain sequence co-ordination for combinations of rapid and delayed protection operations.

6.4 REQUIREMENTS

6.4.1 General

The AR shall be suitable for use on effectively earthed networks and under the system

conditions and service conditions as follows.

The Auto recloser shall have insulation media and interruption with Vacuum Interrupter.

6.4.2 Environmental Conditions

All materials supplied shall be capable of operating under relevant environmental conditions are listed as follows: (Utility may change as per site requirement within logical limit and applicability)

- Maximum Ambient Air Temperature - 60°C
- Average ambient Air temperature - 40°C
- Minimum ambient Air Temperature - -5°C
- Relative Humidity - 0 to 100%
- Altitude - Utility may specify location with altitude more than 2000m above MSL for compliance of in that project area
- Annual rain fall - 750 mm
- Rainy Months - JUNE to OCTOBER
- Average no. of Rainy Days - 60
- Average no of Thunder Storms - 10
- Average Wind speed - 15-30 kmph

6.4.3 Distribution Network Electrical Parameters

The main parameters of the distribution network are as follows:

- | | | |
|---|---|----------------------------|
| a) Nominal system voltage (U) (r.m.s.) | - | 11 kV; |
| b) Maximum system voltage (Um) (r.m.s.) | - | 12 kV; |
| c) Load current | - | 630 A; |
| d) Short circuit-breaking capacity | - | 12.5 KA/1 Sec; |
| e) Lightning Impulse Withstand Voltage (BIL) | - | 75kV peak |
| f) System frequency | - | 50 HZ |
| g) Number of phases | - | 3; |
| h) Interrupting medium | - | Vacuum |
| i) Insulation medium | - | SF6 |
| j) Minimal number of rated load operations | - | 10000 |
| Operating Mechanism | - | LV motor/Magnetic Actuator |
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6.5 Testing

The specified Auto reclosers shall be subject to type tests, routine tests, and acceptance tests. Where applicable, these tests shall be carried out as per the standards stated above. Prior to acceptance testing, the supplier shall prepare and submit a detailed test plan.

6.6 Mounting Features of Autorecloser

The AR shall be suitable for single pole mounting and provided with the mounting bracket. Adequately rated lifting eyes shall be provided and they shall be designed to allow the completely assembled Auto recloser. The diameter of the eyes shall be a minimum of 30mm. Suitable mounting brackets for surge arresters shall be provided. The AR shall have laser cut markings on each bushing marked I, II, III for the normal line side and X, XX, XXX for normal load side. All support structures and associated bolts and nuts with these parts, shall be hot-dip galvanized.

6.7 Bushings

Bushings Terminals - The preferred arrangement for connection to overhead conductor is using crimp lugs with holes. The material for bushing shall be outdoor Cycloaliphatic epoxy resin / hydrophobic Cycle aliphatic epoxy / HECP. There shall be encapsulated CVTs for voltage measurement on bushings required for auto-reconfiguration of the network.

6.8 Finish

- All interior and exterior ferrous surfaces of auto recloser and control cabinets shall be manufactured from 304 or better grade stainless steel.

6.9 Control Equipment

6.9.1 Control cabinet

- Electronic control and protection modules shall be mounted in a weather-proof outdoor cabinet with access to the contents through one door. The cabinet will be mounted independently of the AR.
 - The cabinet shall be manufactured from 304 or better grade stainless steel.
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- Suitable ultraviolet-resistant cable, 7 m long, shall be provided to connect the AR to the control cabinet.
 - It shall be possible to disconnect the cable at the AR while the AR is connected to the power system, without causing damage or malfunction: care shall be taken that CTs are not open circuited. A robust, multi-pin weatherproof connector shall be supplied. The female part of the connector shall be mounted on the AR and the male part shall be mounted on the cable. Preference will be given to products supplying connectors at both the AR and the control cabinet.
 - Cabinets shall be adequately sealed with ingress protection rating of IP55. Internal module design and placement will avoid the need for moisture control heaters.
 - The supplier shall ensure that the equipment housed in the control cabinet can withstand the heating effect of direct solar radiation without causing failure and/or malfunction. Details shall be provided in the tender documentation.
 - The cabinet shall make provision for bottom entry of three cables (excluding the cable connected to the AR). All holes shall be pre-punched, two with a diameter of 20 mm and one with a diameter of 32 mm. The holes shall be suitably blanked off.
 - Ventilation holes shall be provided to drain water and avoid hydrogen build-up.
 - The cabinet shall be fitted with an external M12 earthing stud with a nut, lock nut and a serrated washer.
 - The door of the cabinet shall be fitted with a robust locking arrangement that is capable of being secured by a padlock that has a shackle of 10 mm diameter. A minimum of two latching points shall be provided. The cabinet door shall be removable for replacement in the field.
 - A door stay shall be fitted to keep the door open while operators are attending the unit.
 - Front door entry shall allow access to the operator interface, accessory equipment and communication cables. If an internal swing panel is fitted, the panel shall have a door stay fitted, shall weigh less than 5kg, shall not have any sharp edges and there shall not be any danger of pinching or guillotining an operator's fingers or hands
 - All connections that could potentially expose the operator to dangerous voltages will be shielded to IP2X. These connections include the terminals used for current transformers, primary power supply and voltage measurement inputs.
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6.9.2 Control Equipment

6.9.2.1 The controller shall provide following integrated features:-

- Local human machine interface (HMI) shall be menu driven via 6 menu display groups.
- Protection flags and counters displayed on LCD.
- Large 4 lines by 40 characters LCD **or as per manufacturers std.**
- Four configurable quick keys.
- Operator Interface turns on when opening the door.
- Close and Open indications LEDs.
- Trip & close circuit isolation shall be through large rocker switches.
- Front mounted isolated RS 232 data port for local communication at site.
- It shall be with automatic and manual battery health monitoring.
- Electronic modules shall perform continuous diagnostic monitoring and shall contain hardware and software watchdog checking.

6.10 Protection, Measurement & Power Quality characteristics.

6.10.1 Following protection element shall be provided with at least 4 independent protection group settings.

- Phase Instantaneous Overcurrent
 - Earth Instantaneous Overcurrent
 - Phase Time Overcurrent.
 - Earth Time Overcurrent.
 - Phase time Overcurrent Protection.
 - Loss of Phase (LOP) protection..
 - Sensitive Earth fault (SEF) protection
 - Earth fault protection
 - Voltage Imbalance
 - Negative Sequence Instantaneous Overcurrent.
 - Sensitive Earth Fault Instantaneous Overcurrent.
 - Under frequency & over frequency protection / auto-restoration
 - Under Voltage & over Voltage protection.
 - Cold load pickup control.
-

- Phase Directional protection
- Earth Directional Protection
- Directional Blocking.
- Loop Automation.
- Directional Protections.

6.10.2 - The ratio of drop-off current to pick-up current shall be at least 95 % for all protection functions.

6.10.3 - The E/F and SEF functions shall be equipped with harmonic filtering to prevent operation when harmonics are present in the primary residual earth currents

6.10.4 - All protection functions, i.e. over-current (O/C), earth fault (E/F) and sensitive earth fault (SEF) shall have elements with characteristics that comply with IEC 255.

6.10.5 - All the basic protection parameters shall be provided with Standard inverse (SI), very inverse (VI) or extremely inverse (EI), definite time curve.

6.10.6 - In addition to above, provision for at least four customer programmable curves shall be provided.

6.10.7 - LOP shall be provided to ensure the protection functionality; auto recloser should trip with no auto reclose , in case if there is a loss of voltage on one or two phases on the upstream part of the line. Loss of supply on all three phases shall not generate the protection trip. There shall be facility to turn LOP ON or OFF without affecting other protection functions of the device.

6.10.8 - SEF a primary earth fault current of 4A to 20A in steps not exceeding 1A shall be detectable. Delayed protection operation shall be possible by selecting a definite time protection element with time delay from 3s to 25s, in 1s steps.

6.10.9 - The AR and Control element shall support multiple protection groups and this shall meet the requirements specified below:

- The AR shall have minimum 4 independent protection groups. The Protection Groups shall have clear indication and shall be marked as "I, II, III, IV" or "A, B, C, D"
- Each protection group shall have the facility to configure O/C, E/F and SEF trip current and specify the number of the protection trips independently from others.
- Changes to any of the protection parameter to any of the not active protection group shall not affect the protection functionality of the active protection group.
- Information about activation of any of the protection group shall be recorded in history and shall be easily assessable. Information about protection trip shall clearly indicate the protection group, active at the time of fault.
- AR and Control element shall have the facility for Automatic protection group selection. Automatic Protection Group Selection shall have the facility to be turned ON or OFF with pass-word protection or other form of access control.
- **The auto re-closures shall have the facility including the software of connecting in LOOP AUTOMATION. Supply outage management is in the scope of bidder.**
- The Modem required for the Auto recloser will be provided by the **SCADA Implementing agency (SIA)**.
- The earthing of auto recloser as per the standard including providing of earth pit, and connection to the control cabinet and other allied equipment is in the scope of bidder.

6.11 Auto recloser Operation parameters

- 6.11.1** - The number of sequential trips to reach lockout shall be selectable to be either 1, 2, 3 or 4.
- 6.11.2** - Reset times shall ideally be separately selectable for SEF and the combination of over-current and earth fault functions. The reset time shall be selectable from 5s to 120s in 1s steps.
- 6.11.3** - Dead times shall ideally be separately selectable for SEF and the combination of over-current and earth fault functions. The dead time between each -successive recloser shall be independently selectable from instantaneous to 5s for the first recloser and from a minimum of 2s up to a maximum of 120s for subsequent reclosers.
- 6.11.4** - A close instruction initiated locally or remotely during a dead time shall result in lockout if the fault is still present upon closure.
-

6.12 Auto Recloser Statistical Measurement Functions

6.12.1 - The Measurement shall be done with one of the following methods i.e. three-phase-3-wire method; and or the three-phase-4-wire method and made available at HMI and remote location.

6.12.2 - Quantities to be measured/calculated with specified accuracy are:

- Phase Voltage (V) $\pm 2.5\%$ of auto-recloser rated voltage.
- Line Voltage (V) $\pm 2.5\%$ of auto-recloser rated voltage.
- Phase Current (A) $\pm 2.5\%$ of auto-recloser rated current.
- Three phase active Power (kW) $\pm 5\%$;
- Three phase reactive power (kVAr) $\pm 5\%$;
- Total three-phase active energy (kWh) $\pm 5\%$;
- Power factor $\pm 5\%$;
- Maximum demand $\pm 5\%$.
- Phase Angle ± 10 deg.
- Total Pwr (KW, KVA, KVAr) $\pm 5\%$.

6.12.3 The real power energy and maximum demand measurement shall be integrated with respect to time. Energy values shall be calculated with selectable time **integration periods of 30 min.** The data buffer shall work on the FIFO principle and a minimum size for the data buffer shall store values for 4 months on the 30 minutes integration period.

6.12.4 - Supply Outage management (SOM), AR and Control element shall have the facilities to record the number and duration of outages. The information shall be assessable locally or remotely using SCADA system.

6.12.5 - The following parameters shall be recorded as ,

- Cumulative total number of outages.
- Cumulative total outage duration.
- Time and duration of each outage

6.12.6 - Power Quality analysis characteristics

- **Waveform Capture** It shall capture the Waveform and store in flash memory filtered and scaled raw data (10 x 3200 samples per second) of the **3 line to earth or 3 line to line voltages and 4 currents** for a predefined time window either side of a user-defined trigger. The user shall be able to configure a pre and post trigger time ratio for data to be stored.
- **Harmonic Analysis:** It shall be able to calculate for voltages and currents of 2nd to 7th harmonic and Total Harmonic Distortion (THD) for 4 currents and **3 line to line voltages or 3 line to earth voltages**.
- **Sag and Swell monitoring**, when sag/surge is identified then an event shall be logged. The same shall be downloadable at the remote through communication interface.

6.13 Local Engineering

6.13.1 - The AR controller shall contain a real time clock (with leap year support) that can be set both locally and remotely.

6.13.2 - A facility for selecting all the protection, operating and communications characteristics shall be locally available in the control cabinet. Optional password protection against unauthorized changes shall be available.

6.13.3 - Event Records

- **The controller shall provide, non-volatile memory storage shall be sized to store at least 3,000 logs :**
- All operating, protection and communications parameters.
- **An event record containing at least 3,000 events.**
- All setting change logging.
- Maximum demand shall have the facilities to be configured for weekly or monthly demand.
- Demand Logging shall be daily, weekly, monthly.
- It shall record wide range of parameters such as current, voltage, **including the monitoring of the battery and its healthiness, gas pressure etc. with IEC 104 protocol.**
- **It shall also record specific information including temperature pertaining to Control box**
- Facility for configuring the interval in minutes shall be provided.

6.13.4 - A pointer shall be provided to indicate up to where the data was last read. This will

enable regular uploading of the data without re-loading of previously read data.

6.13.5 - All events shall be time and date stamped with a resolution of at least 10 ms relative to the onboard real time clock.

6.14 Tele Control Requirements

6.14.1 The AR controller shall detect and report disconnection of the control cable between the controller and AR.

6.14.2 It shall be possible to operate AR, change the active protection group, turn Auto-Recloser capabilities ON/OFF and turn E/F and SEF ON/OFF remotely using the protocol specified.

6.15 Communication

6.15.1 As a minimum, one independent RS-232, & two Ethernet communication ports that allow for simultaneous operation shall be provided, to be used as follows

6.15.2- A USB port shall be provided to upload the non-volatile data to and from a personal computer.

6.15.3- To interface to remote communications equipment (modems, radio-modems, GSM/GPRS and Fiber Optic) [GSM/GPRS modem will be supplied through **SCADA Implementing agency (SIA)**].

6.15.4 - As a minimum, it shall be possible for serial ports to operate at the following speeds :

- 1200 bps
- 2400 bps
- 9600 bps
- 19200 bps

6.15.5 - Provision shall be made for mounting modems

6.15.6 - It shall be possible to disconnect the RS-232-to-modem interface to facilitate local protocol and communications troubleshooting. Alternatively, a low-level protocol monitor shall be integrated in the software and accessible via the diagnostic port.

6.15.7- The protocol to be supported by the AR controller for remote communications shall be IEC 60870-5-104 Protocol

6.15.8- The serial ports shall have IEC 60870-5-101 protocol and shall be available as a backup port.

6.16 Power Supply

6.16.1- The AR system shall provide power for the electronics, operation of the AR and Controller operation and Modem being provided separately. The **Dry Type (Resin Cast) 11000/230 V AC Control Transformer shall be used for supplying at least 100VA** or higher suitable for self-operation of AR and Modem.

6.16.2- Primary supply: Preference will be given to the ability to obtain primary power directly from the HV power system requiring no additional primary supply connection.

6.16.3- Test supply: The AR shall accept an external AC 230 V 50 Hz supply.

6.16.4- Auxiliary supply: An auxiliary supply with the following minimum characteristics shall be provided

6.16.5- One battery and constant voltage charger with current limiting shall be part of the AR. Battery standby time shall not be less than 24 hours and shall allow for a minimum of ten (10) sequences of LRC trip-close operations and a transmit/receive standby duty cycle of 10/90 percent with respect to the GPRS modem. The battery shall recharge to 80 % of its capacity in a maximum of 15 h. The total number of circuit-breaker operations under the above communications scenario shall be at least 10 AR operations preventing closing if the battery will not have enough stored energy to open the circuit- breaker for a protection trip condition.

6.16.6- Batteries shall be disconnected at the manufacturer's specified minimum voltage.

6.16.7- Battery Low' indication shall be available locally and remotely and shall include a battery test. The indication of "Battery Low" status shall allow for a further ten AR operations.

6.16.8 -The minimum battery life expectancy shall be 5 years. Details of the guaranteed life expectancy of the battery shall be stated in the tender documentation.

6.17 Maintenance and commissioning

6.17.1 All the communications equipment shall be easily accessible in the control cabinet. Wiring of "communications links in the control cabinet shall permit the connection of a temporary

protocol-Monitor. It shall be possible to perform secondary injection testing while the AR is communicating with the center.

6.17.2 It shall be Possible to disconnect the AR circuit breaker and connect a simulated breaker to the control cabinet for testing purposes.

6.17.3 The AR shall not malfunction while the modem is transmitting via an antenna in close proximity and the control cabinet door is open.

6.17.4 Provision shall be made in the control cabinet for individually isolating the power supply to/from the following:

- Battery;
- Battery charger;
- GPRS modem; and
- Primary supply to the control cabinet electronics.

6.18 Rating Plate

Each AR shall bear a rating plate of an intrinsically corrosion-resistant material, indelibly marked with the sea-level rating for which the equipment has been type tested. The rating plate shall be indelibly marked with:

- The manufacturer's name;
- The equipment type designation and serial number of the AR;
- The mass, in kilograms;
- The date of manufacture;
- The voltage transformer ratio, class and burden.
- Auxiliary supply voltage (if applicable).
- Purchase Order number and date.
- Each AR shall also exhibit a Danger Board to indicate the presence of high voltage.

6.19 Additional Information

The following shall be submitted with the tender.

6.19.1- Circuit breaker details

- Manufacturer;
 - Type designation;
-

- Place of manufacture;
- **Short circuit breaking capacity: 1s**
- Asymmetrical breaking current;
- Peak making current; and
- Critical current (maximum instantaneous peak).

6.19.2- A schematic-wiring diagram of the AR offered.

6.19.3- A general-arrangement drawing of the AR offered.

6.19.4- Details of the maintenance and operating equipment and procedures needed and a detailed parts list of the various components.

6.19.5- A description of the AR operation, with instruction and maintenance manuals, including maintenance schedules, protection characteristics, communications facilities, the method of applying settings to relays and controls, together with any software required and the cost thereof. The software requirements shall be stated in the tender documentation.

6.19.6- Details and the cost of any available portable calibration and diagnostic test set that may be used to perform the functionality described.

6.19.7- A list of recommended spares and tools, quoting the prices of each item and its availability.

6.19.8- If protection setting changes are accomplished by resistors, electronic cards or modules or computer programs, the price and range of such items. The method of changing protection settings shall be stated in the tender documentation.

6.19.9- Details of technical back-up facilities available. These details shall be stated in the tender documentation.

6.19.10- Details of the class, ratio(s) and burden of the protection current transformer and voltage transformer, if supplied, shall be stated in the tender documentation.

6.19.11- The supplier shall include the following details of measurement current transformers (not internal to the AR) that can be supplied with the AR. The following details shall be provided:

- Available ratio(s) and accuracy class;
- Method of fitting; and
- Effect on Creepage distance and BIL

6.19.12- Details of AR service history:

- How many in service, where and for what period;
-

- Contact names and numbers.

6.19.13 - Details of LV trip/close coil if available as an option

6.19.14 - Power requirements for a close operation

6.19.15- The maximum achievable separation between the control unit and the circuit breaker.

6.19.16- Full details of the protocol implementation and the complete point database.

6.20 Tests

6.20.1 Type Tests

The AR shall have been type tested in accordance with, and found to comply with, the requirements of either IS or ANSI/IEEE C37.60-2003/IEC 62271-111 for the following, and the appropriate. Values shall be stated.

- Interrupting performance (automatic operation).
- Interrupting performance (manual operation).
- Operating duty.
- Making current.
- Minimum tripping current.
- Insulation (dielectric tests).
- Radio interference voltage.
- Temperature rise.
- Mechanical operations.
- Control equipment surge withstand capability.

6.20.2 Test records (on identical equipment) in the form of validated copies of test certificates issued by a recognized testing authority shall be submitted with the tender documentation.

6.20.3 Routine tests

- Routine tests, as required in the relevant standards, shall be carried out as a normal requirement of the contract and, unless otherwise agreed upon, shall be witnessed by the purchaser or by his appointed representative. No additional charge shall be levied for such tests or for the production or presentation of documentation related to routine tests.
 - Duplicate copies of routine test certificates shall be supplied together with the equipment when the latter is delivered to the final destination stated in the order.
-

6.21 Packing and Documentation

6.21.1 Packing

All equipment shall be carefully packed to prevent damage or deterioration during normal transportation, handling and storage. Each container shall bear the following information on the outside of the container:

- The address of the destination
- The gross mass, in kilograms
- The name of the manufacturer
- The purchaser's order number and port of destination

6.21.2 Documentation

Each AR shall be supplied complete with the documentation specified in Items, together with the routine test certificates specified above.

Five

2.3.2 11 KV SECTIONALIZER

Description	Standard
11 kV Sectionalizers	
High Voltage Switches	IEC 60265-1
Degrees of protection provided by enclosures (IP Code).	IEC 60529:1989

7.0 SECTIONALIZER

7.1 Scope of Work

This specification covers requirements for outdoor **SCADA Compatible Pole-mounted Sectionalizer** / load break switches **along with Lightning Arrestors and 11KV 400A Conv. AB Switch with Single break** that have programmable fault detection with built-in FRTU and the Sectionalizer features and integrated remote operation capability and that are intended for installation on 11kV Feeders on distribution networks to implement complete overhead network automation.

A primary objective of this specification is to foster modularity and a maximum level of interchangeability and integration to a central SCADA system by supporting IEC 60870-5-

104 communications protocol.

The **Sectionalizer** shall be fixed on the existing **MS pole** or **if additional pole is required, one 9.1 M (height) Steel Girder Pole / Rail Pole or MS Box 175 X 85 mm X 2 Nos. back to back box pole** with all the hardware and clamping structures conductor, concreting and earthing of the equipment etc., is in the scope of the Bidder.

7.2. APPLICABLE STANDARD

The following standards contain provisions that, through reference in the text, constitute requirements of this specification at the time of publication the revisions indicated were valid. All standards are subject to review and parties to purchasing agreements based on this specification are encouraged to investigate the possibility of applying the most recent revisions of the standards listed below.

Description	Standard
High Voltage Switches	IEC 60265-1
Degrees of protection provided by enclosures (IP Code).	IEC 60529:1989

7.3. CONSTRUCTION

7.3.1 General

The Sectionalizer / load break switch shall be suitable for use on non-effectively earthed and effectively earthed networks and under the system conditions and service conditions as follows:

7.3.2 Environmental Conditions

All materials supplied shall be capable of operating under relevant environmental conditions are listed as follows:

- Maximum ambient air temperature : 50 °C
 - Minimum ambient air temperature : 0 °C
 - Average ambient air temperature : 40 °C
 - Maximum relative humidity : 0-100 %
 - Average thunder storm days per annum 10
 - Average rainfall per annum : 400 mm
-

- Maximum wind speed : 119 km/hr
- Utility may specify location with altitude more than 2000m above MSL for compliance of in that project area

7.3.3 Distribution Network Electrical Parameters

The main parameters of the distribution network are as follows:

- | | | |
|---|---|------------------|
| 1) Nominal system voltage (U) (r.m.s.) | - | 11 kV; |
| 2) Maximum system voltage (Um) (r.m.s.) | - | 12 kV; |
| 3) Load current | - | 400 A; |
| 4) Lightning Impulse Withstand Voltage (BIL) | - | 75 kVpeak |
| 5) System frequency | - | 50 / 60Hz; |
| 6) Number of phases | - | 3 |
| 7) Interrupting medium | - | SF6 |
| 8) Insulation medium | - | SF6 |
| 9) Minimal number of rated load operations | - | 600 |
| 10) Minimal number of no load mechanical operation | - | 3000 |
| 11) Operating Mechanism | - | LV motor |

7.4 DEFINITIONS AND ABBREVIATIONS

7.4.1 Automatic Detection Group Selection (ADGS):

An automated feature to determine and activate a pre-programmed group of detection settings based on the direction of power flow.

7.4.2 Cold load pick-up (CLP) feature:

A feature that allows modification of the over-current fault detection characteristics in order to prevent false fault detection under conditions of system energization.

7.4.3 Dead time:

Also referred to as "Reclosing Interval". This is the time between the instant that the current is interrupted by the AR and the instant the contact of the AR closes as a result of an automatic reclose operation.

7.4.4 Definite time:

A fault detect event occurs if the current exceeds the fault threshold setting for a time equal to the definite time setting.

7.4.5 Effectively earthed system:

An earthed system in which the healthy phase power frequency phase-to-earth over voltages associated with earth faults are limited to 80% of the highest phase-to-phase voltage of the system.

7.4.6 Pickup:

The fault detection elements are monitored and an element “picks up” when the measured current exceeds the preset level of the specific element. Typical detection elements are Phase, Earth and Sensitive Earth Fault (SEF).

7.4.7 Pole-mounted remote terminal unit (PMFRTU):

A remote terminal unit that is designed for pole mounting and that operates specific pole-mounted equipment remotely.

7.4.8 Sequence reset time:

The time duration after a supply interruption occurred before the sectionalising sequence resets if the sectionaliser does not detect another fault.

7.4.9 Sectionalising:

The ability of the load break switch to count the operations of an upstream AR and to open during the dead time of the AR after a configurable number of supply interrupts.

7.4.10 Secure control:

A single mechanically non-latching switch that effects one state of a control function only. An example of which is either a non-latching switch or two separate push buttons that affect one state of a control function only in each position. If a control is activated repeatedly it only effects that state and does not change the state of the control.

7.4.11 Sensitive earth fault (SEF):

A relay that is sensitive to very low earth fault currents and in which the operating settings are for current magnitude and definite time delay.

7.4.12 Supervisory:

Remote control and indications of an LBS or a PMRTU by means of a telecommunications link.

7.4.13 Supply Interruption:

A fault pickup followed by a “no current” and “no voltage” condition is called a Supply Interruption. This condition typically occurs when an upstream recloser trips due to a

downstream fault.

7.4.14 Toggled control:

A single mechanically non-latching switch/push-button that enables a single control function on the first operation of the switch/push-button and disables the function on the second operation of the same switch/push button.

7.5 Testing

The specified Sectionalizer shall be subject to type tests, routine tests, and acceptance tests. Where applicable, these tests shall be carried out as per the standards stated above. Prior to acceptance testing, the supplier shall prepare and submit a detailed test plan.

7.6 Mounting of Sectionalizer

The LBS shall be suitable for single pole mounting and shall be provided with mounting brackets. Adequately rated lifting eyes shall be provided and they shall be designed to allow the completely assembled LBS. The diameter of the eyes shall be a minimum of 30mm. Suitable mounting brackets for surge arresters shall be provided. The LBS shall be fitted with an external M12 Earthing stud, complete with a nut, lock nut and spring washer. The earth stud shall be welded to the tank for optimal Earthing connection. All support structures and associated bolts and nuts with these parts, shall be hot-dip galvanized.

The earthing of sectionalizer as per the standard including providing of earth pit, and connection to the control cabinet and other allied equipment is in the scope of bidder.

7.6.1 Bushings

The preferred arrangement for termination is an insulated bushing arrangement achieved by using **epoxy resin bushing/ HECP**. The material for bushing shall be outdoor aromatic epoxy resin with silicon rubber boots details of the type and Creepage shall be provided.

7.6.2 Finish

All interior and exterior ferrous surfaces of the LBS and control cabinets shall be manufactured from marine grade 304 or 316 Stainless steel.

7.6.3 Control Equipment

7.6.3.1 Control cabinet

7.6.3.1.1 Cabinets that house equipment for detection and control shall be mounted independently

of the LBS. The cabinet shall be manufactured from 304 or 316 grade stainless steel.

7.6.3.1.2 Suitable ultraviolet-resistant cable shall be provided to connect the LBS to the control cabinet.

7.6.3.1.3 It shall be possible to disconnect the cable at the LBS while the LBS is connected to the power system, without causing damage or mal-operation: care shall be taken that CTs are not open circuited.

7.6.3.1.4 A robust, multi-pin weather proof connector shall be supplied. Preference will be given to products supplying connectors at both the LBS and the control cabinet.

7.6.3.1.5 Cabinets shall be adequately sealed and dust protected and shall be internally treated to prevent moisture condensation. The degree of protection shall be suitable for purpose.

7.6.3.1.6 The control cabinet shall be for all – weather access & vandal resistant.

7.6.3.1.7 The door of the cabinet shall be fitted with a robust fastening arrangement that is capable of being secured by a padlock that has a two point locking mechanism system.

7.6.3.1.8 The cabinet shall be fitted with an external Earthing stud with a nut, lock nut and a serrated washer.

7.6.3.1.9 The control cabinet shall house Control and detection enclosure, which shall incorporate all the electronic modules. These electronic circuits shall fulfill the functions ,detection ; Network measurement; Communications; Switch control; Operator interface; and Uninterruptible power supply.

7.6.3.1.10 All the components shall be assembled in a die cast aluminum enclosure and shall be housed inside the Box of Stainless steel of grade 304 to protect the electronics against electromagnetic, electrostatic and environmental influences

7.6.3.1.11 The controller shall provide following integrated features: -

- Local human machine interface (HMI) shall be menu driven via 6 menu display groups.
 - Protection flags and counters displayed on LCD.
 - Large 4 lines by 40 characters LCD.
 - Four configurable quick keys.
 - Operator Interface turns on when opening the door.
 - Close and Open indications LEDs.
 - Trip & close circuit isolation shall be through large rocker switches.
 - Front mounted isolated RS 232 data port for local communication at site.
 - It shall be with automatic and manual battery health monitoring.
-

- Electronic modules shall perform continuous diagnostic monitoring and shall contain
- hardware and software watchdog checking.

7.7 Detection, Measurement & Power Quality characteristics.

7.7.1 Detection features:-

The Following detection element shall be provided with at least 4 independent detection group.

- Phase Instantaneous Over-current
- Earth Instantaneous Over-current
- Phase Time Over-current.
- Earth Time Over-current.
- Sensitive Earth fault (SEF).
- Earth fault.
- Sensitive Earth Fault Instantaneous Over-current.
- Cold load pickup control.

7.7.1.1 Each of the detection elements is monitored with independent definite time settings and fault threshold.

7.7.1.2 The ratio of drop-off current to pick-up current shall be at least 90 % for all detection functions.

7.7.1.3 The O/C pick-up setting shall be selectable from 10 A to 400 A in steps.

7.7.1.4 A cold load pick-up feature shall be provided that allows user selectable modification of detection element characteristics under condition of system power restoration.

7.7.1.5 The SEF functions shall be equipped with harmonic filtering to prevent operation when harmonics are present in the primary residual earth currents

7.7.1.6 SEF a primary earth fault current of 4A to 20A in steps not exceeding 1A shall be detectable.

7.7.1.7 The LBS and Control element shall support multiple detection groups and this shall meet the requirements specified below:

- The LBS shall have minimum 4 independent detection groups. The Detection Groups shall have clear indication and shall be marked as "I, II, III, IV" or "A, B, C, D"
- Each detection group shall have the facility to configure O/C, E/F and SEF fault detection current and definite time.
- Changes to any of the detection parameter to any of the not active detection group shall not affect the detection functionality of the active detection group.
- Information about activation of any of the detection group shall be recorded in history and shall be easily assessable. Information about fault detection shall clearly indicate the detection group, active at the time of fault.
- LBS and Control element shall have the facility for Automatic detection group selection. Automatic Detection Group Selection shall have the facility to be turned ON or OFF with password detection or other form of access control.

7.7.2 Sectionalizing function

- The number of detected faults to trip shall be selectable to be either 1, 2, 3 or 4.
- Reset times shall ideally be separately selectable from 5s to 120s in 1s steps.

7.7.3 Statistical measurement functions

The Measurement shall be done with the three-phase-4-wire/ three phase 3 wire method and the data shall be made available at control center for further integration

7.7.4 Quantities to be measured/calculated with specified accuracy are:

- Phase Voltage (V) $\pm 2.5\%$ of Sectionalizer rated voltage.
 - Line Voltage (V) $\pm 2.5\%$ of Sectionalizer rated voltage.
 - Phase Current (A) $\pm 2.5\%$ of Sectionalizer rated current.
 - Three phase active Power (kW) $\pm 5\%$;
 - Three phase reactive power (kVAr) $\pm 5\%$;
 - Total three-phase active energy (kWh) $\pm 5\%$;
 - Power factor $\pm 5\%$;
-

- Maximum demand $\pm 5\%$.
- Phase Angle ± 10 Deg.
- Total Pwr (KW, KAV, KVA_r) $\pm 5\%$.

7.7.4.1 The real power energy and maximum demand measurement shall be integrated with respect to time. Energy values shall be calculated with selectable time integration periods of 5 min, 15 min, 30 min or 60 min. The data buffer shall work on the FIFO principle and a minimum size for the data buffer shall store values for 4 months on the 30 minutes integration period.

7.7.4.2 Supply Outage management (SOM), LBS and Control element shall have the facilities to record the number and duration of outages. The information shall be assessable locally or remotely using SCADA/DMS/OMS AND SUB-STATION AUTOMATION system.

7.7.4.3 The following parameters shall be recorded as,

- Cumulative total number of outages.
- Cumulative total outage duration.
- Time and duration of each outage

7.7.5 Power Quality analysis characteristics

7.7.5.1 Waveform Capture It shall capture the Waveform and store in flash memory filtered and scaled raw data (10 x 3200 samples per second) of the **3 line to earth or 3 line to line voltages and 4 currents** for a predefined time window either side of a user-defined trigger. The user shall be able to configure a pre and post trigger time ratio for data to be stored.

7.7.5.2 Harmonic Analysis It shall be able to calculate **2nd to 7th harmonics** and total harmonics distortion over 40ms period for **4 currents and 3 line to line voltage or 3 line to earth voltage**.

7.7.5.3 Sag and Swell monitoring, when sag/surge is identified then an event shall be logged. The same shall be downloadable at the remote through communication interface.

7.7.6 Local Engineering

- The LBS controller shall contain a real time clock (with leap year support) that can be set both locally and remotely.
- A facility for selecting all the detection, operating and communications characteristics shall be locally available in the control cabinet. Optional password detection against unauthorized changes shall be available.

7.7.7 Event Recording

The controller shall provide, Non-volatile memory storage shall be sized to store **at least 3,000 logs** as:

- All operating, detection and communications parameters.
- An event record containing at least **3,000 events**.
- All setting change logging.
- Maximum demand shall have the facilities to be configured for weekly or monthly demand.
- Demand Logging shall be daily, weekly, monthly.
- It shall record wide range of parameters with the configurable history, such as current, voltage, total power, auxiliary voltage, battery voltage, gas pressure.
- It shall also record specific information pertaining to Control module temperature, Switchgear Temperature and battery temperature.
- Facility for configuring the interval time in minutes shall be provided.
- A pointer shall be provided to indicate up to where the data was last read. This will enable regular uploading of the data without re-loading of previously read data.
- All events shall be time and date stamped with a resolution of at least 10 ms relative to the onboard real time clock.

7.7.8 TELE CONTROL REQUIREMENTS

- The LBS controller shall detect and report disconnection of the control cable between the controller and LBS.
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- It shall be possible to operate LBS change the active detection group, turn Sectionalizer functionally ON/OFF and turn E/F and SEF ON/OFF remotely using the protocol specified.

7.7.9 Communication

7.7.9.1 - As a minimum, one independent RS-232, one RS-485 communication ports & one Ethernet communication ports that allow for simultaneous operation shall be provided, to be used as follows

7.7.9.2- A USB port shall be provided to upload the non-volatile data to and from a personal computer.

7.7.9.3- To interface to remote communications equipment (modems, radio-modems, GSM/GPRS and Fiber Optic).

7.7.9.4 - As a minimum, it shall be possible for serial ports to operate at the following speeds :

- 1200 bps
- 2400 bps
- 9600 bps
- 19200 bps

7.7.9.5 - Provision shall be made for mounting GPRS modems

7.7.9.6 - It shall be possible to disconnect the RS-232-to-modem interface to facilitate local protocol and communications troubleshooting. Alternatively, a low-level protocol monitor shall be integrated in the software and accessible via the diagnostic port.

7.7.9.7- The protocol to be supported by the AR controller for remote communications shall be IEC 60870-5-104 Protocol

7.7.9.8- The serial ports shall have IEC 60870-5-101 protocol and shall be available as a backup port.

7.8 POWER SUPPLIES

7.8.1 The Sectionalizer system shall provide power for the electronics, operation of the Sectionalizer and Controller operation of the inbuilt FRTU and Modem being provided separately by **SCADA Implementing agency (SIA)**. The **Dry type (Resin Cast) 11000V/230V Control Transformer so used shall be capable of supplying at least 100 VA** or higher suitable for self-operation of Sectionalizer and Modem.

7.8.2 Primary supply: Preference will be given to the ability to obtain primary power directly

from the HV power system requiring no additional primary supply connection.

7.8.3 Test supply: The LBS shall accept an external AC 230 V 50 Hz supply.

7.8.4 Auxiliary supply: An auxiliary supply with the following minimum characteristics shall be provided

7.8.5 One SMF VRLA Battery and Constant Voltage charger with current limiting shall be part of the Sectionalizer. Battery standby time shall not be less than 24 hours and shall allow for a minimum of ten (10) sequences of LRC trip-close operations and a transmit/receive standby duty cycle of 10/90 percent with respect to the GPRS modem. The battery shall recharge to 80 % of its capacity in a maximum of 15 h. The total number of circuit-breaker operations under the above communications scenario shall be at least 10. Sectionalizer operations preventing closing if the battery will not have enough stored energy to open the circuit-breaker for a protection trip condition.

7.8.6 Batteries shall be disconnected at the manufacturer's specified minimum voltage.

7.8.7 Battery Low' indication shall be available locally and remotely and shall include a battery test. The indication of "Battery Low" status shall allow for a further ten LBS operations.

7.8.8 The minimum battery life expectancy shall be 5 years. Details of the guaranteed life expectancy of the battery shall be stated in the tender documentation.

7.9 MAINTENANCE AND COMMISSIONING

7.9.1 All the communications equipment shall be easily accessible in the control cabinet. Wiring of "communications links in the control cabinet shall permit the connection of a temporary protocol- Monitor. It shall be possible to perform secondary injection testing while the LBS is communicating with the center.

7.9.2 It shall be Possible to disconnect the LBS circuit breaker and connect a simulated breaker to the control cabinet for testing purposes.

7.9.3 The LBS shall not malfunction while the GPRS Modem is transmitting via an antenna in close proximity and the control cabinet door is open.

7.9.4 Provision shall be made in the control cabinet for individually isolating the power supply to/from the following:

- Battery;
- Battery charger;
- GPRS modem; and
- Primary supply to the control cabinet electronics.

7.10 RATING PLATE

Each LBS shall bear a rating plate of an intrinsically corrosion-resistant material, indelibly marked with the sea-level rating for which the equipment has been type tested. The rating plate shall be indelibly marked with:

- The manufacturer's name;
- The equipment type designation and serial number of the LBS;
- The mass, in kilograms;
- The date of manufacture;
- The voltage transformer ratio, class and burden.
- Auxiliary supply voltage (if applicable).
- Purchase Order number and date.
- Each Sectionalizer shall also exhibit a Danger Board to indicate the presence of high voltage.

7.11 ADDITIONAL INFORMATION

The following shall be submitted with the tender.

7.11.1 Load Break switch details

- Manufacturer;
- Type designation;
- Place of manufacture;
- Fault make capacity; 3s 1s
- Critical current (maximum instantaneous peak).

7.11.2 A schematic-wiring diagram of the LBS offered.

7.11.3 A general-arrangement drawing of the LBS offered.

7.11.4 Details of the maintenance and operating equipment and procedures needed and a detailed parts List of the various components.

7.11.5 A description of the LBS operation, with instruction and maintenance manuals, including

maintenance schedules, detection characteristics, communications facilities, the method of applying settings to relays and controls, together with any software required and the cost thereof. The software requirements shall be stated in the tender documentation.

7.11.6 Details and the cost of any available portable calibration and diagnostic test set that may be used to perform the functionality described.

7.11.7 A list of recommended spares and tools, quoting the prices of each item and its availability.

7.11.8 If detection setting changes are accomplished by resistors, electronic cards or modules or computer programs, the price and range of such items. The method of changing detection settings shall be stated in the tender documentation.

7.11.9 Details of technical back-up facilities available. These details shall be stated in the tender documentation.

7.11.10 Details of the class, ratio(s) and burden of the detection current transformer and voltage transformer, if supplied, shall be stated in the tender documentation.

7.11.11 The supplier shall include the following details of measurement current transformers (not internal to the LBS) that can be supplied with the LBS. The following details shall be provided:

- Available ratio(s) and accuracy class;
- Method of fitting; and
- Effect on Creepage distance and BIL

7.11.12 Details of LBS service history:

- How many in service, where and for what period;
- Contact names and numbers.

7.11.13 Details of LV trip/close motor if available as an option

7.11.14 Power requirements for a close operation

7.11.15 The maximum achievable separation between the control unit and the circuit breaker.

7.11.16 Full details of the protocol implementation and the complete point database.

7.12 TEST

7.12.1 The LBS / Sectionalizer shall have been type tested in accordance with, and found to comply with, the requirements of either IS or IEC/ANSI/IEEE C37.63-2005 for the following, and the appropriate. Values shall be stated.

- Operating duty.
 - Making current.
-

- Insulation (dielectric tests).
- Radio interference voltage.
- Temperature rise.
- Mechanical operations.
- Control equipment surge withstand capability.
- The control cabinet and associated electronics shall have been type tested in accordance with
- Control Apparatus for Generating Stations and Substations: Electromagnetic Compatibility
- Test records (on identical equipment) in the form of validated copies of test certificates issued by a recognized testing authority shall be submitted with the tender documentation.

7.12.2 Routine tests

- Routine tests, as required in the relevant standards, shall be carried out as a normal requirement of the contract and, unless otherwise agreed upon, shall be witnessed by the purchaser or by his appointed representative. No additional charge shall be levied for such tests or for the production or presentation of documentation related to routine tests.
- Duplicate copies of routine test certificates shall be supplied together with the equipment when the latter is delivered to the final destination stated in the order.

7.13 PACKING/DOCUMENTATION

7.13.1 Packing

All equipment shall be carefully packed to prevent damage or deterioration during normal transportation, handling and storage. Each container shall bear the following information on the outside of the container:

- The address of the destination
- The gross mass, in kilograms
- The name of the manufacturer
- The purchaser's order number and port of destination

7.13.2 Documentation

Each LBS shall be supplied complete with the documentation specified in Items, together with the routine test certificates specified above.

7.14 AUXILIARY SUPPLY TO THE CONTROLLER UNIT OF AUTO RECLOSER AND SECTIONLISER

7.14.1 STD: IS 3156-1992: voltage transformers

For charging the batteries of the each auto recloser and Sectionalizer unit. They shall be supplied with a suitable **Dry Type Resin Cast 100 VA or more capacity auxiliary PT** according to the equipment load requirement or any other arrangement for the supply. The auxiliary PTs shall be provided with HT jumper and control cable. For providing auxiliary supply an external voltage transformer shall be mounted on the pole. The primary of the transformer shall be connected to the HV mains and secondary (LV) shall be connected to the control cubical to provide auxiliary power.

The minimum requirement of Auxiliary PT as follows,

- Voltage ratio : Primary 11 KV (Phase to Phase), **Dry Type Resin Cast**
- Voltage ratio : Secondary 230 V AC
- Highest Service voltage : 12 KV
- VA burden : 100 VA
- Insulation level : 12/28/75KVP
- Voltage factor: 1.2 continuous and 1.9 for 8 hrs.
- Winding wires of PT shall be of grade 3 doubled enameled
- THE HV terminal shall be adequately long from the bushing epoxy material such that the connecting lug shall not rest directly on the bushing epoxy

2.4 Fault passage indicators

2.4.1 Environmental specifications

2.4.1.1 Mechanical resistance to vibration and shocks

2.4.1.2 The equipment shall have vibration resistance in accordance with

Description	Standard
10 to 500 Hz; 0.7 mm peak to peak from 10 to 59Hz and 5g from 59 to 500 Hz.	IEC 60068.2.6
40g / 6 ms / 2000 positive and 2000 negative shocks in each direction, in the three directions	IEC 60068.8.77

2.4.2 Dielectric withstand

Description	Standard
Insulation (50 Hz/1 min.): 2 kV	IEC 61010
Impulse wave (1.2/50 μ s): 5 kV	EN 60-950

2.4.3 Electromagnetic compatibility

Description	Standard
Electrostatic discharge	IEC 1000-4-2 Level 3
Radiated fields	IEC 1000-4-3 Level 3
Radio frequency	IEC 1000-4-6 Level 3
Magnetic immunity, 50 Hz	IEC 1000-4-8 Level 4
Emissions	EN 55011 Class A

8.0 Fault passage indicator (Communicable with FRTU)

8.1 Scope

This specification applies to a system allowing to remotely monitor appearance of faults on an Overhead Medium Voltage network so that to localize faulty sections and send patrols for reconfiguration of the network accordingly.

The system shall be made of Fault detection systems with wireless communication to be installed on Medium Voltage Overhead Electric networks.

Survey for feasible locations is under scope of FPI suppliers (actual quantity of supply of FPI/Pole mounted Remote Terminal Unit (RTU) is limited to feasible locations)

Note: The Data Concentrator/Pole mounted RTU/Mini RTU terminologies/GSM-GPRS interface are used interchangeably with same meaning as for as FPIs concerned in this document.

8.2 Quality Assurance

The Bidder shall supply documentary proof that the manufacturer possesses ISO:9001/ISO:14001 Quality assurance certification, from an independent internationally recognized body, for the design, manufacture and testing of Fault Indicators and remote monitoring and control equipment for medium voltage lines

8.3 Wireless communication Fault detection systems

8.3.1 General information

8.3.1.1 System parameters

The Fault detection systems shall be designed to operate on a Medium Voltage overhead network with the following characteristics:

- - Nominal Operation Voltage 7 to 69 kV
- - System Maximum Voltage 69 kV
- - Frequency 50 Hz
- - Type of MV neutral earthing through a resistor or solidly grounded
- - Conductor diameter 5 to 42 mm
- One single product shall be proposed to cover the whole range of above characteristics: Particularly, the same product should be installed on any network from 7 to 69 kV. Offers requiring to have in stock 2 or more different product references depending on the Line Voltage or on the conductor diameter shall not be considered.

8.3.1.2 Service conditions

The Fault detection system shall be designed to operate in the following environmental conditions:

Symmetrical Fault Current	12.5 kA/1s (maximum phase current that the system shall withstand)
Shocks & vibrations	120 minutes of sine vibrations and 2000 negative and 2000 positive shocks, in OX, OY and OZ axes
Lightning surge	As per relevant IS standard
Maximum Ambient Temperature	70° C
Maximum annual average Temperature	30° C
Humidity	At least 95% temperature up to +70°C according to IEC 68-2-30

8.3.1.3 Purpose of equipment

The main functions of the equipment are:

- -To detect phase-to-phase and phase-to-earth fault currents on the MV network.
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- -To detect voltage presence interruptions.
- -To time stamp faults and Voltage dips and store them in memory
- -To transmit information to the control center spontaneously via the GSM/GPRS network.
- -To provide a local light indication of fault.
- -To provide operators with all useful information for fault finding and preventive maintenance.
- -To be self-supplied at all times, including during outages.

8.4 Constitution

8.4.1 Components

The equipment shall be made of the following parts:

- Fault Passage Indicators clipped on the overhead lines. One such device shall be clipped on each phase so that to detect current and Voltage presence in this phase and compute fault detection algorithm accordingly. A short-range radio interface shall be embedded in this Fault Passage Indicator so that to allow it communicate with the pole mounted RTU interface mentioned below.
- A pole-mounted RTU , acting as a communication gateway between Fault Passage Indicators using short-range radio and the remote control center using GSM/GPRS communication.
- **The auxiliary power source shall be provided 11000V/230V, 100VA Potential Transformer (Dry type) along with Charger and Batteries (SMF VRLA), appropriately dimensioned to continuously supply the GSM/GPRS communication interface.**

8.4.2 GSM/GPRS communication interface

The Pole Mounted RTU interface shall be designed to be mounted on a polycarbonate or metallic pole or concrete pole. One Data Concentrator Unit (DCU) shall be able to interface up to 9 numbers of Fault Passage Indicators.

This box shall include the following functions:

- Short range radio interface up to 9 Fault Passage Indicators.
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- External GPRS Modem (will provided by power distribution company/ **SCADA Implementing agency(SIA)** connected to Serial port/RJ 45 of the DCU/Pole mounted RTU/Mini RTU/GSM/GPRS comm **envirunication** interface.
- Communication protocol to the control center shall be IEC 60870-5-104 (so that FPIs sends the monitoring data to the SCADA server and receives the control command sent by the SCADA server to achieve bidirectional controllable operation.)
- Configuration of the Pole Mounted RTU (GPRS communication, definition of alarms) and fault passage indicators (Fault detection thresholds) by connection of a laptop running the configuration software to an RS232 interface on the communication interface. The same software shall also include full diagnostic capabilities. It should be possible to configure these parameters from remote control center over the GPRS network. Suitably power supply with battery backup arrangement for Pole Mounted RTU and GPRS MODEM shall be done by the supplier including Dry Type Resin Cast PT. The maintenance free Battery shall have a warranty of at least 7 years & replaceable. Low battery alarm shall be provided at remote location.

The external GPRS modem will be housed in the Pole mounted RTU control box. (Clamp type mounting).

The exact mounting screw distances and dimensions would be shared for the successful bidder.

8.4.2.1 The Mini RTU GSM/GPRS communication interface shall be designed to be **mounted on a concrete or metallic pole**. It shall be able to interface up to 9 Fault Passage Indicators installed in a 100m maximum range at least, corresponding to up to 3 overhead lines.

8.4.2.2 Solutions using a GSM/GPRS interface allowing to interface only 3 or 6 Fault Passage Indicators, i.e. 1 or 2 MV lines, or within a maximum range less than 100m shall NOT be considered.

8.4.2.3 The GSM/GPRS communication interface shall include the following functions:

- Short range radio Interface to up to 9 Fault Passage Indicators in a 100m range.
 - GSM/GPRS communication to control center
 - Configuration of the communication interface (GSM/GPRS communication, definition of alarms...) and Fault Passage Indicators (Fault detection thresholds...) by connection of a
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laptop running the configuration software to an RS232 interface on the communication interface. The same software shall also include full diagnostic capabilities.

8.5 Fault Passage Indicator

8.5.1 The Fault Passage Indicators shall be designed to be clipped on the Overhead MV line. 3 Fault Passage Indicators shall be clipped on one line, one on each phase. It shall include the following functions:

- Measurement of current running in the phase it is clipped on
- Detection of Voltage absence/presence on the phase it is clipped on
- From the 2 previous functions, detection of phase-to-phase and phase-to-earth faults
- Short-range radio communication with a Mini RTU GSM/GPRS communication interface at a maximum distance of 100m at least.

8.5.2 It shall be self-supplied from a lithium battery of a minimum life time 8 years, in the temperature conditions specified above, including at least 1 short range radio communication with the GSM/GPRS communication interface every hour and 300 hours flashing for fault indication all over these 8 years.

8.5.3 The Fault Passage Indicators shall be suitable for outdoor use in the tropical climate condition stipulated in the relevant paragraph. The components used in the Fault Passage Indicators shall be suitably protected from direct sunlight to prevent malfunctioning due to solar radiation. The maximum operating temperature shall be 70° C. The Fault Passage Indicators shall be suitable for mounting on live line conductors of a diameter ranging between 5 and 42 mm, with clamps designed so that the Fault Passage Indicator can withstand winds of 150km/h without falling from the line. The Fault Passage Indicator shall be fully self-contained type without any external connection, indicator or sensors. The Fault Passage Indicators shall be suitable for use on multiple lines supported by the same pole.

8.6 Installation:

The FPIs shall be suitable for installing on overhead line conductors using hot sticks, while line is in charge condition. The supplier shall supply hot sticks free of charge along with supply of FPIs. The ratio of FPIs v/s hot sticks shall be **10 hot sticks per 30 sets of FPI**.

INRUSH RESTRAINT:

The FPI shall be equipped to filter out the inrush current due to transformer magnetizing currents thus avoiding the possible false indication of faults.

RESET

Once the fault is cleared, the FPI shall reset itself upon the power return, it shall also have a facility of resetting with settable time duration and the manual reset.

TRANSIENT FAULT EVOLUTION:

If FPI is busy in flashing on transient fault and if the permanent fault occurs, the FPI shall automatically change the priority and shall start flashing differently to show the permanent fault; thus helping maintenance crew to review the priorities.

8.7 Operational specifications

8.7.1 Fault detection

8.7.1.1 Fault detection shall be performed by the Fault Passage Indicator described above. Fault sensing shall be made from current measurement and Voltage presence detection, based on detection of the electromagnetic field and its variations.

8.7.1.2 The Fault Passage Indicator shall be of the programmable type, suitable for sensing:

- **Short-circuit faults up to 12.5 kA for 1s.**
 - Low earth leakage faults (referred to as “unbalance”) down to 6A.
 - The Fault Passage Indicators shall detect faults based on 2 simultaneous tripping criteria:
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- In order to detect strong fault currents (typically phase-to-phase faults), it shall trip when the phase current exceeds an absolute threshold for a fixed duration of about 20 to 30 ms. This absolute threshold must be configurable to at least 8 different values between 100 and 800A.
- In order to detect low fault currents (typically resistant phase-to-earth faults), it shall trip when it detects the phase current increase within a fixed duration (about 20 to 30ms) exceeds a relative threshold. This threshold must be configurable to at least 6 different values between 6 and 80A.

8.7.1.3 It shall be possible to disable this second tripping criteria. When a fault occurs on the network, the upstream protection will trip within 70ms maximum (inverse time protection). Therefore, in order to prevent tripping due to a load increase, on detection of one of the above criteria, the Fault Passage Indicators shall confirm the fault by checking if the voltage disappears within the next 70ms, and start to indicate the fault only under this condition. In case of faults, the Fault Passage Indicators which are detecting the variation of the electromagnetic field due to fault current (Fault Passage Indicators installed between the circuit breaker and fault point) shall provide a fault indication, while Fault Passage Indicators downstream the fault or on non-faulty branches shall not provide any indication.

8.7.1.4 The fault indication shall be provided:

- By the means of a flashing light system offering a good contrast against sunshine (red color is preferred) and an MTBF of the light emitting system at least 45 000 Hours (LEDs for instance). It shall provide a light of an intensity of 40 Lumen minimum and give a 360° visibility from at least 50m in sunny day conditions, and at least 300m at night.
 - By an alarm sent to the GSM/GPRS interface which shall itself forward the alarm to the control center according to its configuration.
 - The Fault indication shall remain until:
 - a time-out, configurable to at least 4 possible values between 2 and 16 hours, has expired,
 - the medium voltage is back,
 - the Fault Passage Indicator is reset manually,
 - Whatever condition comes first.
 - Caution: since the load current might be very low upon MV return, load current reset is not acceptable.
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- The Fault indication reset shall consist in:
- Stopping the local light indication flashing
- Sending an alarm to the GSM/GPRS interface which shall itself forward this alarm to the control center according to its configuration.

8.7.1.5 The Fault Passage Indicator shall include some self-test possibility usable when it is on the line (powered or not).

8.7.1.6 The Fault Passage Indicator shall be selective in action as indicated below

- It shall not respond to any sudden variation (increases/decrease) in load current
- It shall not respond to a over current not due to a fault
- It shall not respond to high magnetizing inrush currents, created upon line energizing.

8.7.2 Detection of voltage presence and absence

The Fault Passage Indicator shall send a message to the GSM/GPRS interface as soon as it detects disappearance or appearance of Voltage on the MV conductor. The GSM/GPRS interface shall then memorize the information as a time-stamped event and send an alarm to the control center according to its configuration.

8.7.3 Digital inputs/outputs

The pole mounted RTU to be provided by the bidder shall allow connection of information from sensors available in the immediate vicinity to potential-free inputs. At least 6 potential-free digital inputs shall be included in the GSM/GPRS interface.

- Outputs - 3 digital dry contacts set to repeat phase faults (Phase R, Y, Z) from FPI or short range communication faults or battery faults for transmission by an external FRTU, (3 Relay output contacts 200 V AC/1A).

Pole Mounted Concentrator for FPI:

The Pole Mounted Concentrator should be a low power consumption unit to be used as a gateway to link the communicable FPI to the SCADA application. This pole mounted RTU unit should be mounted on an overhead line pole close to FPI installed in the 11 kV distribution network.

8.7.4 Short-range radio

Short range radio shall use license-free radio frequency. It shall be designed so that to allow a maximum distance between GSM/GPRS interface and the Fault Passage Indicators equal to 100m or more. Indicators of short range radio transmission quality shall be available and displayed by connection of a PC to the pole mounted Concentrator .

Antennas for short-range radio communication shall be embedded in or fixed on the products pole mounted Concentrator /RTU and Fault Passage Indicator) so that no specific installation is required.

8.7.5 Communication with the control center

8.7.5.1 Communication between the pole mounted Concentrator and the control center shall be through GSM/GPRS network, dual-band 900 MHz – 1800 MHz, and using any standard protocol. GPRS modem 4G /5G as per site signal availability, will be supplied by DISCOM/
SCADA Implementing agency (SIA)

It shall allow communication in 2 ways:

- At any time, based on configured periodic calls or on operator action, the pole mounted RTU shall be ready to receive a call from the control center
- Whenever a monitored information declared as alarming in the pole mounted RTU configuration changes status, the pole mounted RTU shall make a call to the control center and send it an alarm.

8.7.5.2 Each monitored information (fault current detection, voltage absence/presence, digital inputs etc...) shall be configurable as "alarming" when changing state, individually and independently of others. If used with GSM communication, as an addition to the alarm to the control center, it shall be possible to configure the pole mounted RTU so that it send an SMS message to a mobile phone. The configuration software shall allow to define the mobile phone number and SMS messages service center number through modem to be provided by the
SCADA Implementing agency (SIA)

8.7.5.3 Monitored information configurable as “alarming” shall include at least the following, consisting both of MV network diagnostic information and monitoring equipment internal faults for self-diagnostic purpose:

- Fault detection appearance with indication of Fault Passage Indicator reporting the fault and tripping criteria tripped.
- Fault detection disappearance with indication of Fault Passage Indicator reporting the fault and tripping criteria tripped.
- Voltage absence
- Voltage presence
- Change of state of a digital input
- Fault Passage Indicator absent (failure of the pole mounted RTU communication interface to communicate with it through short range radio)
- Fault Passage Indicator battery low
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8.7.6 Configuration and maintenance

Equipment configuration and diagnostic shall be performed by connection of a laptop PC to the pole mounted RTU using the PC RS232 interface.

8.7.6.1 Configuration shall include:

Scanning of all Fault Passage Indicators in the short range radio range (at least 100m) and assigning of an identification (typically number) to each of them, so that to allow identification of line (when pole mounted Concentrator/ RTU is monitoring 9 Fault Passage Indicators) and phase on the line on which each Fault Passage Indicator is clipped-on, in order to allow identification by the control center of line and phase where faults or voltage absence are detected.

8.7.6.2 Configuration of fault detection thresholds and other characteristics.

8.7.6.3 Configuration of communication: PIN code, telephone numbers (control center and mobile for sending SMS messages), transmission speed, etc

8.7 Additional requirements

8.7.1 Marking

Each Fault Passage Indicator shall carry a weather and corrosion proof plate indicating the following particulars.

- Manufacturer's identification.
-

- Model or type number (as per catalogue)
- Year of manufacture in characters big enough to allow reading from the ground so that to provide indication of battery age.

8.7.2 Environmental specifications

8.7.2.1 Mechanical resistance to vibration and shocks

8.7.2.2 The equipment shall have vibration resistance in accordance with

8.7.2.3 IEC 60068.2.6: 10 to 500 Hz; 0.7 mm peak to peak from 10 to 59Hz and 5g from 59 to 500 Hz.

8.7.2.4 IEC 60068.8.27: 40g / 6 ms / 2000 positive and 2000 negative shocks in each direction, in the three directions.

8.7.3 Dielectric withstand

Description	Standard
Insulation (50 Hz/1 min.): 2 kV	IEC 61010
Impulse wave (1.2/50 μ s): 5 kV peak	EN 60-950/IEC equivalent

8.7.4 Electromagnetic compatibility

Description	Standard
Electrostatic discharge	IEC 1000-4-2 Level 3
Radiated fields	IEC 1000-4-3 Level 3
Radio frequency	IEC 1000-4-6 Level 3
Magnetic immunity, 50 Hz	IEC 1000-4-8 Level 4
Emissions	EN 55011 Class A/IEC equivalent

8.7.5 Environment

- Maximum ambient air temperature : 70 °C
- Minimum ambient air temperature : -20 °C
- Average ambient air temperature : 40 °C
- Maximum relative humidity : 0-100 %
- Average thunder storm days per annum 10
- Average rainfall per annum : SUITABLE arrangement for high rainfall areas
- Maximum wind speed : up to 120 km/hr
- Altitude above mean sea level : Utility may specify location with altitude more than 2000m above MSL for compliance of in that project area

9.1 Numerical relays /BCPU

In case of numerical relays, RTU at substations to act as gateway , data concentrator for numerical relays/ BCPUs connected over IEC 61850 and I/O Cards in RTUs to be configured accordingly i.e. for bays where requisite I/Os are not served through numerical relays/ BCPUs

The salient features of Numerical replays are:

- The protection relay shall be compact and easy to install and be shall be flush mounting.
- The protection relay shall meet IP54 on the front face.
- The protection relay shall facilitate commissioning tests by having the ability to force the digital outputs to operate and the protection functions to start / trip under test mode.
- The protection relay shall have a display to support single line mimic LCD screens and to allow access to the settings.
- The protection relay shall be a modular design and have full self-diagnostic functions on both energization and operation for hardware and software components to ensure the relay reliability. The relay must have a self-diagnostic watchdog output with a normally closed contact and a normally open contact.
- The protection relay shall have wide operating temperature range from –40°C to +70°C.

1. Communication and Cyber-security

- The protection relay shall provide one USB port on the front panel for local configuration and data extraction.
 - The protection relay shall have 2 no RJ45 port at the rear with IEC 61850 communication. The protection relay shall support RSTP and PRP/HSR redundancy protocols. The protection relay shall support IEC 61850 edition 1 and edition 2.
 - The protection relay shall support IEC 61850 GOOSE communication.
The protection relay shall support simultaneously IEC 61850 (MMS) clients.
 - The protection relay shall provide the enhanced Cyber Security function with the security logs and the full central security management for Role Based Access Control (RBAC) using an industry standard protocol.
 - The protection relay shall secure any firmware upgrade with a firmware signature to avoid unauthorized or malicious firmware downloads and to guarantee the source of the firmware.
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- The relay shall be compliant to IEC 62443 standard, and compliant to NERC CIP requirements.

2. Engineering Tools

- The protection relay PC-installed configuration tool shall, as a minimum, provide the following functions: Setting configuration, Mimic configuration, Logic configuration, LEDs, function keys, digital inputs and outputs configuration, Measurement auto-reading, Events/ fault records/ disturbance records reviewing, Protection status reviewing, Control command execution.
- The protection relay shall support Web-HMI (web browser-based HMI) with secured communication to provide the similar functions as the PC configuration tool above.
- The protection relay and corresponding software tool shall offer the possibility to simulate energy injection to test and validate the protection settings.
- The IEC61850 configuration tool shall support importing and exporting of valid IEC 61850 files (ICD, CID, SCD, IID).

3. Standards Compliance and Certificates

- For Products safety, the protection relay shall meet the product safety requirements according to IEC 60255-27.
- For electromagnetic compatibility (EMC), the protection relay tested under min setting shall meet the EMC requirements according to IEC 60255-26.
- For mechanical robustness, the protection relay shall meet the mechanical test requirements according to IEC 60255-21-1, -2, -3, Class 2 for vibration, shock, bump, earthquakes compliance.
- The protection relay must have an IEC 61850 Edition 2 certificate from an accredited Level A testing laboratory.
- The protection relay shall be compliant to RoHS and REACH and it shall be provided with PEP and EoLI certificates.
- The protection relay shall be compliant to Security assurance Level 1 (SL1) with the 3rd party certified for IEC 62443-4-1 and IEC 62443-4-2.

Relay Hardware

- The protection relay shall have requisite CT inputs and VT inputs. The relay shall provide requisite digital inputs, digital outputs and a watchdog contact.
 - The polarity of the digital outputs of the protection relay shall be settable, as Normally Open or Normally Closed.
 - The protection relay shall have settable digital inputs voltage thresholds from 24V – 220V DC or 220AC.
 - The protection relay shall provide the same wiring terminals for the 1A or 5A rated CT connection of the phase current inputs and residual current input.
 - The protection relay shall support a very sensitive 1A rated CT input for residual current sensing.
 - The protection relay shall have programmable function keys and freely programmable and pre-assigned LEDs.
-

9.2 Protection and Control

- The protection relay shall provide the following protection functions:
 - 1) Multi stage non-directional or directional phase overcurrent protection.
 - 2) Multi stages non-directional or directional earth fault protection
 - 3) The instantaneous trip time at set shall be less than 30 ms.
 - 4) Earth fault protection with optional memory mode to extend the transient fault information and quickly clear the fault.
 - 5) Inrush detection, Cold load pickup and Selective overcurrent logic for non-directional and directional phase overcurrent and earth fault protection
 - 6) Broken conductor , negative sequence overcurrent ,negative sequence overvoltage protection
 - 7) Multi-stages under voltage protection and overvoltage protection with settable any phase or all phases tripping logic
 - 8) Multi- stages neutral overvoltage protection, with neutral voltage either calculated from the three phase voltages or measured from broken delta VT.
 - 9) Thermal overload protection
 - 10) CB Failure protection with independent backup trip timer and re-trip timer
 - 11) Switch onto fault protection
 - 12) Fault locator function
- For non-directional / directional phase overcurrent protection and earth fault protection, the protection relay shall provide the inverse definite minimum time (IDMT) characteristics as per standard IEC, IEEE, ANSI, RI operating curves. The relay shall provide at least three fully user programmable IDMT curves.
- For non-directional / directional phase overcurrent protection and earth fault protection, the protection relay shall operate correctly based on the current sample values under primary CT saturation conditions.
- The protection relay shall support controllable objects (CB, Switches, etc), with Select-Before-Execute or Direct Control principles via local HMI, remote communication, digital input or function keys.

9.3 Measurement, Power Quality and Records

- The protection relay shall offer a complete set of measurement functions, including 3 phase currents and voltages, zero-sequence/ negative-sequence/ positive-sequence currents and voltages.
 - Within the range of ± 5 Hz of the nominal frequency, the protection relay shall provide the current accuracy 0.5% ($I > 0.05 I_n$), the voltage accuracy 0.5% ($V > 0.5 V_n$), the frequency accuracy 0.01 Hz.
 - The protection relay shall provide the power factor, active power, reactive power, apparent power and active energy, reactive energy measurements.
 - The protection relay shall provide the power quality information, including 2nd to 15th harmonic per phase current and voltage, the total harmonic distortion, the voltage sag and swell.
 - The protection relay shall support at least 1000 sequence-of-events associated with time stamps with 1 ms accuracy stored in the relays non-volatile memory.
 - The protection relay shall support at least 20 fault recorders associated with time stamps with 1 ms accuracy stored in the relays non-volatile memory
-

8.7.6 Documentation

Each device shall be supplied with a user manual for installation and commissioning on site.

8.7.7 Labels/Name Plate

Equipment should be provided with name plate giving full details of manufacture, capacities and other details as specified in the relevant ISS/SS. The purchase order No. date and words Funded under RDSS , MoP , GoI Scheme & PFC/REC (Nodal agency for state) name and logo **Utility Name** must be etched on the name plate.

Manufacturer's name or trade mark

Purchase Order number

Year of manufacture

Purchasers name with Serial no

The color and finish may be in accordance with the Manufacturer standards for the service conditions specified, subject to Buyer's approval. The equipment to be supplied shall work satisfactorily under tropical conditions

8.8 SURFACE TREATMENT AND PAINTING OF STEEL PARTS :

- Before painting all un-galvanized parts shall be completely cleaned and made free from rust scale and grease and all external rough surface cavities on castings shall be filled by metal deposition.
- The interior parts and internal structural steel work shall be cleaned of all scale and rust by sand blasting or other approved method.
- All external surfaces shall receive a minimum of 3 coats of paint.
- All equipment furnished by the contractor shall be completely painted for final use, with the exceptions of those parts or surfaces that are expressly designated as unpainted for instance Aluminum Alloy parts.

The contractor shall perform all painting work in his shop before dispatch and only a field touch-up shall be performed after installation. (The paint used for field touch up shall be delivered by the supplier, and shall be of the quality and color shade as used in shop painting). The paint shall be guaranteed for 7 years from the date of receipt of the material.

8.9 WORKMANSHIP:

- a) Workmanship shall be of the highest grade and conform to the best modern practice for the manufacture of high grade machinery and electrical equipment.
- b) Field welding of the equipment is to be avoided and erection at site shall be kept to a minimum. Sub-assemblies erected and tested in the factory are limited only by the transport conditions and handling facilities at site.

8.10 DRAWING AND LITERATURES ETC.:

The drawings with plan elevation and cross section of the equipment to be supplied with complete dimensions and weights of module shall be enclosed. The drawings shall include control circuit drawings, Technical literature covering instruction booklet and O&M manuals of the equipment shall be enclosed to the offer. Tenders not accompanied by the above are liable to be rejected. Six sets of these drawings and literature (Instruction booklets and O&M manuals). The photographs (front and side views) of the equipment offered shall be furnished.

8.11 OVERALL DIMENSIONS:

The manufacturer shall give the necessary information as regards to the overall dimensions of the equipment to be supplied. All the equipment shall be packed in suitable crates with suitable steel bands so as to withstand rough handling and storage at destination.

8.12 TESTS & TEST CERTIFICATES:

The tests shall be carried out as per relevant IS/IEC latest versions and test certificates shall be furnished for approval. The tenderer shall indicate the details of the equipment available with him for carrying out the various tests as per relevant IS/IEC latest versions. The tenderer shall indicate the source of all materials and collaborators if any. They shall also indicate the name of the supplier and make of constructional steel etc. Copy of the type test certificates for the equipment offered shall be enclosed or in case not available, the same shall be provided during finalization of equipment. The bidder shall confirm the same and shall provide the equipment with requisite compliances

8.13 GUARANTEE

- **The Equipment shall be guaranteed for Seven years from the date of operation**
- The manufacturer shall demonstrate the availability of spares for all the above equipment for next 10 years from the date of supply of the product.

8.14 TRAINING:

The supplier shall give as per training schedule in the bid for each RMU/FPI/Sectionalizer/Auto recloser/Numerical in attending trouble shooting and maintenance at owners/utility premises and in the field after successful installation. Training should be at free of cost.

8.15.1 RMUs:

Test certificates certified by CPRI or any international recognized testing laboratory as per IEC 62271-100 / 200 or relevant IS Standard with latest amendments. Following Test Certificate has to be submitted.

- Dielectric Withstand Test
- Short time withstand - STC withstand test
- Mechanical endurance test
- Internal Arc test –(IAC Test) Tank & Cable compartment test
- Degree of protection test – IP test

8.15.2 Auto Reclosers:

Test certificates certified by CPRI or any international recognized testing laboratory as per ANSI / IEEE C37.60/IEC 62271-111 Standard with latest amendments. Following Test Certificate has to be submitted.

- Dielectric Withstand Test
 - Short time & Peak Withstand test - STC withstand test
 - Mechanical endurance test
 - Ingress Protection -IP – Test for Control Cabinet
-

- Electro Magnetic Compatibility - EMC -test for Control Cabinet

8.15.3 Sectionalizer:

Test certificates certified by CPRI or any international recognized testing laboratory as per **IEC 60265-1** Standard with latest amendments. Following Test Certificate has to be submitted.

- Dielectric Withstand Test
- Short time & Peak Withstand test - STC withstand test
- Mechanical endurance test
- Ingress Protection -IP – Test for Control Cabinet
- Electro Magnetic Compatibility - EMC -test for Control Cabinet

8.15.4 Fault passage indicators

Test certificates certified by CPRI or any international recognized testing laboratory as per standard IEC/IEEE/ANSI/IS with latest amendments. **The following Type Test Certificates shall be submitted prior to dispatch and shall also enclose an undertaking letter along with the bid.**

- Dielectric Withstand Test
- Ingress Protection - IP – Test for Control Cabinet
- Short time & Peak Withstand test - STC withstand test

Further , the applicable equipment indicated in the MoP order no 12/34/2020-T&R dtd 08.06.21 & CEA /PLG/R&D/MII/2021 dtd 11.6.21 and any amendment from time to time shall be adhered to. This section is applicable to Group A (Noida Town),B,C ,U towns as per functional requirements. If RMU/SECTIONALIZER or AUTO RECLOSER have built-in FRTU , then the quantity shall be reduced from external FRTU . However, the FRTU shall be meet minimum functional requirement in section for RTU/FRTU

Table-1: List of Tests on IED / BCPU

Test Nos.	DESCRIP	Type test	Routine Test	Field test
A	FUNCTIONAL TESTS FOR IED /			
1.	Check for make, type and rating.		√	√
2.	Check for full model number of IED/		√	√
3.	Verification of CT and VT Ratio		√	√
4.	Verification of programmable <u>DI and</u>		√	√
5.	Check the available protection function stages in IED / BCPU.		√	
6.	Verification of enabled protection			√
7.	Measurement checks via injection kit		√	√
8.	Testing of protection function pickup			√

9.	Check output contacts (DO) through		√	√
10.	Verification of configurable LEDs		√	√
11.	Check event records, fault records		√	√
12.	Verification of communication parameter settings in IED / BCPU.		√	√
13.	Check the IEC61850 communication.			√
B	EMI/EMC IMMUNITY TESTS			
14.	Surge Immunity Test as per IEC 61000-4-5	√		
15.	Electrical Fast Transient Test as per IEC 61000-4-4	√		
16.	Damped Oscillatory Wave Test as per IEC 61000-4-18	√		
17.	Electrostatic Discharge test as per IEC 61000-4-2	√		
18.	Radiated Radio Frequency as per IEC 61000-4-3	√		
19.	Voltage dips, short interruptions and variations IEC 61000-4-11	√		
20.	Immunity to conducted RF disturbances IEC 61000-4-6	√		
C	SAFETY TEST and MECHANICAL TEST FOR IED / BCPU			
21.	Power frequency voltage withstand	√		
22.	1.2/50 μs Impulse voltage withstand Test as per IEC 60255-27	√		
23.	Insulation resistance test IEC 60255-27	√		
24.	Vibrations, Shocks and Bumps IEC 60255-21	√		
D	ENVIRONMENTAL TEST FOR			
25.	Cold test as per IEC60068-2-1	√		
26.	Dry heat test as per IEC60068-2-2	√		
27.	Damp heat test as per IEC60068-2-78	√		
28.	Flowing mixed gas corrosion test	√		
E	Other test			
29.	Cyber security compliance IEC 62443-4-1 and IEC 62443-4-2 certificate of IEC / BCPU from NABL labs as per GoI ORDERS	√		
30.	Communication IEC 61850 Edition-2 from an accredited Level A testing laboratory.	√		

SECTION- 6 SUPPORT SERVICES Chapter 1- Training

This section describes general requirements that apply to all training courses. The Contractor shall submit the training proposal along with the bid. This section is applicable to Group A (Noida Town), B, C towns as per functional requirements.

The training content, schedule and location shall be finalized during project execution.

1.0 General

- (a) Training will be conducted by Contractors personnel, who are experienced instructors and speak understandable English.
- (b) All necessary training materials shall be provided by the Contractor. Each trainee shall receive individual copies of all technical manuals and all other documents used for training.
- (c) Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of owner. Employer/owner reserves the right to copy such materials, but for in-house training and use only.
- (d) Hands-on training shall utilize equipment similar to that being supplied under the contract.
- (e) For all training courses, the travel and per-diem expenses will be borne by the owner.
- (f) The Contractor shall quote training prices under project management cost. & shall be included in the bid
- (g) The schedule, location, and detailed contents of each course will be finalized during employer and Contractor discussions shortly after placement of the award. The Consultant/Employer shall review and approve the contents of the overview training prior to the start of the training.

1.1.1 Training Course Requirements

Employer's training course requirements are described below in terms of the contents of each course to be provided. Training shall be provided on actual database for the application software course and the associate training courses.

1.1.2 Database, Display Building & Report generation Course

The database and display building course shall be the first course to be given in the overall training sequence. It shall be a hands-on course using the hardware and software to be supplied by the contractor. The course shall be designed to train owner personnel in how to develop the databases, displays, reports, and logs for the offered system.

Course objectives shall include:

- a) How to set up a database & display development system
- b) How to identify database fields, entries, records, tables, and contents
- c) How to structure RTU /FRTU table definitions
- d) How to build tables, arrays, and report formats and displays.
- e) How to perform database maintenance
- f) How to generate the database from source information
- g) How to maintain symbol libraries, display color groups, and display string lists.

On course completion, all participants shall be able to prepare the necessary input data to define the system operating environment, build the system database and displays, and prepare the database administrator to maintain and modify the database and its structures.

1.1.3 Computer System Hardware & Software Course

The computer system hardware & Software course shall be offered, at the system level only. The training course shall be designed to give owner hardware & software personnel sufficient 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. The following subjects shall be covered:

- (a) System Hardware Overview: Configuration of the system hardware.
- (b) Operating System: Including 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 Fail over: Including design, theory of operation, and practice
- (d) Equipment Maintenance: Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, LANs, routers and printers. Configuration of all the hardware equipment.
- (e) Diagnostics: Including the execution of diagnostic procedures and the interpretation of diagnostic outputs,
- (f) System Expansion: Techniques and procedures to expand and add equipment such as loggers, monitors, and communication channels.
- (g) System Maintenance: Theory of operation and maintenance of the hardware configuration, fail over of redundant hardware etc.
- (h) Operational Training: Practical training on preventive and corrective maintenance of all equipment, including use of testing tools.

1.1.4 Application Software Course

The Contractor shall provide training on Application software courses covering all applications other than those already covered above. The training shall include:

- (a) Overview: Block diagrams of the application software and data flows. Programming standards and program interface conventions.
- (b) Application Functions: Overview of Functional capabilities, design, and algorithms. Associated maintenance and expansion techniques.
- (c) System Programming: An introduction to software architecture, Effect of tuning parameters (OS software, Network software, database software and Application Software etc.) on the

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performance of the system. Administration of Database (both real- time and RDBMS),

- (d) Software Documentation: Orientation in the organization and use of system software and Application software documentation.
- (e) Hands-on Training: shall be provided with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

1.1.5 RTU/FRTU / SCADA enabler course

The Contractor shall provide an RTU/FRTU course that covers the following subjects as a minimum:

- (a) Theory of operation of all RTU/FRTU functions
- (b) Operational procedures for various modes of operation, including diagnostic tests and interpretation of the associated test results
- (c) Implementing and maintaining multiple communication ports
- (d) Converting an RTU/FRTU from one protocol to a different protocol
- (e) Demonstration of complete RTU/FRTU test set use, including test set connection and set up for all possible modes of operation, all operational procedures, the exercise of each command or feature associated with each mode of operation, the interpretation of results, and how to use the test set to diagnose and isolate RTU problems
- (f) Disconnection and replacement of all RTU/FRTU equipment, including all modules within the RTU/FRTU

1.1.6 Operator Training Course

This training course shall provide training to Owner's operators on SCADA/DMS/OMS AND SUB-STATION AUTOMATION and Billing & Customer Care Systems so that operators can manage the system effectively.

The training shall include:

- (a) System Overview: Configuration of the system, a functional overview, and an overview of system capabilities and performance.
- (b) General Operating Procedures: Hierarchical structure of displays, display capabilities and features, user procedures, log-on and user access restrictions, and error messages.
- (c) System Applications: Theory of operation, capabilities, and operating procedures for each application function.
- (d) Handling of Equipment: Minor maintenance operations, such as removal of stuck

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paper in printers etc., which do not require spares/specialized skills.

- (e) Operator Documentation: Orientation in the organization and application of all user documentation for Operator and verification of the information contained therein.

The course shall focus on hands-on training on the system. The trainees shall perform instructor-defined procedures with the help of the dispatcher documentation. In addition there shall be training for Instructor to use DTS.

1.1.7 SCADA enabler, networking, power supply related Training:

The training shall focus on critical aspects associated with installation, testing & commissioning , operation , maintenance of SCADA enabler (SECTIONLIZER, RMUs , FPIs etc.) & Leased network equipment & Auxiliary power supply related training however, responsibility of service provider & contractor who has signed SLA with utility, but required level of knowledge for troubleshooting, up keeping the equipment will be required. This shall include the state-of-the art techniques employed in laying, splicing & testing of fiber optic cable & terminal equipment etc. The owner's personnel shall be trained in such a way that the basic maintenance of terminal equipment & cable etc. can be carried out effectively.

SECTION- 6

SUPPORT SERVICES

Chapter 2- FMS

This section describes general requirements describes the project's spares and maintenance requirements. This section is applicable to Group A (Noida Town),B,C towns as per functional requirements

2.0 INTRODUCTION

The Contractor shall be required to provide the services through Facility Management Service provider so as to manage SCADA / DMS/ OMS system for all Group A (Noida Town),B,C,U as applicable including all equipment, installations including hardware, software & networks installed & commissioned by Contractor for the utility in order that they meet the availability requirement as specified in the document.

System Management Services shall be provided by FMS Contractor i.e. SIA in order that maximum uptime & performance levels of SCADA systems installed are ensured. As such, FMS Contractor is expected to provide services as per ITIL (IT Infrastructure Library) standards with performance levels meeting or exceeding those mentioned in Service Level Agreement (SLA) agreed between utility & Contractor.

To achieve the desired Service Levels, the Contractor may need to interact, coordinate and collaborate with the other Service Providers as required. The Contractor will act as the Single Point of Contact for all issues relating to the Service Levels. The Contractor will have the responsibility to deal with the other vendors (during warranty period) /other vendors as selected by utility (after warranty period) as the case maybe, to provide the services at agreed service levels. However, the prime responsibility of providing desired services shall be that of lead Contractor during warranty period. The role of FMS Contractor shall start immediately after systems are installed, commissioned and handed over to the owner after Operational acceptance of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION System.

2.1 SCOPE OF WORK

The Scope of Work shall include the software and hardware maintenance support to be provided by the Contractor in respect of the system supplied under this project during five year Facility Management Services (FMS) period along with Supervision & Operationalizing seven year warranty of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION System after the Operational Acceptance of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION System.

The maintenance of the SCADA-DMS System under FMS period shall be comprehensive, as set forth herein, in nature and would broadly include but not be limited to diagnosis and rectification of the hardware and software failures. The Scope also includes:

- Co-ordination with equipment supplier for Repair/ replacement of defective equipment

- Configuration of the replaced hardware/software, periodic routine checking as part of a preventive maintenance program (as described in further detail in this document) which would include checking of functionality of hardware and software,
- Services to bring up any or all SCADA-DMS- OMS systems upon its failure and to restore the functioning of SCADA-DMS system including Control Centers etc. .
- Database sizing and CFE card addition for new RTUs/FRTUs
- Creation / modification /deletion of database , displays , reports , GIS delta changes etc. ,
- The support for the RTU's /FRTUs & SCADA enablers (Sectionalizers, RMUs ,RMUs etc.)
- All Software modules under the SCADA-DMS System and the associated Hardware supplied under this project.
- Communication & auxiliary power supply

Contractor shall also carry out routine works like database building/ modification, report creation/ modification, addition of analog, status points, control points and testing from field and other such day-to-day operational activity in presence, knowledge and concurrence of utility representatives. The information of modifications shall be documented by contractor and utility. Further, supply of quantity of RTU/FRTUs beyond mentioned in the contract shall be responsibility of utility. In case RTU/FRTUs and associated components are added for further growth in the network during FMS period and are part of supply by SIA only (as per same unit rate of the contract for implementation and 5 Years of FMS period, then SIA shall also be responsible for erection , commissioning of the same). Otherwise, the responsibility of SIA will be limited to control center activities database population, mimic, report generation /modification including end to end testing

The Scope does not include management of physical security for access to the said facilities, The following facilities will be provided at the start of contract to FMS Contractor by Utility for carrying out the FMS responsibilities:

- Sufficient Operators for dispatch control (However, SIA shall provide adequate training to utility operators for supervision and control and handhold for at least one initial year during FMS for the same. In any case, operations shall be made by utility personnel or agency hired for operations by utility only).
- Appropriately secured lockable storage/setup area
- Sufficient Sitting/office space in neat & clean environment
- PC (other communication facilities like P&T telephone & internet facility are to be arranged by FMS Contractor)

Utility shall provide all logistic support including access, work permits / shutdowns, Air-conditioning, raw power supply at control centers, furniture and other interface requirements on field of components which are not in the scope of contractor. Further, supply, erection, commissioning of quantity of SCADA enablers beyond in the contract shall be responsibility of utility

2.1.1 Hours of cover

The Contractor's on-site support standard hours of service the timings for Emergency Software Support would be 24 hours a day, 7 days a week throughout the year (i.e. 24x365). Adequacy of Manpower deployment is the responsibility of SIA to maintain SLA. However, per contract there shall be minimum 1 FMS project manager, 1 engineer each for hardware, software, network communication of Control Center, 1 engineer per dist. for RTU, FRTU, Communication/RMU /sect/FPI etc. shall be deployed. 1 certified cyber security engineer per contract/ control Center. The quantity is minimum, however, SIA to evaluate and deploy more manpower if required to meet SLA at no additional cost to utility. The support personnel also deployed shall be qualified personnel having experience in the delivered SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. The Contractor shall submit the CVs of all such personnel to Utility. The manpower specified is minimum, however, contractor shall ensure sufficiency of manpower to meet SLA during FMS period

The Contractor shall be responsible for 24*7*365 management of all the systems as per scope of work with services rendered at least as per Service Level Agreement between utility & Contractor.

2.1.2 Essence of the Agreement

The essence of the Agreement (to be entered) is to provide FMS for the designated hardware and software, with the goal of meeting the Availability as set forth herein and to provide system tuning and configuration to accommodate a growing system.

2.1.2.1 SERVICE DELIVERY MANAGEMENT

FMS Contractor shall provide detailed description for service delivery management for the complete project including transition plan and deliverables and project management methodology.

a. Project Management

During FMS, a Project Manager for the entire discom who will provide the management interface facility and has the responsibility for managing the complete service delivery during the contractual arrangement between utility and the FMS Contractor. Project Manager will be responsible for preparation and delivery of all monthly/weekly reports as well as all invoicing relating to the service being delivered. Project Manager's responsibilities should essentially cover the following:

- Overall responsibility for delivery of the Statement of Work/s (SOW) and
- Meeting Service Level Agreement (SLA).
- Act as a primary interface to Utility for all matters that can affect the baseline, schedule and cost of the services project.
- Maintain project communications through Utility's Project Leader.
- Provide strategic and tactical recommendations in relation to technology related issues
- Provide escalation to Contractor's senior management if required
- Resolve deviations from the phased project plan. Conduct regularly scheduled project status meetings.
- Review and administer the Project Change Control Procedure with utility.

- Identify and resolve problems and issues together with utility Project Leader. Responsible for preparation and delivery of all monthly reports as well as all invoicing relating to the services being delivered

b. Install, Moves, Adds, Changes (IMAC) Services

This Service provides for the scheduling and performance of install, move, adds, and change activities for Hardware and Software. Definitions of these components are as follows:

- i. **Install:** Installation of desktop machines/workstations, servers, peripheral equipment, and network-attached peripheral equipment, which form part of the SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS System supplied under the contract (new equipment needs to be procured by the Utility or due to growth of network).
- ii. **Move:** Movement of desktop machines/workstations, servers, peripheral equipment, and network-attached peripheral equipment.
- iii. **Add:** Installation of additional hardware /software after initial delivery
- iv. **Change:** Upgrade to or modification of existing hardware or software on desktop/workstations and servers etc.

Requests for IMAC shall be prepared by FMS Contractor depending on customer/system requirements & shall be approved by utility. Utility shall formulate guidelines for IMAC & communicate it to FMS Contractor. All procurement shall be done by utility other than replacement of faulty items as per warranty /SLA under FMS period of the said item. Any item consumed during warranty period from SIA supplied spares to utility, shall be replenished by SIA

c. Contractor Management Services

As part of this activity, for efficient and effective warranty implementation, the FMS Contractor's team will:

1. Manage the vendors for escalations on support
2. Logging calls and co-ordination with Contractors
3. Contractor SLA tracking
4. Management of assets sent for repair
5. Maintain database of the various vendors with details like contact person, Tel. Nos., response time and resolution time commitments. Log calls with vendors, Coordinate and follow up with the vendors and get the necessary items exchanged.
6. Analyze the performance of the Contractors periodically (Quarterly basis)
7. Provide MIS to utility regarding tenure of completion of warranty/AMC with outside vendors for software, hardware & networks maintenance in order that utility may take necessary action for renewal of warranty/AMC. FMS Contractor shall also provide MIS regarding performance of said Contractors during existing warranty/AMC.
8. Since during initial seven years, warranty is in scope of OEM vendors there

will be no AMC for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system. During such period, FMS Contractor has to interact with such vendors for maintenance services and spares. After warranty period, if required Utility can award the suitable AMC and FMS Contractor has to interact with Contractors as selected by utility for providing AMC for the said system on mutually agreed terms & conditions.

9. The faulty hardware /software may be replaced from available spares of utility to minimizing downtime time. However, in such case the same be replenished to utility by SIA within a month.

d) FMS Contractor's (SIA) Other Responsibilities

1. Provide a single-point-of-contact for responding to Utility's queries or accepting its problem management requests. **FMS Contractor's** specialist will respond to utility's initial request within agreed service level objectives set forth.
2. Monitor availability & Escalate to service provider and Notify Utility for communication failures.
3. Review the service levels of the service provider (as per pre-defined schedules on SLA performance) along with utility.
4. Provide network availability incident reports severity wise to utility in a format mutually agreed.
5. Provide SLA performance management report of the Service Provider.
6. **Fault Detection and Notification** : The Contractor shall diagnose problems that could arise as part of the LAN/WAN network. These include connectivity problems due to failures in communication transport links, routing configuration points, or from software bugs etc.
7. **Fault Isolation and Resolution** : All faults that have been identified need to be isolated and rectified appropriately. The resolution measures undertaken by the Contractor and results produced accordingly shall be documented in the report.
8. **Carrier Coordination** : Carrier Coordination implies providing a single point of contact to resolve network related problems involving carrier circuits, whether equipment or circuit related. When a problem is diagnosed because of a WAN circuit, the Contractor must coordinate with the corresponding carrier to test and restore the circuit. The Contractor must take the responsibility and ensure that the problem is resolved.
9. **Hardware/Software Maintenance and Monitoring**: This would include problem determination, configuration issues, and hardware and software fault reporting and resolution. All such issues would need to be recorded and rectified.
10. **24x7 Network Monitoring and reporting**: The Contractor shall monitor the network on a continuous basis using the NMS and submit reports on a monthly basis with instances from the NMS system. System performance is to be monitored independently by the Contractor and a monthly report mentioning Service up time etc. is to be submitted to Utility. The report shall include:

- Network configuration changes
 - Network Performance Management including bandwidth availability and Bandwidth utilization
 - Network uptime
 - Link uptime
 - Network equipment health check report
 - Resource utilization and Faults in network
 - Link wise Latency report (both one way and round trip) times.
11. Historical reporting for generation of on-demand and scheduled reports of Business Service related metrics with capabilities for customization of the report presentation.
 12. Generate SLA violation alarms to notify whenever an agreement is violated or is in danger of being violated.
 13. Any other reports/format other than the above mentioned reports required by utility

e) Backup/Restore management

FMS Contractor will perform backup and restore management in accordance with mutually FMS Contractor shall ensure:

1. Backup and restore of data in accordance to defined process / procedure.
2. 24 x 7 support for database restoration requests
3. Maintenance and Upgrade of infrastructure and/or software as and when needed.
4. Performance analysis of infrastructure and rework of backup schedule for optimum utilization.
5. Generation and publishing of backup reports periodically.
6. Maintaining inventory of onsite tapes.
7. Forecasting tape requirements for backup.
8. Ensuring failed backups are restarted and completed successfully within the backup cycle.
9. Monitor and enhance the performance of scheduled backups
10. Real-time monitoring, log maintenance and reporting of backup status on a regular basis.
11. Management of storage environment to maintain performance at optimum levels.
12. Periodic Restoration Testing of the Backup
13. Periodic Browsing of the Backup Media
14. Management of the storage solution including, but not limited to, management of space, volume, RAID configuration, configuration and management of disk array etc.,
15. Interacting with Process Owners in developing / maintaining Backup & Restoration Policies / Procedures to provide MIS reports as per agreement

f) Restoration of Control Centre in case of Failure

The FMS Contractor shall ensure that all the relevant data is transferred from

control center at regular frequency to Data Recovery Centre (DR) which is required for restoration of Control Centre in case of complete failure of Control center. In case of catastrophe / damage of ZSCC control center including force majeure conditions , FMS Contractor shall carry out system build in order to build the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system at Control center from scratch from software licenses of control center data stored at DR Centre . However, in such condition where damage of control center is not attributed to SIA , the development will be done on hardware procured by utility . In case the damage is attributed due to SIA , SIA shall be liable provide control center hardware The same applies to damage of Disaster Recovery center / SDCC in case Group A (Noida Town) towns

g) Performance Monitoring & Reporting

- Regularly monitor and maintain a log of the performance monitoring of servers including but not limited to monitoring CPU, disk space, memory utilization, I/O utilization, Central Storage etc.
- Regular analysis of events and logs generated in all the sub systems including but not limited to servers, operating systems, databases, applications etc. The system administrators shall also ensure that the logs are backed up and truncated at regular intervals.
- The administrators shall undertake actions in accordance with the results of the log analysis to ensure that the bottlenecks in the infrastructure are identified and fine-tuning is done for optimal performance
- Reporting to utility for all system performance monitoring % of availability of RTU, COMMUNICATION in a month (Minimum 99% time) & FRTU , FPI, Numerical relay, Enablers (Minimum 98% time) % of availability of RTU, FRTU , FPI Digital & Analog status & control points (Minimum 98 % of total count end to end tested) status to be derived from trend table and failure reporting of control command execution event , if any
- Cyber security audit from CERT.IN empanelled agency on annual basis or interim audits in case of major change
- No cyber-attack or intrusion in SCADA/DMS/OMS AND SUB-STATION AUTOMATION system incident

The Contractor must adhere to well-defined processes and procedures to deliver consistent quality services throughout its contractual period. Any hardware/software to meet the requirements under this legacy section must be provided by the Contractor. The Contractor is expected to have the following system management controls in place:

i) AVAILABILITY MANAGEMENT

The Contractor must define the processes/procedures which ensure the service delivery as per the required SLAs or exceed it. It should cover various equipment such as all the servers, networks, switches, routers, Modems & other site specific services, and the critical services and their supporting hardware, and software components, as defined in scope of work. Industry standard SLA management tools should be deployed and shall have following essential features:

- Ability to create an escalation for an SLA.
- Ability to workflow the SLAs.
- Ability to create new action types, if needed.

- Ability to define sets of actions that are grouped together in a specific sequence.
- Ability to associate an escalation point with one or more actions through the action group.

ii) PERFORMANCE MANAGEMENT

The recording, monitoring, measuring, analyzing, reporting, and forecasting of current levels, potential bottlenecks, and enhancements of performance characteristics for the services, networks, applications, system software, and equipment within the scope shall be required. System tuning and optimization is an inherent part of this contract. Where warranted, the Contractor will utilize capacity management data in combination with performance management data to identify ways to improve performance levels of the resources, extend their useful life, and request utility to approve revisions/upgrades to the computing and communications hardware, software and other equipment such that higher levels of performance of the resources are obtained.

iii) SECURITY MANAGEMENT

- The protection from unauthorized usage, detection of intrusions, reporting as required and proactive prevention actions are to be provided by the Contractor. No cyber-attack or intrusion in SCADA/DMS/OMS AND SUB-STATION AUTOMATION system incident
- Cyber security audit shall be carried out from CERT.IN empanelled agency on annual basis or interim audit in case of major modification
- No cyber-attack or intrusion in SCADA/DMS/OMS AND SUB-STATION AUTOMATION system incident

2.2 Support Services

2.2.1 Emergency Support

The severity levels are defined under clause [2.3](#) of this chapter. Emergency Support for Severity 1 issues are to be provided 24 hours a day, seven days a week. The on-call support team shall include all key technical competencies so that any aspect of a system failure can be attended. The team comprise of experienced technical staff that are skilled in troubleshooting SCADA / DMS systems. Severity 1 problems shall be reported by telephone for rapid response; target response times are defined in clause [2.5](#). The Contractor shall **submit the process details** to meet the above requirements along with the offer. For severity 1 problems, the key objective is to restore the system to an operational state as quickly as possible, including by a temporary workaround. Resolution of the defect may be completed during standard hours.

Severity 2, 3, and 4 problems shall be reported by Utility through a call tracking system to be provided by the Contractor. The Emergency Support service goal is to meet the availability targets greater than specified in this document (minimum 99% for Overall SCADA/DMS/OMS AND SUB-STATION AUTOMATION System). Resolution of problems may also be provided by an

individual fix that will be installed by the Contractor at no extra cost to Utility.

2.2.2 Monitoring

The Contractor shall conduct the following monitoring, for the supplied SCADA/DMS/OMS AND SUB-STATION AUTOMATION System.

2.2.2.1 Error Log Monitoring

To monitor the performance of SCADA/DMS/OMS AND SUB-STATION AUTOMATION system on a monthly basis, the Contractor shall review the following, analyze the results, and communicate to Utility:

- System logs for a selected day
- System history log
- Aggregate data collection
- Events Collection

During monitoring if any defect is found, the Contractor shall undertake corrective action for the same. The Contractor shall **submit the process details** to meet the above along with the offer

2.2.2.2 Resource Monitoring

Resource Monitoring services comprises checking the system's major node resources, gather log data, analyze results, and advise Utility on the appropriate actions to be taken and undertake any agreed upon actions. A tool will be created to continuously collect the following information:

- CPU loading (Peak and Average)
- System error log
- Disk utilization (Peak and Average)
- Operating system error reports
- LAN utilization (Peak and Average)
- Bandwidth utilization
- Memory utilization (Peak and Average)

The Contractor shall submit the procedures details to meet the above along with the offer.

2.2.3 Support for System expansion

New RTUs, RMUs & FPIs etc. per year are likely to be added to match the growing Power system. The services to be provided by the Contractor will include the Communication Front End (CFE) port/card addition/expansion, database resizing,

interface addition in CFE and support for integration confirming to the IEC standards / existing application. This would not include the cost of equipment/card required for expansion.

2.3 Problem Severity Levels

The problems will be categorized as follows:

Category	Definition
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 (as described at 2.3.1).
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 (as described at 2.3.1. Non-availability of Man-power at control center during working hours
Severity 3 – Minor	Any other system defect, failure, or unexpected operation (as described at 2.3.1.
Severity 4 – General/Technical Help	Request for information, technical configuration assistance, “how to” guidance, and enhancement requests. (as described at 2.3.1 .

The details of the system under different severity level are as below:-

2.3.1 Severity of the system under different Severity level.

a) Severity-1 (Urgent support)

This support is required when there is a complete system failure, severe system instability, the loss/ failure of any major sub-system / system or its components, which may significantly impact the system availability, performance, or operational capability at Control center. For example, loss of data to the operator due to any problem in SCADA-DMS system, ,Loss/failure of DR / Disaster recovery Centre, outages of both the CFEs attributable to any software/hardware related problem, outage of any important software functionality (on both the servers) which is required to disperse Distribution management /OMS functions, , Failure of both GPS clock and time synchronization and outage of both routers, failure of both LAN system, outage of both main and backup servers of any system, firewall would be included under this category. The problem shall be attended by the Contractor at the earliest, within the response/Resolution time as specified in the Agreement on occurrence of incident .The Contractor shall take all steps to restore the SCADA functionality at the earliest to avoid data loss.

b) Severity-2

The support services not defined under Severity-1 are included under this category. Failure of one SCADA/DMS/OMS AND SUB-STATION AUTOMATION/FEP Server/ICCP server, failure of VPS , Stoppage of data collections for archiving, real time calculations, failure in Acquisition of SOE at the respective Control- Centre,

outage of Real Time Network and distribution applications, and other applications are included in this category, (% of availability of RTU, COMMUNICATION in a month (Below minimum 99% time) & FRTU , FPI(below Minimum 98% time) % of availability of RTU, FRTU , FPI Digital & Analog status & control points (below Minimum 98 % of total count end to end tested) status to be derived from trend table and failure reporting of control command execution event

, if any, Coverage under this severity would be outages that do not immediately cause on feeder data loss but subsequently could result into Severity-1 category outage, loss of an important subsystem that may affect the day-to-day works and loss of archived data. Failure of any redundant system component affecting the critical redundancy like loss of any one Application Processor, Router, CFE would also be included in this category. Non availability of SAIDI/SAIFI reports. Non- availability of Man-power at control center during working hours will also be covered under this category.

c) Severity-3 (Standard support)

The support services included under this category are when the outage or loss of functionality is neither an emergency nor a priority functionality as indicated in severity level 1 or 2 above. Problems like database reworking, failure of any one workstation, etc. would be covered under this Severity.

d) Severity-4 (General Technical Help)

Request for information, technical configuration assistance, “how to” guidance, and enhancement requests are included under this category.

2.4 Problem/Defect Reporting Procedure

The Contractor shall propose an appropriate problem/defect reporting procedure to meet the requirement of all severity level cases along with the offer.

2.5 Response and Resolution Time

This clause describes the target times within which the Contractor should respond to support requests for each category of severity. The *Initial Response Time* is defined time as the period between the initial receipt of the support request (through approved communications channels) and the acknowledgment of the Contractor. The *Action Resolution Time* is the period between the initial response/ incident concurrence and the Contractor delivering a solution. This period includes investigation time and consideration of alternative courses of action to remedy the situation. The *Action* is defined as a direct solution or a workaround.

Except for Severity Level 1, all hours and days specified are working hours only.

2.5.1 **Emergency Support Response/Resolution Time**

Severity	Initial Response Time	Action Resolution Time	Action
1	30 minutes	2 hours	An urgent or emergency situation requiring continuous attention from necessary support staff until system operation is restored – may be by workaround.
2	1 day	2 days	Attempt to find a solution acceptable to Utility/ Employer as quickly as practical. Resolution time is dependent on reproducibility, ability to gather data, and Utility prioritization. Resolution may be by workaround.
3	2 days	5 days	Evaluation and action plan. Resolution time is dependent on reproducibility, ability to gather data, and Utility prioritization. Resolution may be by workaround.
4	2 days	5 days	Report on the problem/query is to be furnished.

The Contractor shall submit the detailed format/procedure for all the activities such as Reporting time, Resolution time, Downtime etc. along with the offer.

2.6 **Preventive Maintenance**

The Contractor shall undertake preventive maintenance of all equipment/modules (i.e. Hardware & Software supplied under the SCADA/DMS/OMS AND SUB-STATION AUTOMATION System), under the scope of this contract, in accordance with this section. The Contractor will prepare the report as per periodicity defined below and submit the same to the Engineer-in-charge.

i) Activities shall include but not limited to:

- a) Patch Management for OS and Application Software
- b) Automatic update of Antivirus and firewall signatures on daily basis.
- c) Average and peak usage of CPU, LAN, Memory and Disk –once every month .
- d) Monitoring of machine with reference to error reports and logs - once every week
- e) Online diagnostics for servers and workstations - once every 3 months.
- f) Connection test of LAN cables for identifying potential loose contacts in machines, hubs and routers - once every 3 months.
- g) Physical hardware checks to ensure proper working of cooling fans etc.- once every 3 months.

- h) Physical inspection to check the machines and the panels for rat droppings, lizards or other vermin - once every 3 months,
- i) Cleaning and blowing for removal of dust from Servers , Workstations, CFE panels and RTUs/FRTUs/ Numerical relays supplied etc.- once every 3 months.
- j) Routine maintenance of electronics of RMU/ SECTIONLIZER /FPI

ii) Exclusions:

- a) Maintaining dust free / AC environment and protection from rodents and vermin is the responsibility of Utility.
- b) Regular cleaning of computer furniture and surroundings is the responsibility of Utility.
- c) Equipment shutdown during preventive maintenance shall be deemed as available.

2.7 Availability and Payment charges Calculation

It is the endeavor of both the Contractor and Utility to maximize system availability to the extent possible. The Contractor shall provide guaranteed availability for various types of Severity levels as specified in clause [2.3](#) above. The non-availability hours for availability calculation may be reckoned from the end of the allowed Action Resolution time. A standardized register/ log on system shall be maintained at each site containing full details of each outages, actions taken by Utility to correct the problem, applicable Severity level, time of reporting to the Contractor support engineer/support centers pursuant to the appropriate methods in the Agreement, allowed Response time as per the Response times defined in clause [2.5](#), actual Resolution time, and signature of Engineer-in-charge as well as the Contractor's support engineer of the site. Duration of outages over and above the Action Resolution time in each of the Severity levels shall be counted for the non- availability computation and shall be clearly brought out in the register. The resolution may be accomplished by a work around, and such solution shall mark the end of non-availability. In the event of multiple failures at a site, due to a common cause, the first FPR (Field Problem, Report) logged shall be used for the purpose of availability calculation. However, simultaneous multiple outages due to unrelated cause would be counted separately

2.7.1 Availability computation for SCADA-DMS-OMS System

Availability would be on per quarterly basis. The formula to be used for availability computation would be as under:

Availability per quarter (per site) = $\frac{\text{THQ} - (S1 \times 1 + S2 \times 0.4 + S3 \times 0.1)}{\text{THQ}} \times 100\%$

Where THQ is total hours in the quarter

S1 is the total non-available hours in Severity Level-1

S2 is the total non-available hours in Severity Level-2

S3 is the total non-available hours in Severity Level -3

In case of cyber-attack incident which is not neutralized by cyber security and affected the system, the availability shall be considered nil

2.7.2 Payment of maintenance charges (based on SCADA-DMS -OMS System availability)

In the event of availability below a certain level, the maintenance charges would be proportionately reduced as follows:

For overall system availability

Availability per Quarter	Deduction as % of the apportioned price of total FMS for SCADA-DMS -OMS portion of the contract applicable for that site
$\geq 99\%$	NIL
Less than 99%	Deduction of 2.5 % of the apportioned price on each 1% non-availability below 99% and upto 95% and deduction of 4 % of the apportioned price on each 1% non-availability up to 90% & 100% deduction below 90%

For individual hardware & noncritical functions

Availability per quarter	Deduction as % of the apportioned price of total FMS for SCADA-DMS- OMS portion of the contract applicable for that site
$\geq 98\%$	NIL
Less than 98%	Deduction of 2.5 % of the apportioned price on each 1% non-availability below 98% and up to 95% and deduction of 5% of the apportioned price on each 1% non-availability up to 90% & 100% deduction below 90%

Utility may go for upward revision for availability conditions

While calculating Availability following shall be considered :

The Overall SCADA/DMS/OMS AND SUB-STATION AUTOMATION/ OMS System shall be considered as available if

- a) All SCADA applications are available
- b) All OMS/DMS applications are available
- c) All SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS functions described in the specification are executed at periodicities specified in the specification. without degradation in the response times
- d) Requests from available Operator Consoles & VPS are processed
- e) Information Storage and Retrieval applications are available
- f) Data exchange with other system is available
- g) One of the redundant hardware is available so that all the SCADA/DMS/OMS AND SUB-STATION AUTOMATION applications are functional to ensure the design & performance requirement as envisaged in the MTS
- h) Availability of SAIDI/SAIFI report
- i) Minimum 95 % availability of RTU /Numerical relays and minimum 90% availability of /FRTU/FPI /RMU/SECT/

Further, Non-Availability of legacy systems shall not be considered for calculating Overall SCADA/DMS/OMS AND SUB-STATION AUTOMATION System Availability.

However each device, including RTU, FRTU & Servers etc. shall individually exhibit a minimum availability of 98%. Further, the non-availability of following Non-Critical functions shall not be considered for calculations of SCADA/DMS/OMS AND SUB-STATION AUTOMATION System availability , however these functions should be available for 98% of the time.

- (a) Database modification and generation
- (b) Display modification and generation
- (c) Report modification and creation
- (d) DTS

Availability of RTU/FRTU/FPI/SECT/RMU and other field equipment like APS

% of availability of RTU, COMMUNICATION in a month (Minimum 95% time)
& FRTU , FPI (Minimum 90% time) % of availability of RTU, FRTU , FPI data (Minimum 98 % of total count end to end tested)

2.7.3 The computation of Availability / Non-availability would be rounded up to 2 decimal places at each Contract Co-ordination Site on quarterly basis and any deduction in the FMS charges thereof would be calculated as stated above in Clause [2.7.2](#) on pro-rata basis.

2.8 The Contractor's Obligations

2.8.1 In order to optimize and improve the response of the system, the Contractor may re-install the program modules after making the Utility engineer aware of the consequence (like data loss, database rebuild etc.).

2.8.2 Any modification of software/Operating System required to restore functionality due to hardware upgrades, patches, or arising out of a necessity to fix FPRs, would be done by the Contractor at no extra cost to Utility . Also, any software

updates/upgrades released till the completion of warranty period /AMC shall be provided and installed & commissioned free of cost as per instructions from Utility.

2.8.3 The Contractor shall ensure that all components (Hardware & Software) covered under 7 years comprehensive on-site warranty are maintained in good working condition and in case of any defect , timely replacement/repair shall be carried out so as to meet the availability requirements specified herein.

2.8.4 The Contractor will submit FSR (Field Service Report) and the steps taken to solve the problem, along with details of code changes.

2.9 Responsibilities of Utility

- a. Utility will ensure the availability of competent staff appropriately trained in the administration and use of existing SCADA/DMS/OMS AND SUB-STATION AUTOMATION systems for proper operation of the system.
- b. Utility shall ensure that proper Environmental conditions are maintained for the system.
- c. Utility shall ensure that the System is kept and operated in a proper and prudent manner and only trained Utility employees (or persons under their supervision) are allowed to operate the system.
- d. Utility shall provide access to the sites of installation for purposes of providing Support Services.
- e. Utility shall provide the Contractor with Office and storage space for their maintenance staff and spares. However , contractor shall be responsible for security of the items stored

2.10 Responsibility Matrix

The table in this clause provides a summary definition of the roles and responsibilities of the Contractor and Utility.

Legend: This indicates who has primary responsibility to perform this function.
 A This indicates who will provide assistance.

Item	Task	Utility / Employer	Contractor
0.0	PROBLEM IDENTIFICATION		
0.1	Root cause analysis to determine whether the fault is attributable to Hardware or Software.		A
0.2	Resolution of problems involving third party maintainer where there is uncertainty whether the root cause is hardware or software.		A
1.0	SOFTWARE PROBLEM RESOLUTION		

1.1	Report problem and assist with problem identification		A
1.2	Provide or recommend corrections, temporary patches, workarounds or other fixes to system problems		A
1.3	Install and test corrections, temporary patches, workarounds or other fixes to system problems Report Problem in supervision and control		A
2.0 ROUTINE SOFTWARE SUPPORT			
2.1	Build and maintain database, displays and reports		A
2.2	Perform system back-ups		A
2.3	Restore or reinstall software from back-ups		A
2.4	Monitor system logs (part of remote monitoring service)		A
2.5	Maintain system logs		A
2.6	Maintain user accounts		A
3.0 HARDWARE PROBLEM RESOLUTION			
3.1	Report problem and assist with defining problem		A
3.2	Troubleshoot problem to diagnose if it is software-related or hardware-related		A
3.3	Identify failed component, Replace failed components in online system using parts from spares inventory		A
3.4	Restore operation of repaired/replaced equipment		A
4.0 HARDWARE SPARE PARTS			
4.1	To keep inventory for SLA by SIA		A
4.2	Provide appropriate facility for local storage of spares in case not available with SIA but this is not obligation for Utility.	A	
4.3	Replenish local spares inventory		A
5.0	Integration and database work		A
5.1	CFE /RTU/FRTU Card addition/Expansion field equipment		A
5.2	Database resizing		A
5.3	Annual cyber security audit		A

The contractor shall be responsible for all the maintenance of the system till the operational acceptance. The consumables and spares wherever required for maintaining the system shall be provided by the contractor till operational acceptance of the system. The consumable items shall include but not be limited to (a) VPS lamps (b) printer paper (c) Printer toner, ink, ribbons and cartridges (d) Special cleaning material

SECTION - 7

PROJECT MANAGEMENT, QUALITY ASSURANCE AND DOCUMENTATION

This section describes the project management, schedule, quality assurance, and documentation requirements for the project. This section is applicable to Group A (Noida Town), B, C, U towns as per functional requirements

7.1 Project Management

The Contractor shall assign a project manager with the authority to make commitments and decisions that are binding on the Contractor. Employer will designate a project manager to coordinate all employer project activities. All communications between employer and the Contractor shall be coordinated through the project managers. The project managers shall also be responsible for all communications between other members of the project staffs.

Bidder shall submit the manpower deployment plan along with the bids, describing the key roles of each person.

7.2 Project Schedule

The project implementation schedule shall not exceed 24 months from the date of award. Based upon this schedule the bidder shall submit a preliminary implementation plan along with the bid. The detail project implementation schedule shall be submitted by the contractor after award for employer's approval, which shall include at least the following activities:

- a) Site Survey
- b) Documents submission and approval schedule
- c) Factory & Site Testing Schedule
- d) Database development schedule
- e) Hardware purchase & Manufacturing, Software development & integration schedule
- f) Dispatch Schedule
- g) Installation / commissioning schedule
- h) Training schedule

The project schedule shall include the estimated period for completion of and its linkage with other activities.

7.2.1 Progress Report:

A progress report shall be prepared by the Contractor each month against the activities listed in the project schedule. The report shall be made available to employer on a monthly basis, e.g., the 10th of each month. The progress report shall include all the completed, ongoing and scheduled activities.

7.3 Transmittals

Every document, letter, progress report, change order, and any other written transmissions exchanged between the Contractor and employer shall be assigned a unique transmittal number. The Contractor shall maintain a correspondence index and assign transmittal numbers consecutively for all Contractor documents. Employer will maintain a similar correspondence numbering scheme identifying documents and correspondence that employer initiates.

7.4 Quality Assurance & Testing

All materials and parts of the system / sub-system to be supplied under the project shall be of current manufacture from a supplier regularly engaged in the production of such equipment.

7.4.1 Quality Assurance and Quality Control Program

The Contractor shall maintain a Quality Assurance/Quality Control (QA/QC) program that provides that equipment, materials and services under this specification whether manufactured, designed or performed within the Contractor's plant, in the field, or at any sub-contractor source shall be controlled at all points necessary to assure conformance to contractual requirements. The program shall provide for prevention and ready detection of discrepancies and for timely and positive corrective action. The Contractor shall make objective evidence of quality conformance readily available to the Owner. Instructions and records for quality assurance shall be controlled and maintained at the system levels. The Contractor shall describe his QA/QC program in the Technical Proposal, (along with samples from his QA/QC manual) and shall submit his QA/QC Manual for review and acceptance by the Owner.

Such QA/QC program shall be outlined by the Contractor and shall be finally accepted by Owner after discussions before the award of Contract. A Quality Assurance Program of the Contractor shall generally cover but not be limited to the following:

- a) The organization structure for the management and implementation of the proposed Quality Assurance Program.
- b) Documentation control system.
- c) Qualification data for key personnel.
- d) The procedure for purchase of materials, parts/components and selection of sub-contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases, etc.
- e) System for shop manufacturing including process controls.
- f) Control of non-conforming items and system for corrective action.
- g) Control of calibration and testing of measuring and testing equipment.
- h) Inspection and test procedure for manufacture.

- i) System for indication and appraisal of inspection status.
- j) System for quality audits.
- k) System for authorizing release of manufactured product to utility.
- l) System for maintenance of records.
- m) System for handling, storage and delivery.
- n) A Quality Plan detailing out the specific quality control procedure adopted for controlling the quality characteristics of the product.

The Quality Plan shall be mutually discussed and approved by the employer after incorporating necessary corrections by the Contractor as may be required.

Neither the enforcement of QA/QC procedures nor the correction of work mandated by those procedures shall be cause for an excusable delay. An effective Quality Assurance and Quality Control organization shall be maintained by the Contractor for at least the duration of this Contract. The personnel performing QA/QC functions shall have well-defined responsibility, authority, and organizational freedom to identify and evaluate quality problems and to initiate, recommend, or provide solutions during all phases of the Contract. The QA/QC organization of the Contractor shall be an independent administrative and functional structure reporting via its manager to the Contractor's top management. The QA/QC manager(s) shall have the authority within the delegated areas of responsibility to resolve all matters pertaining to quality to the satisfaction of employer when actual quality deviates from that stated in the Work Statement.

The Contractor shall be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of employer's inspection of equipment/materials.

The employer or his duly authorized representative reserves the right to carry out Quality Audit and Quality Surveillance of the systems and procedures of the Contractor's/his vendor's Quality Management and Control Activities.

The scope of the duties of the employer, pursuant to the Contract, will include but not be limited to the following:

- a) Review of all the Contractor's drawings, engineering data etc.
- b) Witness or authorize his representative to witness tests at the manufacturer's works or at site, or at any place where work is performed under the Contract.
- c) Inspect, accept or reject any equipment, material and work under the
a. Contract in accordance with the specifications.
- d) Issue certificate of acceptance and/or progressive payment and final
payment certificate

- e) Review and suggest modification and improvement in completion schedules from time to time; and
- f) Monitor the Quality Assurance program implementation at all stages of the works.

7.4.2 Inspection

The Contractor shall give the employer/Inspector two weeks in case of domestic supplies and six weeks in case of foreign supplies written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The employer/Inspector, unless witnessing of the tests is waived, will attend such tests on the scheduled date for which employer/Inspector has been so notified or on a mutually agreed alternative date. If employer/Inspector fails to attend the testing on the mutually agreed date, Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and Contractor shall forthwith forward to the Inspector, duly certified copies of the test results in triplicate.

The employer/Inspector shall, within fourteen (14) days from the date of inspection as defined herein, give notice in writing to the Contractor of any objection to any drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall make the modifications that may be necessary to meet said objections. When the factory tests have been completed at the Contractor's or Sub-contractor's works, the employer/Inspector shall issue a certificate to this effect within fourteen (14) days after completion of tests but if the tests are not witnessed by the employer/Inspector, the certificate shall be issued within fourteen (14) days of receipt of the Contractor's Test Certificate by the Employer/Inspector. The completion of these tests or the issue of the certificates shall not bind the employer to accept the equipment should it, on further tests after erection, be found not to comply with the Contract.

In cases where the Contract provides for tests, whether at the premises or works of the Contractor or of any Sub-contractor, the Contractor except where otherwise specified shall provide free of charge items such as labor, materials, electricity, fuel, water stores, apparatus and instruments, as may be reasonably demanded by the employer/Inspector or his authorized representative to carry out effectively such tests of the equipment in accordance with the Contract and shall provide facilities to the employer/Inspector or his authorized representative to accomplish testing.

The inspection by Employer and issue of Inspection Certificate thereon, shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed Quality Assurance Program forming a part of the Contract.

The Contractor shall keep the Employer informed in advance of the time of starting of the progress of manufacture of material in its various stages so that arrangements can be made for inspection.

Record of routine test reports shall be maintained by the Contractor at his works for

periodic inspection by the Employer's representative.

Certificates of manufacturing tests shall be maintained by the Contractor and produced for verification as and when desired by the Employer. No material shall be dispatched from its point of manufacture until it has been satisfactorily inspected and tested. Testing shall always be carried out while the inspection may be waived off by the Employer in writing only.

However, such inspection by the Employer's representative(s) shall not relieve the Contractor from the responsibility for furnishing material, software, and equipment to conform to the requirements of the Contract; nor invalidate any claim which the Employer may make because of defective or unsatisfactory material, software or equipment.

Access to the Contractor's facilities while manufacturing and testing are taking place, and to any facility where hardware/software is being produced for Employer shall be available to Employer representatives. The Contractor shall provide to Employer representatives sufficient facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification. Inspection rights shall apply to the Contractor's facilities and to subcontractor facilities where equipment is being manufactured.

Inspections will be performed by Employer, which will include visual examination of hardware, enclosure cable dressings, and equipment and cable labeling. Contractor documentation will also be examined to verify that it adequately identifies and describes all wiring, hardware and spare parts. Access to inspect the Contractor's hardware quality assurance standards, procedures, and records that are applicable to the facilities shall be provided to Employer.

7.4.3 Inspection and Test

All materials furnished and all work performed under this Specification shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, all deficiencies have been corrected to Employer's satisfaction, and the equipment has been approved for shipment by Employer.

Should any inspections or tests indicate that specific hardware, software or documentation does not meet the Specification requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The test shall be considered complete when (a) when all variances have been resolved (b) all the test records have been submitted (c) Employer acknowledges in writing the successful completion of the test.

7.4.3.1 Test Plans & Procedures

Test plans for both factory and field tests shall be provided by the Contractor to

ensure that each test is comprehensive and verifies all the features of the equipment are tested. The test plans for factory and field tests shall be submitted for Employer approval before the start of testing.

The contractor shall prepare detail testing procedure in line to specification and submit for employer's approval. The procedure shall be modular to the extent possible, which shall facilitate the completion of the testing in the least possible time.

7.4.3.2 Test Records

The complete record of all factory and field acceptance tests results shall be maintained by the

Contractor. The records shall be maintained in a logical form and shall contain all the relevant information. The test reports shall be signed by the testing engineer and the engineer witnessing the tests.

7.4.3.3 Reporting of variances

A variance report shall be prepared by either Employer or Contractor personnel each time a deviation from specification requirements is detected during inspection or testing. All such variances shall be closed in mutually agreed manner.

However, at any stage if employer feels that quality of variances calls for suspension of the testing the testing shall be halted till satisfactory resolution of variances, which may involve retesting also.

7.4.3.4 Factory Test

The factory tests shall be conducted on all the equipment and shall include, but not be limited to the following, appropriate to the equipment being tested:

- a. Verification of all functional characteristics and requirements specified
- b. Inspection and verification of all construction, wiring, labeling, documentation and completeness of the hardware

Before the start of factory testing, the Contractor shall verify that all changes applicable to the equipment have been implemented. As a part of the factory tests, unstructured testing shall be performed for SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS system to allow Employer representatives to verify proper operation of the equipment under conditions not specifically tested in the above structured performance test. The Contractor's test representative shall be present and the Contractor's technical staff members shall be available for consultation with Employer personnel during unstructured test periods. All special test facilities used during the structured performance test shall be made available for Employer's use during unstructured testing.

Unless otherwise specified in the relevant sections of the specification & except for SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS Hardware , Software, RTUs , the sampling size for FAT () is

10% and in case any selected sample fails during the test, the failed samples shall be rejected and 20% of the samples from the balance quantity shall be tested. If any failures are observed, the entire lot shall be rejected.

7.4.3.5 Field Performance Test

After the equipment has been installed, the Contractor shall start up and check the performance of the equipment of field locations. All hardware shall be aligned and adjusted, interfaces to all inputs and outputs installed, operation verified, and all test readings recorded in accordance with the Contractor's recommended procedures. The field performance test shall exhibit generally all functions of the equipment and duplicate factory test. All variances must be corrected prior to the start of the field performance test. The list of final tests to be carried out in the field shall be listed in the site-testing document in line to the requirements specified in the relevant sections of this volume.

7.5 Type Testing

The equipment being supplied shall conform to type tests as per technical specification and shall be subjected to routine tests in accordance with requirements stipulated under respective sections. The type test shall be conducted on the equipment if it is specifically mentioned in the relevant section, for other equipment the type test report shall be submitted. Employer reserves the right to witness any or all the type tests. The Contractor shall intimate the Employer the detailed program about the tests at least three (3) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

The reports for all type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body viz. NABL / of the country where laboratory is located) or witnessed by the representative(s) of Utility. However, type test reports shall not more than 5 year old than the date of bid opening or validity of report by testing lab whichever is lower.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design / manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or the type test(s) not carried out, same shall be carried out without any additional cost implication to the Employer.

In case of failure during any type test, the Supplier at his own expenses shall modify the equipment and repeat all type tests successfully at his own cost and within the project time schedule.

Wherever, the make of the items is indicated in the technical specification, the type test reports are not required to be submitted for the makes, indicated in the specification. For the new makes (other than those indicated in the technical specification), type test reports as per relevant standard shall be submitted for Employer's approval.

7.6 Documentation

To ensure that the proposed systems conform to the specific provisions and general intent of the Specification, the Contractor shall submit documentation describing the systems to employer for review and approval. Further the contractor shall also submit the drawings/documents for all the hardware & software required for site installation, testing and commissioning and thereafter operation of the system. The contractor shall obtain approval of employer for the relevant document at each stage before proceeding for manufacturing, system development, factory testing, site testing, training etc. The schedule for submission/approval of each document shall be finalized during the discussions before placement of the contract, this schedule shall be in line to overall project schedule.

Each document shall be identified by a Contractor document number, the employer document number, and the employer purchase order number. Where a document is revised for any reason, each revision shall be indicated by a number, date, and description in a revision block along with an indication of official approval by the Contractor's project manager. Each revision of a document shall highlight all changes made since the previous revision.

The contractor shall submit two copies of each document/drawing for employer's review and approval. After approval five sets of all the documents shall be submitted as final documentation, however, for site specific documents two sets of documents shall be provided for each site. Any changes observed during field implementation shall be incorporated in the as-build drawing and required sets of the same shall be submitted to employer/owner. In addition to paper copies all the documents shall also be provided on electronic media in two copies. In case any documentation requirement is specified in the relevant section the same shall apply for the equipment /system defined in that section. The contractor shall also supply five sets of User manuals/guides/O&M manuals/manufacture's catalogues for all the hardware & software supplied under the contract which shall be in addition to the one set each at all the locations where the System has been installed. The user manual shall at minimum include the principle of operation, block diagrams, troubleshooting and diagnostic and maintenance procedures. Considering all the components of the project briefly the following documents/drawings shall be required under the project.

- (a) System Description Documents (Overview)
- (b) Data Requirement sheets
- (c) Software Requirements Specification
- (d) Data base Documents
- (e) Drawings/Documents for manufacturing/Assembly of the equipment/system
- (f) Drawings/Documents for installation of the equipment/system at site
- (g) Software description/design documents for each software module
- (h) Testing Procedures and reports
- (i) Manuals for each equipment/hardware/test equipment
- (j) Bill of Quantities
- (k) Site Testing documents
- (l) Training documents

- (m) System Administrator Documents
- (n) User guide for Dispatcher

However, all the above type of documents may not be required for each sub-system of the project e.g. item (n) above may not be required for auxiliary power supply system, therefore, the contractor shall submit a comprehensive list of the document as applicable for the offered system for employer's approval immediately after signing of the contract and the documents shall be finalised as per the approved list. In regard to Data requirement sheets (DRS) for these will be duly filled in by the bidder & submitted along with the bid. During detailed engineering, contractor will be required to submit detailed DRS to include all technical parameters of the equipment to ensure that the offered equipment meets all the technical specification requirements

The Licensed Equipment manufacturers shall be able to manufacture, assemble, test, market and sell the product as per OEM type tested design under technology transfer agreement. The Licensed Equipment manufacturers should submit following documents

- a) Licensed Equipment manufacturers should furnish Technology Licensee certificate or agreement copy.
- b) Licensed Equipment manufacturers should be able to furnish valid Type test certificate from OEM.
- c) Tender specific Authorization letter backed by OEM shall be submitted at the time of tender.

SECTION 8

A) DESIGN PARAMETERS AND PERFORMANCE TABLES

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be designed as per the technical parameters defined in the specification and the tables specified here. The SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS system (such as databases, network elements etc.) shall be sized to accommodate the requirement mentioned in table 7. This section is applicable to Group A (Noida Town),B,C ,U towns as per functional requirements.

The system shall be tested with the doubled present power system size (ultimate capacity) as defined in table 7& measure the various performance of the system as defined in the tables and technical specification including peak and average load scenarios.

The auxiliary memory utilization , average CPU, RAM & LAN utilization parameters shall not exceed the limits as defined in table 8. This memory utilization includes the memory used for storage of data for the defined duration as specified in the various sections of technical specification.

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall be suitable for addition of at least double the operator workstations (in future) without requiring any up gradation of the servers.

The SCADA/DMS/OMS AND SUB-STATION AUTOMATION system design & performance parameters are defined in the following tables:

TABLE 1 - DESIGN PARAMETERS FOR SCADA FUNCTIONS

TABLE 2 - DESIGN PARAMETERS FOR ISR FUNCTIONS

TABLE 3 - DESIGN PARAMETERS FOR DMS FUNCTIONS

TABLE 4 - MAINTENANCE ACTIVITIES

TABLE 5- DESIGN PARAMETERS FOR USER INTERFACE

TABLE 6 - CONFIGURATION CHARACTERISTICS & AVAILABILITY FUNCTIONS

TABLE 7 - POWER SYSTEM SIZE

TABLE 8-OTHER PERFORMANCE REQUIREMENTS AND ACTIVITIES FOR
NORMAL AND PEAK LEVEL OF LOADING

TABLE 1 – DESIGN PARAMETERS FOR SCADA FUNCTIONS

Note ; The parameters which are not indicated in the tables & only mentioned elsewhere in the specification shall also be considered as design parameters

Function Description	Design capacity	Execution rate
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Function Description	Design capacity	Execution rate
Data Acquisition from	As per specification	
a) Status data	All status points	By exception, updated & displayed within 4sec from data collection from RTU at S/s 6 sec from data collection from FRTU/ FPI Integrity check of all status at every 10 Minutes (configurable) On demand
b) Analog data	All analog points	By exception, updated & displayed within 5 sec & 10sec Integrity check for all analog at every 10 Minutes (configurable) provision for all analog update periodicity of 10 sec configurable upto 1 hour. Energy values periodically configurable from 5 min to 24 hours On demand SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center ,S/S , RMU,FPI shall not be more than 0.1sec at each location & latency shall not be more than 0.5sec for status. For analog data the time skew shall not be more than 1sec & latency shall not be more than 1sec for analog as per IEEE C37.1. Energy values of 15 minute blocks shall be collected periodically from the RTU, FRTU at scan rate of 15 minute/1

		24 hours). Alternatively, the energy values shall be calculated for each 15 minute/1 hour blocks at SCADA level from the acquired energy values of MFTs through RTU & FRTU.
Time synchronization of RTU	All RTUs shall be synchronized from Master station	every 5 Minutes (Configurable from 5-60 minutes)

Function Description	Design capacity	Execution rate
SCADA/DMS/OMS AND SUB-STATION AUTOMATION Data Exchange with other system as specified	As per specification	A/R for ISR function & data exchange
Data Processing		
Analog data processing:		
a) Conversion to engineering units	Per analog points	Each time the value is received in
b) Zero dead band processing	Per analog points	Each time the value is received in
c) Reasonability Limit checking	High and Low reasonability limits per analog point	Each time the value is received in SCADA
d) Limit Monitoring (Operational, Alarm and Emergency limits)	High and Low for each of the limits per analog point	Each time the value is received in SCADA
e) RATE OF CHANGE	per analog point	Each time the value is received in SCADA
f) Sign conventions	per analog point	Each time the value is received in SCADA
g) Accumulator processing	Accumulator points	Each time the value is received in SCADA
Calculated Data Processing:		
- Arguments for analog	32	Each time the value is received in
- Arguments for status calculations	32	Each time the value is received in SCADA
- No. of calculated data (Min / Max with time stamp and Average)	3 X no. of analog point for max /min/avg and 1x no. of max/min/avg for other calculations	Min/Max /Average calculation for each 5 min duration

Substation Processing	Topology	For no. of status, refer RTU/FRTU/FPI point counts in the technical specification. within 1sec response after updation in SCADA database	Triggered by status change.
Alternate source of data		For all status , analog telemetered parameters	Each time the value is received in SCADA
Quality codes		As per specification	Each time value is received by

Continuous Real time data storage & Playback	a) At least 2 days storage for all tele-measurands	a) Each time the value is received from RTU in SCADA database
	b) Playback of stored data for selected time period of 1 to 10 minutes	b) playback sampling rate configurable in Second/ minutes
Sequence-of-Events data	1000 events circular buffer in the SCADA database	SOE retrieval Periodically (5 minutes) or by exception and On demand
Supervisory Control		
a) Control inhibit Tag Types	4	(a) (b) (c) On demand by Dispatcher/DMS function initiated
b) Control inhibit Tags Per Device	4	
c) Control Action Monitor		10 timer periods (1 to 60 sec)
d) Control permissive		d) Each time supervisory control is requested

Fail soft capability	Critical functions	
		In the event of system crosses mark of peak loading requirements. Graceful degradation of non –critical functions & also relaxing periodicity /update rate of display refresh & critical functions by 50%.

TABLE 2 – DESIGN PARAMETERS FOR ISR FUNCTIONS

Function Description	Design capacity	Execution rate	Response time
Circuit breaker status table	Data as per spec for all CBs	Updation on change in CB status or any of the associated information	2' after up in S da ab
	b) data storage On Auxiliary memory	b) 24 months Retention	
Data Snapshot table	a) Volume of data = Total telemetered status and analog points and max/min with time stamp each analog point with quality codes	a) Snapshot - 5 minutes periodicity	
	b) data storage On Auxiliary memory	b) 24 months Retention	
Hourly data table	a) Volume of = Total telemetered points and max/min with stamp and average for each analog point with quality	a) Hourly	
	b) data storage On Auxiliary memory	b) 24 months Retention	

Hourly Energy data table/Missed hourly table	a) Volume of = Export/Import KWh & Export/Import KVARh for all energy meters with quality code	a) Energy values of 15 minute blocks of each Hour	
	b) data storage On Auxiliary memory	b) 24 months Retention	
Daily Energy data table	Volume of data = Export/Import	a) Energy values of 15 minute blocks of each Hour	
	KWh & Export/Import KVARh for all energy meters with quality code b) data storage On Auxiliary memory	b) 2 Retention Months	
SAIDI/SAIFI TABLES	PLANNED , UNPLANNED AND TOTAL SAIDI & SAIFI FEEDERWISE, TOWN WISE	DAILY, MONTHLY, QTRLY, YEARLY AND ON USER REQUEST PERIOD B) retention – 2years	

Function Description	Design capacity	Execution rate	Response time
Load priority table	Data as per spec for all CBs	On demand by Billing system Under R-APDRP IT implementation. Besides load priority shall be possible to assign locally in SCADA/DMS/OMS AND SUB-STATION AUTOMATION system .	
SOE data table	daily 4 changes per SOE point	Each time the is received from RTU/FRTU/FPI in SCADA database	
Data exchange with Billing system Under R-APDRP IT implementation	a) Daily Energy values of specified hour b) Load priority table	a) Daily & on demand b) On demand by SCADA or change priorities by Billing system Under R-APDRP IT implementation	a) 30 sec
Data Exchange with Legacy system implementation		May be defined by utility	
Data Exchange with NPP	SAIDI/SAIFI through API	Pull request for Daily/monthly from NPP	
Historical information data retrieval	Retrieval of all stored data	On demand	
System message Log Storage	a) 20,000 entries /month		
	b) data storage On Auxiliary memory	b) 2 months retention	
Mass storage of data file	As per spec		
DR function	As per spec	As per spec	

TABLE 3 - DESIGN PARAMETERS FOR DMS FUNCTIONS

Name	Design capacity	Execution rate	Response time
NETWORK MODEL	One model with at least 10 possible islands. Islands may be formed dynamically. All electrical components mentioned in		
NETWORK CONNECTIVITY ANALYSIS	Complete network		
2) Real time mode		- - Event driven	2sec
b) Study mode		- On demand	2sec
State estimation	Complete Network	On change	Complete network
LOAD FLOW APPLICATION (LFA)	Complete Network		
a) Real time mode		- periodic (10 minutes) - On demand by user/application On demand	5sec
b) Study mode			5 sec
Voltage/VAR Control	All tap Changers	On change	5sec
LOAD SHED APPLICATION (LSA)	Complete Network		
a) Manual mode		a) On demand	a) 30sec (for analysis)

Name	Design capacity	Execution rate	Response time
b) Auto mode		b1) On scheduled time (Time of day) b2) Event driven (Frequency)	b) 30 sec (for analysis)
FAULT MANAGEMENT & SYSTEM RESTORATION (FMSR)	At least two simultaneous faults in the network shall supported & Complete network		30 sec
Manual mode		On demand	
Auto mode Generation of switching plans		Event driven	
Prefault configuration mode		On demand	
LOSS MINIMISATION VIA FEEDER RECONFIGURATION Generation of switching plans	Complete network	-Periodic (15 -On demand	30 sec
LOAD BALANCING VIA FEEDER RECONFIGURATION Generation of switching plans	Complete network	-Event -periodic (15 minutes)	30sec
Forecasting	network		
Operations Monitor	Complete network	change in devices status	5 sec
DTS (Also refer specification clause 2.13)	Complete Network	Replica of SCADA/DMS	Same response

Table -4

Maintenance activities

Action	Performance
Complete database regeneration	2 hours
Complete system software build, including operating system, applications, and	6 hours
Software build or all applications and databases	3 hours
Software build of a single applications and	10 minutes
Installation of a single, new display including distribution to all consoles	60 seconds
Reinstallation of all displays	60 minutes
Perform an on-line update of a database parameter and propagation of the change to the source data	60 seconds

TABLE 5 - DESIGN PARAMETERS FOR USER INTERFACE

Name	Min Design capacity	Execution rate
SCADA/EMS SYSTEM ACCESS SECURITY		
Function and Data Access	16	
Windows		
Environment		
Rooms	32	
Layers	8	
Declutter Levels	16	
Panning and Zooming	Supported	
TREND		
a) Trend files	10	
b) Variables per trend	4	

Name	Design capacity	Execution rate
c) Samples per trend variable	5,000	
d) Sampling rate	Configurable from 5 sec to 15 minutes	
ALARMS		Triggered By event
Alarm priority levels	16	
Alarm Message Recording on auxiliary memory - alarms	2months	
EVENTS Event Message Recording on Auxiliary memory - events	2months	

TABLE 6 - CONFIGURATION CHARACTERSTICS & AVAILABILITY FUNCTIONS

Reference Section	Name	Execution Rate	Maximum Response Time (With in)
6.6	CONFIGURATION AND AVAILABILITY Backup Databases Data backup	60 seconds or event	5 seconds
6.8	Processor Errors Processor failure detection Device Errors Device failure detection		10 seconds 10 seconds
6.10	Processor Redundancy and Configuration Management Function Restart Other functions except ISR ISR		30 seconds 120 seconds
6.11	Processor Start-Up with applications functional		1) Not more than failover time

			Maximum Response Time (With in)
Reference Section	Name	Execution Rate	
	2) Warm Start a) all applications 3) Cold Start a) Application except ISR operational b) ISR application		2) 10 minutes a) 15 minutes 3) 15 minutes a) 20 Minutes) 60 Minutes
6.12	Device/Processor Failover		30 seconds from detection of failure

TABLE 7- POWER SYSTEM SIZE

POWER DISTRIBUTION SYSTEM SIZING

AS PER ATTACHED NETWORK DIAGRAMS –

Note Control system hardware & software shall be equipped & sized for for double the size of the above

S.no	System	Present (Nos)	Ultimate (DOUBLE OF PRESENT Size)
1.	Primary S/S		
2.	RMU		
3.	Sectionizer		
4.	FPI		
5.	Power transformer		
6.	Distribution transformer		
7.	Feeders		
8.	Bus bars		
9.	Capbanks		
10.	OLTCs		
11.	Switchable breakers		
12.	Switchable isolators/switches		
13.	MFTs		
14.	IEDs		
15.	DOUBLE STATUS POINTS		

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SCADA/DMS, system under Part A –R-APDRP
Model Technical specification

16	SINGLE STATUS POINTS		
17	CONTROL POINTS		
18	ANALOG STATUS		
19	Any other network parameter		

Table 8- PERFORMANCE REQUIREMENTS

(a) USER INTERFACE REQUIREMENTS

At no time the SCADA/DMS/OMS AND SUB-STATION AUTOMATION system shall delay the acceptance of User request or lockout console operations due to the processing of application functions.

User interface requirements	Response time (Peak loading)
Requests for call-up of displays shall be acknowledged indication of request is being processed	Within 2 sec
Any real time display and application display (except DB displays) on workstation console, Complete display & values shall appear on screen	Within 3 sec after acknowledgement of request
Manual Data entry of the new value shall appear on	Within 2 sec
Display update rate	Every 2 sec for at least 4 displays together
Panning of a world display from one end of screen to other of screen in a continuous manner	Within 2sec
Supervisory control action shall be completed with displayed on the screen	Within (2sec + scan time + communication delay time +field device
Alarm and event response time	display within 1 sec of receipt in SCADA/DMS/OMS AND SUB- STATION AUTOMATION
Alarm and event acknowledgement	With in 2 sec
Requests for printing of displays shall be acknowledged an indication of request is being processed	Within 2 sec
Requests for generation of reports shall be acknowledged an indication of request is being processed	Within 2 sec

(b) UTILISATION

(Considering double the present power system size)

Power Finance Corporation
SCADA/DMS, system under Part A –R-APDRP
Model Technical specification

Name	Average Utilization	Comments
PROCESSOR		
Servers	30%	Normal loading
	50%	Peak loading
Communication Front end/	30%	Normal Loading
ICCP server	67%	Peak loading
LOCAL AREA NETWORKS		
Uncontrolled Access	15%	Normal loading

Name	Average Utilization	Comments
(e.g., Ethernet)	20%	Peak loading
Controlled Access	40%	Normal loading
(e.g., token-ring)	40%	Peak loading
Memory		
Main memory utilisation	50%	Normal loading
(avg)	67%	Peak loading
Auxiliary memory utilisation	50%	

Table 8c- ACTIVITIES FOR NORMAL AND PEAK LEVEL OF LOADING

(Considering double the present power system size)

(1) NORMAL LEVEL OF ACTIVITY

The normal level of activity shall simulate system activities spread over one hour period. During the testing, the response times and the average utilizations shall not exceed the specified values. The following conditions define normal level of system activity to generate the normal loading scenario. Test simulation shall be done using software tool to generate this loading within 1 hr . Staggering of loads during the test duration of I hour is permitted.

- (a) All RTU/FRTU/FPI data shall be scanned and processed as specified in the Specification.
- (b) All data exchange with other systems shall occur as specified in the Specification. (c) All periodic functions shall be executed at the rates defined in tables
- (d) The following SCADA/DMS/OMS AND SUB-STATION AUTOMATION functions shall be executed on-demand:

Function	Number of demand executions
Substation topology processor	50 state changes
Sequence-of-Events data	50 SOE points reported
All DMS applications	4 on-demand per DMS application

- (e) Alarms (2 X no. of RTUs +FRTU+FPI) per hour shall be generated. Each alarm shall be acknowledged individually within 5 seconds.
- (f) Events (2 X no. of RTUs +FRTU+FPI) per hour shall be generated.

- (g) 1% analog of total analog/ 5sec measurements of total analog point count changes as per IEEE C37.1
- (h) One complete run of on-line diagnostics shall be performed on all computers
- (i) Communications channel monitoring shall be performed.
- (j) The following user interface actions shall be performed:

Display Selection	30 per operator workstation & VPS
Supervisory control actions	2 per RTU & 1 per 50 FRTUs
Display Updates	Each operator workstation shall display 3 updating and 1 non-updating display window per monitor. This also includes VPS. Updating displays: - alarm summary list - world display containing a S/S SLD - Network display Non-updating displays: - SCADA/DMS/OMS AND SUB-STATION AUTOMATION System Display
Data Entry	5 data entry actions from any single display
Display Trending	8 display trends, each trending 4 variables
Reports	Prepare and printing of 5 reports

- (k) The following maintenance activities shall be performed:

Function	Task
On-Line Database Editing	Modify 20 data points in each of the 5 RTUs
Display Generator and Management	Modify one single-line diagram one tabular display

2) PEAK LEVEL OF ACTIVITY

The peak level of activity is an addition to the average level of activity described in (A) NORMAL LEVEL OF ACTIVITY above. The peak level of activity shall be applied for a five minute period. During the next ten minutes, only the normal level of system activity shall be applied. This test shall be repeated for four consecutive fifteen minute periods, for a total peak level test time of one hour. The five-minute peak loading period shall coincide with SCADA/ DMS system period where all periodic software is scheduled for execution and at least one five minute period shall span an hour boundary to consider the scheduled hourly periodic activities. There shall be no restrictions on the period when the five-minute peak can occur.

The software execution rates and response times defined in tables of this section , shall not be degraded and the utilization defined in tables of this section shall not exceed during the peak loading conditions. The following conditions shall define the additional peak level of system activity:

- (a) As per IEEE C37.1
 - a. 15 % of status of total status points/ 5sec measurements
 - b. 40% analog of total analog measurements /5sec
- 50% of the alarms shall be acknowledged within the five-minute period
(automatic acknowledgement is unacceptable).
- (c) Display Requests
6 display requests per minute per console
- (d) Supervisory Control
Total 1 per RTU & 1 per 10/ FRTUs in four 5Minute period of peak loading cycles
- (e) DMS applications
3 Network Connectivity Analysis
- (f) Reports
Prepare 5 reports.

End of SCADA/DMS/OMS AND SUB-STATION AUTOMATION PERFORMANCE TABLES

SECTION 9

The BOQ shall be composite along with separate for break up for each Control center (I.E. SCADA /DMS & SCADA District Control center

A1) BILL OF QUANTITY

SCADA/DMS/OMS AND SUB-STATION AUTOMATION control center (BoQ) SDCC& Standard / Zonal SCADA Distt Controlcenter (SSCC/ZSCC)

S.No.	Equipment	Unit	Quantity
A1	Server/ workstation Hardware		
1.	SCADA server for Group A (Noida Town) ,B,C	No.	2
2	DMS server for Group A (Noida Town)		2
3	OMS server for Group A (Noida Town)		2
4.	FEP server with interface switches	No.	2
5.	ISR server	No.	2
6.	NMS server	No.	2
7.	DTS server	No.	1
8	Developmental server	No.	1
9.	Communication Server	No.	2
10	Web/Directory server	No.	2
11	Workstation with dual LED Monitors (S/S	No.	Min 3 upto 20SS; 1 each additional @ 20ss
12.	Workstation with dual LED Monitors (Distribution network	No.	1 PER 100 FRTU locations OR 2 WHICHEVER Is HIGHER OR 1 PER 100 FPIs

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification

13.	Remote VDUs with one LED Monitors	No.	1 at circle , DIV, Subdiv & common at Utility HQ for all
12.	Developmental console with one LED	No.	2
13.	DTS /Workstation Console with dual LEDs	No.	2
14.	DTS instructor with dual LEDs	No	1
15	DLP based Video Projection system with 3x4 Module configuration with each module at least 67" diagonal with common projector (3X4)	No.	1
	Storage & Backup Devices		
16.	External RAID Mass storage device (for 2 years online backup)	No.	1
17.	Switches		
	Layer II switch (SCADA/DMS/OMS AND SUB-STATION AUTOMATION LAN)	No.	2
19.	Layer II switch (Development system LAN)	No.	1
20.	Router one each for DR center/ external system legacy system if envisaged	No.	A/R
21	Router at remote VDU	No.	1/RVDU
22	Firewall & network IPS	No.	1
	Other Active Devices		
23	GPS Time synchronization system	Set	2
24	Time, day & date digital displays	Set	1
	Printers		
25.	A3 Color inkjet printer	No	1
26	B/W Laser printer	no	1
27.	Color laser printer	No	1
	<u>Security system (DMZ)</u>		
28	Web server with load balancing	No.	2
29	Mail server	No.	2
30.	Router	No.	2
31	Firewall & network IPS	No.	2
32	Layer II switch	No.	2
	Cabling System		
33	Cable, Jacks etc.	Lot	1
34.	Any other item to meet specification requirements		
A2	Mandatory Spares		
35.	5% of a1	No.	1
A3	Software		
36.	SCADA software	Lot	1

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification

37.	ISR Software	Lot	1
38.	DMS software (Group A (Noida Town))	Lot	1
39	OMS Software (Group A (Noida Town))	Lot	1
40	RT-DAS Software (Group C)	Lot	1
41.	DTS software	Lot	1 at DTS location
42	Developmental software	Lot	1
43	Network Management Software	Lot	1
44	RDBMS package	(incl in ISR)	
45	WEB /Network security software	(Incl in web server)	
46	GIS Adaptor/Engine for importing data from GIS system under IT system	Lot	1
47	Any other item to meet specification requirements	Lot	A/R

5 % MANDATORY SPARE MAY BE CONSIDERED

UTILITY SHALL ATTACH SCADA/DMS/OMS AND SUB-STATION
AUTOMATION CONFIGURATION DIAGRAM
Common DRR center for Group A (Noida Town) towns (Replica ofSDCC)

S.No.	Equipment	Unit	Quantity
A1	Server/ workstation Hardware		
1.	SCADA server for Group A (Noida Town)	No.	2
2	DMS server for Group A (Noida Town)		2
3	OMS server for Group A (Noida Town)		2
4.	FEP server with interface switches	No.	2
5.	ISR server	No.	2
6.	NMS server	No.	2
7.	DTS server	No.	1
8	Developmental server	No.	1
9.	Communication Server	No.	2
10	Web/Directory server	No.	2

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification

11	Workstation with dual LED Monitors (S/S	No.	Min 3 upto 20SS; 1 each additional @ 60ss
12.	Workstation with dual LED Monitors (Distribution network	No.	1 PER 300 FRTU locations OR 2 WHICHEVER Is HIGHER OR 1 PER 300 FPIs
13.	Remote VDUs with one LED Monitors	No.	-
12.	Developmental console with one LED	No.	2
13.	DTS /Workstation Console with dual LEDs	No.	--
14.	DTS instructor with dual LEDs	No	---
15	DLP based Video Projection system with 2x3 Module configuration with each module at least 67" diagonal with common projector (2X3)	No.	-- --
	Storage & Backup Devices		
16.	External RAID Mass storage device (for 2 years online backup)	No.	1
17.	Switches		
	Layer II switch (SCADA/DMS/OMS AND SUB-STATION AUTOMATION LAN)	No.	2
19.	Layer II switch (Development system LAN)	No.	1
20.	Router one each for DR center/ external system legacy system if envisaged	No.	A/R
21	Router at remote VDU	No.	1/RVDU
22	Firewall & network IPS	No.	1
	Other Active Devices		
23	GPS Time synchronization system	Set	2
24	Time, day & date digital displays	Set	1
	Printers		
25.	A3 Color inkjet printer	No	1
26	B/W Laser printer	no	1
27.	Color laser printer	No	1
	<u>Security system (DMZ)</u>		
28	Web server with load balancing	No.	2
29	Mail server	No.	2
30.	Router	No.	2

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification

31	Firewall & network IPS	No.	2
32	Layer II switch	No.	2
	Cabling System		
33	Cable, Jacks etc.	Lot	1
34.	Any other item to meet specification requirements		
A2	Mandatory Spares		
35.	5% of al	No.	1
A3	Software (Replication software)		
36.	SCADA software	Lot	1
37.	ISR Software	Lot	1
38.	DMS software (Group A (Noida Town))	Lot	1
39	OMS Software (Group A (Noida Town))	Lot	1
40	RT-DAS Software (Group C)	Lot	1
41.	DTS software	Lot	--
42	Developmental software	Lot	1
43	Network Management Software	Lot	1
44	RDBMS package	(incl in ISR)	
45	WEB /Network security software	(Incl in web server)	
46	GIS Adaptor/Engine for importing data from GIS system under IT system	Lot	1
47	Any other item to meet specification requirements	Lot	A/R

BILL OF QUANTITY

Common DRR center for group B&C towns (Replica of SDCC)

S.No.	Equipment	Unit	Quantity
B1	Server/ workstation Hardware		
1.	DR server	No.	2
2.	Communication Server	No.	2
3.	Workstation with one TFT Monitors	No.	2
B2	Storage & Backup Devices		
4.	External Mass storage device	No.	1

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification

B3	Switches		
5.	Layer II switch (DR LAN)	No.	2
	Routers		
6	Router for interfacing at SCADA DMS center	No.	1
B4	Printers		
7.	Color inkjet printer	Set	1
8.	B/w Laser printer	Set	1
9.	Color laser printer	Set	1
B5	Cabling System		
10.	Cable, Jacks etc.	lot	1
11.	Any other hardware to meet functional /performance requirement of MTS	lot	
B6	Mandatory Spares for DR center		
12.	5% of b1	No.	1
B7	Software for Control Centre		
13	RDBMS package	Incl in DR system	

5 % MANDATORY SPARE MAY BE CONSIDERED

UTILITY SHALL ATTACH SCADA/DMS/OMS AND SUB-STATION AUTOMATION CONFIGURATION DIAGRAM

C) BILL OF QUANTITY

RTU

S.No.	Equipment	Unit	Quantity
C1	RTUs		
1.	RTU comprising panels, racks, sub-racks, Power Supply modules, CPU analog / digital input & control output module as per specification interfacing equipment, required converters & all other required items/accessories including complete wiring for all modules for locations mentioned below	Set	1/ss
A	Rack	No.	As per I/O
B	POWER SUPPLY CARD	No.	1S/S
C	CPU/ PROCESSOR CARD	No.	1 S/S
D	COMMUNICATION CARD	No.	As per I/O
E	DIGITAL INPUT CARD	No.	As per I/O

F	ANALOG INPUT CARD	No.	As per I/O
G	DIGITAL CONTROL CARD	No.	As per I/O
H	ANY OTHER CARD TO MEET FUNCATLITY /PERFORMANCE IF ANY	No.	A/R
2.	MFTs	No.	As per I/O
3.	CMRs	No.	As per I/O
4.	HDR	No.	As per I/O
5.	Transducer OLTC	No.	PER xFERMER
6.	Transducer Winding Temp	No.	PER xFERMER
7.	Transducer Oil temp	No.	PER xFERMER
8	Router	No.	Per S/S
9.	Single TFT PC for LDMS	No	Per S/S
10.	1 B/W laser printer	No	Per S/S
11.	Any other hardware to meet functional /performance requirement of MTS	Lot	A/R
C2	LDMS		
12.	LDMS	No.	1/ss
13	Any other software to meet functional /performance requirement of MTS	Lot	A/R
C3	TEST EQUIPMENT for RTU		
14.	RTU Database Configuration & Maintenance Software tool	No.	1/20SS
15.	Master Station cum RTU Simulator & Protocol analyzer software tool	No.	1/20SS
16.	Laptop PC for above software tools along with interfacing hardware including Hub	No.	1/20SS
C4	MANDATORY SPARES FOR RTU 5% of c1 Sub - Total (mandatory spare) -D4	No	-

UTILITY SHALL ATTACH RTU & FRTU
CONNECTIVITY DIAGRAM

[illegible]

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification

TOTAL										

RTU I/O COUNT

Note: - SS : Single status input, DS : Double status input for CBs, DC : Digital Control Output (Trip & Close)/Raise /lower CMR : Contact Multiplying Relay, HDR : Heavy Duty Relay, METER : Energy meter, CM: Communication Module , DI : Digital input , DO : Digital Output AI: Analog module

- Note:**
1. MFT provide data that is to be acquired by RTU on Modbus/or IEC protocol for Voltage (phase to phase and phase to neutral), Current (phase and neutral), Active Power, Reactive Power, Apparent Power, Power Factor, Frequency, active energy (import & export), reactive energy (import & export) etc.
 2. CMRs shall be mounted in the existing C&R panels. Wherever the space is not available in the existing panels the same shall be mounted panels. Heavy Duty Relays shall be provided for Digital outputs for CBs and shall be mounted in the RTU panels itself.
 3. The RTU shall be equipped for the above specified I/O (analog input MFT), digital input & digital output) point points, which includes 20 future use . These 20 % spare points shall be terminated on terminal blocks in RTU panel.
 4. All protection relay/Alarm points & CBs shall be considered for SOE.
 5. Point counts include three alarms per station for auxiliary system and fire, which shall be interfaced to RTU.

D) BILL OF QUANTITY

FRTU

S.No.	Equipment	Unit	Quantity
D1	FRTUs		
1.	Mini pole mounted FRTU base equipment along with enclosure suitable to work in open environment (Adequate protection from water & dust) , racks, sub-racks, Power	Set	1/RMU/SECTIONLIZER
	Supply modules with power backup , I/o modules, CPU, interfacing equipment, required converters & all other required items/accessories including complete wiring for all modules for locations mentioned BELOW		
A	Rack	No.	As per I/O
B	POWER SUPPLY CARD	No.	1/FRTU
C	CPU/ PROCESSOR CARD	No.	1/FRTU

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification

D	COMMUNICATION CARD	No.	As per I/O
E	DIGITAL INPUT CARD	No.	As per I/O
F	ANALOG INPUT CARD	No.	As per I/O
G	DIGITAL CONTROL CARD	No.	As per I/O
H	ANY OTHER CARD TO MEET FUNCTIONALITY /PERFORMANCE IF ANY	No.	A/R
2.	MFTs	No.	As per I/O As per I/O As per I/O A/R
3.	CMRs	No.	
4.	HDR	No.	
5.	modem	No.	
6.	Any other ITEM to meet functional /performance requirement of MTS		
D2	TEST EQUIPMENT for FRTU		
7.	FRTU Database Configuration & Maintenance Software tool	No.	1/100FRTU
8.	Master Station cum RTU Simulator & Protocol analyser software tool	No.	1/100FRTU
9.	Laptop PC for above software tools along with interfacing hardware including Hub	No.	1/100FRTU
D3	MANDATORY SPARES FOR FRTU		

5 % MANDATORY SPARE MAY BE CONSIDERED

UTILITY SHALL ATTACH RTU & FRTU
CONNECTIVITY DIAGRAM

FRTU I/O COUNT

SNO	STATION	SS	DS	DC	CMR	HDR	MFT	Com module	DI module	DO module	AI module
	TOTAL										

Note: - SS : Single status input, DS : Double status input for CBs, DC : Digital Control Output (Trip & Close) CMR : Contact Multiplying Relay, HDR : Heavy Duty Relay, METER : Energy meter, CM: Communication Module, DI : Digital input, DO : Digital Output: AI: Analog input

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification

Note:

6. MFT provide data that is to be acquired by RTU on Modbus/or IEC protocol for Voltage (phase to phase and phase to neutral), Current (phase and neutral), Active Power, Reactive Power, Apparent Power, Power Factor, Frequency, active energy (import & export), reactive energy (import & export) etc.
7. CMRs shall be mounted in the existing C&R panels. Wherever the space is not available in the existing panels the same shall be mounted in the RTU panels. Heavy Duty Relays shall be provided for Digital outputs for CBs and shall be mounted in the RTU panels itself.
8. The RTU shall be equipped for the above specified I/O (analog input (meter), digital input & digital output) point points, which includes 20 % spare for future use (except for CMRs & HDRs). These 20 % spare points shall be terminated on terminal blocks in
9. All protection relay/Alarm points & CBs shall be considered for SOE.
10. Point counts include three alarms per station for auxiliary system and fire, which shall be interfaced to RTU.

F) SCADA ENABLERS

S.No.	Equipment	Unit	Quantity
E1	RMU (Group A (Noida Town) towns only)		
a	Specify way (3,4,5) with or without built in FRTU	Set	
b			
E2	Sectionlizer (Group A (Noida Town) towns only)	Set	
	Specify with or without built in FRTU	Set	
E3	Auto relasers (Group A (Noida Town) towns only)	Set	
	Specify with or without built in FRTU		
E4	Fault passage Indicators (communicable)	Set	
E5	Numerical relays /BCPUs	Nos	

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification
E) BILL OF QUANTITY

UTILITY SHALL ATTACH COMMUNICATION NETWORK DIAGRAM

Communication system

F1- Communication system - VPN (MLLN/ MPLS) Broadband

S.No.	Equipment	Unit	Quantity
E2A	Bandwidth Charges		
1.	Network Connectivity Charges for 2Mbps MPLS-broadband Link	p.a per site	A/R
2.	Network Connectivity Charges for 64Kbps MPLS-broadband Link	p.a per site	A/R
3.	Network connectivity charges for FRTUs & FPIs on GPRS /CDMA	p.a per site	A/R

G) Auxiliary Power supply

At SDCC, DRR.SSCC/ZSCC, DR

S.No.	Item	Unit	Quantity
F1	At SDCC, SSCC/ZSCC,		
1.	UPS with suitable rating running in parallel redundant mode*	Set of two	1
2.	VRLA type Battery banks for above UPS for minimum 30 min. backup duration		
F2	At DRR./ DR		
5.	UPS with suitable rating running in parallel redundant mode*	Set of two	1
6.	VRLA type Battery banks for above UPS for minimum 30 min. backup duration		
F3	Mandatory Spares for UPS		A/R
F4	Mandatory Spares for DCPS		A/R
F5	For RTU / Data Concentrator / Communication Eqpts.		
9.	DC Power Supply (DCPS) system based on SMPS	No	1/RTU
10.	Battery bank for above DCPS (VRLA Type) for minimum 4 hrs. backup		
F6	III For FRTU		
11.	48V DC Power Supply (DCPS) system based on SMPS	No	1/ FRTU
12.	Battery bank for above DCPS (VRLA Type) for minimum 4 hrs backup		
F7	V Remote VDU location		

Power Finance Corporation
SCADA/DMS, system under Part A –RDSS
Model Technical specification

13.	UPS (2 kVA)	No	1/ RVDU
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KVA rating of UPS may change as decided by SDC. It should be accompanied with proper justification

A/R : As required as per site requirements

List of mandatory spares shall be provided by the contractor up to 5 % of the total cost to meet the availability requirements. Failure to maintain the same would be liable for suitable penalty. Inventory for the same shall be maintained during FMS period of 5 years.

Provide Equipment break-up at each location

UTILITY SHALL ATTACH COMMUNICATION NETWORK DIAGRAM FOR ALL PROPOSED MODES

H) Training including refresher course after Operational Acceptance

S.No.	Description	Duration in days	No. Of Trainees
A.	Operator's Training		
1.	Operator for SCADA/DMS/OMS AND SUB-STATION AUTOMATION Control Centre	5	1 Per workstation console/ shift at control center
2.	Instructor for DTS	10	2 Per Control center
B.	Maintenance Training		
1	Computer Hardware & System Software	10	2 Per Control center
2.	Application Software (SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS)	10	2 Per Control center
3.	RTU & FRTU	5	2 Per Town
4.	Database & display development	5	2 Per Control center
6.	Auxiliary Power Supply	3	2 Per Control center
7.	NMS/ Communication	5	2 Per Control center
8.	SCADA enablers(RMU/SECTIONLIZER/FPI etc.)		2 Per Town

I) FMS

SI No.	Description	Duration
1a	FMS charges for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system (maintaining overall system availability as per TS)	Two Years
1b	FMS charges for SCADA/DMS/OMS AND SUB-STATION AUTOMATION system (maintaining overall system availability as per TS)	3 additional years
3	Total FMS charges	Five Year

The cost of shall not be less than 20 % of total contract value . The cost per year for all 5 year shall be same

1. The necessary spares required for maintenance of the system during FMS shall be provided by the contractor. However, the consumables shall be provided by the owner.

1 FMS shall include all the supplied hardware & software under the project.

FMS for 2 years after operational acceptance or up to Sunset of scheme is provisioned under GOI sanction and remaining 3 years will be borne by utility. However, the cost of all 5 years shall be same and will form part of financial evaluation.

Power Finance Corporation
SCADA/DMS/OMS AND Sub- station Automation, system under Part
RDSS Scheme - Govt. of India
Model Technical Specifications

J) IMPLEMENTATION SCHEDULE

S. No.	Items	Completion Schedule from the Award of Contract
1	SCADA/DMS/OMS AND SUB-STATION AUTOMATION/OMS System (Group A (Noida Town))	24 months from award
2	SCADA system (Group BC)	24 months from award
3	SCADA system (Group U)	24 months from award

BIDDER SHALL PROVIDE IMPEMETATION SCHEDULE INDICATING MILESTONES

**Technical Specification for 33 kV, 630 Amps, Extensible / Non extensible type,
Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit
Breaker**

1.0 Scope:

- i) This specification covers design, manufacture, assembly, Stage inspection, testing before supply, inspection, packing and delivery of SF6 gas filled 33 kV, 630 Amps, Extensible / Non extensible type, Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker.
- ii) The Ring Main Unit shall be complete with all the accessories and auxiliary equipment's required for their satisfactory operation in Distribution Network of PUVNL in UP State, India.
- iii) The Ring Main Unit should have compatibility with Open Protocol Control and data Acquisition system. The Ring Main Units are capable of being monitored and controlled by the Supervisory Control and data Acquisition (SCADA)/ Distribution Management System (DMS). The Ring Main Units should have the castell lock for avoiding dual supply and safety purpose.
- iv) The Ring Main Unit shall be complete with various combinations of Load Break Isolators & Circuit Breaker for Distribution transformers center and feeders.
- v) The Ring Main Units to be supplied against this specification are required for vital installations where continuity of service is very important. The design, materials and manufacture of the Ring Main Unit shall, therefore, be of the highest order to ensure continuous and trouble-free service over the years.
- vi) It is not the intent to specify, completely here in all the details of design and construction of the Ring Main Unit. However, the Ring Main Unit shall conform, in all respects to high standards of engineering, design and workmanship as per recent Indian standards or International standards. It shall be capable of performing in continuous commercial operation up to the supplier's guaranteed life of Ring Main Unit in a manner acceptable to the purchaser who will interpret the meanings of drawings and specifications and shall have power to reject any work or material which, in his judgment, is not in accordance therewith. The Ring Main Unit offered shall be compact, maintenance free, easy to install reliable, safe and easy to operate and complete with all parts necessary for their effective and trouble-free operation. Such components shall be deemed to be within the scope of supplier's supply, irrespective of whether those are specifically brought out in this specification and/or in the commercial order or not.
- vii) Recommended spares: The bidder shall furnish in his offer a list of recommended spares with unit rates for each set of Ring Main Unit that may be necessary for satisfactory operation and maintenance of Ring Main Unit for a period of 5 years.

Technical Specification for 33 kV, 630 Amps, Extensible / Non extensible type,

Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker

33 kV, 630 Amps, Extensible / Non extensible type, Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker

The purchaser reserves right of selection of items and quantities of these spares to be ordered. The cost of such spares shall not be considered for tender evaluation.

- viii) Erection and maintenance tools: The bidder shall submit a list and unit rates of all the special tools, equipment and instruments required for erection, testing, commissioning and maintenance of the Ring Main Unit. The purchaser shall decide the quantity of tools to be ordered. Prices of these tools shall not be considered for tender evaluation. However, the list of necessary tools/equipment which will be supplied free of cost with each Ring Main Unit may be furnished separately.
- ix) The Bidder shall bind himself to abide by these considerations to the entire satisfaction of the purchaser and will be required to adjust such details at no extra cost to the purchaser over and above the tendered rates and prices.

2.0 System Particulars:

Nominal System Voltage	:	33kV
Voltage variation on supply side	:	± 10 %
Corresponding Highest System Voltage:		36kV
Frequency	:	50 Hz with ± 3 % tolerance
Transient condition	:	-20 % or + 10 % combined variation of Voltage and frequency.
Number of Phase	:	3 Phases
Neutral earthing	:	Solidly earthed.
Fault level (minimum) kA /Sec	:	25/3
Lightning Impulse Withstand		
Voltage (kVp)	:	170
One minute dry/wet power frequency		
withstand voltage primary (kV rms)	:	70
Rated Dynamic Withstand Current for		
1 second duration (kAp)	:	62.5

3.0 Service Conditions :

- A) The SF6 gas filled 33 kV, 630 Amps, Extensible / Non extensible type, Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker to be supplied against this specification shall be suitable for satisfactory continuous operation under the following tropical conditions.

3.2	Maximum temperature in shade (Degree C)	45
3.3	Minimum Temperature (Degree C) <small>Power Finance Corporation SCADA/DMS, system under Part A –RDSS</small>	3.5
3.4	Relative Humidity (percent) <small>Model Technical specification</small>	10 to 95
3.5	Maximum Annual rain fall (mm)	1450
3.6	Maximum wind pressure (kg/sq.m)	150

Technical Specification for 33 kV, 630 Amps, Extensible / Non extensible type,
Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker

3.7	Maximum altitude above mean sea level (Meter)	1000
3.8	Isoceran level (days per year)	50
3.9	Seismic level (Horizontal Acceleration)	0.3 g
3.10	Climatic condition	Moderately hot and humid

tropical climate conducive to rust and fungus growth

- B) The climatic conditions are prone to wide variations in ambient conditions and hence the SF6 gas filled 33 kV, 630 Amps, Extensible / Non extensible type, Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker shall be of suitable design to work satisfactorily under these conditions.

4.0 Objective of Work & Tolerances:

It is intended to have

- Enhanced safety and reliability.
- Maintenance free Ring Main Units.
- Reduction in space requirement
- Integrated remote control and monitoring-SCADA compatible.

Tolerances: Tolerances on all the dimensions shall be in accordance with provisions made in the relevant Indian/International standards amended up to date and in this specifications. Otherwise the same will be governed by good engineering practice in conformity with required quality of the product.

5.0 Auxiliary Power Supply:

- A. C. supply shall be provided for Control & Protective devices, lighting fixtures, space heaters and motors.
- D.C. supply shall be provided for alarm, control and protective device.

The rating, quality and location of electrical supply system that will be made available by the supplier for operation of the Ring Main units are described below:

i.	A. C. Supply	230 volts with $\pm 10\%$ variation
ii	D.C. Supply	24 V DC to 30 V DC with +10% to – 15% variation
iii	Frequency	50 Hz with $\pm 3\%$ variation

6.0 Applicable Standards:

- The design, manufacture and performance of the Ring Main Units shall comply with all currently applicable statutes, regulations and safety codes.

Nothing in this specification shall be construed to relieve the bidder off his responsibilities.

- Unless otherwise specified, the Ring Main Units offered shall conform to the latest applicable Indian, IEC, British, U.S.A. or International Standards and in particular, to the following:

Sr. No.	Standards	Particulars
1.	IEC 62271-200/ IEC 60 298/ IS 12729 : 1988	General requirement for Metal Enclosed Switchgear
2.	IEC 265	Medium Voltage Switches
3.	IEC 60129/ IEC 62271 – 102/ IS 9921	Alternating Current dis-connectors (Load Break Isolators) and earthing switch
4.	IEC 62271-100/IEC 60056/ IS 13118 : 1991	Specification for alternating current breakers
5.	IEC 62271 – 1/ IEC 60694	Panel design, SF6/ Vacuum Circuit Breakers
6.	IEC 60044 –1/ IEC 60185/ IS 16227 (Part-1)/(Part-2) /2016	Current Transformers
7.	IEC 60265/IS 9920 : 1981	High voltage switches
8.	IEC 376	Filling of SF6 gas in RMU
9.	IEC 60273/ IS : 2099	Dimension of Indoor & Outdoor post insulators with voltage > 1000 V
10.	IEC 60273/ IS 13947 (Part1)	Degree of protection provided by enclosures for low voltage Switchgear and control gear.
11.	IEC 60694	Common clauses for high voltage switchgear and control gear standards
12.	IEC 62271-103	High voltage switches for rated voltages above 1 KV and less than 52 KV.
13.	IEC 60137	Bushings for alternating voltages above 1000 V
14.	IEC 60233	Tests for hollow insulators for use in electrical equipment
15.	IEC 60376	New Sulphur hexa-fluoride (SF6)
16.	IEC 60480	Guidelines for checking and treatment of Sulphur-hexafluoride (SF6)
17.	IEC 61243-5	Voltage detection systems
18.	IEC 60044-2	Potential transformers
19.	IEC 62271-209	Cable connections for gas insulated switch gears
20.	IS:2544/1973	Porcelain Post Insulators / Resin cast insulators
21.	IS 8828/1996	MCB
22.	IS 12063/1987	Degree of protection provided for enclosures for electrical equipment.
23.	IS 5/2005	Colors for ready mixed paints and enamels.
24.	IS 5578/1984	Marking of insulated conductor.
25.	11353/1985	Guide for Uniform System of Marking and Identification of Conductors and Apparatus Terminals
26.	IS 1248/2003	Indicating instruments.
27.	IS 14697/1999 amended up to date & as per updated technical specifications of PVVNL	HT Static tri vector TOD Energy meters
28.	IS 6875 amended up to date	Control switches.

29.	IS 3231/1986	Electrical Relays for Power System Protection.
30.	IEC 60255 amended up	Numerical protection relays.
31.	IS 8686/1977	Static protective relays.
32.	IS 4794/68 & 86	Push button.
33.	IS 9431/1979	Indoor post insulator of organic material
34.	IEC 60529 / EN 60529	Protection against accidental contact, foreign Objects and water.
35.	IEC 60529	Classification of degrees of protection provided enclosures of electrical equipment
36.	IEC 60298	A.C metal-enclosed switchgear and control gear for rated voltages above 1KV and up to and including 52kV
37.	IEC 1330	High voltage/Low voltage prefabricated substations
38.	IEC 60801	Monitoring and control
39.	BS 159	Bus Bar
40.	CP 1013(British Code of Practice)	Earthing
41.	IEC 60255	Specification for Static Protective Relays
42.	BS 6231	Wires and wiring
43.	IEC 61000	Electromagnetic compatibility
44.	IEC 60129	Alternating current dis-connector (isolators) and earthing switches
45.	IEC 60060-1, BS 923	High Voltage test technique
46.	IEC 60947-4-1	Control Gears

All Indian Electricity Rules/ Bills amended up to date applicable for clearances, safety and operation of the equipment.

The Ring Main Unit meeting with the requirements of any other standards, which ensures equal or better quality than the standard mentioned above shall also be acceptable. If the Ring Main Unit, offered by the bidder conforms to other standards, salient points of difference between the standards adopted and the specific standards shall be clearly brought out in relevant schedule. In case of any difference between provisions of these standards and provisions of this specification, the provisions contained in this specification shall prevail. One copy of such standards with authentic English Translations in Hard Copy shall be furnished along with the offer.

7.0 General Requirement of Ring Main Unit:

The Ring Main Unit shall be installed at 33 kV junction points such as 200kVA, 315kVA, 630kVA distribution transformers centers or feeder branches to isolate faulty section. The Ring Main Unit shall be both Non extensible/Extensible. Two Load break isolators for incoming & outgoing cables and one Circuit breaker for transformer or feeder protection shall be enclosed in the main tank using SF6 gas as insulating and vacuum as arc quenching medium.

7.01 The Inner tank shall be stainless steel sheet (SS304 grade) if minimum 2mm thickness and robotically welded with a pressure relief arrangement.

7.02 Both the load break switches and circuit breaker shall be suitable for motorization. The total breaking time for transient fault should not exceed 100 ms (CB + Relay+ trip coil).

7.03 The main tank (Inner enclosure of Circuit Breaker & Load break Isolators assembly) and all Switchboard assembly shall be housed in a single compact metal clad suitable for both indoor/outdoor applications.

The design of enclosure for Switchgear, Ring Main Unit & Switchboard housing shall be in accordance with IEC 298. The design of Ring Main Unit shall be in accordance with the Technical Specification.

The switchgear and switchboard shall be designed such that the position of the different devices shall be visible to the operator on the front of switchboard and easy to operate and prevent access to all live parts during operation without the use of tools. There shall be no access to exposed conductors.

7.04 Circuit Breaker supplied with each Ring Main Unit shall be Vacuum Circuit Breaker. Vacuum Interrupter must be RMU OEM's own make. Insulating media for copper Bus Bar, Load Break Isolator, Earth Isolator and other associated equipment in Inner enclosure should be SF6 Gas.

An absorption material such as activated alumina or any other in the tank shall be provided to absorb the moisture from the SF6 gas to regenerate the SF6 gas following arc interruption. A temperature compensating gas pressure indicator offering a simple indication shall constantly monitor the SF6 insulating medium.

7.05 Each Ring Main Unit shall include its own power supply unit (including auxiliary transformer, batteries, and battery charger), which shall provide a stable power source for the Ring Main Unit. The auxiliary transformer of rating 500VA 33kV/230 Volt shall provide a stable power source which will supply **230V** AC for Remote Terminal unit (RTU).

The Ring Main Unit shall also provide the necessary space for housing the Remote Terminal unit (RTU). In addition, space must be provided for auxiliary power transformer, which shall serve as the AC power supply 230 V inputs, along with all other Ring Main Unit devices.

7.06 Within this context, the general requirements of the Ring Main Unit shall include, but shall not be limited to provision of the following monitoring and control features:

- i) Positions of local/remote switches as used to control local and remote access to circuit breakers and load break switches.
- ii) Power supply indications including battery failure and voltage alarms.
- iii) Open/Closed position of load break switches, circuit breakers, and earthing switches.
- iv) Enclosure door-open indications
- v) SF6 gas-pressure low alarm
- vi) Circuit breaker spring and load break switch charge (switch readiness) indications
- vii) Circuit breaker relay indications
- viii) Indications of fault current in the Ring Main Unit main feeder circuit as detected by the Fault Passage Indicator (FPI).
- ix) Measurement of 22 kV or 33 kV voltages, current, power, energy, and power factor values as per voltage level.
- x) Load break switch and circuit breaker open/close control
- xi) Fault Passage Indicator (FPI) reset control
- xii) Automatic Water Level Control

xiii) Relay settings control

The acceptance of the RMUs shall not be complete until they have been demonstrated on a point-to-point basis to be fully inter-operatable with the Remote Terminal unit (RTU).

7.07 The Ring Main Unit shall be provided with necessary take off terminal units for automations and all these units should be shielded in an outdoor metal-body enclosure for making them suitable for Outdoor / Indoor use. The insulation/dielectric media of Inner enclosure stainless steel tank should be SF6 gas. The Ring Main Units shall be extensible on both sides.

7.08 The Ring Main Units should be motorized and suitable to be connected to Field / Feeder Remote Terminal unit (F-RTU) so as to be monitored and controlled through Supervisory Control and data Acquisition (SCADA)/ Distribution Management System (DMS).

7.09 A remote terminal unit (RTU) is a microprocessor-controlled electronic device that interfaces objects in the physical world to a distributed control system or SCADA (Supervisory Control and Data Acquisition) system by transmitting telemetry data to a master system, and by using messages from the master supervisory. The Supervisory Control and Data Acquisition (SCADA) system is the heart of Distribution Management System (DMS).

7.10 The Ring Main Unit shall be equipped with main-line load break switches and a fault passage indicator (FPI). Furthermore, to protect each of its transformer / feeders, it shall be equipped with a corresponding set of circuit breakers and self-powered numerical relays. The Ring Main Unit shall include potential-free contacts and control contacts so as to connect to SCADA/DMS/OMS AND SUB-STATION AUTOMATION via FRTUs, so as to:

- i) Monitor and control the open/closed status of the Ring Main Unit circuit breakers and load break switches.
 - ii) Monitor the local/remote position of Ring Main Unit motorized (in case if failure of motor) manually-operated switches that can be used to enable and disable remote monitoring.
 - iii) Monitor the health of the power supply, which will include battery failure and low voltage indications.
 - iv) Monitor the open/closed status of Ring Main Unit earthing switches.
 - v) Monitor the open/closed status of RMU enclosure doors in case of Hinge doors.
- FRTU, Modem, Power and I/O cable interface between FRTU and Control panel of Ring Main Unit /sectionalizer are excluded in the scope of supply and these items will be provided by PVVNL.

8.0 Principal Technical Parameters of Ring Main Unit and accessories:

The Ring Main Unit and accessories covered under this specification shall conform to specific parameters given below:

Sr. No.	Description	33 kV Ring Main Unit
A) Ring Main Unit Assembly		
1.	Indoor / Out door	Indoor / Out door
2.	Configurations(Type)	3 Way, M+LLV+ L= Isolator. V= VCB. M=Metering
3.	Reference Standard	IEC-62271-100, 200, 103, IEC-62271-1
4.	Rated Voltage in kV	33

5.	Highest System Voltage in kV, Max.	36
6.	Number of Phase	3
7.	Frequency in HZ.	50 Hz \pm 3%
8.	Short Circuit rating	
	a) Breaking Symmetrical for 3 Sec. in KA	25
	b) Breaking Asymmetrical for 3 Sec. in KA	25
	c) Short time for 3 Sec. in KA.	25
9.	Insulation Level	
	a) Impulse withstand in KV peak.	170
	b) 1 Minute 50 Hz. Voltage withstand in KV rms	70
10.	Internal arc rating for 1 sec. in kV for AFLR	25
11.	Construction: Material and Size	
	Inner Enclosure	Main Stainless Steel Tank with 2 mm Thickness
	Outer Enclosure	CRCA Sheet of 2 mm thickness or Galvanized Sheet of 1.6 mm thickness
12.	Degree of protection	
	Inner Enclosure	IP 67
	Outer Enclosure	IP 54 (Main Door close) and IP 41 (Main Door open)
13.	The Ring Main Unit and accessories completely wire and tested at factory	Yes
14.	Paint	Polyurethane based powder Paint
15.	Color	Dark Admiralty Grey, Shade No. 632 as per IS: 5, 2007
16.	Thickness of coat, Min.	150 microns for CRCA Sheet and 80 microns for galvanized sheets
B) Bus Bar		
17.	Reference Standard	IS: 1897, 2008
18.	Grade and Material	Electrolytic Grade Copper
19.	Cross sectional area in mm ²	400
20.	Size in mm or as per design	40 x 10
21.	Current Density in Amps/mm ² , Max.	1.6
22.	Continuous Current in Amps	630
23.	Maximum temperature rise over an ambient temperature 50°C.	55°C
24.	Short time current rating for 3 Sec in kA rms	25
25.	Clearance in mm from bare bus bar or as per design	
	Phase to Phase for Isolator or as per design	78
	Phase to Phase for VCB	78

	Phase to Earth for Isolator or as per design	78
	Phase to Earth for VCB or as per design	78
26.	Bus Supports	
	Reference Standard	IEC 60243-1, ASTM D 648
	Voltage Class in kV	33 kV
	Creepage distance in mm or as per design	180 in SF6 gas
	Bus Bar support spacing in mm or as per design	420
27.	Filling SF6 gas pressure (Filling pressure at 20°C), Min.	1.4 Bar
28.	Operating SF6 gas pressure at 20°C, Min.	0.5 Bar
29.	Reference Standard	IEC 62271-100
30.	Rated Voltage in kV	33
31.	Highest System Voltage in kV, Max.	36
32.	Type	Vacuum Type
33.	Rated Frequency in Hz.	50 Hz \pm 3%
34.	No. of Poles	3
35.	Rated Current	630A
36.	Maximum temperature rise over an ambient temperature 50°C.	55°C
37.	Rated operating Duty	O-3min-CO-3min-CO O-0.3sec-CO-3min-CO
38.	Rupturing capacity at rated voltage in MVA, Min.	As per design
39.	Breaking Capacity at rated voltage & operating duty	
	Symmetrical in kA rms	25
	Asymmetrical in kA rms	25
40.	Rated making current in kA peak	62.5
41.	Short time current for 3 sec in kA rms	25
42.	Transient Recovery Voltage	
	Rate of rise in kV/ μ s	0.64 kV/ μ s as per IEC 62271-100
	Peak Voltage in kV	70
43.	Insulation Level	
	Impulse Voltage with stand on 1.2/50 μ s full wave in kV	170
	1 minute power frequency voltage withstand in kV	70
44.	Total breaking time for transient fault (CB + Relay+ trip coil) in ms	<45 ms 100ms
45.	Opening time No load condition in ms	<45 ms 100ms
46.	Opening time under SF6 gas low or vacuum loss condition in ms	<45 ms 100ms
47.	Number of breaks per pole	Single
48.	No of breaker operations permissible without requiring inspection replacement of contacts and other Main parts	

	At 100% rated current		2000 10000
	At 100% rated breaking current, Min.		20
49.	Type of contacts		
	Main		Butt Type
	Arcing		Butt Type
50.	Material of contacts		
	Main		Copper
	Arching		Copper
	Chromium / Silver plated		Chromium / Silver plated
51.	Mechanical Endurance Test for Circuit Breaker, Number of operations		2000 10000
52.	Spring charging mechanism		Motor Operated
53.	Operating mechanism for closing of Circuit Breaker		
	Type		Spring operated Mechanism
	No of breaker operations stored		One
	Trip free or fixed trip		Trip Free
	Earthing for operating mechanism and metal parts		Solidly Earthed
	Earth terminal size and material, Min.		Electrolytic grade Copper 25 x 3mm
54.	Operating mechanism for tripping of Circuit Breaker		
	Type		Spring Operated Mechanism
	No of breaker operations stored		One
	Trip free or fixed trip (V)		Trip Free
	Earthing for operating mechanism and metal parts		Solidly Earthed
	Earth terminal size and material		Electrolytic grade Copper 25 x 3mm
55.	Breaker Accessories		
	Mechanical safety Interlock		Provided
	Automatic safety Interlock		Provided
	Operational Interlock		Provided
	Emergency manual trip		Provided
	Operation counter		Provided
	Spring charge / discharge indicator		Provided
	Manual spring charging facility		Provided
c) Isolators			
56.	Reference standard		IEC-62271-102 / IEC-62271-103
57.	Nominal Voltage in KV		33
58.	Highest System Voltage in kV, Max.		36

59.	Rated Frequency in HZ	50 Hz \pm 3%
60.	No. Of poles	3
61.	Rated Current in Amps	630
62.	Maximum temperature rise over an ambient temperature 50°C.	60°C 55°C
63.	Operation	Close-Open-Earth
64.	Rupturing Capacity at rated voltage	630 Amps at 33kV
65.	Maximum over voltage factor when switching off Loaded feeder cable in kA	62.5
66.	No. of isolator operation permissible without requiring inspection, replacement of contacts and other main parts	
	Mechanical Endurance in Number of operations	1000
	At 100% rated making current in Number of operations	100
	At 100% rated breaking current in Number of operations	100
67.	Isolator provided with the following Mechanical safety	
	Mechanical ON and OFF Indication	Provided
	Cable Earth Indication	Provided
	Operational Counter	Provided
	Manual Spring Charging facility	Provided
D) Current Transformer		
68.	Reference standard	IS:16227, I & II
69.	Type	Ring Type, Resin Cast/Tape wound
70.	Nominal Voltage in KV	33
71.	Highest System Voltage in kV, Max.	36
72.	Rated Frequency in HZ	50 Hz \pm 3%
73.	Current Transformer Ratio	200-100/1Amps
74.	Short circuit withstand	
	Short time current for 1 sec. in kA rms	5
	Dynamic current in kA peak, Min.	7.5
75.	Class of insulation	Class B
76.	Basic insulation level in kV rms	3
77.	Maximum temperature rise over an ambient temperature 50°C.	60°C
78.	Class of Accuracy	
	Metering Core	0.5
	Protection Core	5P10
79.	Rated Burden	2.5 VA
80.	Over Current Rating in %	120
81.	Continuous Over Load in %	120
E) Metering Voltage(Potential) Transformer		
82.	Reference standard	IS:16227, I & III
83.	Type	Resin Cast/Tape wound
84.	Nominal Voltage in KV	33
85.	Highest System Voltage in kV, Max.	36

86.	Rated Frequency in HZ	50 Hz \pm 3%
87.	Voltage Transformer Ratio	33 kV/ $\sqrt{3}$ /110V/ $\sqrt{3}$
88.	Rated Primary Voltage in kV	33 kV/ $\sqrt{3}$
89.	Rated Secondary Voltage in V	110V/ $\sqrt{3}$
90.	Rated Burden in VA	50
91.	Accuracy Class	0.5
92.	Insulation Class	B
93.	Voltage Factor	1.2 Continuous and 1.9 for 8 hrs.
94.	One Minute Power Frequency Dry Withstand Voltage Rating	
	Primary Winding Induced Test in kV rms	70
	Secondary Winding in kV rms	3
	Rated Impulse Voltage in kV peak	170
F) Auxiliary Voltage(Potential) Transformer		
95.	Reference standard	IS:16227, I & III
96.	Type	Resin Cast/Tape wound
97.	Nominal Voltage in KV	33
98.	Highest System Voltage in kV, Max.	36
99.	Rated Frequency in HZ	50 Hz \pm 3%
100.	Voltage Transformer Ratio	33 kV / 230V
101.	Rated Primary Voltage in kV	33 kV
102.	Rated Secondary Voltage in V	230V
103.	Rated Burden in VA	500 VA
104.	Voltage Regulation in %	5
105.	Insulation Class	B
106.	Voltage Factor	1.2
107.	Application & Construction Type	Indoor, Single Phase/Two Pole
108.	One Minute Power Frequency Dry Withstand Voltage Rating	
	Primary Winding Induced Test in kV rms	70
	Secondary Winding in kV rms	3
	Rated Impulse Voltage in kV peak	170
G) Numerical Protection Relay		
109.	Reference Standard	IEC 60255
110.	Type and Model	3 Over Current(O/C) and 1 Earth fault(E/F)
111.	Current Transformer Secondary Input to Relay	1 A
112.	Operating Curve Type	Inverse Definite Minimum Time (IDMT)Relay
113.	Auxiliary Supply	Self Powered relay for Protection
114.	Rated Frequency in HZ	50 Hz \pm 3%
115.	Over Current Protection	
	Low set Over Current protection	20-200% of CT secondary rated current with increment/decrement by 1 %

	High set Over Current protection	100-2000% of CT secondary rated current with increment/decrement by 50%
116.	Earth Fault Protection	
	Low set Earth Fault protection	5% to 80% of the CT rated current in steps of 1%
	High set Earth Fault protection	100-1000% of the CT rated current in steps of 50%
117.	Mounting	Flush Mounted
118.	Operational Indicator	LCD display and LED annunciation lamps
119.	Contact Details	4 Binary Input(BI) and 6 Binary Output(BO)
120.	Self-diagnosis feature	Yes
121.	Password protection	Yes
122.	Communication Protocol	RS 232 or RS 485 Port for IEC 103, Communication Protocol
123.	Event / fault record, Min.	10 Event and 5 Fault Records available
124.	Setting groups	2 Groups available
125.	Circuit Breaker control available	Yes, Only Trip
H) Tripping Coil		
126.	DC Voltage in Volt	24
127.	Maximum Tripping Current at rated voltage in Amps.	5
	Minimum Permissible voltage variation in %	85 to 110
I) HT three phase four wire CT / PT operated 1 Amps fully Static & AMR compatible TOD Tri - vector Energy Meter		
128.	Reference Standard	IS: 14697, 1999 IS: 15959, 2011
129.	Make	Any Reputed make
130.	Auxiliary supply Voltage	110V/√3
131.	Class of Accuracy	0.5S
132.	Type of Display	Customized backlite liquid crystal display
133.	Measuring Parameters as per PVVNL Specification	
		Instantaneous parameters
		Block Load Profile parameters
		Billing Profile Parameters
		Name Plate details Programmable Parameters
		Event Conditions
		All logging parameters for each of the event condition

		for 3 Φ / 4W
J) Fault Passage Indicator (FPI) on Short Circuit and Earth fault		
134.	Operating point/Current short circuit in Amp	Adjustable 100/200/300 /400/500 /600/700 /800/900/1000 /1100/1200A ($\pm 15\%$)
135.	Operating point/Current earth fault in Amp	Adjustable 10/20/30/40 /60/80/100A ($\pm 15\%$)
136.	Response Time in ms	For Short Circuit Adjustable 40/60/80/100/120 /160/200/240 ms Sec(± 100 m Sec) For Earth Fault Adjustable 40/60/80/160 ms (± 100 m Sec)
137.	Auto Reset Time in Hrs	1/2/4/8 hrs (+ / - 1%) after fault
K) Battery Charger		
138.	Input AC Voltage in V	230
139.	Rated Frequency in Hz	50 Hz $\pm 3\%$
140.	Output DC Voltage in V	24
141.	Current Rating in Amps	10
142.	Output DC Voltage for charger	
	Boost Mode in V	27 to 28
	Float Mode in V	27 to 28
143.	Operating Temperature in $^{\circ}\text{C}$	-25 to 60
144.	Temperature Compensation	Junction temperature of SMPS crosses 142 $^{\circ}\text{C}$, thermal shutdown occurs.
145.	Short Circuit and Overload Protection	Provided
146.	High Voltage Isolation	2 kV for 1 minute
147.	Efficiency	Above 85 %
L) Battery		
148.	Type	Dry Type
149.	Ah Efficiency	> 95%
150.	Self-Discharge	Self-Discharge
151.	Operating Temperature	Normal : +20 $^{\circ}\text{C}$ to +30 $^{\circ}\text{C}$ & Limits : -20 $^{\circ}\text{C}$ to +50 $^{\circ}\text{C}$
152.	Voltage (V)	24V (2 x 12V)
153.	Ah Capacity	7Ah / 12 Ah / 26 Ah
M) Manometer with Non Return Valve		

154.	Type		Analogue
155.	Material		Stainless Steel
156.	Accuracy of calibration pressure		+/-1% at 20°C
157.	Pressure Element		Stainless Steel Welded
158.	Dial		2"
159.	Pointer		Dark
160.	Window		Round
161.	Gas pressure low signal		Indicated by Red Color Zone
162.	Non Return Valve(NRV) Material		Stainless Steel
N) Indoor cable terminations kits			
163.	Type		33 kV touch proof screened termination kit
164.	Materials		Epoxy / EPDM / Silicon Rubber
165.	Size		Up to 3 x 400 sq. mm 33 kV HT cables
166.	Height of Bus bar / transformer / feeder Cable box from ground level		As per Manufacture design
167.	Arrangement for mounting an extra cable at incoming and outgoing side box of Bus bar.		As per Manufacture design
168.	Arrangement for mounting an extra cable at outgoing side box of transformer / feeder.		As per Manufacture design
O) Automatic Water Level Controller			
172.	Position of Automatic Water Level Controller		200 mm below live contacts
173.	Auxiliary contacts		4 NO + 4 NC
174.	Breaker Tripping and Load break Isolator opening due to water level increases signals to Control room		Yes
P) Name Plate			
175.	Material		Anodized Aluminum / Stainless Steel
176.	Thickness		18 swg / 1.00 mm
177.	Size		145 mm x 116 mm
Q) Painting			
178.	Inside		Powder Coated
179.	Outside		Polyurethane based powder paint. Dark Admiralty Grey, Shade No. 632 as per IS: 5, 2007.

9.0 Principle Requirement of Ring Main Unit:

9.1 Enclosure:

- i) The Ring Main Unit enclosure (Outer) shall be made up of CRCA Sheet of 2 mm thickness or galvanized Sheet of 1.6 mm thickness. The rating of enclosure shall be suitable for operation on three phases, three wire, 33 kV, 50 cycles, A.C. System with short-time current rating of 25kA for 3 seconds for 33kV with Panels. The complete Ring Main Unit Outer enclosure shall be of degree of protection IP 54 (Main Door close) and IP 41 (Main Door open).
- ii) The enclosure shall provide full insulation, making the Switchgear insensitive to the environment like temporary flooding, high humidity etc. The active parts of the Switchgear shall be maintenance-free and the unit shall be minimum -maintenance.
- iii) The Ring Main Unit Outer enclosure shall be painted with Polyurethane based powder paint. The color of Ring Main Unit Outer enclosure shall be Dark Admiralty Grey, Shade No. 632 as per IS: 5, 2007.
- iv) Each switchboard shall be identified by an appropriately sized label which clearly indicates the functional units and their electrical characteristics.
- v) The Ring Main Unit metal parts shall be made of high thickness high tensile steel which must be grit/short blasted, thermally sprayed with Zinc alloy (not galvanized), phosphate and subsequently painted with Polyurethane based powder paint, the overall (Including outer and inner paint layer), the thickness of paint layer shall be not less than 150 microns for CRCA Sheet and 80 microns for galvanized Sheet.

9.2 Inner enclosure (Main tank):

- i) The tank shall be robotically welded stainless steel sheet of minimum 2 mm thickness. The tank shall be sealed and no handling of gas is required throughout the 25 years of service life. However, the SF₆ gas pressure inside the tank shall be constantly monitored by a temperature compensating gas pressure indicator offering a simple go, no-go indication. The gas pressure indicator shall be provided with green pressure and red pressure zones. There shall be one Non – return valve to fill up the gas. The manufacturer shall give guarantee for maximum leakage rate of SF₆ gas will be lower than 0.1 % per year. An absorption material such as activated alumina in the tank shall be provided to absorb the moisture from the SF₆ gas to regenerate the SF₆ gas following arc interruption. The degree of protection of the inner enclosure shall be IP 67.
- ii) Oil or Air filled Switchgear will not be considered. The temperature rise test shall be carried out on complete Ring Main Unit and test reports shall be submitted with the offer.
- iii) The compact Ring Main Unit shall be provided with a pedestal made up of M.S. Angle to mount the unit on plain surface. The height of the bottom of cable box shall be 310 mm to provide the turning radius for the HT cable termination.

9.3 Configurations recommended:

The following configurations of Ring Main Units are recommended:

i) Non Extensible:

Non extensible Ring Main Unit with one number of 200A circuit breaker for transformer protection up to 630 kVA and two number of Load Break Isolators for network sectionalizing with earth isolator.

ii) Extensible:

Extensible Ring Main Unit with one number of 200A circuit breaker and two Load break isolators with earth isolator arrangement having provision for adding one number of 200A circuit breaker for one extensible and two 200 A circuit breakers for two extensible Ring Main Unit.

9.4 Bus bars:

The three numbers of continuous Bus bars made up of EC grade tinned copper of rating current 630A shall be provided. The Short time rating current shall be 25 kA for 3 seconds for 33kV. The Bus bar connections shall Anti- oxide greased.

9.5 Sulphur Hexa Fluoride Gas (SF6 Gas):

The SF6 gas shall comply with IEC 376,376A and 376B and shall be suitable in all respects for use in Ring Main Units under the stipulated service conditions. The SF6 gas shall be tested for purity, dew point air hydrolysable fluorides and water content as per IEC 376,376A and 376B and test certificate shall be furnished to the bidder indicating all the tests as per IEC 376 for each lot of SF6 Gas.

9.6 Load Break Switches (Load Break Isolators):

- i) The Load Break Isolators for Incoming and Outgoing supply must be provided and the load break isolators are fully insulated by SF6 gas.
- ii) The operating mechanism shall be spring assisted mechanism with operating handle for ON /OFF. Earth positions with arrangement for padlocking in each position. Also independent manual operations with mechanically operated indicator. The earth switch shall be naturally interlocked to prevent the main and earth switch being switched “ON” at the same time. The selection of the main and earth switch is made by a lever on the fascia, which is allowed to move only if the main or earth switch is in the off position.
- iii) The load break isolators shall be remotely operated. Each load break switch shall be of the triple pole, simultaneously operated, automatic type with quick break contacts and with integral earthing arrangement.
- iv) The rated current of Isolator shall be 630 Amps continuous at maximum ambient temperatures. No Derating shall be allowed. For the isolator at an Ambient temperature of 50 °C, which means that Isolator rating should be 630 Amps maximum ambient temperature of 50 °C. The temperature rise of Isolator shall be 55°C maximum. The relevant type test report to prove the temperature rise below 55 °C shall be submitted by the bidder with the offer.

9.7 Current Transformer:

- i) The Current Transformers being prone to failure due to various reasons, the quality and reliability of the Current Transformers are of vital importance. Current Transformer's insulation used shall be of very high quality, details of which shall be furnished in the technical offer.
- ii) The Current Transformers shall be single wound double ratio, one Current Transformers for metering and one Current Transformers for protection.

- iii) The instrument security factor for metering Current Transformers shall be low enough but not greater than 5 at lower ratio. This shall be demonstrated on metering Current Transformers in accordance with the procedure specified in IS: 16227, I & II and relevant IEC.
- iv) The Current Transformers shall be ring type (Tape wound / resin cast). Contact tips of terminals shall be silver plated.
- v) Correct polarity shall be invariably marked on each terminal.
- vi) A panel shall be provided in each Ring Main Unit enclosure to mount a single wound double ratio, Current Transformers for metering and protection purposes. Current Transformers access for maintenance or any other purpose shall be from the back of these panels.
- vii) Secondary terminals of Current Transformers shall be brought out suitably to a terminal block, which will be easily accessible for testing and terminal connections.
- viii) Further characteristics and features of Current Transformers used for metering and protection are listed as follows:

Metering Current Transformers:

- a) Type: Ring Type
- b) Material:, Resin Cast
- c) Burden: 2.5VA
- d) Ratio: 200-100/1 Amps
- e) Accuracy Class for metering: 0.5

Protection Current Transformers:

- a) Type: Ring Type
- b) Material:, Resin Cast
- c) Burden: 2.5VA
- d) Ratio: 200-100/1 Amps
- e) Accuracy Class for protection: 5P10.

9.8 Metering Voltage (Potential) Transformer:

- i) The Potential Transformers shall be of Resin Cast and they shall conform to IS: 16227, I & III. Their design and construction, in particular, shall be sufficiently robust to withstand the thermal and dynamic stresses during short circuits.
- ii) A panel shall be provided in each Ring Main Unit enclosure to mount Potential Transformers. The primary and secondary contacts (moving & fixed type) shall have firm grip while in service. Service position locking mechanism shall be provided and indicated by bidder in relevant drawing. Rigidity of primary stud point with earth bus in service position shall be confirmed.
- iii) Contact tips of primary/secondary contacts shall be silver plated. Correct polarity shall be distinctly marked on primary and secondary terminal.
- iv) Secondary terminal studs shall be provided with at least three nuts, two plain and two spring washers for fixing leads. The stud nut and washer shall be of brass, duly nickel plated. The minimum outside diameter of the studs shall be 6 mm. The length of at least 15 mm shall be available on the studs for inserting

the leads. The space clearance between nuts on adjacent studs when fitted shall be at least 10 mm.

- v) Each secondary core will be protected by suitable MCB.
- vi) HRC fuses shall be provided on the HV side.
- vii) Further characteristics and features of Potential Transformers used for metering are listed as follows:
 - a) Type: Ring Type
 - b) Material: Resin Cast
 - c) Burden: 50 VA
 - d) Ratio: $33 \text{ kV}/\sqrt{3} / 110\text{V}/\sqrt{3}$
 - e) Accuracy Class for metering: 0.5

9.10 Auxiliary Voltage (Potential) Transformer:

- i) The Auxiliary Potential Transformers shall be of Resin Cast and they shall conform to IS:16227, I & III. Their design and construction, in particular, shall be sufficiently robust to withstand the thermal and dynamic stresses during short circuits.
- ii) A panel shall be provided in each Ring Main Unit enclosure to mount Auxiliary Potential Transformers. The primary and secondary contacts (moving & fixed type) shall have firm grip while in service. Service position locking mechanism shall be provided and indicated by bidder in relevant drawing. Rigidity of primary stud point with earth bus in service position shall be confirmed.
- iii) Contact tips of primary/secondary contacts shall be silver plated. Correct polarity shall be distinctly marked on primary and secondary terminal.
- iv) Further characteristics and features of Potential Transformers used for metering are listed as follows:
 - a) Type: Ring Type
 - b) Material: Resin Cast
 - c) Burden: 500 VA
 - d) Ratio: $33 \text{ kV}/\sqrt{3} / 230\text{V}$
 - e) Voltage Regulation: 5 %

Note: Instrument transformers shall be suitable for continuous operation at the ambient temperature prevailing inside the Ring Main Unit enclosure, when the Ring Main Unit is operating at its rated load and the outside ambient temperature is 50°C. The class of insulation shall be E or better.

All instrument transformers shall withstand the power frequency and impulse test voltage specified for the Ring Main Unit assembly. The current transformer shall further have the dynamic and short time ratings at least equal to those specified for the associated Ring Main Unit and shall safely withstand the thermal and mechanical stress

produced by maximum fault currents specified when mounted inside the Ring Main Unit enclosure.

The parameters of instrument transformers specified in this specification are indicative and shall be finalized by the Employer during detailed engineering, considering the actual burden of various relays and other devices finally selected. In case the Bidder finds that the specified ratings are not adequate for the relays

and other devices offered by him, he shall offer instrument transformer of adequate ratings without any cost implication.

All instrument transformers shall have clear indelible polarity markings. All secondary terminals shall be wired to separate terminals on an accessible terminal block.

9.10 Earthing of Bus bars (Earth Switch):

- i) The unit shall consist of a 630 Amp Tee Off spring assisted three position rotating arc type SF6 circuit breaker unit, with integral fault making/dead breaking earth switch, the function shall be naturally interlocked to prevent the main and earth switch from being switched `ON` at the same time and the CB not allowed to close in `Earth On` position. The selection of the main/earth switch lever on the fascia, which is allowed to move only if the main or earth switches in the off position. The lever may be padlocked in either the main or earth position.
- ii) The cables shall be earthed by an integral earthing switch with short-circuit making capacity, in compliance with IEC 129 standard. The earthing switch shall be operable through the main circuit mechanism and manual closing shall be driven by a fast-acting mechanism, independent of operator action.

9.11 Circuit Breaker (Vacuum media for arc quenching):

- i) The 3 pole circuit breaker for the protection of Distribution transformers or feeder shall be enclosed in the main tank. The rated breaking and making current at rated voltage shall be as follows:

For 33 kV System: Rated breaking capacity shall be 25 kA for 3
second. Rated making current shall be 62.5 kA for
3second.

- ii) The manual operation of the circuit breaker shall not have an effect on the spring charging mechanism. The interrupter must be RMU OEM's own make.
- iii) The circuit breaker shall be fitted with a mechanical flag, which shall operate in the event of fault occurrences. The breaker indications ON and OFF positions shall be indicated by suitable flag. For ON position indication by Red flag and OFF position indication by Green flag shall be provided.
- iv) The circuit breaker shall be operated by the same unidirectional handle or switch. The rated operating sequence shall be O-3min-CO-3 min- CO O-0.3sec-CO-3 min- CO

9.12 Bushings:

All the bushings shall be of same height, parallel, on equal distances from the ground and protected by a cable cover. It is preferable to have bushings accessible from the front / rear side of the Ring Main Unit.

9.13 Cable Boxes:

All cable boxes shall be air insulated suitable for dry type cable terminations. The cable boxes at each of the two ring switches suitable HV cables of size 3C x 300 sq.mm and circuit breaker cable suitable up to 3C x 300 sq.mm. Necessary Right

angle Boot should be supplied to the cable terminations. Compound filled cable boxes are not acceptable. The cable box shall be arc resistant as per IEC 62271-200 amended up to date.

The internal arc fault test on cable box shall be carried out for 33 kV systems at 25 kA for 1 second with AFLR classification.

The clearance between phase to phase and phase to earth shall be as per IEC 61243 – 5 amended up to date. The cable termination and gland arrangements shall be appropriate for the type and style of cables used at the time.

The cable boxes for an isolator in its standard design should have sufficient space for connecting two cables per phase. Necessary Right angle Boot should be supplied to the cable terminations. The type of the Right angle Boot should be cold applied insulating Boot.

9.14 Voltage Indicator Lamps and Phase Comparators:

The Ring Main Unit shall be equipped with a voltage indication. There should be a facility to check the synchronization of phases with the use of external device. It shall be possible for the each of the function of the Ring Main Unit to be equipped with a permanent voltage indication as per IEC 61958 to indicate whether or not there is voltage on the cables.

The capacitive dividers will supply low voltage power to sockets at the front of the unit, an external lamp must be used to indicate live cables.

Three outlets can be used to check the synchronization of phases with the use of an external device.

9.15 Extensible:

Each combination of Ring Main Unit shall have the provision for extension by load break isolators / breakers in future, with suitable trenching chamber, accessories and necessary Bus bars. Extensible isolators and circuit breakers shall be individually housed in separate SF6 gas enclosures. Multiple devices inside single gas tank / enclosure will not be acceptable. In case of extensible circuit breakers, the Breaker should be capable of necessary short circuit operations as per IEC standard i.e 25 kA for 1 second for 33 kV system. The Breaker should have a rated current carrying capacity of 200 A for Distribution Transformers and Feeders.

9.16 Wiring and Terminals:

- a) The wiring should be of high standard and should be able to withstand the tropical weather conditions. All the wiring and terminals (including take off terminals wiring for automation, DC, Control wiring), Spare terminals shall be provided by the bidder. The wiring cable must be standard single-core multi stranded, non-sheathed, Core marking (ferrules), stripped with non-notching tools and fitted with end sleeves, marked in accordance with the circuit diagram with printed adhesive marking strips.
- b) The wiring shall be carried out using single core multi-strand copper conductor super flexible PVC insulated and shall be flame retardant low smoke type wires of 1.1 KV Grade for AC Power, DC Control and CT circuits. Suitable colored wires shall be used for phase identification and interlocking type ferrules shall be provided at both ends of the wires for wire identification. Terminal should be suitably protected to eliminate sulphating. Connections and terminal should be able to withstand vibrations. The terminal blocks should be stud type for controls and disconnecting link type terminals for CT leads with suitable spring washer and lock nuts.

- c) Flexible wires shall be used for wiring of devices on moving parts such as swinging Panels (Switch Gear) or panel doors. Panel wiring shall be securely supported, neatly arranged readily accessible and connected to equipment terminals, terminal blocks and wiring gutters. The cables shall be uniformly bunched and tied by means of PVC belts and carried in a PVC carrying trough.
- d) The position of PVC carrying trough and wires should not give any hindrance for fixing or removing relay casing, switches etc., Wire termination shall be made with solder less crimping type of tinned copper lugs. Core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted with both ends of each wire. Ferrules shall fit tightly on the wire when disconnected. The wire number shown on the wiring shall be in accordance with the IS.375.
- e) All wires directly connected to trip circuits of breaker or devices shall be distinguished by addition of a red color unlettered ferrule.
- f) Inter-connections to adjacent Panels (Switch Gear) shall be brought out to a separate set of Terminal blocks located near the slots or holes to be provided at the top portion of the panel. Arrangements shall be made for easy connections to adjacent Panels (Switch Gear) at site and wires for this purpose shall be provided and bunched inside the panel. The bus wire shall run at the top of the panel. Terminal block with isolating links should be provided for bus wire. At least 10% of total terminals shall be provided as spare for further connections. Wiring shall be done for all the contacts available in the relay and other equipment and brought out to the terminal blocks for spare contacts. Color code for wiring is preferable in the following colors:

Voltage supply: Red, Yellow, Blue for phases, Black for Neutral

CT circuits: Red, Yellow, Blue for phases, Black for

Neutral 230V AC circuits: Black for both phases and neutral

Earthing: Green

The wiring shall be in accordance to the wiring diagram for proper functioning of the connected equipment. Terminal blocks shall not be less than 650V grade and shall be piece-moulded type with insulation barriers.

The terminal shall hold the wires in the tight position by bolts and nuts with lock washers. The terminal blocks shall be arranged in vertical formation at an inclined angle with sufficient space between terminal blocks for easy wiring.

The terminals are to be marked with the terminal number in accordance with the circuit diagram and terminal diagram. The terminals should not have any function designation and are of the tension spring and plug-in type.

9.17 Earthings:

The Ring Main Unit outdoor metal clad, Switch Gear, Earth contact of Load break isolators, Neutral and body of Distribution Transformer, M.S. Channels / M.S. Angles etc, shall be equipped with an earth bus securely fixed along the base of the Ring Main Unit.

When several units of the Ring Main Unit (Extra Isolators / Breakers) are mounted adjoining to each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply. The size of earth bus bar of tinned copper flat shall be as per IEC/IS standards and shall be fixed with the Ring Main Unit. Provision shall be made on end of Ring Main Unit for connecting the earth bus to the earth grid by erecting suitable 2 earth pipes of 40mm diameter MS rod of 3 meters in pits. Both the earth pipes are also to be connected in a grid formation. Necessary terminal clamps and connectors shall be included in the scope of supply.

9.18 Motorization :

All the functions within the Ring Main Unit i.e Isolators / Breakers should be fitted with motor mechanism and closing coil making it suitable to make it ON from remote.

Control Supply and Auxiliaries following has to

- considered: (i) Shunt trip coil – 24VDC for Isolators and Breakers
- (ii) Closing Coil – 24VDC
- (iii) Motor Mechanism – 24VDC
- (iv) 6NO+6NC – Potential free auxiliary contacts for breakers / isolator
- (v) Auxiliary supply should be – 24VDC
- (vi) Battery/ Battery charger with battery backup of at least 1hours
- (vii) Local / Remote switch for breaker and Isolators.

9.19 Metering:

The Ring Main Unit should be provided with separate Metering Module Consisting of Bus connected Potential Transformer and metering cum protection Current Transformer to be provided for VCB function i.e. for Distribution Transformer / Feeder along with provision of installing Tri-vector Meter (TVM). The Potential Transformer with PT Fuse and Ring Core type Current Transformer provided shall be made up of Epoxy Cast Resin. The CT ratio shall as per transformer rating.

9.20 Take OFF Terminal Units for Automation:

The Ring Main Unit should be provided with necessary take off terminal units for automations. Remote operation of the Ring Main Units line switches must be possible using motors fitted to the operating mechanism.

It shall be possible to fit the motors either directly in manufacturing plant or on site as and when required. Installation on site shall be possible with the Ring Main Unit fully energized and manufacturer should provide detailed instructions for installation to the control mechanism.

The fitting of the motors to the mechanism must not in any way impede or interfere with the manual operation of the switches or circuit breaker.

The bidder may wish to advice of options and cost for remote supervisory control units of the Ring Main Unit and MV network supervisory control system.

Complete Ring Main Unit shall be capable of withstanding 630A current without any damage being caused, in accordance with the recommendations IEC 694 and IEC 298.

Control and Interlocks:

The circuit breaker shall normally be controlled remotely from SCADA system closing through Motor and tripping through spring.

The isolators and earth isolator shall normally be controlled remotely from SCADA system closing and opening through Motor.

However, it shall also be designed to control locally from Ring Main Unit panel. Suitable mimic on Panel shall be provided.

Facilities shall be provided for mechanical tripping of the breaker in an emergency. Facility shall also be provided for manual charging of the stored energy mechanism for a complete duty cycle.

Necessary mechanical & Electrical interlocks shall be provided between CB, Isolator & Earth switches for safe operation.

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Each CB, Isolator & earth switch shall have 8 NO + 6 NC Auxiliary spare of good quality (corrosion free and easy for making connection) for future use by owner. It should be located at accessible position in panel.

All the binary inputs/outputs shall be wired to the terminals & kept ready for SCADA connectivity.

9.21 Fault Passage Indicators (FPI) on Short Circuit and Earth fault:

These shall facilitate quick detection of faulty section of line. The fault indication may be on the basis of monitoring fault current flow through the device. The unit should be self-contained requiring no auxiliary power supply. The Fault Passage Indicators (FPI) shall be integral part of Ring Main Unit.

The Fault Passage Indicators (FPI) shall facilitate for detection of short circuit fault and earth fault through Current Transformer inbuilt in Fault Passage Indicators.

9.22 Tropicalisation:

Due regard should be given to the climatic conditions under which the equipment is to work. Ambient temperature normally varies between 20 °C and 32 °C, although direct sun temperature may reach 45 °C. The climate is very humid and rapid variations occur, relative humidity between 90% and 100% being frequently recorded, but these values generally correspond to the lower ambient temperatures. The equipment should also be designed to prevent ingress of vermin, accidental contact with live parts and to minimize the ingress of dust and dirt. The use of materials, which may be liable to attack by termites and other insects, should be avoided.

9.23 Safety of people:

Any accidental overpressure inside the sealed chamber will be limited by the opening of a pressure limiting device in the enclosure. Gas will be released to the rear of the unit away from the operator. Manufacturer shall provide type test report to prove compliance with IEC 298 appendix AA 'Internal fault'.

9.24 Automatic Water Level Controller Using Mercury Float Switch:

The float switch shall be provided in Ring Main Unit at 200 mm below live contacts to avoid flash over due to water.

The float switch is a device used to detect the level of water within the Ring Main Unit. The float switch shall be used in the Ring Main Unit as an indicator, an alarm (at Control Room), tripping of Vacuum Circuit Breaker and opening of Load Break switch.

A mercury switch is a switch whose purpose is to allow the flow of electric current in an electrical circuit in a manner that is dependent on the switch's physical position. Mercury switches shall have 4 NO + 4 NC Auxiliary contacts in a sealed glass envelope which contains a bead of mercury. The envelope may also contain air, an inert gas, or a vacuum. Gravity is constantly pulling the drop of mercury to the lowest point in the envelope. When the switch is tilted in the appropriate direction, the mercury touches a set of contacts, thus completing the electrical circuit through those contacts. 'Normally Open' contact becomes 'Normally Close' contact, hence signals to breaker and motor for tripping of Vacuum Circuit Breaker and opening of Load Break switch. These signals shall be sent to Sub Station Control Room / SCADA Control Room via RTU with opening reason for further action.

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9.25 Operating lever:

An anti-reflex mechanism on the operating lever shall prevent any attempts to re-open immediately after closing of the switch or earthing switch.

All manual operations will be carried out on the front of the switchboard.

The effort exerted on the lever by the operator should not be more than 250 N for the switch and circuit breaker.

The overall dimensions of the Ring Main Unit shall not be increased due to the use of the operating handle. The operating handle should have two workable positions 180° apart.

9.26 Front plate:

The front shall include a clear mimic diagram which indicates different functions.

The position indicators shall give a true reflection of the position of the main contacts.

They shall be clearly visible to the operator.

The lever operating direction shall be clearly indicated in the mimic diagram.

The manufacturer's plate shall include the switchboard's main electrical characteristics.

9.27 Danger Board:

The danger Board plate as per relevant IS: 2551, 1982 shall be riveted on the front plate of the Ring Main Unit.

9.28 Internal arc rating:

The Ring Main Unit shall have a design such that in the event of an internal arc fault, the operator shall be safe. This should be in accordance with IEC 298 and relevant Test certificates shall be submitted with the Tender.

The Ring Main Unit shall be tested for an internal arc rating of 25 kA for 1 Sec for 33 kV with AFLR classification.

Suitable temperature rise test on the Ring Main Unit shall be carried out & test reports shall be submitted with tender for technical bid evaluation.

9.29 Specific Requirement for Automation:

The Ring Main Units should be provided with provision of following minimum signals available at separate SCADA terminal box.

Minimum signals for SCADA/DMS/OMS AND SUB-STATION AUTOMATION - to be wired to separate TBs

Sr. No.	Particulars	Contacts
1.	CB Close / Open	Potential free contacts
2.	LBS Close / Open	Potential free contacts
3.	LBS & CB Earth Switch Close / Open	Potential free contacts
4.	CB Test/Service Position	Potential free contacts

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5.	Spring charge Status indication	Potential free contacts
6.	SF6 gas pressure low	Potential free contacts
7.	O/C Operated	Potential free contacts
8.	E/F Operated	Potential free contacts
9.	Local/Remote	Potential free contacts
10.	Common Power Supply Healthy	Potential free contacts
11.	Motor MCB Healthy Status	Potential free contacts
12.	Battery charger Fail	Potential free contacts
13.	RMU Door Open	Potential free contacts
14.	CB Trip Coil Healthy	Potential free contacts
15.	Current Transformer Status	Potential free contacts
16.	Potential Transformer Status	Potential free contacts
17.	FPI Control	Potential free contacts
18.	CB control	Potential free contacts
19.	LBS Control	Potential free contacts
20.	Water Level Alarm	Potential free contacts
21.	CB Open	Potential free contacts
22.	LBS Open	Potential free contacts

A) Specific requirement for SCADA Connectivity:

- i) Fault Passage Indicator shall be provided per isolator
- ii) DC control supply system should be 24V DC.
- iii) Battery charger to cater load of minimum 10 motorized operation cycles (Close- Open) in absence of battery.
- iv) Battery to cater load of minimum 10 motorized operation cycles (Close-Open) in absence of battery charger. The battery backup should be minimum of 6 Hrs.
- v) Miniature Circuit Breakers (MCB) shall be provided for battery charger supply, RMU Motor supply & FRTU supply (Minimum 2 Amp circuit for future use of FRTU).
- vi) Individual control circuit of Isolator/Circuit Breaker to have point of isolation/protection.
- vii) Individual motor circuit of Isolator/Circuit Breaker to have point of isolation/protection.
- viii) The Ring Main Unit shall have minimum protection of IP54 for Outer Enclosure with gland plate & knock outs. Provision for control cable entry should

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preferably be from Right/ Left top through LV cable box & shall be independent of HV Isolator/Circuit Breaker status. It should be vermin proof.

- ix) Control cable gland plate shall be independent of power cable gland plate.
- x) A point of earthing for control cables shall be electrically isolated from power cable earthing.

- xi) Ambient temperature of 50°C max. Allowable temperature rise of battery & battery charger above ambient 40°C.
- xii) Local / Remote switch shall be provided on all the isolator & breaker panels for selection of controls.
- xiii) Current Transformer & Potential Transformer terminals for all the circuit breakers for Distribution Transformers / Feeders only.

B) Following is the list of I/O requirements for Ring Main Unit modules. Please note that all DI & DO should be potential free contacts.

i) List of potential free contacts for Isolator (Terminals shall be provided):

a) Digital Indications:

1. Isolator ON --02 No. & 2 NC
2. Isolator OFF --02 No. & 2 NC
3. Isolator Earth switch Status (ON/OFF)
4. FPI Operated
5. LOCAL/REMOTE switch position

b) List of commands:

1. Isolator Close
2. Isolator Open
3. FPI reset

ii) List of potential free Contacts for Circuit Breakers (Terminals shall be provided):

a) Digital Indications:

1. Circuit Breaker ON
2. Circuit Breaker OFF
3. Auto Trip
4. LOCAL/REMOTE switch position

b) List of commands:

1. Circuit Breaker Close
2. Circuit Breaker Open

iii) Requirement of Tri-Vector Meter (TVM):

- a) The terminals shall be provided for CT and PT Connections
- b) Space shall be provided for Tri-Vector Meter (TVM) mounting on Outer Enclosure panel

9.30 Distribution Automation System Interface:

The Ring Main Unit shall be equipped so that it can be monitored and controlled via the SCADA. In this respect, it shall interoperate with the RTU that will be housed in the Ring Main Unit Control Cabinet. The RTU in turn will interoperate with the SCADA via the remote communications system.

The Ring Main Unit shall have provisions for opening and closing its switches / breakers using output from the RTU. The Ring Main Unit shall also supply analog and status signals to the RTU for monitoring the condition of the Ring Main Unit's distribution network circuits as well as the components of the Ring Main Unit.

10.0 Tests:

a. Type tests:

The Ring Main Unit and accessories offered in the tender should have been successfully type tested at NABL laboratories in India or equivalent International Laboratories in line with the relevant standard and technical specification, within the last 5 (five) years from the date of offer. The bidder shall be required to submit complete set of the type test reports in physical format along with the offer. The bidder must provide the original copies of type test reports for verification purpose or produce authentic documents to confirm the type tests are authentic in case of tests carried out at equivalent International Laboratories

In case these type tests are conducted earlier than five years, all the type tests as per the relevant standard shall be carried out by the successful bidder at NABL in presence of purchaser's representative free of cost before commencement of supply. The undertaking to this effect should be furnished along with the offer without which the offer shall be liable for rejection.

Type tests:

- i) Short time current withstand test and peak current withstand test.
- ii) Lightning Impulse voltage with-stand test
- iii) Temperature rise test.
- iv) Short Circuit current making and breaking tests.
- v) Power frequency voltage withstand test (dry).
- vi) Capacitive current switching test confirming to IEC.
- vii) Mechanical operation test.
- viii) Measurement of the resistance of the main circuit.
- ix) Degree of protection of Inner enclosure and outer enclosure
- x) Switch, circuit breaker, earthing switch making capacity.
- xi) Switch, circuit breaker breaking capacity.

- xii) Internal arc withstand Test for Inner Enclosure and Cable Chamber with AFLR classification.
- xiii) Checking of partial discharge on complete unit.

The details of type test certificate according to the composition of the Switchboard shall be submitted with the offer.

In addition, for switches, test reports on rated breaking and making capacity shall be supplied.

For earthing switches, test reports on making capacity, short-time withstand current and peak short-circuit current shall be supplied.

In addition to that, Test report of Vacuum Interrupter along with Catalogues & Literatures to be submitted along with the Offer.

b. Acceptance and Routine Tests:

All acceptance and routine tests as stipulated in the respective applicable standards amended up-to-date for all the equipment shall be carried out by the supplier in the presence of purchaser's representative without any extra cost to the purchaser before dispatch.

The bidder shall have full facilities to carry out all the acceptance and routine test as per the applicable standards at RMU OEM's own factory premises.

After finalization of the program of acceptance/routine testing, the supplier shall give 15 days' advance intimation to the purchaser, to enable him to depute his representatives for witnessing the tests.

The routine tests should be carried out by the manufacturer at his works in presence of PVVNL Officials.

All the Ring Main Units must be routine tested for the following:

1. Conformity with drawings and diagrams,
2. Measurement of closing and opening speeds,
3. Measurement of operating torque,
4. Checking of filling pressure,
5. Checking of gas-tightness / SF6 gas leak test.
6. Dielectric testing and main circuit resistance measurement.
7. Power frequency voltage
8. Resistance test for the circuit
9. Mechanical operation tests.
10. Micro-ohm test for the assembly inside the tank.
11. Circuit breaker analyzer test so as to ensure the simultaneous closing of all poles for VCB.
12. Partial Discharge test on the complete gas tank so as to be assure of the proper insulation level and high product life.
13. High voltage withstands.
14. Secondary test to ensure the proper functioning of the live line indicators, fault passage indicators and relays.

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All major type tests shall have been certified at an independent authority with the tests carried outside country of manufacture shall be translated in English and submitted in hard copy.

The supplier in the presence of PVVNLs representative shall carry out all above acceptance and routine tests. The supplier shall give at least 15 days advance intimation to the PVVNL to enable them to depute their representative for witnessing the tests. The cost towards transport, stay and other expenses shall be borne by the supplier.

The PVVNL reserves the right for carrying out any other tests of a reasonable nature at the works of the supplier/laboratory or at any other recognized laboratory/research institute in addition to the above mentioned type, acceptance and routine tests at the cost of the PVVNL to satisfy that the material complies with the intent of this specification.

11.0 Inspection:

The inspection may be carried out by the purchaser at any stage of manufacture at RMU OEM's factory where Gas tank & outer enclosures including Cable box are manufactured. The successful bidder shall grant free access to the purchaser's representative/s at a reasonable notice when the work is in progress. Inspection and acceptance of any equipment under this specification by the purchaser shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective.

The supplier shall keep the purchaser informed, in advance, about the manufacturing program so that arrangement can be made for stage inspection.

The purchaser reserves the right to insist for witnessing the acceptance/routine testing of the bought out items. The supplier shall keep the purchaser informed, in advance, about such testing program.

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12.0 Drawings and Documentations:

Il drawings shall conform to relevant IEC Standards Specification. All drawings shall be in clear and visible.

The Bidder shall submit following drawings for approval:

- i) General Arrangement Drawing.
 - ii) General Arrangement Drawing with Door Open.
 - iii) Name Plate Drawing.
 - iv) Foundation Drawing.
 - v) Single Line Diagram Drawing.
 - vi) MIMIC Diagram Drawing.
 - vii) Control Schematic Wiring Diagram of Load Break Switch.
 - viii) Control Schematic Wiring Diagram of Circuit Breaker.
 - ix) Control Schematic Wiring Diagram of Earth Switch.
 - x) Control Schematic Wiring Diagram of Automatic Water Level Controller.
 - xi) Control Schematic Wiring Diagram of Voltage Indicator Lamps.
 - xii) Control Schematic Wiring Diagram of Fault Passage Indicators (FPI).
 - xiii) Terminal Block Drawing.
 - xiv) Mechanical Interlock Drawing.
 - xv) Electrical Interlock Drawing.
 - xvi) SF6 Monitoring Pressure Switch and Indication Schematic Drawing.
 - xvii) Schematic Wiring Diagram of Metering Unit.
 - xviii) Vacuum Interrupter Drawing.
 - xix) Danger Plate Drawing.
 - xx) Two Cable Arrangement Drawing.
 - xxi) Technical Detail Sheet Drawing.
 - xxii) Bill of Material.
 - xxiii) Packing List.
1. After issue of letter of acceptance, the successful bidders shall submit 3 identical sets of complete drawings along with detailed bill of materials for approval, to the Chief Engineer if any modifications are required on these, the same will be conveyed to the supplier who shall modify the drawings accordingly and furnish final drawings for approval. Inno case delivery extension will be granted for any delay in drawing approval.

2. The manufacturing of the Ring Main Units shall be strictly in accordance with the approved drawings and no deviation will be permitted without the written approval of PVVNL. All manufacturing and fabrication work in connection with the Ring Main Units prior to the approval of the drawings shall be at the supplier's risk and cost.
 3. Approval of drawings by the purchaser shall not relieve the supplier of any of his responsibility and liability for ensuring correctness and correct interpretation of the drawings for meeting the requirements of the latest revisions of applicable standards, rules and codes of practices.
 4. After approval of the drawings detailed packing lists and bills of materials, the suppliers shall be forwarded to the respective consignees. Copies of packing lists shall also be submitted to the PVVNL along with the bills for payment.
 5. Before dispatch of Ring Main Units to various consignees, the suppliers shall furnish sets of final drawings, including bills of materials and wiring schedules and also sets of technical literature and commissioning manuals. These shall be in Five sets and shall be furnished to the PVVNL positively before the dispatch of Ring Main Units. All drawings shall preferably be of A3 size. No drawing of width more than 35 cm will be acceptable. One set each of the final drawings; bill of materials, wiring schedules and commissioning manuals shall invariably be forwarded to the consignee along with each Ring Main Units consignment and shall be listed out in the packing list, when submitted for approval.
 6. In case the supplier fails to furnish contractual drawings and manuals even at the time of supply of Ring Main Units, the date of furnishing of drawings/manuals will be considered as the date of supply of Ring Main Units for the purpose of computing penalties for late delivery.
 7. The successful bidder shall furnish in the form of nicely bound volumes, the manuals covering erection, commissioning, operation and maintenance instructions and all relevant information and drawings pertaining to the Ring Main Unit as well as auxiliary devices. Marked erection drawings shall identify the component parts of the Ring Main Unit as shipped to enable Engineer/Purchaser to carry out erection with his own personnel. Each manual shall also contain one set of all the approved drawings type test reports as well as acceptance test reports to corresponding consignment dispatched. The total quantity of the operating manuals/approved drawings sets to be supplied by the supplier shall be equal to the number of Ring Main Units ordered.
- b.** The Bidder shall submit along with his tender illustrative and descriptive literature in triplicate for various items in the Ring Main Units, which are all essentially required for automation.

The Bidder shall submit following documents along with the tender:

- i) Instruction manuals.
- ii) Catalogues of spares recommended with drawing to indicate each items of spares.
- iii) List of spares and special tools recommended by the supplier.
- iv) Copies of Type Test Certificates as per latest IS/IEC.
- v) Dimensional drawings of each material used for item.
- vi) Actual single line diagram of Ring Main Unit with or without extra combinations shall be made displayed on the front portion of the Ring Main Unit so as to carry out the operations easily.

Operation, Maintenance and erection instruction manual in English language shall be also supplied along with each Ring Main Unit to the respective consignee as per the dispatch instructions given from PVVNL. The successful bidder shall submit the drawings, bill of materials, packing lists, etc. in time and get these approved from the office of Chief Engineer

13.0 Name Plate:

Each Ring Main Unit and its associated equipment shall be provided with a nameplate legible and indelibly marked with at least the following information.

- b. Name of manufacturer.
- c. Type.
- d. Serial number.
- e. Voltage.
- f. Current.
- g. Frequency.
- h. Symmetrical breaking capacity.
- i. Making capacity.
- j. Short time current and its duration.
- k. Purchase Order number and date.
- l. Month and Year of supply.
- m. Rated lightning impulse withstands voltage.

14.0 Packing and Forwarding :

The equipment shall be packed in crates suitable for vertical/horizontal transport as the case may be and the packing shall be suitable to withstand handling during the transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit, due to improper and inadequate packing. The easily damageable materials shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc. shall be provided. Any material found short inside the packing cases shall be supplied by the supplier without any extra cost. Each consignment shall be accompanied by a detailed packing list containing the following information:

- a. Name of the consignee.
- b. Details of consignment
- c. Destination.
- d. Total weight of consignment.
- e. Sign showing upper/lower side of the crate.
- f. Handling and unpacking instructions.
- g. Bill of material indicating contents of each package.

All the equipment covered in this specification shall be delivered to the various stores centers of the PVVNL as will be intimated to the successful bidders. The equipment shall be delivered to these stores centers only by road transport and shall be suitably packed to avoid damages during transit in the case of indigenous supplies.

The bidder shall quote delivery periods for various equipment and shall stick to the committed delivery. The delivery period will be counted from the date of receipt of letter of award of the contract. It is therefore, the responsibility of the successful bidder to submit the drawings, bill of materials, packing lists, etc. in time and get these approved from the office of Chief Engineer, PVVNL

It may clearly be noted that the delivery period will under no circumstances be linked up with other formalities like drawing approval, etc.

15.0 Training:

All successful bidders for Ring Main Units shall provide training facilities for the PVVNL's Engineers. The training shall be for not less than 8 man weeks. Syllabus and other details of the training shall be finalized in consultation with the PVVNL Boarding, lodging and traveling expenses for the deputed trainees will be borne by the PVVNL. Charges for training shall be quoted in the offer separately. These will not be considered for evaluation of the offer.

16.0 Performance Guarantee:

All Ring Main Units and accessories supplied against this specification shall be guaranteed for a period of 66 months from the date of receipt at the consignee's Stores Center or 60 months from the date of commissioning, whichever is earlier. However, any engineering error, omission, wrong provision, etc. which do not have any effect on the time period, shall be attended to as and when observed/pointed out without any price implication.

17.0 Annexure:

The bidder shall fill in the following Annexure 'A' which forms part of the Tender Specification and offer. If the Annexure 'A' is not submitted duly filled in with the offer, the offer shall be liable for rejection.

Annexure 'A' - Principal Technical Parameters of Ring Main Units.

18.0 Schedules:

The bidder shall fill in the following Schedule which forms part of the Tender Specification and offer. If the schedules are not submitted duly filled in with the offer, the offer shall be liable for rejection.

Schedule – 'A' - Guaranteed Technical Particulars of 33 kV Ring Main Units. Schedule – 'B' - List of Type Test Reports to be enclosed with the offer Schedule – 'C' - Schedule of Deviations from Specification Schedule – 'D' - Schedule of Bidder's Experience Schedule – 'E' - Schedule of Deviations from Specified Standards Schedule – 'F' - Deviations from specified Test requirements specified in

Relevant Standards and Present Specification Schedule – 'G' - Proforma of Undertaking

The Bidder shall submit the list of orders for supply of Ring Main Units executed or under execution during last three years, with full details, in the schedule of Bidders experience (Schedule 'D') to enable the purchaser to evaluate the tender.

33 kV, 630 Amps, Extensible / Non extensible type,

Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker

Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker

Any additional information may be furnished separately by the bidder, if felt necessary by him.

19.0 Guaranteed Technical Particulars:

The bidder should fill up the details in schedule A – “Guaranteed Technical Particulars” and the statement such as “as per drawing enclosed”, “as per PVVNL requirement”, “as per IS”, “as per specification” etc. shall be considered as details not furnished and such offers will be rejected.

Annexure 'A'**Principal Technical Parameters of Ring Main Unit and accessories:.**

Sr. No.	Description	33 kV Ring Main Unit
1.	Indoor / Out door	Indoor / Out door
2.	Configurations(Type)	3 Way, M+LLV+ L= Isolator. V= VCB. M=Metering
3.	Reference Standard	IEC-62271-100, 200, 103, IEC-62271-1
4.	Rated Voltage in kV	33
5.	Highest System Voltage in kV, Max.	36
6.	Number of Phase	3
7.	Frequency in HZ.	50 Hz \pm 3%
8.	Short Circuit rating	
	a) Breaking Symmetrical for 3 Sec. in KA	25
	b) Breaking Asymmetrical for 3 Sec. in KA	25
	c) Short time for 3 Sec. in KA.	25
9.	Insulation Level	
	a) Impulse withstand in KV peak.	170
	b) 1 Minute 50 Hz. Voltage withstand in KV rms	70
10.	Internal arc rating for 1 sec. in kV	25
11.	Construction: Material and Size	
	Inner Enclosure	Main Stainless Steel Tank with 2 mm Thickness
	Outer Enclosure	CRCA Sheet of 2 mm thickness or Galvanized Sheet of 1.6 mm thickness
12.	Degree of protection	
	Inner Enclosure	IP 67
	Outer Enclosure	IP 54 (Main Door close) and IP 41 (Main Door open)
13.	The Ring Main Unit and accessories completely wire and tested at factory	Yes

14.	Paint		Polyurethane based powder paint
15.	Color		Dark Admiralty Grey, Shade No. 632 as per IS: 5, 2007
16.	Thickness of coat, Min.		100 +/- 25 microns
17.	Reference Standard		IS: 1897, 2008
18.	Grade and Material		Electrolytic Grade Copper
19.	Cross sectional area in mm ²		400
20.	Size in mm or as per design		40 x 10
21.	Current Density in Amps/mm ² , Max.		1.6
22.	Continuous Current in Amps		630
23.	Maximum temperature rise over an ambient temperature 50°C.		55°C
24.	Short time current rating for 3 Sec in kA rms		25
25.	Clearance in mm from bare bus bar or as per design		
	Phase to Phase for Isolator or as per design		78
	Phase to Phase for VCB		78
	Phase to Earth for Isolator or as per design		78
	Phase to Earth for VCB or as per design		78
26.	Bus Supports		
	Reference Standard		IEC 60243-1, ASTM D 648
	Voltage Class in kV		33 kV
	Creepage distance in mm or as per design		180 in SF ₆ gas
	Bus Bar support spacing in mm or as per design		420
27.	Filling SF ₆ gas pressure (Filling pressure at 20°C), Min.		1.4 Bar
28.	Operating SF ₆ gas pressure at 20°C, Min.		0.5 Bar
29.	Reference Standard		IEC 62271-100
30.	Rated Voltage in kV		33
31.	Highest System Voltage in kV, Max.		36

32.	Type	Vacuum Type
33.	Rated Frequency in Hz.	50 Hz \pm 3%
34.	No. of Poles	3
35.	Rated Current	630A
36.	Maximum temperature rise over an ambient temperature 50°C.	55°C
37.	Rated operating Duty	O-3min-CO-3min-CO
38.	Rupturing capacity at rated voltage in MVA, Min.	As per design
39.	Breaking Capacity at rated voltage & operating duty	
	Symmetrical in kA rms	25
	Asymmetrical in kA rms	25
40.	Rated making current in kA peak	62.5
41.	Short time current for 3 sec in kA rms	25
42.	Transient Recovery Voltage	
	Rate of rise in kV/ μ s	0.64 kV/ μ s as per IEC 62271-100
	Peak Voltage in kV	70
43.	Insulation Level	
	Impulse Voltage with stand on 1.2/50 μ s full wave in kV	170
	1 minute power frequency voltage withstand in kV	70
44.	Total breaking time for transient fault (CB + Relay+ trip coil) in ms	100ms
45.	Opening time No load condition in ms	100ms
46.	Opening time under SF6 gas low or vacuum loss condition in ms	100ms
47.	Number of breaks per pole	Single
48.	No of breaker operations permissible without requiring inspection replacement of contacts and other Main parts	
	At 100% rated current	10000
	At 100% rated breaking current, Min.	20
49.	Type of contacts	
	Main	Butt Type
	Arcing	Butt Type
50.	Material of contacts	
	Main	Copper
	Arching	Copper
	Chromium / Silver plated	Chromium / Silver plated
51.	Mechanical Endurance Test for Circuit Breaker, Number of operations	10000

52.	Spring charging mechanism	Motor Operated
53.	Operating mechanism for closing of Circuit Breaker	
	Type	Spring operated Mechanism
	No of breaker operations stored	One
	Trip free or fixed trip	Trip Free
	Earthing for operating mechanism and metal parts	Solidly Earthed
	Earth terminal size and material, Min.	Electrolytic grade Copper 25 x 3mm
54.	Operating mechanism for tripping of Circuit Breaker	
	Type	Spring Operated Mechanism
	No of breaker operations stored	One
	Trip free or fixed trip (V)	Trip Free
	Earthing for operating mechanism and metal parts	Solidly Earthed
	Earth terminal size and material	Electrolytic grade Copper 25 x 3mm
55.	Breaker Accessories	
	Mechanical safety Interlock	Provided
	Automatic safety Interlock	Provided
	Operational Interlock	Provided
	Emergency manual trip	Provided
	Operation counter	Provided
	Spring charge / discharge indicator	Provided
	Manual spring charging facility	Provided
56.	Reference standard	IEC-62271-102 / IEC-62271-103
57.	Nominal Voltage in KV	33
58.	Highest System Voltage in kV, Max.	36
59.	Rated Frequency in HZ	50 Hz \pm 3%
60.	No. Of poles	3
61.	Rated Current in Amps	630
62.	Maximum temperature rise over an ambient temperature 50°C.	60°C
63.	Operation	Close-Open-Earth
64.	Rupturing Capacity at rated voltage	630 Amps at 33kV
65.	Maximum over voltage factor when switching off Loaded feeder cable in kA	62.5
66.	No. of isolator operation permissible without requiring inspection, replacement of contacts and other main parts	
	Mechanical Endurance in Number of operations	1000
	At 100% rated making current in Number of operations	100
	At 100% rated breaking current in	100

	Number of operations		
67.	Isolator provided with the following Mechanical safety		
	Mechanical ON and OFF Indication		Provided
	Cable Earth Indication		Provided
	Operational Counter		Provided
	Manual Spring Charging facility		Provided
68.	Reference standard		IS:16227, I & II
69.	Type		Ring Type, Resin Cast/Tape wound
70.	Nominal Voltage in KV		33
71.	Highest System Voltage in kV, Max.		36
72.	Rated Frequency in HZ		50 Hz \pm 3%
73.	Current Transformer Ratio		200-100/1Amps
74.	Short circuit withstand		
	Short time current for 1 sec. in kA rms		5
	Dynamic current in kA peak, Min.		7.5
75.	Class of insulation		Class B
76.	Basic insulation level in kV rms		3
77.	Maximum temperature rise over ambient temperature 50°C.		60°C
78.	Class of Accuracy		
	Metering Core		0.5
	Protection Core		5P10
79.	Rated Burden		2.5 VA
80.	Over Current Rating in %		120
81.	Continuous Over Load in %		120
82.	Reference standard		IS:16227, I & III
83.	Type		Resin Cast/Tape wound
84.	Nominal Voltage in KV		33
85.	Highest System Voltage in kV, Max.		36
86.	Rated Frequency in HZ		50 Hz \pm 3%
87.	Voltage Transformer Ratio		33 kV/ $\sqrt{3}$ /110V/ $\sqrt{3}$
88.	Rated Primary Voltage in kV		33 kV/ $\sqrt{3}$
89.	Rated Secondary Voltage in V		110V/ $\sqrt{3}$
90.	Rated Burden in VA		50
91.	Accuracy Class		0.5
92.	Insulation Class		B
93.	Voltage Factor		1.2 Continuous and 1.9 for 8 hrs.
94.	One Minute Power Frequency Dry Withstand Voltage Rating		
	Primary Winding Induced Test in kV rms		70
	Secondary Winding in kV rms		3
	Rated Impulse Voltage in kV peak		170
95.	Reference standard		IS:16227, I & III
96.	Type		Resin Cast/Tape wound
97.	Nominal Voltage in KV		33
98.	Highest System Voltage in kV, Max.		36
99.	Rated Frequency in HZ		50 Hz \pm 3%
100.	Voltage Transformer Ratio		33 kV / 230V

101.	Rated Primary Voltage in kV	33 kV
102.	Rated Secondary Voltage in V	230V
103.	Rated Burden in VA	500 VA
104.	Voltage Regulation in %	5
105.	Insulation Class	B
106.	Voltage Factor	1.2
107.	Application & Construction Type	Indoor, Single Phase/Two Pole
108.	One Minute Power Frequency Dry Withstand Voltage Rating	
	Primary Winding Induced Test in kV rms	70
	Secondary Winding in kV rms	3
	Rated Impulse Voltage in kV peak	170
109.	Reference Standard	IEC 60255
110.	Type and Model	3 Over Current(O/C) and 1 Earth fault(E/F)
111.	Current Transformer Secondary Input to Relay	1 A
112.	Operating Curve Type	Inverse Definite Minimum Time (IDMT)Relay
113.	Auxiliary Supply	Self Powered relay for Protection
114.	Rated Frequency in HZ	50 Hz \pm 3%
115.	Over Current Protection	
	Low set Over Current protection	20-200% of CT secondary rated current with increment/decrement by 1 %
	High set Over Current protection	100-2000% of CT secondary rated current with increment/decrement by 50%
116.	Earth Fault Protection	
	Low set Earth Fault protection	5% to 80% of the CT rated current in steps of 1%
	High set Earth Fault protection	100-1000% of the CT rated current in steps of 50%
117.	Mounting	Flush Mounted
118.	Operational Indicator	LCD display and LED annunciation lamps
119.	Contact Details	4 Binary Input(BI) and 6 Binary Output(BO)
120.	Self-diagnosis feature	Yes
121.	Password protection	Yes
122.	Communication Protocol	RS 232 or RS 485 Port for IEC 103, Communication Protocol
123.	Event / fault record, Min.	10 Event and 5 Fault Records available

124.	Setting groups	2 Groups available
125.	Circuit Breaker control available	Yes, Only Trip
126.	DC Voltage in Volt	24
127.	Maximum Tripping Current at rated voltage in Amps.	5
	Minimum Permissible voltage variation in %	85 to 110
128.	Reference Standard	IS: 14697, 1999 IS: 15959, 2011
129.	Make	Secure / L&T / other PVVNL approved make
130.	Auxiliary supply Voltage	110V/ $\sqrt{3}$
131.	Class of Accuracy	0.5S
132.	Type of Display	Customized backlite liquid crystal display
133.	Measuring Parameters as per PVVNL Specification	
		Instantaneous parameters
		Block Load Profile parameters
		Billing Profile Parameters
		Name Plate details Programmable Parameters
		Event Conditions
		All logging parameters for each of the event condition for 3 Φ / 4W
134.	Operating point/Current short circuit in Amp	Adjustable 100/200/300 /400/500 /600/700 /800/900/1000 /1100/1200A ($\pm 15\%$)
135.	Operating point/Current earth fault in Amp	Adjustable 10/20/30/40 /60/80/100A ($\pm 15\%$)
136.	Response Time in ms	For Short Circuit Adjustable 40/60/80/100/120 /160/200/240 ms Sec(± 100 m Sec) For Earth Fault Adjustable 40/60/80/160 ms (± 100 m Sec)
137.	Auto Reset Time in Hrs	1/2/4/8 hrs (+ / - 1%) after fault
138.	Input AC Voltage in V	230
139.	Rated Frequency in Hz	50 Hz $\pm 3\%$
140.	Output DC Voltage in V	24
141.	Current Rating in Amps	10

142.	Output DC Voltage for charger		
	Boost Mode in V		27 to 28
	Float Mode in V		27 to 28
143.	Operating Temperature in °C		-25 to 60
144.	Temperature Compensation		Junction temperature of SMPS crosses 142°C, thermal shutdown occurs.
145.	Short Circuit and Overload Protection		Provided
146.	High Voltage Isolation		2 kV for 1 minute
147.	Efficiency		Above 85 %
148.	Type		Dry Type
149.	Ah Efficiency		> 95%
150.	Self-Discharge		Self-Discharge
151.	Operating Temperature		Normal : +20°C to +30°C & Limits : -20°C to +50°C
152.	Voltage (V)		24V (2 x 12V)
153.	Ah Capacity		7Ah / 12 Ah / 26 Ah
154.	Type		Analogue
155.	Material		Stainless Steel
156.	Accuracy of calibration pressure		+/-1% at 20°C
157.	Pressure Element		Stainless Steel Welded
158.	Dial		2''
159.	Pointer		Dark
160.	Window		Round
161.	Gas pressure low signal		Indicated by Red Color Zone
162.	Non Return Valve(NRV) Material		Stainless Steel
163.	Type		33 kV touch proof screened termination kit
164.	Materials		Epoxy / EPDM / Silicon Rubber
165.	Size		Up to 3 x 400 sq. mm 33 kV HT cables
166.	Height of Bus bar / transformer / feeder Cable box from ground level		As per Manufacture design
167.	Arrangement for mounting an extra cable at incoming and outgoing side box of Bus bar.		As per Manufacture design
168.	Arrangement for mounting an extra cable at outgoing side box of transformer / feeder.		As per Manufacture design

33 kV, 630 Amps, Extensible / Non extensible type,

Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker

172.	Position of Automatic Water Level Controller		200 mm below live contacts
173.	Auxiliary contacts		4 NO + 4 NC
174.	Breaker Tripping and Load break Isolator opening due to water level increases signals to Control room		Yes
175.	Material		Anodized Aluminum / Stainless Steel
176.	Thickness		18 swg / 1.00 mm
177.	Size		145 mm x 116 mm
178.	Inside		Powder Coated
179.	Outside		Polyurethane based powder paint. Dark Admiralty Grey, Shade No. 632 as per IS: 5, 2007.

Schedule 'B'

Guaranteed Technical Parameters of 33 KV, 630 Amps with, Extensible / Non extensible type, Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker

Sr. No.	Description	33 kV Ring Main Unit	Parameters to be filled by Bidder
A)Ring Main Unit Assembly			
1.	Indoor / Out door	Indoor / Out door	
2.	Manufacturer's Name & address		
3.	Manufacturer's Type Designation		
4.	Model		
5.	Configurations(Type)	L= Isolator. V= VCB. M=Metering	
	Configurations	3 Way, M+LLV+	
6.	Reference Standard	IEC-62271-100, 200, 103 and IEC-62271-1	
7.	Rated Voltage in kV	33	
8.	Highest System Voltage in kV, Max.	36	
9.	Number of Phase	3	
10.	Frequency in HZ.	50 Hz \pm 3%	

Technical Specification for 33 kV, 630 Amps, Extensible / Non extensible type,

Outdoor / Indoor, SCADA Compatible Motorized Ring Main Unit with 200Amps Vacuum Circuit Breaker

11.	Short Circuit rating		
	a) Breaking Symmetrical for 3 Sec. in KA	25	
	b) Breaking Asymmetrical for 3 Sec. in KA	25	
	c) Short time for 3 Sec. in KA.	25	
12.	Insulation Level		
	a) Impulse withstand in KV peak.	170	
	b) 1 Minute 50 Hz. Voltage withstand in KV rms	70	
13.	Internal arc rating for 1 sec. in kV	25	
14.	Construction: Material and Size		
	a) Inner Enclosure	Main Stainless Steel Tank with 2 mm Thickness	
	b) Outer Enclosure	CRCA Sheet of 2 mm thickness or Galvanized Sheet of 1.6 mm thickness	
15.	Degree of protection		
	a) Inner Enclosure	IP 67	
	b) Outer Enclosure	IP 54 (Main Door close) and IP 41 (Main Door open)	
16.	The Ring Main Unit and accessories completely wire and tested at factory	Yes	
17.	Paint	Polyurethane based powder paint	
18.	Color	Dark Admiralty Grey, Shade No. 632 as per IS: 5, 2007	
19.	Thickness of coat, Min.	150 microns for CRCA Sheet and 80 microns for	
Overall Dimensions and Weight			
20.	Tolerance to Overall Dimensions	+ 5 %	
	Extensible 3 Way RMU(3 Way, M+LLV+)	As per Manufacture Design	
	W x D x H, in mm	As per Manufacture Design	
	Weight in kg	As per Manufacture Design	
B) Bus Bar			
21.	Make	As per Manufacture Design	
22.	Reference Standard	IS: 1897, 2008	
23.	Grade and Material	Electrolytic Grade Copper	
24.	Cross sectional area in mm ²	400	
25.	Size in mm	40 x 10 or as per Manufacture design	
26.	Current Density in Amps/mm ² , Max.	1.6	
27.	Continuous Current in Amps	630	

28.	Maximum temperature rise over an ambient temperature 50°C.	55°C	
29.	Short time current rating for 3 Sec in kA rms	25	
30.	Clearance in mm from bare bus bar		
	a) Phase to Phase for Isolator or as per design	78	
	b)Phase to Phase for VCB or as per design	78	
	c)Phase to Earth for Isolator or as per design	78	
	d)Phase to Earth for VCB or as per design	78	
31.	Bus Supports		
	i)Make	As per Manufacture Design	
	ii)Type	As per Manufacture Design	
	iii)Reference Standard	IEC 60243-1, ASTM D 648	
	iv)Voltage Class in kV	33 kV	
	v) Creepage distance in mm or as per design	180 in SF6 gas	
	vi)Bus Bar support spacing in mm or as per design	420	
32.	Filling SF6 gas pressure (Filling pressure at 20°C), Min.	1.4 Bar	
33.	Operating SF6 gas pressure at 20°C, Min.	0.5 Bar	
C)Vacuum Circuit Breaker			
34.	Make	As per Manufacture Design	
35.	Type	As per Manufacture Design	
36.	Reference Standard	IEC 62271-100	
37.	Rated Voltage in kV	33	
38.	Highest System Voltage in kV, Max.	36	
39.	Type	Vacuum Type	
40.	Rated Frequency in Hz.	50 Hz \pm 3%	
41.	No. of Poles	3	
42.	Rated Current	630A	
43.	Maximum temperature rise over an ambient temperature 50°C.	55°C	
44.	Rated operating Duty	O-3min-CO-3min-CO	
45.	Rupturing capacity at rated voltage in MVA, Min.	400	
46.	Breaking Capacity at rated voltage & operating duty		
	i)Symmetrical in kA rms	25	
	ii)Asymmetrical in kA rms	25	
	iii)Rated making current in kA peak	62.5	

47.	Short time current for 3 sec in kA rms	25	
48.	Transient Recovery Voltage		
	i)Rate of rise in kV/ μ s	0.64 kV/ μ s as per IEC 62271-100	
	ii)Peak Voltage in kV	70	
49.	Insulation Level		
	a)Impulse Voltage with stand on 1.2/50 μ s full wave in kV	170	
	b)1 minute power frequency voltage withstand in kV	70	
50.	Vacuum Bottle		
	i)Make	As per Manufacture Design	
	ii)Type	As per Manufacture Design	
	iii)Rated Voltage in kV	As per Manufacture Design	
	iv)Rated Current in Amps.	As per Manufacture Design	
51.	Total breaking time for transient fault (CB + Relay+ trip coil) in ms	<45 ms	
52.	Opening time No load condition in ms	<45 ms	
53.	Opening time under SF6 gas low or vacuum loss condition in ms	<45 ms	
	i)At 100% Breaking capacity		
	a) Opening time (ms)	As per Manufacture Design	
	b) Arcing time (ms)	As per Manufacture Design	
	c) Total break time (ms)	As per Manufacture Design	
	ii)At 60% Breaking capacity		
	a) Opening time (ms)	As per Manufacture Design	
	b) Arcing time (ms)	As per Manufacture Design	
	c) Total break time (ms)	As per Manufacture Design	
	iii)At 30% Breaking capacity		
	a) Opening time (ms)	As per Manufacture Design	
	b) Arcing time (ms)	As per Manufacture Design	
	c) Total break time (ms)	As per Manufacture Design	
	iv)At 10% Breaking capacity		
	a) Opening time (ms)	As per Manufacture Design	
	b) Arcing time (ms)	As per Manufacture Design	
	c) Total break time (ms)	As per Manufacture Design	
54.	Number of breaks per pole	Single	
55.	No of breaker operations permissible without requiring inspection replacement of contacts and other Main parts		
	a)At 100% rated current	2000 10000	
	b)At 100% rated breaking current, Min.	20	
56.	Type of contacts		
	i)Main	Butt Type	
	ii)Arcing	Butt Type	
57.	Material of contacts		

	i)Main	Copper	
	ii)Arching	Copper	
	iii)Chromium / Silver plated	Chromium / Silver plated	
58.	Mechanical Endurance Test for Circuit Breaker, Number of operations	10000	
59.	Spring charging mechanism	Motor Operated	
60.	Operating mechanism for closing of Circuit Breaker		
	i)Type	Spring operated Mechanism	
	ii)No of breaker operations stored	One	
	iii)Trip free or fixed trip	Trip Free	
	iv)Earthing for operating mechanism and metal parts	Solidly Earthed	
	v)Earth terminal size and material, Min.	Electrolytic grade Copper 25 x 3mm	
61.	Operating mechanism for tripping of Circuit Breaker		
	i)Type	Spring Operated Mechanism	
	ii)No of breaker operations stored	One	
	iii)Trip free or fixed trip (V)	Trip Free	
	iv) Earthing for operating mechanism and metal parts	Solidly Earthed	
	v)Earth terminal size and material	Electrolytic grade Copper 25 x 3mm	
	vi)Spring charging mechanism		
	a)Make	As per Manufacture Design	
	b)Type	As per Manufacture Design	
	c)Motor, Voltage and Watts	As per Manufacture Design	
62.	Breaker Accessories		
	i)Mechanical safety Interlock	To be Provided	
	ii)Automatic safety Interlock	To be Provided	
	iii)Operational Interlock	To be Provided	
	iv)Emergency manual trip	To be Provided	
	v)Operation counter	To be Provided	
	vi)Spring charge / discharge indicator	To be Provided	
	vii)Manual spring charging facility	To be Provided	
63.	Impact load on foundation design (to include dead load plus impact value on Closing at maximum interrupting rating)in kg		
	Extensible 3 Way RMU(3 Way, M+LLV+)	As per Manufacture Design	
D)Isolators			
64.	Make	As per Manufacture Design	
65.	Type	As per Manufacture Design	

66.	Reference standard	IEC-62271-102 / IEC-62271-103	
67.	Nominal Voltage in KV	33	
68.	Highest System Voltage in kV, Max.	36	
69.	Rated Frequency in HZ	50 Hz \pm 3%	
70.	No. Of poles	3	
71.	Rated Current in Amps	630	
72.	Maximum temperature rise over an ambient temperature 50°C.	60°C	
73.	Operation	Close-Open-Earth	
74.	Rupturing Capacity at rated voltage	630Amps at 33 kV	
75.	Maximum over voltage factor when switching off Loaded feeder cable in kA	62.5	
76.	No. of isolator operation permissible without requiring inspection, replacement of contacts and other main parts		
	i)Mechanical Endurance in Number of operations	1000	
	ii)At 100% rated making current in Number of operations	100	
	iii)At 100% rated breaking current in Number of operations	100	
77.	Isolator provided with the following Mechanical safety		
	a)Mechanical ON and OFF Indication	To be Provided	
	b)Cable Earth Indication	To be Provided	
	c)Operational Counter	To be Provided	
	d)Manual Spring Charging facility	To be Provided	
E) Current Transformer			
78.	Make	As per Manufacture Design	
79.	Reference standard	IS:16227, I & II	
80.	Type	Ring Type, Resin Cast/Tape wound	
81.	Nominal Voltage in KV	33	
82.	Highest System Voltage in kV, Max.	36	
83.	Rated Frequency in HZ	50 Hz \pm 3%	
84.	Current Transformer Ratio	200-100/1Amps	
85.	Short circuit withstand		
	i)Short time current for 3 sec. in kA rms	5	
	ii)Dynamic current in kA peak,	7.5	

	Min.		
86.	Class of insulation	Class B	
87.	Basic insulation level in kV	3	
88.	Maximum temperature rise over an ambient temperature 50°C.	60°C	
89.	Class of Accuracy		
90.	Metering Core	0.5	
91.	Protection Core	5P10	
92.	Rated Burden	2.5 VA	
93.	Over Current Rating in %	120	
94.	Continuous Over Load in %	120	
F) Metering Voltage (Potential) Transformer			
95.	Make	As per Manufacture Design	
96.	Reference standard	IS:16227, I & III	
97.	Type	Resin Cast/Tape wound	
98.	Nominal Voltage in KV	33	
99.	Highest System Voltage in kV, Max.	36	
100.	Rated Frequency in HZ	50 Hz \pm 3%	
101.	Voltage Transformer Ratio	33 kV/ $\sqrt{3}$ /110V/ $\sqrt{3}$	
102.	Rated Primary Voltage in kV	33 kV/ $\sqrt{3}$	
103.	Rated Secondary Voltage in V	110V/ $\sqrt{3}$	
104.	Rated Burden in VA	50	
105.	Accuracy Class	0.5	
106.	Insulation Class	B	
107.	Voltage Factor	1.2 Continuous and 1.9 for 8 hrs.	
108.	One Minute Power Frequency Dry Withstand Voltage Rating		
	a) Primary Winding Induced Test in kV rms	70	
	b)Secondary Winding in kV rms	3	
	c)Rated Impulse Voltage in kV peak	170	
G) Auxiliary Voltage(Potential) Transformer			
109.	Make	As per Manufacture Design	
110.	Reference standard	IS:16227, I & III	
111.	Type	Resin Cast/Tape wound	
112.	Nominal Voltage in KV	33	
113.	Highest System Voltage in kV, Max.	36	
114.	Rated Frequency in HZ	50 Hz \pm 3%	
115.	Voltage Transformer Ratio	33 kV/ $\sqrt{3}$ / 230V	
116.	Rated Primary Voltage in kV	33 kV/ $\sqrt{3}$	
117.	Rated Secondary Voltage in V	230 V	
118.	Rated Burden in VA	500 VA	
119.	Voltage Regulation in %	5	
120.	Insulation Class	B	
121.	Voltage Factor	1.2	

122.	Application & Construction Type	Indoor, Single Phase/Two Pole	
123.	One Minute Power Frequency Dry Withstand Voltage Rating		
	a)Primary Winding Induced Test in kV rms	70	
	b)Secondary Winding in kV rms	3	
	c)Rated Impulse Voltage in kV peak	170	
H) Numerical Protection Relay			
124.	Make	As per Manufacture Design	
125.	Type and Model	As per Manufacture Design	
126.	Reference Standard	IEC 60255	
127.	Type and Model	3 Over Current(O/C) and 1 Earth fault(E/F)	
128.	Current Transformer Secondary Input to Relay	1 A	
129.	Operating Curve Type	Inverse Definite Minimum Time (IDMT)Relay	
130.	Auxiliary Supply	Self Powered relay for Protection	
131.	Rated Frequency in HZ	50 Hz \pm 3%	
132.	Over Current Protection		
	a)Low set Over Current protection	20-200% of CT secondary rated current with increment/decrement by 1 %	
	b)High set Over Current protection	100-2000% of CT secondary rated current with increment/decrement by 50%	
133.	Earth Fault Protection		
	a)Low set Earth Fault protection	5% to 80% of the CT rated current in steps of 1%	
	b)High set Earth Fault protection	100-1000% of the CT rated current in steps of 50%	
134.	a)Mounting	Flush Mounted	
	b)Mounting Dimensions, W X L x H in mm	As per Manufacture Design	
135.	Operational Indicator	LCD display and LED annunciation lamps	
136.	Contact Details	4 Binary Input(BI) and 6 Binary output(BO)	
137.	Self-diagnosis feature	To be Provided	
138.	Password protection	To be Provided	
139.	Communication Protocol	RS 232 or RS 485 Port for IEC 103 Communication Protocol	
140.	Event / fault record, Min.	10 Event and 5 Fault Records available	
141.	Setting groups	2 Groups available	
142.	Circuit Breaker control	Yes, Only Trip	

	available		
I) Tripping Coil			
143.	Make	As per Manufacture Design	
144.	Type	As per Manufacture Design	
145.	DC Voltage in Volt	24, Pulse operated	
146.	Maximum Tripping Current at rated voltage in Amps.	5	
147.	Minimum Permissible voltage variation in %	85 to 110	
148.	Power at Voltage in Watts	As per Manufacture Design	
J) HT three phase four wire CT / PT operated 1 Amps fully Static & AMR compatible TOD Tri - vector Energy Meter			
149.	Reference Standard	IS: 14697, 1999 IS: 15959, 2011	
150.	Make	Any Reputed make	
151.	Auxiliary supply Voltage	110V/√3	
152.	Class of Accuracy	0.5S	
153.	Type of Display	Customized backlite liquid crystal display	
154.	Measuring Parameters as per PVVNL Specification		
	i)Instantaneous parameters	To be Provided	
	ii)Block Load Profile parameters	To be Provided	
	iii)Billing Profile Parameters	To be Provided	
	iv)Name Plate details Programmable Parameters	To be Provided	
	v)Event Conditions	To be Provided	
	vi)All logging parameters for each of the event condition for 3 Φ / 4W	To be Provided	
K)Fault Passage Indicator (FPI) on Short Circuit and Earth fault			
155.	Make	As per Manufacture Design	
156.	Type and Model	As per Manufacture Design	
157.	Operating point/Current short circuit in Amp	Adjustable 100/200/300 /400/500 /600/700 /800/900/1000 /1100/1200A (±15%)	
158.	Operating point/Current earth fault in Amp	Adjustable 10/20/30/40 /60/80/100A (±15%)	
159.	Response Time in ms	For Short Circuit Adjustable 40/60/80/100/120 /160/200/240 ms Sec(±100m Sec) For Earth Fault Adjustable 40/60/80/160 ms (±100m Sec)	

160.	Auto Reset Time in Hrs	1/2/4/8 hrs (+/- 1%) after fault	
L) Battery Charger			
161.	Make	As per Manufacture Design	
162.	Type and Model	As per Manufacture Design	
163.	Input AC Voltage in V	230	
164.	Rated Frequency in Hz	50 Hz \pm 3%	
165.	Output DC Voltage in V	24	
166.	Current Rating in Amps	10	
167.	Output DC Voltage for charger		
	i)Boost Mode in V	27 to 28	
	ii)Float Mode in V	27 to 28	
168.	Operating Temperature in °C	-25 to 60	
169.	Temperature Compensation	Junction temperature of SMPS crosses 142°C, thermal shutdown occurs.	
170.	Short Circuit and Overload Protection	To be Provided	
171.	High Voltage Isolation	2 kV for 1 minute	
172.	Efficiency	Above 85 %	
173.	Mounting Arrangement	As per Manufacture Design	
174.	Dimensions, W x D x H in mm	As per Manufacture Design	
N) Battery			
175.	Make	As per Manufacture Design	
176.	Type	Dry Type	
177.	Ah Efficiency	> 95%	
178.	Self-Discharge	Self-Discharge	
179.	Operating Temperature	Normal : +20°C to +30°C & Limits : -20°C to +50°C	
180.	Voltage (V)	24V (2 x 12V)	
181.	Ah Capacity	7Ah / 12 Ah / 26 Ah	
O) Manometer with Non Return Valve			
182.	Make	As per Manufacture Design	
183.	Type and Model	Analogue, ---	
184.	Material	Stainless Steel	
185.	Accuracy of calibration pressure	+/-1% at 20°C	
186.	Pressure Element	Stainless Steel Welded	
187.	Dial	2"	
188.	Pointer	Dark	
189.	Window	Round	

190.	Gas pressure low signal	Indicated by Red Color Zone	
191.	Non-Return Valve(NRV) Material	Stainless Steel	
P) Indoor cable terminations kits			
192.	Make	As per Manufacture Design	
193.	Type	33 kV touch proof screened termination kit	
194.	Materials	Epoxy / EPDM / Silicon Rubber	
195.	Cable Size	Up to 3 x 400 sq. mm 33 kV HT cables	
196.	Height of each Cable box from ground level	As per Manufacture Design	
197.	Arrangement for mounting an extra cable at incoming and outgoing side box of Bus bar.	As per Manufacture Design	
198.	Arrangement for mounting an extra cable at outgoing side box of transformer / feeder.	As per Manufacture Design	
Q) Automatic Water Level Controller			
199.	Make	As per Manufacture Design	
200.	Type and Model	As per Manufacture Design	
201.	Position of Automatic Water Level Controller	200 mm below live contacts	
202.	Auxiliary contacts	4 NO + 4 NC	
203.	Breaker Tripping and Load break Isolator opening due to water level increases; signals to Control room	To be Provided	
R) Name Plate			
204.	Material	Anodized Aluminum / Stainless Steel	
205.	Thickness	18 swg / 1.00 mm	
206.	Size	145 mm x 116 mm	
S) Painting			
207.	Inside	Powder Coated	
208.	Outside	Polyurethane based powder paint. Dark Admiralty Grey, Shade No. 632 as per IS: 5, 2007.	
T) Danger Board			
209.	Reference Standard	IS: 2551, 1982	
210.	Material	Mild Steel	
211.	Thickness in mm, Min.	1.6	
212.	Size H x L in mm	200 x 250	
U) Type Test			
213.	Following Type Test carried out within 5 years at NABL		

	laboratories in India or equivalent International Laboratories, Yes / No		
214.	Short time Current withstand test and peak current withstand test.	Yes	
215.	Lightening Impulse voltage with-stand test	Yes	
216.	Temperature rise test.	Yes	
217.	Short Circuit current making and breaking tests.	Yes	
218.	Power frequency voltage withstand test (dry).	Yes	
219.	Capacitive current switching test confirming to IEC.	Yes	
220..	Mechanical operation test.	Yes	
221.	Measurement of the resistance of the main circuit.	Yes	
222.	Degree of protection of Inner enclosure and outer enclosure	Yes	
223.	Switch, circuit breaker, earthing switch making capacity.	Yes	
224.	Switch, circuit breaker breaking capacity.	Yes	
225.	Internal arc withstand Test for Inner Enclosure and Cable Chamber.	Yes	
226.	Checking of partial discharge on complete unit.	Yes	
227.	Guarantee of Ring Main Units and accessories supplied against this specification	66 months from the date of receipt at the consignee's Stores Center or 60 months from the date of commissioning	

Schedule 'C'

List of Type Test Reports to be enclosed with the offer

Sr. No.	Description of Type Test	Type & Make of Ring Main Unit & its rating	IS/IEC Clause No.	Testing Lab. & Date of Testing	Type test report No., dt & pages	Whether certificate of compliance with IS/IEC is enclosed with T.R.
1.						
2.						
3.						
4.						

Name of the firm_____Signature of the bidder_____
Designation_____Date_