सत्यमेव जयते

GOVERNMENT OF INDIA
MINISTRY OF POWER

STANDARD BIDDING DOCUMENT
SECTION-VI
MODEL TECHNICAL SPECIFICATION
SCADA/DMS/OMS

पी एफ सी
PFC

POWER FINANCE CORPORATION

Table of Contents

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 system; 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 recognitions 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 works related to loss reduction and system strengthening. 33kv level and below will be eligible under this component. In areas, were 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 Armoured / 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 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 UGVCL).

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 system encompassing all distribution Sub-stations & secondary network emanating from S/S shall be implemented to achieve objective of this scheme. SCADA/DMS system for Towns with following criteria shall be eligible

Non special category states

- **Town population > = 2.75 Lacs (as per 2011 Census data) in non-special category states and Capital /Discom/PD HQ towns**

Special category states

- **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 RTDAS under IPDS is commissioned, the existing 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 towns

Major components that a SCADA /DMS 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, Supply, Design, Engineering, Installation, Testing, Commissioning, Go-Live & service based (SLA) for UGVCL for:

a. SCADA/DMS Control Centre (SDCC) at each Group-A town
b. Common Disaster Recovery Centre for SCADA/DMS for group-A towns per UGVCL or town as per requirement and availability of infrastructure (Building etc.) by UGVCL (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/ Dispatcher training simulator (DTS) for each town
i. SCADA/DMS system to supervise & control primary S/S & secondary HV Distribution network
j. RTUs at all primary S/S & FRTUs at RMUs, /Auto Reclosers/Sectionalizers, 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. Sectionalizers 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 of 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 Control center /DR center & state load dispatch center(optional)

iv. Support /compliance to IEC61850 ,IEC60870-5 suite for RTU/CC for numerical relays

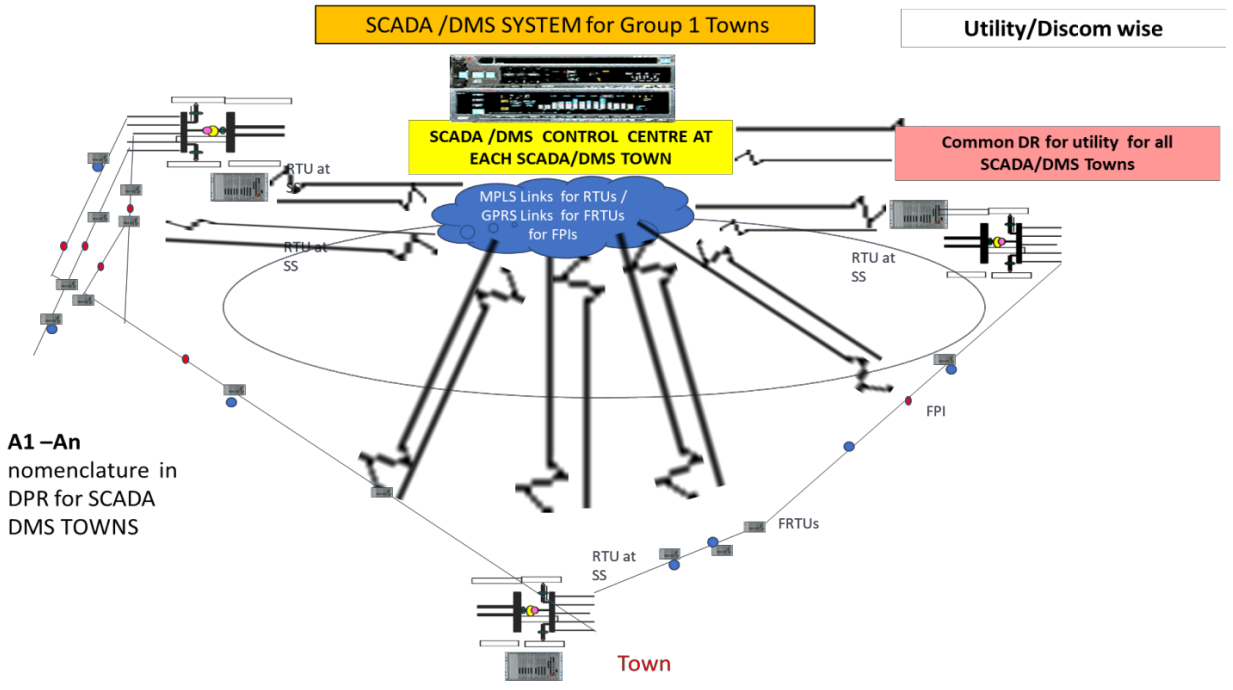
q. Support /compliance to DLMS/ IEC 62056 for SMART meters

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 UGVCL post enterprise Go-Live to UGVCL



Ref Fig 1.1

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 shall be implemented 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 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, Supply, Design, Engineering, Installation, Testing, Commissioning, Go-Live & service based (SLA) UGVCL 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 etc. may have common ZSCC in each state for all towns for SCADA besides SDCC for capital town. This is a guideline to create appropriate architecture. However, utilities of other states can decide to club / co-locate ZSCC with SDCC as per the ease in monitoring /control of electrical network / optimize control centers requirements based on availability of building infra for control centers as per sanction
- Common Data Recovery Centre for SCADA for group-B towns per UGVCL
- 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 of 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 Control center /DR center & state load dispatch center(optional)
- Support /compliance to IEC61850 ,IEC60870-5 suite for RTU/CC for numerical relays

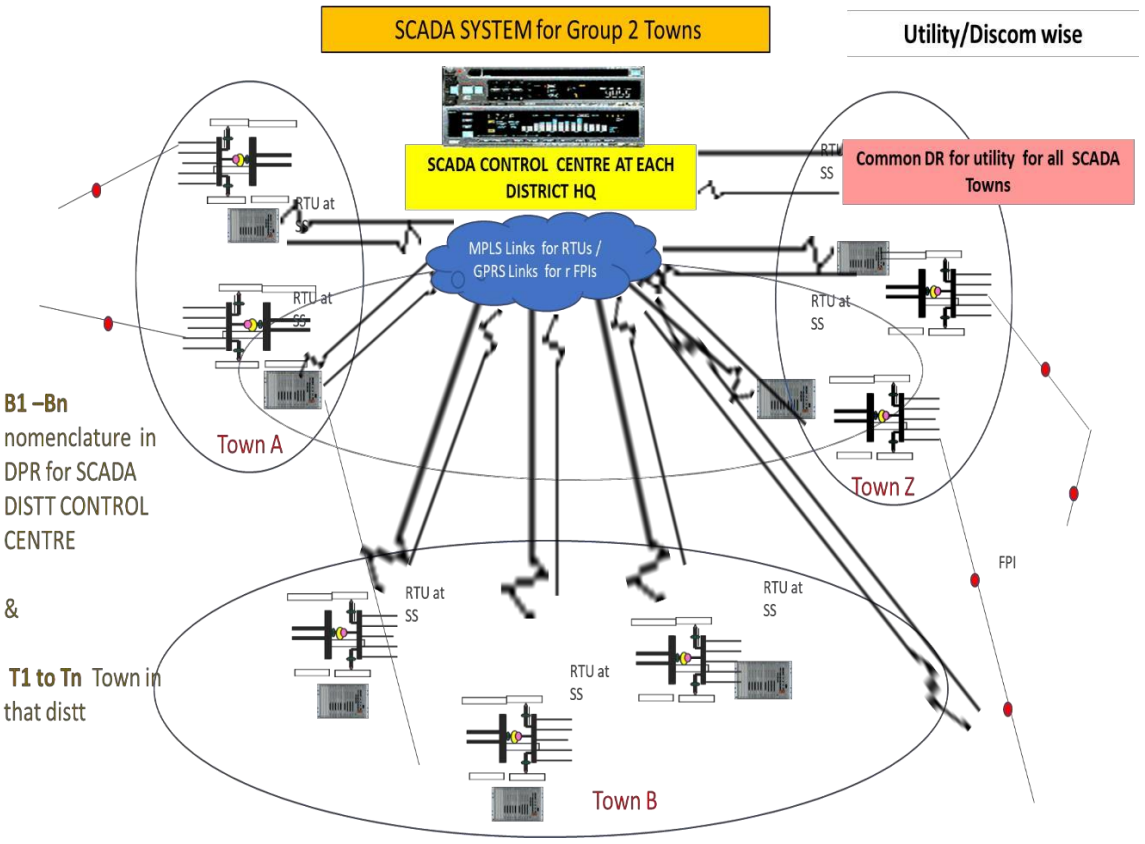


FIG – STANDARD SCADA CONTROL CENTRE (SSCC) FOR DISTT OR ZONAL SCADA CONTROL CENTRE (ZSCC EACH SCADA AND RT-DAS TOWNS (GROUP B &C)

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 UGVCL post Operational acceptance (S.A.T)
- Further , where RTDAS under IPDS is commissioned , existing 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

1.3.1.3 Group-C : RT-DAS system in 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 shall be implemented to achieve objective of this scheme. SCADA system for Towns with following criteria shall be eligible

RT-DAS in 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. However, based on the requirement, UGVCL may opt basic SCADA

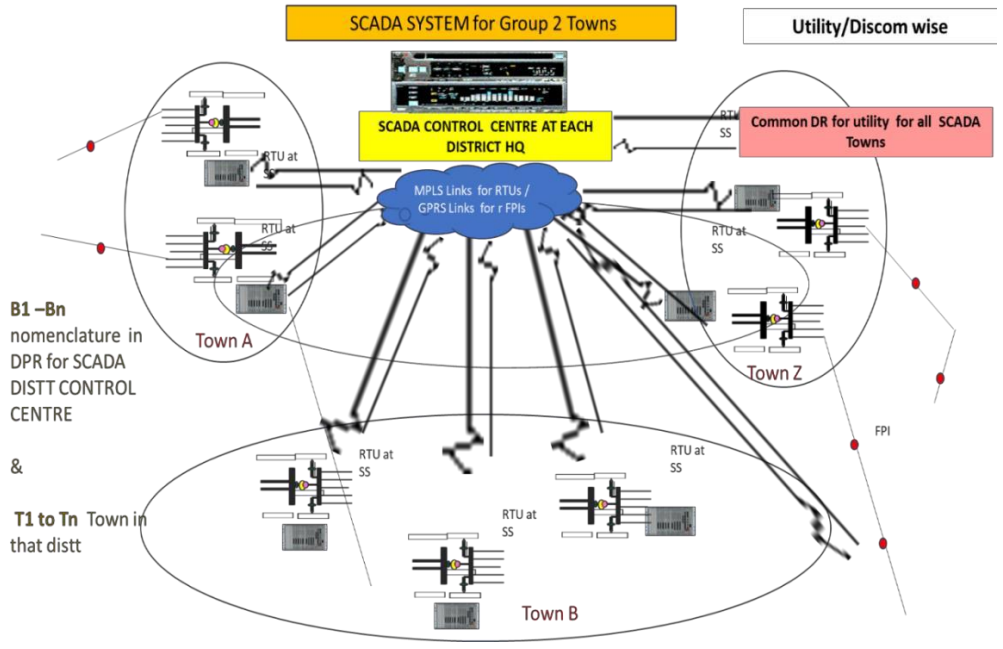
1.3.1.3.2 Components of Group- C towns

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, Supply, Design, Engineering, Installation, Testing, Commissioning, Go-Live & service based (SLA) for UGVCL 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 of 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 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 UGVCL 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 UGVCL (as per the requirement to be given in the detailed RFP and group A , B , C, U towns) shall carry out field survey, design ,engineering, supply, installation, testing & commissioning of SCADA/DMS 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 UGVCL 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 UGVCL. In case UGVCL 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 seven 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, Sectionalizers, 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 control center along with associated hardware and software, the SIA shall design and provide the Software & hardware at SCADA/DMS 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 UGVCL

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, RTDAS 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 UGVCL 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 change/ growth of electrical network in form of new RTU/FRTU/ RMU/Sectionalizers/ FPIs , numerical replays etc. provided by UGVCL. The activities shall be ensured for atleast post successful completion of acceptance tests for a period of seven years from the date of completion of operational acceptance of the SCADA/DMS 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 7 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 UGVCL 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 UGVCL & 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 UGVCL (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 empaneled agency or any agencies notified by MoP/GoI /Nodal agency under this project during 7 year Facility Management Services (FMS) period along with Supervision & Operationalizing 7 year warranty of the SCADA,DMS,OMS, RTDAS 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 UGVCL 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 UGVCL. SIA shall also be responsible for successful conduction of cyber security audit by CERT.IN empaneled agency.

7) **Geographical Scope:** The Locations where the systems shall be implemented shall be detailed by the particular UGVCL 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 system, RTU/FRTU, IT systems, Numerical relays etc. including billing , customer care , GIS etc. already existing and functional in the UGVCL, but outside the present scope of work and defined in RFP by UGVCL . 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 system as specified in the RFP may be integrated seamlessly.

9) **Training for Employees:** The SIA shall organize training to the core Group of

implementation team of the UGVCL 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 UGVCL 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 UGVCL. 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 UGVCL, service provider & SIA shall be signed.

e) Sufficient SPARES /INVENTORY for FMS period of 7 years to meet SLA

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 UGVCL with a high quality system

b. **Interface Coordination:** The bidder shall identify all interface issues with UGVCL and other agencies if any, and inform UGVCL which shall interface, coordinate and exchange of all necessary information among all concerned agencies.

c. **Scope Change Management:** UGVCL 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 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 UGVCL can provide the same as per bidder's requirement

b. Manpower required operating SCADA/DMS, SCADA, RTDAS 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 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 UGVCL 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 Towns of SCADA/DMS, bidding can be done in multiple packages (Maximum 5 towns of Group A). Also, for Group U Towns of SCADA/DMS, bidding can be done in multiple packages (Maximum 5 towns of Group U). The package mentioned here is indicative for optimal configuration for packaging and UGVCL may reconfigure as per the need of the project

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

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. Retrofittment 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, it is essential that 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 equipments 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 equipments, RTUs /FRTUs/APS etc.in line with SCADA/DMS system implementation schedule.

l. Providing details of Existing Legacy systems if any SCADA/DMS/ RTDAS, RTU/FRTU, IT, Numerical relays RMU/FPI, GIS etc. system under R-APDRP for integration.

m. UGVCL shall ensure that Project implementation & operation to be done by O&M dept. of UGVCL 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 substations 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 biding documents.

4. The type test certificates for the offered equipments. 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 UGVCL
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 the section- 9.

c. The database, displays and reports for SCADA/DMS/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 for SCADA/DMS as per list in section 9 Annexure 1. The minimum to maximum temperature & relative humidity generally falls between … to … C. & ..... to.... % respectively. The sites are located in the towns of Group B for SCADA as per list in section 9 Annexure 2. Further, where RTDAS under IPDS is commissioned, the existing 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 as per list in section 9 Annexure 2.

The minimum to maximum temperature & relative humidity generally falls between … to … C. &..... to.... % respectively. The sites are located in the towns of Group C for SCADA as per list in Annexure 3 …. . The minimum to maximum temperature & relative humidity generally falls between … to … C. &..... to.... % respectively. The sites are located in the towns of Group U for SCADA /DMS as per list in Annexure 4 …. . The minimum to maximum temperature & relative humidity generally falls between … to … C. &..... to.... % respectively. UGVCL shall also indicate locations at above 2000 m form 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 , SCADA/DMS/OMS and Group B , SCADA and Group C RTDAS and Group U shall be considered irrespective of terms of SCADA , DMS, OMS, RTDAS is mentioned in any combination in specification as per the relevant functional requirements common and specific both that group .

1.3.12 Warranty

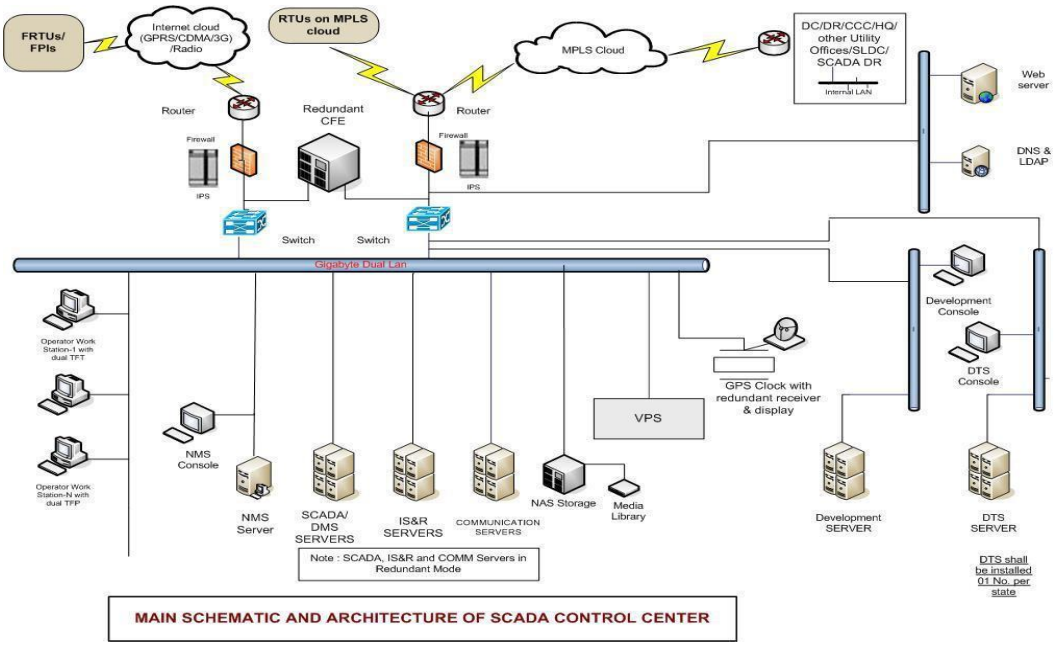
This would include seven years warranty for the related hardware & software supplied under the SCADA/DMS project after the Site acceptance test (S.A.T), operational acceptance of the SCADA/DMS System. The 7 year warranty shall include comprehensive OEM on-site warranty for all components (H/W and Software 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 UGVCL & SIA

The term contractor & bidder shall be referred as SCADA/DMS implementation agency (SIA) & owner; employer shall be referred as UGVCL where ever mentioned in the RFP /Model Technical specification (MTS)

1.3.14 Proposed SCADA/DMS system

UGVCL shall write in brief about the proposed system for Group A ,B &C



Ref Fig 1.3

1.3.15 Existing System for Group A , B, C & U towns separately.

UGVCL 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. UGVCL shall provide details electrical system considered /committed, enabling SCADA/DMS implementation.

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

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

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

End of Chapter 1

CHAPTER -2: SCADA FUNCTIONS

2.0 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, B, C, U towns as per functional requirements

2.1 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 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 Towns only means that system will presently be using 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 or SCADA or RTDAS shall be considered by per functional requirement of Group A , Group B towns , Group C and term SCADA/DMS shall be read as SCADA for B , C Towns accordingly as per functional and BoQ requirements or unless specified in the bid specifically .

2.1.1 SCADA/DMS 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

2.1.2 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 Towns only)

f) Data exchange among the contractor supplied SCADA/DMS system, IT system established under R-APDRP

g) Web server applications, Security applications

h) Network Management system (NMS)

i) Disaster Recovery for Group A & 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

2.2 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/U towns
- Data Acquisition from RTUs at S/S & FPIs for Group B,C Towns
- Time synchronization of RTUs,, FRTUs & FPIs(if time synch is supported in FPI)

- Data Exchange among the contractor supplied SCADA/DMS 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 for all towns except Group C
- 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 & Data recovery function (DR) for Group B& C

The System Design Parameters of SCADA/DMS functions ,The power system sizing, Performance requirements for complete SCADA/DMS system are specified are specified in DESIGN PARAMETERS AND PERFORMANCE given section 8

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 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 Towns only)

All input data and parameters, whether collected automatically or entered by a 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.

2.2.1 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

(d) 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)

(e) For IT Systems - (in specified format (OPC / CIM-XML / ODBC Format) Model & Data Exchange over IEC 61968-1 Enterprise SOA Based BUS)

(f) In case existing system uses DNP3.0 protocol, the same shall be used for integration of existing RTUs.

(g) 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

2.2.2 Data Acquisition

SCADA system shall acquire data from Remote Terminal Units (RTUs) (Group A, B, C, U Towns), FRTUs (Group A, U Towns) & FPIs (Group A, 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 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 in Section 9.**

2.2.2.1 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 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 minutes/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 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 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. In case, RMU & Sectionlizer is supplied with built -in FRTU is supplied, then also the above time skew and update requirement shall be met .

2.2.2.2 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.

2.2.3 Time synchronization of RTUs

The SCADA/DMS 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 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 associated SCADA/DMS control center or SCADA centre in the DISCOM

2.2.4 Data Exchange

UGVCL 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. UGVCL shall also provide the required access & information of such existing systems to SIA for implementation

2.2.4.1 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 status /reports in view only mode for capacity building may be required to be linked with any common infra directed by MoP/ PFC

2.2.4.2 SCADA/DMS system with IT system (optional)

If data exchange requirement of specific parameters with IT system is envisaged by UGVCL in the RFP then, SCADA/DMS 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 SOA based 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 UGVCL 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:

2.2.4.3 For data exchange between SCADA/DMS control centers & DR center, optional (SLDC):

If opted & requirement specified by UGVCL in this RFP, then SCADA/DMS 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 UGVCL 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 nonproprietary/ 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.

2.2.5 Data Processing

The SCADA/DMS 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 UGVCL 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

2.2.5.1 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:

Value = (A * 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 UGVCL 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 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.

2.2.5.2 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 & uncommanded 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

2.2.5.3 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 combinational 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.

2.2.5.4 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 disconnectors, in order to defi~~n~~e 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.

2.2.5.5 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.

2.2.5.6 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.

S. No.	Quality code	Code	Reason
1.	Telemetry Failure (RTU Link)	T	Telemetry has failed
2.	Manual Replaced	M	Manual updation
3.	Delete from Scan (RTU/point)	D	User disabled the scan of the of data/point
4.	Questionable data	Q	Analog values of the de- energized elements
5.	Calculated	C	Calculated data
6.	Estimated	E	Estimated data from state estimator
7.	Limit Override	L	Limits are overridden
8.	Primary /secondary source	P/S	Primary or secondary source
9.	Reasonability Limit Exceeded	R	Value beyond reasonability limit
10.	Alarm Inhibit	A	Alarm processing is inhibited
11.	Test or maintenance mode	X	Point is in test /maintenance mode

2.2.6 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.

2.2.7 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 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**.**

2.2.8 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.

2.2.9 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/FPI 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 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

2.2.9.1 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.

2.2.9.1.1 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

2.2.9.1.1.1 Reset flag of FPI

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

2.2.9.1.1.2 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.

2.2.9.1.1.3 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 pushbuttons 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 pushbuttons shall continue to be displayed, and it shall be possible to initiate these controls repeatedly without reselection of the controlled point, provided that the execution of the previous control command has successfully been completed.
3. The RAISE/LOWER pushbuttons 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.

2.2.9.1.1.4 Set point Control

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

2.2.9.1.1.5 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 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 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 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.

2.2.9.1.1.6 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.

2.2.9.1.1.7 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.

2.2.9.1.1.8 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.

2.2.10 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%.

2.2.11 Remote database downloading, diagnostics & configuration :

The SCADA/DMS 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.

2.3 Information Storage and Retrieval

Information Storage and Retrieval (ISR) function shall allow collection of data from real-time SCADA/DMS 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 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 UGVCL 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 System.

In ISR should also support ad-hoc queries /reports, 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 19**

2.3.1 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 enterable 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.

2.3.2 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 tele-metered 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.

2.3.3 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 (atleast maxima & minima with associated time and average) alongwith 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 alongwith 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.

2.3.3.1 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.

(d) 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.

2.3.3.2 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

2.3.4 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.

2.3.5 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 10^{th} of every month.

2.3.6 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 based on AT&C and revenue generation /collection or any other priority Besides, this system shall also be able to set load priority based on the AT&C an revenue information collected from IT system for each feeder

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

2.3.7 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 years 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.

2.3.8 Feeder Limit overshoot table

ISR system shall maintain feeder limit over shoot instances record for each feeder load for overload condition, voltage for under voltage, over voltage and power factor for low power factor any other parameter UGVCL required to define Feeder Limit overshoot table. The data shall contain count of such instances and duration for which feeder experienced such condition and index for overshoot limit of voltage) low ,high), current (high), power factor (low) etc on daily, monthly, quarterly, yearly basis. Such daily tables for two years duration shall be stored on auxiliary memory. Tables for the previous day shall be backed up to Magnetic tape/ MO disks by the user at 10AM of every day.

2.3.9 FPI fault table

ISR system shall maintain feeder FPI instances record for each feeder for o/c & E/F instances required to define FPI index table . The data shall contain count of such instances and type , section (FPI) for which feeder experienced such condition and index for FPI fault index on daily, monthly, quarterly, yearly basis. Such daily tables for two years duration shall be stored on auxiliary memory. Tables for the previous day shall be backed up to Magnetic tape/ MO disks by the user at 10AM of every day

2.3.10 Equipment Failure Table

ISR system shall maintain record of DT, Power transformer failure information on weekly manner . The same shall be collected from ERP system if any or any other system where such data is maintained and also there shall be provision for user to enter data pertaining to failure of power transformer and DT to determine DT & Power transformer failure rate shoot instances record on weekly monthly, quarterly, yearly basis. Such daily tables for two years duration shall be stored on auxiliary memory. Tables for the previous day shall be backed up to Magnetic tape/ MO disks by the user at 10AM of every day.

2.3.11 User defined index table

ISR system shall maintain record of user defined indexes derived for performance from telemetered data to record on daily weekly monthly, quarterly, yearly basis. Such daily tables for two years duration shall be stored on auxiliary memory. Tables for the previous day shall be backed up to Magnetic tape/ MO disks by the user at 10AM of every day.

2.3.12 Average time restoration table

ISR system shall maintain record of avg time to report outage location, restoration of supply of feeder, project area on monthly, quarterly, yearly basis. Such daily tables for two years duration shall be stored on auxiliary memory. Tables for the previous day shall be backed up to Magnetic tape/ MO disks by the user at 10AM of every day.

2.3.13 Daily /Weekly Flash report for management of UGVCL

ISR system shall maintain record and flash report in form of dashboard for management of UGVCL exhibiting key performance indices. Such daily tables for two years duration shall be stored on auxiliary memory. Tables for the previous day shall be backed up to Magnetic tape/ MO disks by the user at 10AM of every day

2.3.14 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

2.3.15 System Message Log Storage and Retrieval

System message log, which shall consist of the chronological listing of the SCADA/DMS 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 10^{th} 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.

2.3.16 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 & OMS application

b) 10 Output results of each DMS & OMS applications

2.4 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 despatcher 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 despatcher 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 Load Shed operation shall be archived in Information storage and retrieval (IS&R) system.

2.4.1 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.

2.4.2 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.

2.4.2.1 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 despatcher shall select & execute one

of these options for affecting the load shed.

2.4.2.2 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 despatcher. The despatcher 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.

2.4.2.3 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 despatcher 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 accidently 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.

2.4.2.4 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 despatcher 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 accidently 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.

2.4.3 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.

2.4.4 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, d a t e /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 equipments.

(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 despatcher 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.

2.5 Common Disaster Replica Recovery Centre (DRR)

The same shall be replica of SCADA DMS Control center for Group A and with secured permission and upon non availability of main SCADA/DMS Control center, the operation of that town shall be possible from DRR. However, system shall remain in sync at hourly basis and shall be suitable interlocks to avoid any accidental command. In case main control center is not available, all underlying equipment i.e. RTU/FRTU/FPI etc shall switch reporting to DRR and DRR will now act as master and sych old master. The process of switching shall not take more than 15 minutes. Now, after swapped configuration of DRR and Main Control Centre, the data sych shall continue from new master SCADA Centre to swapped DRR centre

2.6 Data recovery function (DR)

The DR function is a repository of system build up software of all towns Group B & Group C towns.Two 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 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 control center upon attaining user defined threshold e.g. 80% for storage at DR center.

2.7 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 Chapter 2

CHAPTER 3: DMS FUNCTIONS & SUPPORTING FUNCTIONS

3.0 General Requirements

This Section describes the Distribution Management System (DMS) applications & other supporting applications that are required for SCADA/DMS 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. 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.

3.1 DMS functions

These functions are applicable to Group A Towns only except LSA, LFA, OM & DTS functions which are also applicable for Group B, 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). (**Ref. Section 2, Chapter 1, Clause No. 1.4))**
- 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)

Other Supporting functions

- Dispatcher training Simulator (DTS)

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 UGVCL and UGVCL shall provide the same to run DMS functions.

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 disconnector
6. Non remote controllable disconnector.
7. Fuse
8. Ground/ Earth switch etc.
9. RMUs
10. Sectionlizer
11. Communicable FPIs

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) RMUs &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 application 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 UGVCL 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 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 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 UGVCL. 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 UGVCL and UGVCL shall provide the same to run DMS application.

3.1.1 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) Modelled 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

(e) Energized /de-energized state of network equipments

(f) Representation of Loops (Possible alternate routes)

(g) Representation of parallels

(h) Abnormal/off-normal state of CB/Isolators

The NCA shall assist operator 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.

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.

3.1.1.1 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 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.

3.1.1.2 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.

3.1.1.3 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.

3.1.1.4 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.

3.1.1.5 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 addition 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.

3.1.1.6 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

3.1.2 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 artificially 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.

3.1.2.1 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 forecasted 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.

3.1.3 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

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

3.1.3.1 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.

3.1.3.2 Study Mode Load Flow Execution:

It shall provide despatchers 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 fifty 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 transformers, as well as the total circuit loss

3.1.3.3 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

3.1.3.4 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.

3.1.3.5 Alarms

The LFA shall warn the Despatcher when the current operating limits are exceeded for any element or when lines are de-energized. It shall also warn the Despatcher 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.

3.1.4 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. The despatcher 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.

3.1.4.1 Modes of operation

The VVC function shall have following modes of reconfiguration process:

(a) Auto mode

(b) Manual mode

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

Auto mode

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

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.

3.1.4.2 Reports

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

3.1.4.3 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

3.1.5 Fault Management & System Restoration (FMSR) Application

The Fault Management & System Restoration application software shall provide assistance to the despatcher 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.

3.1.5.1 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.

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 (Despatcher configurable) and shall be able to report separately in the form of pending restoration actions.

3.1.5.2 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 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.

3.1.5.3 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 t h e 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 disconnector
6. Non remote controllable disconnector.
7. Fuse
8. Ground/ Earth switch etc.

3.1.5.4 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 done be by closing NO switch to allow the power from alternate source. In case more than one feasible switching plan exist, the despatcher shall be guided for most optimum plan based on the merit order ie minimum switching operations, minimum loss path, and system operation within the safe limits of various network elements. The despatcher 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 despatcher’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 despatcher 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 despatcher 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 despatcher for step by step restoration. Despatcher shall be allowed to introduce new steps.

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

3.1.5.5 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

3.1.5.6 Displays

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

(a) Network & tabular display to identify faulty network

(b) Network & tabular display to identify remotely controllable devices

(c) 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 despatcher.

(d) 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

(e) Delay in the restoration of network beyond specified time (Despatcher configurable) shall be reported separately in the form of pending restoration actions in Tabular display.

(f) 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.

3.1.6 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 characteristic of equipments & 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 despatcher 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.

3.1.6.1 Modes of operation

The LMFR function shall have following modes of reconfiguration process:

(a) Auto mode

(b) Manual mode

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

Auto mode

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

Manual mode

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

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

3.1.6.2 Displays & Reports

At the defined periodicity or on demand, the despatcher 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 despatcher 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.

3.1.7 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 despatcher. 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 despatcher 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.

3.1.7.1 Modes of operation

The function shall have following modes of reconfiguration process:

(a) Auto mode

(b) Manual mode

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

Auto mode

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

Manual mode

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

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

3.1.7.2 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.".

3.1.8 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 appear

3.2 Outage Management System

3.2.1 Outage Scheduling Management

The system shall enable UGVCL to partially or completely deenergize an electric circuit and notify UGVCL concerned personnel and provide interface to customer care system. The system shall exhibit following features

- 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

3.2.2 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.
- 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

3.2.3 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

3.2.4 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 and shall be defined apart from UGVCL 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

3.2.5 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
- System Monitoring & KPI Views
- Geographical Power Distribution Views
- Alarms & Events

- Load Shedding System View
- Switching Sequence Management
- Customizable User Interface & Reporting

3.3 Disptacher Training Simulator (DTS)

A Dispatcher Training Simulator (DTS) shall be provided for SCADA/DMS 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 control center for Group A 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 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:

   (i) Normal steady state

   (ii) Disturbed network conditions for distribution network

   (iii) High & Poor Voltage conditions

   (iv) Poor VAR conditions

   (v) Indiscriminate tripping

   (vi) islanding

   (vii) System blackout

   (viii) System restoration

   (ix) Conditions/functions included for SCADA/DMS real time system

   (x) OMS related actions

i. Following features as minimum:

(i) All SCADA/DMS/OMS functions as envisaged in the specification

(ii) Cry wolf alarms

(iii) Record/ Playback /slow/real-time/fast forward

(iv) Record trainee actions

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

1. Instructor Control
2. Trainee Control

3.3.1 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 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:

3.3.2 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.

3.3.3 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.

3.3.4 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

(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 and to store the updated version.

3.3.5 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

3.3.6 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.

3.3.7 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.

(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.

3.3.8 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.

3.3.9 DTS Performance and Sizing

The DTS shall be sized the same in all respects as the SCADA/DMS 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

3.3.10 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 Chapter 3

CHAPTER –4: USER INTERFACE REQUIREMENTS

4.0 General Requirements

This chapter describes the User Interface requirements for the SCADA/DMS system. All SCADA/DMS 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, 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**

4.1 System Users

The term "user" is applied to the personnel interacting with the SCADA/DMS 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 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 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 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 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 UGVCL with login as supervisor shall be able to assign the operation of certain functions, or features of functions, to specific user modes. UGVCL 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 functions shall follow a consistent set of common user access guidelines. A mechanism for defining and controlling user access to the SCADA/DMS system shall be provided.

Password security shall be provided for access to the SCADA/DMS 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.

4.2 Function and Data Access Security

After a user has successfully logged on, access to the SCADA/DMS 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 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 using individually defined user name and password which permits appropriate level of access to all SCADA/DMS 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.

4.3 Windows Environment

The user interface for SCADA/DMS system shall be web enabled. The SCADA/DMS 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 wide area network (WAN).

Alternatively, the SCADA/DMS 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.

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 OpenGL 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, HPUX 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.

4.4 Display interactions

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

4.4.1 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.

4.4.2 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 pushbuttons 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 particular component exists.

4.4.3 Permanent Indicators

Several indicators, including those listed below, shall be permanently shown on each SCADA/DMS 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 Name of the active server
- Name of the SCADA/DMS display accessed
- Name of the display window

4.4.4 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.

4.4.5 Display Note pad

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.

4.4.6 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.

4.5 User Interaction Techniques

The user's interaction with the SCADA/DMS 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.

4.5.1 User Guidance

The SCADA/DMS 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.

4.5.2 User Help

In addition to the user guidance, general and specific context-sensitive on-line help shall be available to the SCADA/DMS 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 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

4.5.3 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 console at a time. An attempt to initiate control of the power system device from another window shall result in a user guidance message.

4.5.4 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.

4.6 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.

4.6.1 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.

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

4.6.2 Tabular Trending

Tabular trending shall be a listing of the time-sequential values of a variable/ variables. 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.

4.7 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) Uncommanded changes of a power system device state

(d) SCADA/DMS application program results

(e) Data source communication errors resulting in loss of data

(f) SCADA/DMS system hardware or software failures.

Each alarm shall be subjected to a series of alarm processing functions. A device or value's alarmable 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 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.

4.7.1 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.

4.7.2 Alarm Priority levels

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.

4.7.3 User Interaction for Alarms

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

4.7.4 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.

4.7.5 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

4.7.5.1 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.

4.7.5.2 Change Alarm Limits

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 annunciated 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.

4.7.5.3 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.

4.8 Events

Events are conditions or actions that shall be recorded by the SCADA/DMS 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 system and archived in chronological order and reverse chronological order.. It shall be possible to sort, display, and print event messages from any console.

4.9 Hardcopy Printout

The SCADA/DMS 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 selectable by the SCADA/DMS 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 selectable from the print Menu.

4.10 Report Generation

The contractor shall be required to generate the Daily, Weekly, Monthly reports formats for SCADA/DMS 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:

(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 to132 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.

4.11 System Configuration Monitoring and Control

The user shall be provided with the capability to review SCADA/DMS 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 functions

4.12 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. 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.

4.13 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.

4.14 Display Types

The following indicative list describes the types of displays that are to be included in the SCADA/DMS 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.

4.14.1 Dashboard

A suitable dashboard for UGVCL to view vital parameters at a glance shall be created.

4.14.2 SCADA/DMS System Display

A display shall be provided that lists all SCADA/DMS 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.

4.14.3 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. Cursor selection of a substation/ power station symbol shall result in the associated Single line diagram display for that substation/ power station.

4.14.4 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.

4.14.5 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.

4.14.6 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.

4.14.7 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

4.14.8 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.

4.14.9 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.

4.14.10 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.

4.14.11 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.

4.14.12 Manual Override Summary

The manual override summary shall list all telemetered and calculated device status and data values for which a user has substituted a value

4.14.13 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.

4.14.14 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

4.14.15 Alarm Inhibit Summary

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

4.14.16 Tag Summary

This display shall list and describe all active device tags.

4.14.17 Graphical 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.

4.14.18 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.

4.14.19 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.

4.14.20 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

4.14.21 RTU/ FRTU/FPI Communication Channel Monitoring and Control Display

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

4.14.22 SCADA/DMS 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.

4.14.23 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 UGVCL on daily, weekly, month, quarterly, FY , Yearly basis with comparison with past years through suitable navigation

4.14.24 GIS integration

The SCADA/DMS 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.

4.14.25 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.

End of Chapter 3

CHAPTER -5: SYSTEM SOFTWARE REQUIREMENTS

5.0 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/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,B,C towns as per functional requirements

5.1 Software Standards

All SCADA/DMS 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 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.

5.1.1 Design and Coding Standards for SCADA/DMS applications

All SCADA/DMS applications shall be maintainable by employer using the supplied software utilities and documentation. The SCADA/DMS 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 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 manufacturer, 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

5.2 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.

5.3 Time and Calendar Maintenance

The SCADA/DMS 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 system time. All Servers and Operator workstation clocks shall be synchronized within the accuracy of +/-100 milliseconds. The SCADA/DMS system shall not be dependent on a particular server for time /calendar maintenance. . The SCADA/DMS 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 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 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.

5.4 Network Software

The network software for SCADA/DMS system shall include software for network communication, security and services.

5.4.1 Network Communication

Users and various applications shall be able to communicate within the SCADA/DMS 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.

5.4.2 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 /RTDAS 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/SLA

5.4.3 Network services

The following network services shall be provided for the users of SCADA/DMS 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

5.4.4 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 Multilayer (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.
- 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

5.4.5 Features

Followings are the features specific to each component of security system

5.4.5.1 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 ActiveX 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.

5.4.5.1.1 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 two years shall be provided and there should be provision for creating customized signature

(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 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.
- 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 backdoors, 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.

5.4.5.1.2 Gateway Antivirus

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.

5.4.6 Other Aspects of Security

5.4.6.1 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.

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

5.4.6.2 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.

5.4.6.3 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.

5.4.6.4 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 UGVCL 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 protected LAN.

c) Internal SCADA/DMS 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 system to the Web server system, the SCADA/DMS 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 system LAN. Interface between Web server and SCADA/DMS 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 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**.** 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.

5.4.6.5 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.

5.4.6.6 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 servers, workstations, devices, communication interface equipment, and all SCADA/DMS 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 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 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 devices for local area network.

(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.

(g.) SLA monitoring - Availability of all devices shall be monitored and SLA shall be calculated as per SLA requirement specified in FMS chapter

5.4.6.7 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 antimalware, 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.
- 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,

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 identity 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 reengineering efforts.

5.5 Database structure

The SCADA/DMS 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 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 – the Source Database (SDB). All information needed to describe the models on which the SCADA/DMS operates, shall be defined once in the SDB and made available to all SCADA/DMS 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 databaseVersion, 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 shall provide a consistent interface to accept XML format data for updates from other database applications; and provide a consistent interface to import & export data in XML format.

5.5.1 Software Maintenance and Development Tools

5.5.1.1 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:

5.5.1.2 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.

5.5.1.3 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.

5.5.1.4 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 breakpoint 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.

5.5.1.5 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 functions. The capability to restore the system to its status prior to the new program integration shall be provided.

5.5.1.6 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. 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.

5.5.1.7 Code Management

A code management UGVCL shall be provided for documenting and controlling revisions to all SCADA/DMS application programs. The UGVCL 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 UGVCL 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 shall provide a software configuration management system to define the elements and the associated attributes of the applications provided in the SCADA/DMS. 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

5.6 Database Development software

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 system. All the facilities required for generating, integrating and testing of the database shall be provided with the SCADA/DMS system. The delivered SCADA/DMS 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 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 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.

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

5.6.1 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.

5.6.1.1 Data Retention

The database generation process shall retain and utilize data from the current SCADA/DMS 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.

5.6.1.2 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 server to ensure that all databases are consistent. Inconsistencies shall be annunciated to the user.

5.6.1.3 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 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 system's reaction to hardware and software failures nor shall it require suspension of exchange of data among servers for backup purposes.

5.6.1.4 Tracking Database Changes

The database manager UGVCL 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 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 atleast 2 months.

5.6.1.5 Initial Database Generation

The initial database shall contain all data required by the SCADA/DMS 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.

5.7 Display Generation and Management

SCADA/DMS 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 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 functions. All user interface features defined in this Specification shall be supported by the display generator.

5.7.1 Display Elements

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 functions and dynamically transformed on the display as governed by linkages to the database.

5.7.1.1 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 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.

5.7.1.2 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

5.7.2 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 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.

5.8 Report Generation Software

The SCADA/DMS /OMS system shall include report generation software to generate new report formats for SCADA/DMS/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.

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 functions.

5.9 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 system. System build is the process under which all the above executable and the executable provided for SCADA/DMS application software are ported to the SCADA/DMS 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 system. The contractor shall also provide the complete backup of the SCADA/DMS system in electronic media such as tapes, CDs, MO disks etc. Employer personnel shall be able to restore the SCADA/DMS 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 control center .

5.10 Software Utilities

All software utilities used to maintain SCADA/DMS 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 application functions that is running concurrently. This UGVCL software shall be accessible from workstations, programming terminals, and command files on auxiliary memory. Multiple users shall have concurrent access to a UGVCL program task, provided there are no conflicts in the use of peripheral devices.

5.10.1 File Management UGVCL

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.

5.10.2 Auxiliary Memory Backup UGVCL

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

5.10.3 Failure Analysis UGVCL

Failure analysis UGVCL 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.

5.10.4 Diagnostic UGVCL

The system shall have suitable auto diagnostic feature, on line & offline diagnostic UGVCL for on-line and off-line monitoring for equipments of SCADA/DMS system shall be provided.

5.10.5 System utilization Monitoring UGVCL

Software UGVCL 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 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.

5.10.6 Other UGVCL Services

On line access to user and system manuals for all software/Hardware products (e.g., Operating System and Relational Database Software/hardware) and SCADA/DMS applications shall be provided with computer system.

End of Chapter 5

CHAPTER -6: HARDWARE REQUIREMENTS FOR SCADA/DMS

6.0 Introduction

This section articulates the hardware requirements for the SCADA/DMS system. The conceptual hardware configuration diagram of SCADA/DMS 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 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 system specification. This chapter is applicable to Group A,B,C, U towns as per functional requirements

6.1 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 UGVCL, 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 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 or obtained from third party vendors, both for capacity expansion and for upgrading functionality, without affecting existing SCADA/DMS components or operation.

To be recognized as a true open computer system, all internal communications among the

SCADA/DMS Servers and all external communications between the SCADA/DMS 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.

6.2 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.

6.2.1 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 ONLY)
- OMS (Group A 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

/DRR/DR/ Communication server ^

The minimum hardware configuration of the servers shall be:

- 2.4 GHZ each processor (in case the offered server is RISC & EPIC based processor speed shall be at least 1.2GHz)
- Minimum 2 Processors
- 16GB Main memory (RAM)
- 1 TB HDD
- 19" LED color monitor
- Keyboard & Mouse
- Dual 10/100/1000Mbps Ethernet ports (Single for DTS & Developmental server #)
- One hot pluggable port for external STORAGE drive
- TPC/ Spec mark performance compliance
- redundant power supply
- redundant fan

SCADA/DMS 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.

6.2.1.1 Application servers

Redundant SCADA/DMS servers shall house SCADA/DMS 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

Redundant Web / Active Directory Services Server shall host Web Applications for SCADA/DMS LAN and the DNS configuration

Redundant NMS server shall be provided to host NMS application

6.2.1.2 Communication Servers:

6.2.1.2.1 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 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 is 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 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 UGVCL 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

6.2.1.2.2 ICCP Server /inter control center communication server

Depending upon the protocol i.e ICCP o other intercontrol 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 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 UGVCL to exchange data with State Load Dispatch Centers (SLDC) of the state where scheme will be implemented for exchange of scheduling data.

6.2.1.2.3 Network Management System (NMS) Servers

Redundant NMS servers shall be used for configuration management, fault management & performance monitoring of servers, workstations, routers & LAN equipments etc. Part of the above functions may be performed by other servers as per the standard design of offered product.

6.2.1.2.4 Web servers with Active directory:

Redundant Web servers with active directory LDAP, DNS shall be provided.

6.2.1.3 Demilitarized/ Security servers

6.2.1.3.1 Web servers with Firewalls and IPS:

Redundant Web servers shall be provided to allow the access of SCADA/DMS system data, displays by outside users. One router shall be provided which shall be connected to the external LAN/WAN communicating SCADA/DMS system. The external LAN/WAN users shall be able to access SCADA/DMS 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 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 shall be 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

6.2.1.3.2 Firewall:

Two firewalls shall be provided, one between Web servers & SCADA/DMS dual LAN and another between Web servers & W eb 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.

6.2.1.4 Training & development system server

6.2.1.4.1 DTS server;

A non - redundant server to host DTS applications shall be provided to impart the training.

6.2.1.4.2 Development server

A non- redundant server to host Developmental applications shall be provided

6.2.1.5 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

6.2.2 Operator Workstations

The operator Workstation console shall be used as a Man Machine Interface (MMI) by despatcher for interacting with all SCADA/DMS 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 inch LED colour 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 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 system & have facility to generate report. The additional associated hardware is mentioned in the BOQ.

6.2.3 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

6.2.4 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:

- 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 interface, NMS software and as well through Telnet.

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 UGVCL'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

Router redundancy Protocol (VRRP) or equivalent

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 Kpps or higher as per UGVCL 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 router
- Intranet router at/DMZ
- DR router
- Router at S/S & remote VDUs locations

6.2.5 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 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 LAN & (24)ports be considered for DMZ system, DTS & development system & DR system each,)

6.2.6 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 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
- 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 take prints of 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

6.2.7 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 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 $\pm$1.5microsec. 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, jitter, wander etc. Alternatively, a separate GPS clock for synchronization of communication system is also acceptable.

6.2.8 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 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 system through dual LAN connectivity.

d) Each projector shall provide a minimum resolution of 1400x1050 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 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

UGVCL can also VPS based on LED technology with relevant parameters for LED type VPS
from the above mentioned features

6.2.9 Furniture

UGVCL shall provide necessary furniture & shall look aesthetically pleasing. It is not in the scope of contractor.

6.3 Auxiliary Power Supply for Computer systems

The computer system should be suitable for operation with single-phase, 230 ±10% Vac,50 ±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.

6.4 Environmental Conditions

Equipment to be located in the SCADA/DMS 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 UGVCL

6.5 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.

6.6 Construction Requirements of panels

In case the equipments 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.

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 cablings.

6.7 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.

6.8 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.

6.9 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

6.10 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 cities (Group A) . However, as per availability of infrastructure by UGVCL , the same may corresponding to each control center .
3. Each DR for ZSCC
4. For (Group B&C) or combined can be considered as per infrastructure availability by UGVCL
5. Workstation

   For S/S - 2 minimum and 1 per each 20s/s and maximum upto 5 workstations

   For network - 1minimum and 1 per each per 100 FPIs locations and maximum upto 3 workstations
6. 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 Chapter 6

CHAPTER 7: CONFIGURATION & SYSTEM AVAILABILITY

7.0 General

This chapter describes the requirement of monitoring and managing the SCADA/DMS 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, B, C ,U,towns as per functional requirements except legacy system

7.1 System Redundancy

The SCADA/DMS/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 system shall be as follows:

a) Servers: The servers for SCADA/DMS, 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 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.

7.2 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.

7.3 Server States

Each server shall be assigned to one of the following states:

(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

7.4 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 it's 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 alongwith 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.

7.5 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.

7.6 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 dis~~ru~~ptions of any duration. 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.

7.7 Error Detection and Failure Determination

All servers, peripheral devices, on-line software functions, and maintenance functions in SCADA/DMS/OMS 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.

7.8 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.

7.9 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 system.

7.10 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 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 sever, the ISR data shall be stored in the SCADA/DMS 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 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.

7.11 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 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 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.

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.

7.12 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.

7.13 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 atleast 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 Chapter 7

CHAPTER 8: TESTING & DOCUMENTATION

8.0 General

This section describes the specific requirements for testing and documentation of the SCADA/DMS system. The general requirements of testing and documentation are covered in **Section 7**. This section is applicable to Group A, B, C , U towns as per functional requirements**.**

8.1 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 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 oder 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 sections, the above shall prevail

8.2 Factory Acceptance Tests (FAT)

For each SDCC , ZSCC , SCADA/DMS/OMS 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 system and atleast two RTUs alongwith, 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 system. The factory tests, requiring site environment, shall be carried out during the Field Tests after mutual agreement for the same from owner.

8.2.1 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 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 verifie

8.2.2 System Build test

After completion of hardware integration test, the SCADA/DMS 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.

8.2.3 Functional Performance Test

The functional performance test shall verify all features of the SCADA/DMS 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 & other software application in line 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.

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 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 system. (s) Functions of DR /DRR system, if it is in the project area.

x) Unstructured testing of the SCADA/DMS 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)

8.2.4 Continuous operation Test (48 hours)

This test shall verify the stability of the SCADA/DMS/OMS hardware and software after the functional performance test has been successfully completed. During the test, all SCADA/DMS 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.

8.3 Field Tests (Site Acceptance tests -SAT)

The SCADA/DMS system shall be tested at the site. All hardware and software associated with the SCADA/DMS system along with all RTUs/FRTUs/FPIs along with all field devices including MFTs connected shall be tested under the field tests.

8.3.1 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 though 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/ software basic functions

The Contractor shall be responsible for performing the field installation tests and Employer may witness these tests

8.3.2 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 system

b) the RTU /FRTU/FPI communication channel monitoring in the SCADA/DMS /OMS 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.

8.3.3 Field Performance Test

The field performance test shall concentrate on areas of SCADA/DMS/OMS 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 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 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 /OMSsystem

f) Verify the execution rates of all SCADA/DMS/OMS 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 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

8.3.4 Cyber security compliance

Compliance of cyber security without threatening vulnerabilities by CERT.IN empaneled 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.

8.4 System Availability Test (360 hours)

Contractor shall provide & approve theoretical and practical figures used for this calculation at the 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 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 system (hardware and software systems) shall be available for

99% of the time during the 360hours (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%, 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 /FPI 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/FPI 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 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 system shall be considered as available if

a) one of the redundant hardware is available so that all the SCADA/DMS/OMS 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, OMS applications are available

f) All SCADA/DMS/ OMS 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

j) DC/DR data exchange and synch at defined periodicity

k) SAIDI/SAIFI and other performance (KPIs) related reports are 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.

8.4.1 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.

8.4.2 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 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.

8.5 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 and software.

The contractor shall submit the paper copy of all necessary standard and customized documents for SCADA/DMS 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 system on electronic media and two copies of these backup software shall be submitted to the owner.

End of Chapter 8

CHAPTER-9: TECHNICAL REQUIREMENTS OF RTU

9.0 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 equipments 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,B,C & new RTUs of Group U as per functional requirements

9.1 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

9.2 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 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 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 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.

(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 need be

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.

9.3 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.

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 Master control using IEC60870-5-104 /101 protocol over MPLS/GPRS.

9.3.1 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)

9.3.2 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 UGVCL/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 UGVCL /contractor to assess this option & only opt in case it is found feasible,

9.4 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 ºC 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 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.

9.5 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.

9.6 Sequence of Events (SOE) feature

To analyse 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.

9.7 IED pass through

The Master Station user shall be able to perform a virtual connection with any IED connected to 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

9.8 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.

9.9 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 atleast 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.

9.9.1 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.

9.9.2 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.

9.9.3 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.

9.9.4 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.

9.10 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-enegizing 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.

9.11 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.

9.12 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.

9.13 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 .

9.14 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. In place of 48VDC , UGVCL may opt any other voltage level such as 12, 24, 110 ,125
VDC etc. The permissible ranges as per applicable standards specified shall be adhered to accordingly . The interface components like CMRs , HDRs MFT etc. may also be selected accordingly.

9.15 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. UGVCL may specify location with altitude more than 2000m above MSL for compliance of RTUs to be installed in that project area

9.16 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.

9.17 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 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.

9.18 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 mm^2 for PT cables, 4 mm^2 for CT cables, if applicable and 2.5 mm^2 for Control outputs and 1.5mm^2 for Status inputs

c) Rated voltage Uo/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.

9.19 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.

9.20 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 asses the requirement of RTU panels for such design and supply panels accordingly. This is applicable for Numerical replay/BCPU concept

In both cases the RTU requirements as envisaged in this specification shall be followed.

9.21 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 system. The hardware & software specification, features shall be same as of remote VDU defined for SCADA/DMS system.

End of Chapter 9

CHAPTER-10: TECHNICAL REQUIREMENTS OF FRTU

10.0 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 equipments indicated in the MoP oder 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 towns as per functional requirements

10.1 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

10.2 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 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.

10.3 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 if need be..

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.

10.3.1 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)

10.3.2 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 60870-5-104/101 protocol.

10.4 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 ºC 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.

10.5 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.

10.6 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.

10.7 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.

10.7.1 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.

10.7.2 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.

10.7.3 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 output s. 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.

10.7.4 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.

10.8 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.

10.9 Time facility

The internal FRTU time base shall have a stability of 100 ppm. The RTU shall be synchronised through synchronisation message from master station at every 5 minutes (configurable from 5 minutes to 60 minutes) over IEC 60870-5-104/101/NTP/SNTP

10.10 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 fail- ures of other functional areas defined in the specification of the RTU.

10.11 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. UGVCL may opt any other voltage level such as 12, 24, 110
VDC etc. and permissible ranges and applicable standards specified shall be adhered to accordingly. The interface components like CMRs , HDRs MFT etc. may also be selected accordingly.

10.12 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. UGVCL may specify location with altitude more than 2000m above MSL for compliance of FRTUs to be installed in that project area

10.13 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.

10.14 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 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 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

(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.

10.15 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.

b) Minimum core cross-section of 2.5 mm^2 for PT cables, 4 mm^2 for CT cables, if applicable and 2.5 mm^2 for Control outputs and 1.5mm^2 for Status inputs

c) Rated voltage Uo/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.

10.16 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.

End of Chapter 10

CHAPTER-11: TRANSDUCER & MODEM REQUIREMNTS

11.0 Transducer & Modem Requirements:

All transducers shall use a 48 Vdc or 12/24/110/125VDC etc auxiliary power supply as provided for the RTU/FRTU and applicable values /limits/ permissible test values shall be considered as per nominal value of voltage. 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 equipments indicated in the MoP oder 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,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.

(a) Voltage:

Voltage test and other safety requirement compliance as specified in IEC 60688 or 60687and IEC 414.

(b) Impulse Withstand:

IEC 60688 or 60687 compliance is required.

(c) Electromagnetic Compatibility:

IEC 60688 or 60687 and IEC 801-3, level 1 compliance is required.

(d) Permanent Overload Protection:

IEC 60688 or 60687 compliance is required.

(e) Temporary Overload Protection:

IEC 60688 or 60687 compliance is required.

(f) 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 60687compliance is required.

(e) Temperature Rise:

IEC 60688 or 60687 compliance is required.

(f) Operating Temperature: 0 ^{o} C to + 60 ^{o} C (-5 ^{o} C to + 55 ^{o} C for project area with snowfall history)

11.1 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 multifunction transducers shall be selectable. 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.

11.2 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 UGVCL/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 ±0.5%

11.3 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

11.4 Modems

- The modem shall have suitable interface facility to connect with the meter by using the RS232 /485cable
- The offered modems should be capable of operating on Threephase 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 modemvoltage surges. Modem at FRTU locations should be capable of operating on dc voltage in line with FRTU voltage . 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
- The offered Modem should be capable to transfer the entire data as per the FRTU data requirement of FRTU/FPI at control center i.e. 4G /5G as per site signal condition
- The offered Modem should be supplied with power cable, antenna with co-axial cable of length, RS 232 /485connecting suitable cable, mounting adopter etc
- 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.
- 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.
- 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.

- 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
- The Modem should act a completely transparent channel i.e. the Commands received from SCADA/DMS 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.
- 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.
- The Modem should be capable of operating with SIMs of local GSM/CDMA Service provider in the area.
- Modem should be capable for continuous working for 24 hours every day under field conditions
- 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.
- Modem should be Dual Band modem capable of operating at 900 and 1800 MHz transmission. GSM Modem should support bothData and SMS transmission. It should have both GSM and GPRS/EDGE feature
- 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
- Storage Temperature : -20 degrees to +70 degree Celsius
- Operating Temperature: -10 degrees to +60 degree Celsius
- Humidity:- 95% RH (Non - Condensing)
- UGVCL may specify location with altitude more than 2000m above MSL for compliance of FRTUs to be installed in that project area
- Maximum Power Output should be 2 W at 900 MHz (Class 4) and 1W at 1800 MHz (Class 1).
- Sensitivity :- GSM 900 : <-100 dBm GSM 1800 : <-100 dBm
- Standard AT Command set (GSM 07.05, GSM07.07)
- TCP/IP stack access via AT
- Internet Services : TCP, UDP, HTTP, FTP, SMTP, POP3
- Max. Baud Rate: for GSM -9600
- GPRS Class B Multi slot class 12 or class B Multi slot class 10 Packet channel

support : PBCCH

- EDGE (EGPRS) Multi slot class12 or Multi slot class 10Mobile station Class B Modulating and coding schemes : MCS 1 to 9 Packet channel support : PBCCH
- **SMS Features: -** Text and PDU Point to point (MT/MO, Cell broadcast
- 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.,

11.5 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 shall be considered.

End of Chapter 11

SECTION 3, CHAPTER –12

TEST EQUIPMENTS FOR RTU/FRTU

12.0 RTU/FRTU Configuration and Maintenance Tool

Test equipment for RTU/FRTU shall have Configuration and maintenance tool consisting of the followings:

12.1 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.

12.2 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

12.3 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.

End of Chapter 12

CHAPTER –13: TESTING, TRAINING & DOCUMENTATION

13.0 RTU/FRTU Testing

This chapter describes testing, training & documentation requirement for RTU/FRTU

(a) Type Testing:

RTU/FRTU in 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 with in last 5years 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.

13.1 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

13.2 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.

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 drawings	√	√	√
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	√		√

Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine test	Field test
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	√		

Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine test	Field test
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	O**ther 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 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) Electrical Fast	ON	Level 3	2 Kv	1 kV	2 kV	A
Transient Burst Test (Test 29) Damped Oscillatory	ON	Level 3	2 KV	-	1 kV	A
Wave Test (Test 30) Electrostatic	ON	Level 3	2.5 kV	1 kV	2.5 kV	A
Discharge (Test 31) Radiated	ON	Level 3	+/- 6 kV in Contact discharge mode or +/- 8 kV in Air discharge mode			A
Electromagnetic Field (Test 32)	ON	Level 3	10 V/m electric field strength			A
Damped Oscillatory Magnetic Field test	ON	Level 3	30 A/m at 1MHz of magnetic field strength			A

(Test 33)				
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

End of Chapter 13

CHAPTER 14: AUXILIARY POWER SUPPLY SYSTEM

14.0 General

This section describes the technical requirements for Auxiliary Power Supply System. The BOQ for Auxiliary Power Supply system equipments required for SCADA/DMS 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, B, C towns as per functional requirements

14.1 Uninterruptible Power Supply (UPS)

The technical requirements for the Uninterruptible Power Supply (UPS) System and associated equipments to be provided by the contractor are described below.

The UPS system shall include the following:

- UPS equipments 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

14.1.1 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.

14.1.2 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.

14.1.3 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 b e 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.

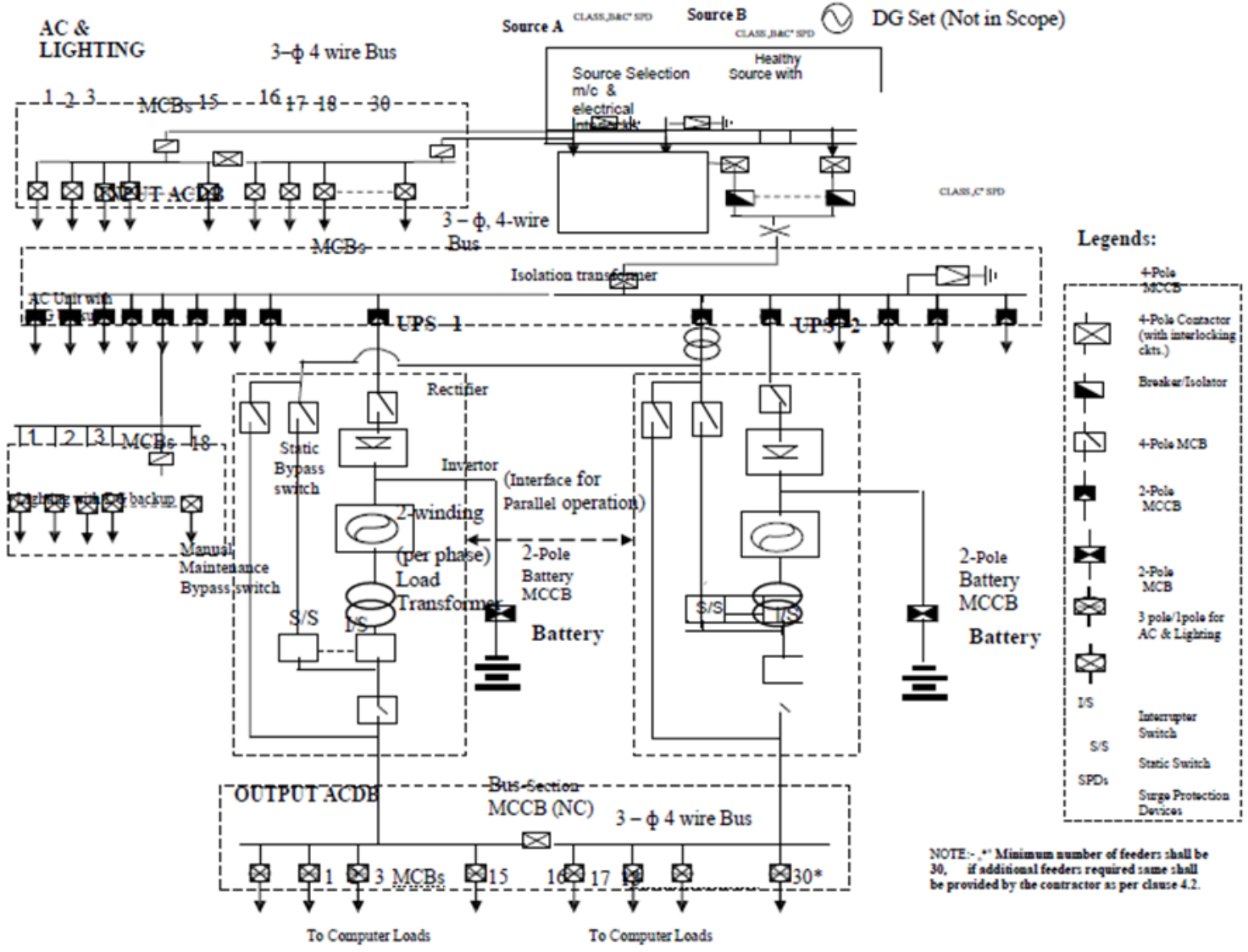
14.1.4 Rectifier/Charger Units

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. 14-1: CONCEPTUAL AUXILIARY POWER SUPPLY SYSTEM CONFIGURATION



14.1.5 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 ±1%, 3-phase, 4-wire AC up to rated load.

(c) The transient voltage response shall not exceed 4% for the first half-cycle recovering to 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 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 equipments 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.

14.1.6 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 though 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 invertors 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 ±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 ± 1% of 50Hz (adjustable to 1/2/3/4/5 percent).

b. The inverter output voltage and frequency are beyond the preset range.

c. An overload exists.

14.1.7 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.

14.1.8 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.

14.1.9 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.

14.1.10 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.

14.1.11 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.

14.1.12 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.

14.1.13 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.

14.1.14 External Power Connections

All breakers/switches shall be suitably rated to match the requirement of external power

connections.

14.1.15 Testing of UPS

14.1.16 Type Test of UPS

The Contractor shall supply type tested UPS equipments. 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.

14.1.17 Factory Acceptance Test of UPS

A factory acceptance test shall be conducted on all the equipments 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 equipments and also as per specification requirements.

(e) Inspection and verification of all construction, wiring, labeling

14.1.18 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

14.1.19 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 0^0 to 50^0C 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.	Test	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	√	√
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		√

14.2 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.

14.2.1 Enclosures/Panels

The equipments 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.

14.2.2 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	$I_n \geq 10$ kA, 8/20 µS for each phase
N & PE	$I_n \geq 20$ kA, 8/20 µS

I_n= Value of Nominal Discharge Current.

14.2.3 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.

14.2.3.1 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).

14.2.3.2 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.

14.2.3.3 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.

14.2.3.4 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.

14.2.3.5 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 mm^2, 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.

14.3 DC Power Supply System

The DC Power Supply system shall be capable of meeting the load requirements for various Telecom equipments, 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	$I_{imp} \geq 50$ kA, 10/350 µS for each phase
N & PE	$I_{imp} \geq 100$ kA, 10/350 µS

I_{imp}= Value of Lightning Impulse Current

b) Low Voltage Surges (Class C)

Between	**Requirement**
Ph & N	$I_n \geq 10$ kA, 8/20 µS for each phase
N & PE	$I_n \geq 20$ kA, 8/20 µS

I_n= Value of Nominal Discharge Current.

14.3.1 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.

14.3.2 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 confer to relevant IEC/IS standards. The contractor shall obtain Employers approval of major component before procurement of the same. Conceptual diagram is 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 %. UGVCL may specify requirements as per site conditions

14.3.3 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 IS 1554 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.

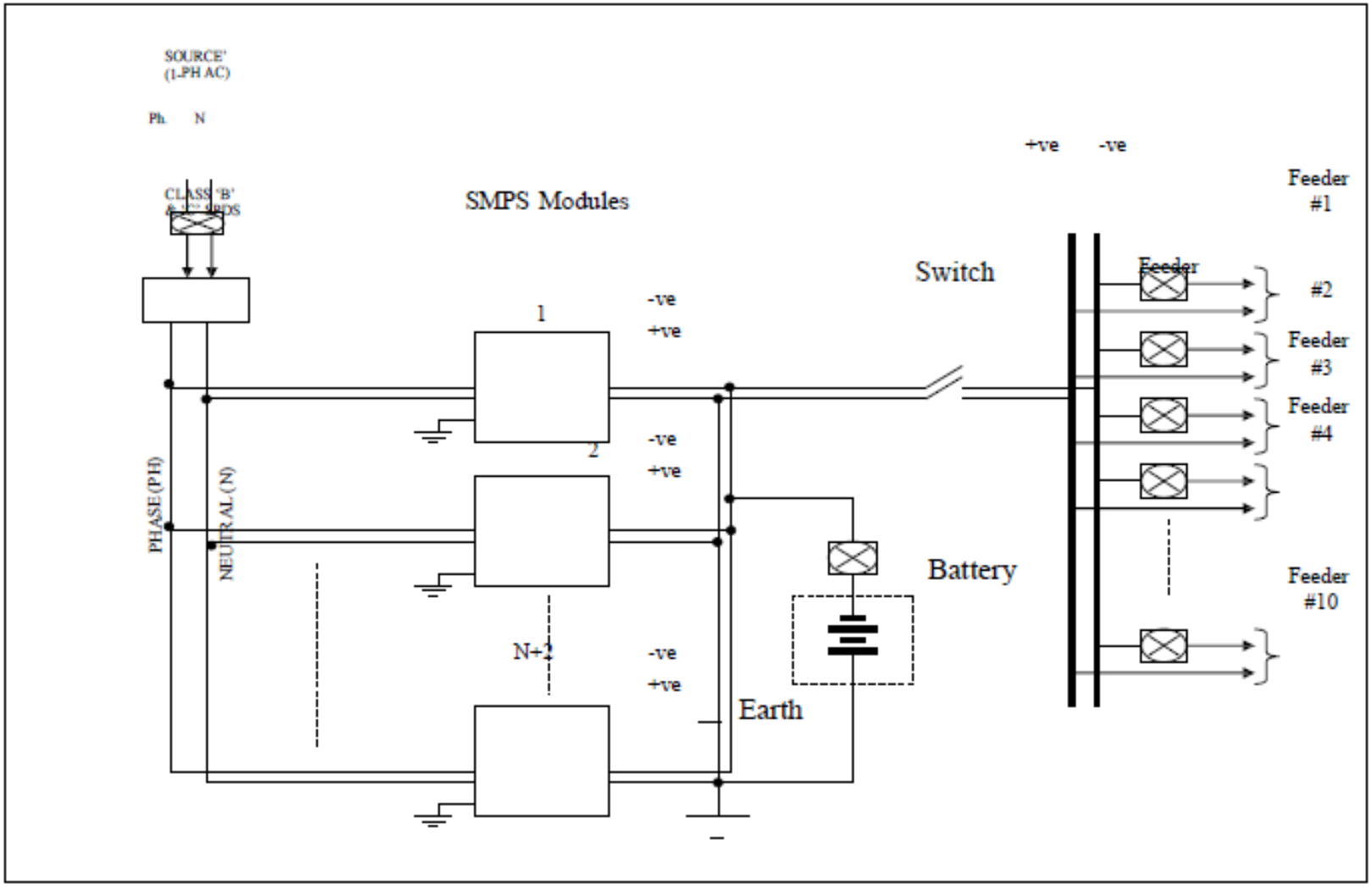
14.3.4 Bus Bars

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.

14.3.5 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



14.3.6 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.

14.3.7 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.

14.3.8 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

14.3.9 System and Panel Configuration

The mechanical and electrical requirements of the Panel are described as below:

14.3.10 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.

14.3.11 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.

14.3.12 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 ±5V may be acceptable for protection & alarm operation.

14.3.13 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.

14.3.14 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.

14.3.15 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.

14.3.16 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 ± 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 ± 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.

14.3.17 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.

14.3.18 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 ± 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.

14.3.19 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.

14.3.19.1 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 ± 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.

14.3.20 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.

14.3.21 AC Under/Over Voltage Protection

AC input Under/Over voltage protection shall be provided as per clause 4.3.12 for Electrical Requirements.

14.3.22 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).

14.3.23 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.

14.3.24 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 equipments 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.

14.3.25 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.

14.3.26 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.

14.3.27 Earthing Cables

Earthing cables between equipment and grounding bus bars shall be minimum size 70 mm^2 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.

14.3.28 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 ± 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) 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.

14.3.29 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 may be 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.

14.3.30 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 31/2 digital display of height 12mm and shall have accuracy 1.5% or better.

14.3.31 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

14.3.32 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 tests 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	√*	√

Sl. No.	Test	FAT	SAT
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	√*	
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.

14.4 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.

14.4.1 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.

14.4.2 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.

14.4.3 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.

14.4.4 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.

14.4.5 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.

14.4.6 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.

14.4.7 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.

14.4.8 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.

14.4.9 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.

14.4.10 Capacity Requirements

When the battery is discharged at 10-hour rate, it shall deliver 80% of C (rated capacity, corrected at 27ºCelcius) 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 27ºCelcius) 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 35º 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%.

14.4.11 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 27º 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).

14.4.12 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.

14.4.13 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 Hrs. Charge and 30 minutes (duration as Specified) discharge test at full rated load for UPS.		√

14.5 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 or mal-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.

14.6 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 %)
	Frequency	50 Hz & ±0.2%(Free Running)
	Regulation	±1%
	Transient Response	±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	Maximum12 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	0-45º C (Battery shall be sized at an average Temp. Of 27 Deg C.)
	Humidity	Upto95% 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).

14.7 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

14.8 Mandatory Spares

List of mandatory spares for UPS, DCPS are mentioned in the BOQ

End of Chapter 14

CHAPTER-15: SCADA ENABLERS

15.0 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 UGVCL.

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 ± 3%) ensuring the safety, further include all necessary provisions ensuring the safety of the operating and maintenance personnel.

d) As part of customization, UGVCL may change control voltage 24/48 Vdc etc as per site requirement but shall be uniform accords 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 UGVCL 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, UGVCL may opt RMUs / sectionalizer /AR with built in FRTU. In that case, The
Quantity of the same shall be deducted from BOQ of FRTU.

f) The applicable standards of various equipment for the DMS project is as specified here below:

15.1 11kV 5 - 3 way Ring Main unit	
Description	**Standard**
11kV 5 way - 3 way Ring Main unit	
AC metal enclosed switchgear and control gear for rated voltages above 1 kV and up to and including 52 kV	IS 3427
Classification of degrees of protection provided by enclosures of electrical equipment	IS 12063
High Voltage Switches	IS 9920 (Parts 1 to 4)
Specification for AC disconnectors and earthing switches for voltages above 1000 V	IS 9921 (Parts 1 to 5)
HV AC Circuit Breakers	IS 13118
Dimensions of terminals of HV Switchgear and Control gear	IS 10601
General requirements of switchgear and control gear for voltages exceeding 1000 V	IS 12729
High voltage/Low voltage prefabricated substations	IEC 1330
Common clauses for MV switchgear standards	IEC 62271-100/200
Monitoring and control	IEC 6081

Description	Standard
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

15.1.1 Key RMU Configurations of Ring Main Unit

- **<u>WAY RMU –</u> 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 disconnector 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 also in the scope of the Bidder.
- **<u>WAY RMU -</u> 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 disconnector 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 also in the scope of the Bidder.

15.1.2 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. This also includes supply of relevant 11 kV cable termination kits including the jointing as per this tender specification
- 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 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 UGVCL scope.**

15.1.3 Environmental Conditions

All materials supplied shall be capable of operating under relevant environmental conditions are listed as follows:

- Maximum ambient air temperature: - 70 ºC
- Minimum ambient air temperature : --10 ºC
- Average ambient air temperature : - 40 ºC
- Maximum relative humidity: - 0-100 %
- Average thunder storm days per annum: - 10
- Average rainfall per annum: - 400 mm
- Maximum wind speed: - 119 km/hr
- UGVCL may specify location with altitude more than 2000m above MSL for compliance of in that project area The above environmental conditions are indicative and UGVCL, msy specify as per site conditions

15.1.4 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

15.1.5 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 UGVCL.

15.1.6 11 kV 5 way and 3 way RMU Technical Parameters

The scope of supply is supply 11 kV 5 Way RMU and 3 Way RMU suitable for outdoor application.

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

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

It shall include, within the same metal enclosure number of MV functional units required for connection,

- Power supply including the battery bank for controlling the LBS and breakers
- Load break switches,
- Earthing Switches
- Breakers
- Relays
- BUS PT metering module, FPI's and other allied equipment.
- Space for FRTU

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

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

The high-tension switchgear offered shall in general comply with the latest issues including amendments of the following standards but not restricted to them.

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

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

15.1.7 Maintainability, Expandability and Life Span

15.1.7.1 Maintainability

The UGVCL 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 UGVCL will prefers RMU designs that do not require periodic preventive maintenance and inspections. To facilitate expansion and maintenance, the RMUs should be of modular type.

15.1.7.2 Expandability

The whole switchgear (RMU) should be suitable for extension on at least one side either left or right.

15.1.7.3 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.

15.1.8 Outdoor Features

15.1.8.1 General

- The RMUs shall be designed specifically for outdoor installation with ingress protection degree of IP54. They shall also be suitable for conditions in which they will be exposed to heavy industrial pollution, and high levels of airborne dust.
- The Outdoor RMU shall be conformably coated to meet these climatic conditions. In this respect, standards such as IEC 62271-200, covering equipment, systems, operating conditions, and environmental conditions shall apply. In particular, the RMU equipment shall have been type tested for IP54 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 proof.

15.1.8.2 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** so as to have high corrosion resistance and ensure high longevity. This tank containing SF6 to a **maximum pressure of 1.3 bars @ 20 deg C** should be hermetically welded and sealed for life, ensuring a leakage rate not more than 0.1 % per annum. Except for stainless steel, all steel surfaces that are not galvanized shall be treated to protect against corrosion. As a minimum, corrosion treatment shall include the following procedures:

- The surface shall be cleaned to bare material by mechanical or chemical means.
- Must be powder coated by means of seven tank process

- 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 80-90 microns to withstand tropical heat and extremes of weather.

15.1.8.3 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.

15.1.8.4 Minimum Insulation of Equipment

The RMUs shall be of SF6 gas-insulated type with a maximum gas operating pressure up to **1.2 BAR @ 20 deg C**.

15.1.8.5 Nameplate Information

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

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

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

15.1.9 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.

15.1.9.1 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.

15.1.9.2 Connectors

- **Nuts & Bolts type terminal blocks shall be provided in LV compartment for SCADA connectivity and to accommodate FRTU**.

15.1.9.3 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.

15.1.10 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 Circuit Breakers used in the RMU shall be **vacuum interrupter type**.
- 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.

15.1.11 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

- SF_6 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.

15.1.12 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:	20 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	50 kA peak at rated voltage

Parameter	Value
	(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 UGVCL

15.1.13 Design Details

- The RMU shall be designed to operate at the rated voltage of 12 kV.
- It shall include, within the same metal enclosure, On-load break switch, circuit breakers and earthing switches for each Load Break Switch/Circuit Breaker.
- Suitable fool-proof interlocks shall be provided to the earthing switches to prevent inadvertent or accidental closing when the circuit is live and the concerned Load Break Switch/Circuit Breaker is in its closed position.
- The degree of protection required against prevailing environmental conditions, including splashing water and dust, shall be not less than IP 54 as per IS 12063.
- The active parts of the switchgear shall be maintenance free. Otherwise, the RMU shall be of low-maintenance type.
- **The tank shall be made of minimum 2.5 mm thickness of stainless steel.**
- 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.
- 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.

15.1.14 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 mm^2 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.

15.1.15 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.

15.1.16 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 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.

15.1.17 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.

15.1.18 Safety of Equipment

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

15.1.19 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.

15.1.19.1 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:

15.1.19.1.1 CTs for Metering:

- Material : Epoxy resin cast/ Tape wound
- Burden : 2.5VA
- Ratio : 400-200-100/1 A
- Accuracy Class : 0.5

15.1.19.1.2 CTs for Protection:

- Material : Epoxy resin cast/ Tape wound
- Burden : 2.5VA
- Ratio : 400-200-100/1 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.

15.1.19.2 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 V/ root 3 /110 V/ root 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.

15.1.20 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.

15.1.20.1 The FPIs shall include:

- Fault detection - Phase to phase and Phase to earth faults.
- One potential-free output contacts for hardwiring to FRTUs. On this basis, the SCADA/DMS will be able to monitor phase / earth fault condition.
- Local fault indications - LCD 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.

15.1.20.2 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.

15.1.20.3 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

15.1.20.3.1 General

The Circuit Breaker in the RMU shall be fitted with a communicable-type, self-powered numerical relay, i.e., one for each outgoing circuit breaker. The protection relay's auxiliary contacts shall be provided for hardwiring to the FRTU. The relay shall also interface with the FRTU via an RS 232/485 port in order to send, as minimum, real-time readings using the MODBUS protocol.

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 Overcurrent Protection (50/51)
- Earth Fault Protection (50N/51N)

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

15.1.20.3.2 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.
- Iinstantaneous 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 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.

15.1.21 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 25ºC**.
- 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.
- 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

15.1.22 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**.**

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

e) Power (active, apparent, and reactive)

f) Energy (active and reactive)

g) Total harmonic distortion

15.1.23 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.

15.1.24 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 mm^2 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 ºC shall be installed in the enclosure for this purpose.
- Means of protection against rain water, and high levels of airborne dust, should be provided.
- Means of enabling the SCADA to monitor the open/closed status of the enclosure door. A SCADA equipment alarm shall be produced whenever the enclosure door is open.
- 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.

15.1.25 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 UGVCL'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.

15.1.26 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 UGVCL representatives will participate in the RMU inspections and will witness the testing as described in the following sub-clauses.

15.1.26.1 Inspections

- UGVCL's representatives shall be allowed access to supplier's facility where the RMU or its parts are being produced or tested. Such access will be used to verify by inspection that the RMUs are being or have been fabricated and tested in accordance with the Technical Specifications.

- The supplier shall give the UGVCL'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 UGVCL'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.

15.1.26.2 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 UGVCL.
- 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.

15.1.26.3 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.

15.1.26.4 Factory Acceptance Test

- A formal factory acceptance test shall be conducted to ensure that the RMUs have been designed to meet the UGVCL's functional requirements in all respects. UGVCL 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 UGVCL. Should the factory acceptance test prove unsatisfactory in any way, the UGVCL reserves the right to have further tests conducted and, if applicable, request further improvements in the supplier's RMU design.

15.1.26.5 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 UGVCL's discretion, UGVCL 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 UGVCL 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.

15.1.27 Operating Manuals

- The Supplier shall submit, operating manuals for all RMU components including items such as FPI, Relay, and other equipment provided by the bidder. These manuals shall be in English. They shall include the RMU operating instructions. Context sensitivity shall be used to go directly to the appropriate place in the manual.
- The manuals shall be organized for quick access to each detailed description of the operator procedures that are required to interact with the RMU functions. This shall include the procedures to define, build, edit, and expand all data points provided with the RMU.
- The manuals shall present in a clear and concise manner all information that operators, including maintenance personnel, need to know to understand and operate RMUs satisfactorily. The manuals shall make abundant use of diagrams and/or photographs to illustrate the various procedures involved.

15.1.27.1 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 UGVCL.

15.2 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/IEEEC37.60**-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	Requirements for overhead, pad mounted, dry vault, and submersible automatic circuit	

Standard	Description	Level
IEC 62271-111	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/m²	
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

15.2.1 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.
- 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 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.

15.2.2 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/IEEEC37.60**-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

15.2.3 Definitions and Abbreviations

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.

Auto-recloser (AR)

A mechanical switching device that, after opening, closes automatically after a predetermined time. Several reclosers could occur before lockout.

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.

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]

Definite time lag (DTL) protection element:

A protection element with a settable time delay that is constant above the pick-up current setting.

Delayed protection operation:

The protection functionality enabling delayed circuit-breaker operation, whether this is due to an IDMTL or DTL protection element.

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.

Fast curve protection element:

A family of curves with operating times approximately constant (slightly inverse) relative to the multiple of pick-up setting.

Instantaneous protection element:

An element with no intentional time delay active above a pre-determined pick-up current setting.

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.

Lockout:

Where the recloser remains open and will not reclose automatically.

Pole-mounted remote terminal unit (PMRTU):

A remote terminal unit that is designed for pole mounting and that operates specific pole-mounted equipment remotely.

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.

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.

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.

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.

Supervisory:

Remote control and indications of an AR or a PMRTU by means of a telecommunications link.

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.

Sequence co-ordination:

The feature that allows protection devices to maintain sequence co-ordination for combinations of rapid and delayed protection operations.

15.2.4 Requirements

15.2.4.1 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.

15.2.4.2 Environmental Conditions

All materials supplied shall be capable of operating under relevant environmental conditions are listed as follows: (UGVCL 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 - UGVCL 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

Environmental parameter specified are indicative only, UGVCL may specify as per site conditions and standard product

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

k) Operating Mechanism - LV motor/Magnetic Actuator

15.2.4.3 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.

15.2.4.4 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.

15.2.4.5 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.

15.2.4.6 Finish

All interior and exterior ferrous surfaces of auto recloser and control cabinets shall be manufactured from 304 or better grade stainless steel.

15.2.4.7 Control Equipment

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.
- 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 moun5ted 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.

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/ user configurable function keys.
- 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.

Protection, Measurement & Power Quality characteristics.

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.

The ratio of drop-off current to pick-up current shall be at least 95 % for all protection functions.

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

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.

All the basic protection parameters shall be provided with Standard inverse (SI), very inverse (VI) or extremely inverse (El), definite time curve.

In addition to above, provision for at least four customer programmable curves shall be provided.

LOP shall be provided to ensure the protection functionality; auto recloser should trip with no autoreclose , 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.

6SEF 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.

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.

15.2.5 Auto recloser Operation parameters

The number of sequential trips to reach lockout shall be selectable to be either 1, 2, 3 or 4.

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.

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.

A close instruction initiated locally or remotely during a dead time shall result in lockout if the fault is still present upon closure.

15.2.6 Auto Recloser Statistical Measurement Functions

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.

Quantities to be measured/calculated with specified accuracy are:

- Phase Voltage (V) ±2.5% of auto-recloser rated voltage.
- Line Voltage (V) ±2.5% of auto-recloser rated voltage.
- Phase Current (A) ±2.5% of auto-recloser rated current.
- Three phase active Power (kW) ± 5 %;
- Three phase reactive power (kVAr) ± 5 %;
- Total three-phase active energy (kWh) ± 5 %;
- Power factor ± 5 %;
- Maximum demand ± 5 %.
- Phase Angle ± 10 deg.
- Total Pwr (KW, KVA, KVAr) ± 5 %.

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.

Supply Outage management (SOM) which is a part of SCADA system.

The following parameters shall be recorded in SCADA

- Cumulative total number of outages.
- Cumulative total outage duration.
- Time and duration of each outage

15.2.7 Power Quality analysis characteristics

- Waveform Capture It shall capture the Waveform and store in flash memory filtered and scaled raw data (32 samples per cycle) of the **3 line to earth or 3line 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 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.

15.2.7.1 Local Engineering

The AR 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 protection, operating and communications characteristics shall be locally available in the control cabinet. Optional password protection against unauthorized changes shall be available.

15.2.7.2 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 / 101/103/ Modbus**
- **It shall also record specific information including temperature pertaining to Control box**

- Facility for configuring the interval 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.

15.2.7.3 Tele Control Requirements

The AR controller shall detect and report disconnection of the control cable between the controller and AR.

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.

15.2.7.4 Communication

As a minimum, one independent RS-232, & two Ethernet communication ports that allow for simultaneous operation shall be provided, to be used as follows

A USB port shall be provided to upload the non-volatile data to and from a personal computer.

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)**.

As a minimum, it shall be possible for serial ports to operate at the following speeds :

-1200 bps

-2400 bps

-9600 bps

- 19200 bps

Provision shall be made for mounting modems

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.

The protocol to be supported by the AR controller for remote communications shall be IEC 60870-5-104 Protocol

The serial ports shall have IEC 60870-5-101 protocol and shall be available as a backup port.

15.2.7.5 Power Supply

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.

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.

Test supply: The AR shall accept an external AC 230 V 50 Hz supply.

Auxiliary supply: An auxiliary supply with the following minimum characteristics shall be provided

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.

Batteries shall be disconnected at the manufacturer's specified minimum voltage.

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.

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.

15.2.7.6 Maintenance and commissioning

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.

It shall be Possible to disconnect the AR circuit breaker and connect a simulated breaker to the control cabinet for testing purposes.

The AR shall not malfunction while the modem is transmitting via an antenna in close proximity and the control cabinet door is open.

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.

15.2.7.7 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.

15.2.7.8 Additional Information

The following shall be submitted with the tender.

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).

A schematic-wiring diagram of the AR offered.

A general-arrangement drawing of the AR offered.

Details of the maintenance and operating equipment and procedures needed and a detailed parts list of the various components.

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.

Details and the cost of any available portable calibration and diagnostic test set that may be used to perform the functionality described.

A list of recommended spares and tools, quoting the prices of each item and its availability.

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.

Details of technical back-up facilities available. These details shall be stated in the tender documentation.

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.

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

Details of AR service history:

- How many in service, where and for what period;
- Contact names and numbers.

Details of LV trip/close coil if available as an option

Power requirements for a close operation

The maximum achievable separation between the control unit and the circuit breaker.

Full details of the protocol implementation and the complete point database.

15.2.7.9 Tests

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.

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.

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.

15.2.7.10 Packing and Documentation

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

Documentation

Each AR shall be supplied complete with the documentation specified in Items, together with the routine test certificates specified above.

15.3 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

15.3.1 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.

15.3.2 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

15.3.3 Construction

15.3.3.1 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:

15.3.3.2 Environmental Conditions

All materials supplied shall be capable of operating under relevant environmental conditions are listed as follows:

- Maximum ambient air temperature : 50 ºC
- Minimum ambient air temperature : 0 ºC
- Average ambient air temperature : 40 ºC
- Maximum relative humidity : 0-100 %
- Average thunder storm days per annum : 10
- Average rainfall per annum : 400 mm
- Maximum wind speed : 119 km/hr
- UGVCL may specify location with altitude more than 2000m above MSL for compliance of in that project area
- Environmental parameter specified are indicative only, UGVCL may specify as per site conditions and standard product

15.3.3.3 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**

15.3.4 Definitions And Abbreviations

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.

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.

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.

Definite time:

A fault detect event occurs if the current exceeds the fault threshold setting for a time equal to the definite time setting.

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.

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).

Pole-mounted remote terminal unit (PMFRTU):

A remote terminal unit that is designed for pole mounting and that operates specific pole-mounted equipment remotely.

Sequence reset time:

The time duration after a supply interruption occurred before the sectionalising sequence resets if the sectionaliser does not detect another fault.

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.

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.

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.

Supervisory:

Remote control and indications of an LBS or a PMRTU by means of a telecommunications link.

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.

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.

15.3.5 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.

15.3.6 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.

15.3.7 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.

15.3.8 Finish

All interior and exterior ferrous surfaces of the LBS and control cabinets shall be manufactured from marine grade 304 or 316 Stainless steel.

15.3.9 Control Equipment

Control cabinet

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.

Suitable ultraviolet-resistant cable shall be provided to connect the LBS to the control cabinet.

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.

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.

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.

The control cabinet shall be for all – weather access & vandal resistant.

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.

The cabinet shall be fitted with an external Earthing stud with a nut, lock nut and a serrated

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.

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

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.

15.3.10 Detection, Measurement & Power Quality characteristics.

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.

Each of the detection elements is monitored with independent definite time settings and fault threshold.

The ratio of drop-off current to pick-up current shall be at least 90 % for all detection functions.

The O/C pick-up setting shall be selectable from 10 A to 400 A in steps.

A cold load pick-up feature shall be provided that allows user selectable modification of detection element characteristics under condition of system power restoration.

The SEF functions shall be equipped with harmonic filtering to prevent operation when harmonics are present in the primary residual earth currents

SEF a primary earth fault current of 4A to 20A in steps not exceeding 1A shall be detectable.

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.

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.

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

Quantities to be measured/calculated with specified accuracy are:

- Phase Voltage (V) ±2.5% of Sectionalizer rated voltage.
- Line Voltage (V) ±2.5% of Sectionalizer rated voltage.
- Phase Current (A) ±2.5% of Sectionalizer rated current.
- Three phase active Power (kW) ± 5 %;
- Three phase reactive power (kVAr) ± 5 %;
- Total three-phase active energy (kWh) ± 5 %;
- Power factor ± 5 %;
- Maximum demand ± 5 %.
- Phase Angle ± 10 Deg.
- Total Pwr (KW, KAV, KVAr) ± 5 %.

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.

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 system.

The following parameters shall be recorded as,

- Cumulative total number of outages.
- Cumulative total outage duration.
- Time and duration of each outage

15.3.11 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 able to calculate **2nd to 7th harmonics** and total harmonics distortion an over 40ms period for **4 currents and 3 line to line voltage or 3 line to earth voltage**.

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.

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.

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.

15.3.12 Tele Control Requirements

- The LBS controller shall detect and report disconnection of the control cable between the controller and LBS.
- 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.

15.3.13 Communication

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

USB port shall be provided to upload the non-volatile data to and from a personal computer.

To interface to remote communications equipment (modems, radio-modems, GSM/GPRS and Fiber Optic).

As a minimum, it shall be possible for serial ports to operate at the following speeds :

-1200 bps

-2400 bps

-9600 bps

- 19200 bps

Provision shall be made for mounting GPRS modems

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.

The protocol to be supported by the AR controller for remote communications shall be IEC 60870-5-104 Protocol

The serial ports shall have IEC 60870-5-101 protocol and shall be available as a backup port.

15.3.14 Power Supplies

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.

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.

Test supply: The LBS shall accept an external AC 230 V 50 Hz supply.

Auxiliary supply: An auxiliary supply with the following minimum characteristics shall be provided

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 10Sectionalizer operations preventing closing if the battery will not have enough stored energy to open the circuit- breaker for a protection trip condition.

Batteries shall be disconnected at the manufacturer's specified minimum voltage.

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.

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.

15.3.15 Maintenance and Commissioning

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.

It shall be Possible to disconnect the LBS circuit breaker and connect a simulated breaker to the control cabinet for testing purposes.

The LBS shall not malfunction while the GPRS Modem is transmitting via an antenna in close proximity and the control cabinet door is open.

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.

15.3.16 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.

15.3.17 Additional Information

The following shall be submitted with the tender.

Load Break switch details

- Manufacturer;
- Type designation;
- Place of manufacture;
- Fault make capacity; 3s 1s
- Critical current (maximum instantaneous peak).

A schematic-wiring diagram of the LBS offered.

A general-arrangement drawing of the LBS offered.

Details of the maintenance and operating equipment and procedures needed and a detailed parts List of the various components.

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.

Details and the cost of any available portable calibration and diagnostic test set that may be used to perform the functionality described.

A list of recommended spares and tools, quoting the prices of each item and its availability.

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.

Details of technical back-up facilities available. These details shall be stated in the tender documentation.

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.

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

Details of LBS service history:

- How many in service, where and for what period;
- Contact names and numbers.

Details of LV trip/close motor if available as an option

Power requirements for a close operation

The maximum achievable separation between the control unit and the circuit breaker.

Full details of the protocol implementation and the complete point database.

15.3.18 Test

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.

15.3.19 Packing/Documentation

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

Documentation

Each LBS shall be supplied complete with the documentation specified in Items, together with the routine test certificates specified above.

15.3.20 Auxiliary Supply to the Controller Unit of Auto Recloser and Sectionliser

15.3.20.1 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

15.3.21 Fault passage indicators

15.3.21.1 Environmental specifications

Mechanical resistance to vibration and shocks

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

Dielectric withstand

Description	Standard
Insulation (50 Hz/1 min.): 2 kV	IEC 61010
Impulse wave (1.2/50 µs): 5 kV	EN 60-950

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

15.4 Fault Passage Indicator (Communicable with FRTU/ Direct to Control Centre)

15.4.1 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.

15.4.2 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

15.4.3 Wireless communication Fault detection systems

15.4.3.1 General information

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.

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

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.
- 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.

15.4.4 Constitution

15.4.4.1 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.
- FPI shall commnucte to control entre thorugh GPRS modem and link or through DCU /Mini RTU (SIA to provide configuration to meet SLA)
- **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.
- External GPRS Modem with 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 thetrol command sent by the SCADA server to achieve bidirectional controllable operation.)

- The maintenance free Battery shall have a warranty of at least 7 years & replaceable. Low battery alarm shall be provided at remote location.

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.

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.

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.

15.4.5 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.**

15.4.5.1 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.

15.4.5.2 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.

15.4.5.3 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.

15.4.6 Operational specifications

15.4.6.1 Fault detection

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.

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:
- 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.

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.

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.
- 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.

The Fault Passage Indicator shall include some self-test possibility usable when it is on the line (powered or not).

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.

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.

Communication with the control center

Communication between the FPI 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.

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 FPIs so that it send an SMS message to a defined 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)**

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

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.

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.

Configuration of fault detection thresholds and other characteristics.

Configuration of communication: PIN code, telephone numbers (control center and mobile for sending SMS messages), transmission speed, etc

15.4.7 Additional requirements

15.4.7.1 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.

15.4.7.2 Environmental specifications

Mechanical resistance to vibration and shocks

The equipment shall have vibration resistance in accordance with

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.

IEC 60068.8.27: 40g / 6 ms / 2000 positive and 2000 negative shocks in each direction, in the three directions.

15.4.7.3 Dielectric withstand

Description	Standard
Insulation (50 Hz/1 min.): 2 kV	IEC 61010
Impulse wave (1.2/50 µs): 5 kV peak	EN 60-950/IEC equivalent

15.4.7.4 Electromagnetic compatibility

Description	Standard
Electrostatic discharge	IEC 1000-4-2 Level 3

Description	Standard
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

15.4.7.5 Environment

- Maximum ambient air temperature : 70 ºC
- Minimum ambient air temperature : -20 ºC
- Average ambient air temperature : 40 ºC
- 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 : UGVCL may specify location with altitude more than 2000m above MSL for compliance of in that project area

UGVCL may change environmental requirement as per site requirements and availability of standard products

15.5 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.
- **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.
- The relay shall be compliant to IEC 62443 standard, and compliant to NERC CIP requirements.

15.5.1 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).

15.5.2 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.

15.5.3 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.

15.5.4 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 In), the voltage accuracy 0.5% (V > 0.5 Vn), 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 2^{nd} to 15^{th} 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

15.6 General Requirements

15.6.1 Documentation

Each device shall be supplied with a user manual for installation and commissioning on site.

15.6.2 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 **UGVCL** must be etched on the name plate.

- Scheme Name (RDSS Govt. of India)
- 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

15.6.3 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.

15.6.4 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.

15.6.5 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.

15.6.6 Overall Dimensions

The manufacturer shall give the necessary information as regards to the overall dimensions of the equipment to be supplied. All the equipments shall be packed in suitable crates with suitable steel bands so as to withstand rough handling and storage at destination.

15.6.7 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

15.6.8 Guarantee

- **The Equipments 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.

15.6.9 Training

The supplier shall give rigorous training to the engineers & staff (40 persons) for 2 days for

each RMU/FPI/Sectionalizer/Auto recloser/Numerical in attending trouble shooting and maintenance at owners/UGVCL premises and in the field after successful installation. Training should be at free of cost.

15.6.10 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

15.6.11 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

15.6.12 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

15.6.13 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 equipments indicated in the MoP oder 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,B,C ,U towns as per functional requirements. If RMU/SECTIOLIZER 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.	DESCRIPTION OF THE TEST	Type test	Routine Test	Field test
A	**FUNCTIONAL TESTS FOR IED / BCPU**			
1.	Check for make, type and rating.		√	√
2.	Check for full model number of IED / BCPU, no. of CT, VT, DI and DO.		√	√
3.	Verification of CT and VT Ratio settings in IED / BCPU.		√	√
4.	Verification of programmable DI and DO configuration in IED / BCPU.		√	√
5.	Check the available protection function stages in IED / BCPU.		√	
6.	Verification of enabled protection function stages and its parameter settings.			√
7.	Measurement checks via injection kit – Current and Voltage (if applicable)		√	√
8.	Testing of protection function pickup and time delay though secondary injection. kit.			√
9.	Check output contacts (DO) through force function of IED / BCPU.		√	√
10.	Verification of configurable LEDs settings.		√	√
11.	Check event records, fault records and disturbance record settings.		√	√
12.	Verification of communication parameter settings in IED / BCPU.		√	√
13.	Check the IEC61850 communication.			√
B	**EMI/EMC IMMUNITY TESTS FOR IED / BCPU**			
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	√		

Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine Test	Field test
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 Test as per IEC 60255-27	√		
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 IED / BCPU**			
25.	Cold test as per IEC60068-2-1	√		
26.	Dry heat test as per IEC60068-2-2	√		
27.	Damp heat teat as per IEC60068-2-78	√		
28.	Flowing mixed gas corrosion test IEC60068-2-60	√		
E	O**ther test**			
29.	Cyber security compliance IEC 62443-4-1 and IEC 62443-4-2 certificate of IEC / BCPU from NABL labs asper GoI ORDERS	√		
30.	Communication IEC 61850 Edition-2 from an accredited Level A testing laboratory.	√		

End of Chapter 15

CHAPTER 16: SUPPORT SERVICES AND 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, B, C towns as per functional requirements.

The training content, schedule and location shall be finalized during project execution.

16.0 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.

16.1 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.

16.1.1 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.

16.1.2 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 UGVCL 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 equipments.

(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.

16.1.3 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 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.

16.1.4 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

16.1.5 Operator Training Course

This training course shall provide training to Owner's operators on SCADA/DMS 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 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.

16.1.6 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 UGVCL, 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 equipments etc. The owner's personnel shall be trained in such a way that the basic maintenance of terminal equipments & cable etc. can be carried out effectively.

End of Section 6, Chapter 16

CHAPTER 17: SUPPORT SERVICES- FMS

This section describes general requirements describes the project's spares and maintenance requirements. This section is applicable to Group A,B,C towns as per functional requirements

17.0 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,B,C,U as applicable including all equipments, installations including hardware, software & networks installed & commissioned by Contractor for the UGVCL 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 UGVCL & 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 UGVCL (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 System.

17.1 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 five year warranty of the SCADA/DMS System after the Operational Acceptance of the SCADA/DMS 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 equipments
- 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 UGVCL representatives. The information of modifications shall be documented by contractor and UGVCL. Further, supply of quantity of RTU/FRTUs beyond mentioned in the contract shall be responsibility of UGVCL. 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 7 Years of FMS period, then SIA shall also responsible erection , commissioning of the same). Otherwise, the responsibility of SIA will be limited to control center activities data base 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 UGVCL for carrying out the FMS responsibilities:

- Sufficient Operators for dispatch control (However, SIA shall provide adequate training to UGVCL 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 UGVCL personnel or agency hired for operations by UGVCL 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)

UGVCL 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 UGVCL

17.1.1 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). At least three Engineers including Site Manager along with one on-site support personnel for Hardware and one on-site personnel for Software shall be deployed at each control center and at least one field engineer per district in case of Group B & C. towns and one field engineer each for Group A /U town The support personnel so deployed shall be qualified personnel having experience in the delivered SCADA/DMS system. The Contractor shall submit the CV's of all such personnel to UGVCL .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 UGVCL & Contractor.

17.1.2 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.

17.1.2.1 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 UGVCL 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 UGVCL for all matters that can affect the baseline, schedule and cost of the services project.
- Maintain project communications through UGVCL'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 UGVCL
- Identify and resolve problems and issues together with UGVCL 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 System supplied under the contract (new equipment needs to be procured by the UGVCL or due to growth of network).

ii. **Move: Mo**vement 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 UGVCL. UGVCL shall formulate guidelines for IMAC & communicate it to FMS Contractor. All procurement shall be done by UGVCL 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 UGVCL, 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 UGVCL regarding tenure of completion of warranty/AMC with outside vendors for software, hardware & networks maintenance in order that UGVCL 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 five years, warranty is in scope of OEM vendors there will be no AMC for SCADA/DMS system. During such period, FMS Contractor has to interact with such vendors for maintenance services and spares. After warranty period, if required UGVCL can award the suitable AMC and FMS Contractor has to interact with Contractors as selected by UGVCL for providing AMC for the said system on mutually agreed terms & conditions.
9. The faulty hardware /software may be replaced from available spares of UGVCL to minimizing downtime time. However, in such case the same be replenished to UGVCL by SIA within a month.

d) FMS Contractor's (SIA) Other Responsibilities

1. Provide a single-point-of-contact for responding to UGVCL's queries or accepting its problem management requests. **FMS Contractor's** specialist will respond to UGVCL's initial request within agreed service level objectives set forth.
2. Monitor availability & Escalate to service provider and Notify UGVCL for communication failures.
3. Review the service levels of the service provider (as per pre-defined schedules on SLA performance) along with UGVCL
4. Provide network availability incident reports severity wise to UGVCL 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 UGVCL. 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 UGVCL

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
14. Periodic Browsing of the Backup Media
15. Management of the storage solution including, but not limited to, management of space, volume, RAID configuration, configuration and management of disk array etc.,
16. 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 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 UGVCL . 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 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 UGVCL 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 empaneled agency on annual basis or interim audits in case of major change
- No cyber-attack or intrusion in SCADA/DMS 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 equipments 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 UGVCL to approve revisions/upgrades to the computing and communications hardware, software and other equipments 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 system incident
- Cyber security audit shall be carried out from CERT.IN empaneled agency on annual basis or interim audit in case of major modification
- No cyber-attack or intrusion in SCADA/DMS system incident

17.2 Support Services

17.2.1 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 UGVCL 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 System). Resolution of problems may also be provided by an individual fix that will be installed by the Contractor at no extra cost to UGVCL.

17.2.2 Monitoring

The Contractor shall conduct the following monitoring, for the supplied SCADA/DMS System .

17.2.2.1 Error Log Monitoring

To monitor the performance of SCADA/DMS system on a monthly basis, the Contractor shall review the following, analyze the results, and communicate to UGVCL:

- 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

17.2.2.2 Resource Monitoring

Resource Monitoring services comprises checking the system's major node resources, gather log data, analyze results, and advise UGVCL 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.

17.2.3 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 equipments/card required for expansion**.**

17.3 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:-

17.3.1 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/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.

17.4 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.

17.5 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.

17.5.1 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 UGVCL/ Employer as quickly as practical. Resolution time is dependent on reproducibility, ability to gather data, and UGVCL 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 UGVCL prioritization. Resolution may be by workaround.
4	2 days	10 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.

17.6 Preventive Maintenance

The Contractor shall undertake preventive maintenance of all equipment/modules (i.e. Hardware & Software supplied under the SCADA/DMS 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 UGVCL.

b) Regular cleaning of computer furniture and surroundings is the responsibility of UGVCL.

c) Equipment shutdown during preventive maintenance shall be deemed as available.

17.7 Availability and Payment charges Calculation

It is the endeavor of both the Contractor and UGVCL 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 UGVCL 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

17.7.1 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:

$$\text{Availability per quarter (per site)} = \frac{\text{THQ- (S1 x 1+S2 x0.4+S3 x 0.1)}}{\text{/THQ}} \times 100\%$$

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

17.7.2 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 (S)

Availability per Quarter	Deduction as % of the apportioned price of total FMS for SCADA-DMS -OMS portion of the contract applicable for that site
≥ 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 upto 93% & nil below 93%

For individual critical hardware & functions (C.)

Availability per quarter	Deduction as % of the apportioned price of total FMS for SCADA-DMS- OMS portion of the contract applicable for that site
≥ 99%	NIL
Less than 99%	Deduction of 2.5 % of the apportioned price on each 1% non-availability below 99% and up to 95% and deduction of 4% of the apportioned price on each 1% non-availability u upto 93% & nil below 93%

For individual hardware & non critical functions (N)

Availability per quarter	Deduction as % of the apportioned price of total FMS for SCADA-DMS- OMS portion of the contract applicable for that site
≥ 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%

UGVCL may go for upward revision for availability conditions

CALCULATION OF EACH CRITICAL HARDWARE /SOFTWARE FOR SITE FOR FQUARTERLY FMS =

= S*C FOR CRITICAL INDIVIDUAL HW/ SW

= S*N FOR NON CRITICAL INDIVIDUAL HW/ SW

While calculating Availability following shall be considered:

The Overall SCADA/DMS/ 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 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
e. Data exchange with other system is available

f. One of the redundant hardware is available so that all the SCADA/DMS applications are functional to ensure the design & performance requirement as envisaged in the MTS

g. Availability of SAIDI/SAIFI and other Key performance indictor reports

h. Minimum 98% availability of RTU /Numerical relays

i. and minimum 95% availability of /FRTU/FPI /RMU/SECT/

j. J) DC/DR data exchange and synch at defined periodicity

k. K) saidi /saifi reports and KPI reports

Further, Non-Availability of legacy systems shall not be considered for calculating Overall SCADA/DMS 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 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

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.

17.8 The Contractor's Obligations

In order to optimize and improve the response of the system, the Contractor may re-install the program modules after making the UGVCL engineer aware of the consequence like data loss, database rebuild etc.).

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 UGVCL. 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 UGVCL.

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.

The Contractor will submit FSR (Field Service Report) and the steps taken to solve the problem, along with details of code changes.

17.9 Responsibilities of UGVCL

a. UGVCL will ensure the availability of competent staff appropriately trained in the administration and use of existing SCADA/DMS systems for proper operation of the system.

b. UGVCL shall ensure that proper Environmental conditions are maintained for the system.

c. UGVCL shall ensure that the System is kept and operated in a proper and prudent manner and only trained UGVCL employees (or persons under their supervision) are allowed to operate the system.

d. UGVCL shall provide access to the sites of installation for purposes of providing Support Services.

e. UGVCL 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

17.10 Responsibility Matrix

The table in this clause provides a summary definition of the roles and responsibilities of the Contractor and UGVCL.

Legend:		This indicates who has primary responsibility to perform this function.
	A	This indicates who will provide assistance.

Item	Task	UGVCL / Employer	Contractor
1.0	**PROBLEM IDENTIFICATION**		
1.1	Root cause analysis to determine whether the fault is attributable to Hardware or Software.		A
1.2	Resolution of problems involving third party maintainer where there is uncertainty whether the root cause is hardware or software.		A
2.0	**SOFTWARE PROBLEM RESOLUTION**		
2.1	Report problem and assist with problem identification		A
2.2	Provide or recommend corrections, temporary patches, workarounds or other fixes to system problems		A

2.3	Install and test corrections, temporary patches, workarounds or other fixes to system problems Report Problem in supervision and control		A
3.0	**ROUTINE SOFTWARE SUPPORT**		
3.1	Build and maintain database, displays and reports		A
3.2	Perform system back-ups		A
3.3	Restore or reinstall software from back-ups		A
3.4	Monitor system logs (part of remote monitoring service)		A
3.5	Maintain system logs		A
3.6	Maintain user accounts		A
4.0	**HARDWARE PROBLEM RESOLUTION**		
4.1	Report problem and assist with defining problem		A
4.2	Troubleshoot problem to diagnose if it is software-related or hardware-related		A
4.3	Identify failed component, Replace failed components in online system using parts from spares inventory		A
4.4	Restore operation of repaired/replaced equipment		A
5.0	**HARDWARE SPARE PARTS**		
5.1	To keep inventory for SLA by SIA		A .
5.2	Provide appropriate facility for local storage of spares in case not available with SIA but this is not obligation for		A

	UGVCL.		
5.3	Replenish local spares inventory		A
6.0	**INTEGRATION AND DATABASE WORK**		
6.1	CFE /RTU/FRTU Card addition/Expansion field equipment		A
6.2	Database resizing		A
6.3	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

End of Chapter 17

CHAPTER 18: 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,B,C, U towns as per functional requirements

18.0 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 persons.

18.1 Project Schedule

The project implementation schedule shall be not exceed 18 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.

18.2 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.

18.3 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.

18.4 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.

18.4.1 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 equipments.

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

UGVCL. 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 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.

18.4.2 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.

18.4.3 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.

18.4.3.1 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.

18.4.3.2 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.

18.4.3.3 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.

18.4.3.4 Factory Test

The factory tests shall be conducted on all the equipments 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 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 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.

18.4.3.5 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.

18.5 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 UGVCL. 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.

18.6 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/manufacturer'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 Despatcher

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 finalized 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.

Chapter 19

A) DESIGN PARAMETERS AND PERFORMANCE TABLES

The SCADA/DMS system shall be designed as per the technical parameters defined in the specification and the tables specified here. The SCADA/DMS/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,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 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 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

Chapter 2 /clause	**Function Description**	**Design capacity**	**Execution rate**
2.2.2 & Subclauses	**Data Acquisition**	As per spec	
	STATUS	By exception Integrity All status periodically 10 min (configurable cycle)	From RTU shall be reported by exception and shall be updated and displayed within 2 seconds. Digital status data From FRTU & FPI shall be also be reported by exception and shall be updated and displayed within 4 seconds.
	Analog	By exception Integrity All analog periodically 10 min (configurable cycle)	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 5 seconds.
		Max Time skew status	0.1sec at each location

		Max latency status	0.5sec .
		Max Time skew analog Max latency analog	1 sec at each location 1 sec
	Energy values	15-minute blocks shall be collected periodically from the RTU, FRTU at scan rate of 15 minute/1 hour (configurable up to 24 hours	Update time and time skew as per analog data
2.2.3 & Subclauses	Time synchronization	RTU/FRTUs/FPI/ NUMERICAL RELAYS	Every 15 minutes (user configurable from 5 minutes to 24 hrs.)
2.2.4& Subclauses	Data exchange	NPP	SAIDI/SAIFI data with planned /unplanned and total / other parameters as defined by UGVCL .As required for ISR function & data exchange
		IT system If opted	As defined by UGVCL. As required for ISR function & data exchange
		SLDC if opted	As defined by UGVCL. As required for ISR function & data exchange
2.2.5 & Subclauses	Data Processing (status & analog) Min, max ,Avg		Each time the value is received For analog vlaues

2.2.7 **Sequence-of-Events data** 1000 events circular

	uffer in the	SOE retrieval Periodically (5

		SCADA database	minutes) or by exception
2.2.9 & subclauses	Supervisory Control		Within as per SoP of utiliy
	a) Control Inhibit Tag Type	4	(a) (b) (c) On demand by Dispatcher/DMS function initiated
	b) Control inhibit Tags / device	4	
	c) Control Action Monitor		10 timer periods (1 to 60 sec) For all control points
	d) Control permissive		d) Each time supervisory control is requested
2.2.10	Fail-soft capability	in the event of system crosses mark of peak loading requirements	graceful de-gradation of non – critical functions & also relaxing periodicity / update rate of display refresh & critical functions by 50%.

TABLE 2 – DESIGN PARAMETERS FOR ISR FUNCTIONS

Chapter 2 /clause	Function Description	Design capacity	Execution rate
2.3.1	**Circuit breaker status Table**	Real-time status of all Circuit breakers, in case of RMU - LBS, isolators & FPI Sectionalizers alongwith quality date & time of tripping and requirements as per specification	Every time status changes Daily tables online storage for 24 months
2.3.2	**Real-time Database Snapshot Tables**	a) All telemetered analog values and Calculated values for all tele-metered 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	Every 5 min . Daily tables online storage for 24 months
2.3.3	**Hourly Data tables**	Selected analog values along with their associated quality codes Selected status values along with their associated quality codes Results of hourly calculations for selected analog points (atleast maxima & minima with associated time and average) alongwith their associated quality codes. 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 alongwith their associated quality codes.	Hourly tables incl Missed and hourly data calculation on daily basis online storage for 24 months

2.3.4	SAIDI/SAIFI Table	SAIDI/SAIFI data with reason of outage in terms of planned and unplanned outage	SAIDI/SAIFI on daily/ weekly/ monthly/ quarterly, yearly and user defined timeline basis on daily basis online storage for 24 months
2.3.5	**Daily Energy Data**		
		daily energy data table shall be generated for storage of daily energy values for 15 minute blocks / one hour blocks of a day feeder on daily basis along with quality codes.	daily basis online storage for 24 months
2.3.6	Load priority Table	Load priority table containing information such as breaker name, number of consumers connected to each Breaker and Load priority of each Breaker/ Feeder	Monthly basis online storage for 24 months
2.3.7	SOE Data Table	. All CBs, protection and alarm contacts shall be considered as SOE.	Minimum daily 4 changes per SOE point may be considered Daily basis online storage for 24 months
2.3.8	Feeder Overshoot limit table	Table shall contain count of such instances and duration for which feeder experienced such condition and index for overshoot limit of voltage) low ,high), current (high), power factor (low) etc	Minimum daily 4 overshoots per parameter may be considered Daily basis online storage for 24 months
2.3.9	FPI fault table	Table shall contain count and time of such FPI fault for O/C and E/F	Minimum daily 4 faults may be considered Daily basis online storage for 24 months
2.3.10	Equipment failure detail	DT, Power transformer failure information on weekly manner from IT / ERP system on weekly basis	Minimum monthly 1 incident per device may be considered Monthly basis online storage for 24 months

2.3.11	User definable index table	Customized report	Daily basis online storage for 24 months
2.3.12	Average Time Restoration Table	avg time to report outage location, restoration of supply of feeder	Minimum daily 4 time restoration may be considered Monthly basis online storage for 24 months
2.3.13	Daily/Weekly Flash reports	Customized report for Management for daily basis	Daily basis online storage for 24 months
2.3.15	System Message Log Storage	System message log data storage shall be sized for up to 20,000 entries per month.	Monthly basis online storage for 24 months
2.3.16	Mass storage of data/files	□10 save-cases for each DMS & OMS application □10 Output results of each DMS & OMS applications	As per functional requirement in Spec
2.4	Load Shed Application (LSA)	As per functional requirement	As per functional requirement in Spec
2.5	**Common Disaster Replica Recovery**	Switchover in 15 min	As per functional requirement in Spec
2.6	**DATA recovery centre**	network model of SCADA/DMS control center of each town shall be sent to DR center periodically once a day & upon user request. 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 control center upon attaining user defined threshold e.g. 80% for storage at DR center.	As per functional requirement in Spec

2.7	**RT-DAS**	All SCADA feature except controllability	As per specification

TABLE 3 - DESIGN PARAMETERS FOR DMS /OMS FUNCTIONS

Chapter 3 clause	**Name**	**Design capacity**	**Execution rate**	**Response time**
3.1.1	**Network Connectivity analysis**	One model with atleast 10 possible islands. Islands may be formed dynamically.. All electrical components mentioned in the spec		
		Complete network		
	2) Real time mode		- Event driven	2sec
	b) Study mode		- On demand	2sec
3.1.2	State estimation	Complete network	On change	5sec
3.1.3	**Load Flow**	Complete network		
	a) Real time mode		- periodic (10 minutes) - On demand -Event driven -user/application - Jumper /Cut	5sec
	b) Study mode		On demand	5 sec
3.1.4	**Voltage/VAR Control**	All tap changers/ cap bank switching	On change	5sec
3.1.5	**FAULT MANAGEMENT & SYSTEM RESTORATION (FMSR)**	At least 2 simultaneous fault scenario and prescribed solution in auto and manual modes both	auto and manual modes both on actuation of fault	Solution prescribed in 15 sec
3.1.6	**Loss minimization via Feeder reconfiguration (LMFR)**	At least 2 simultaneous scenario and prescribed solution in auto and manual modes both	auto and manual modes both on availability of minimal loss path	Solution prescribed in 15 sec

3.1.7	**Loss minimization via load balancing (LBFR)**	At least 2 simultaneous scenario and prescribed solution in auto and manual modes both	auto and manual modes both on availability for load balancing	Solution prescribed in 15 sec
3.2	**Outage Management System (OMS)**	As per spec Notification to crew	As per spec On fault / maintenance	Update time and time skew of devices fro data acquisition of SCADA

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

Chapter 4	Description	Minimum
	Windows	16
	Rooms	16
	Layers	8
	Variable per trend	8
	Alarm levels	8

TABLE 6 - CONFIGURATION CHARACTERSTICS & AVAILABILITY FUNCTIONS

Chapter 6	Description	Max time in sec
	Processor error detection	5
	Other devices error detection	5
	Processor switchover	30
	Functional availability after switchover	10

	ISR availability after switchover	120
	Processor – Hot startup	Limited to switching time
	Processor – Warm startup	600(10 min)
	Processor- Cold startup except ISR /with ISR	900(15 min) / 1800(30min) ISR

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

Control centre wise

S.no	System	Present (Nos)	Ultimate (DOUBLE OF PRESENT
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		
16	SINGLE STATUS POINTS		
17	CONTROL POINTS		
18	ANALOG STATUS		
19	Any other network parameter		

Table 8- PERFORMANCE REQ

(a) USER INTERFACE REQUIREMENTS

At no time the SCADA/DMS 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 screen	Within 2 sec
Display update rate	Every 2 sec for at least
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 operation time)
Alarm and event response time	display within 1 sec of receipt in SCADA/DMS system
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)

Name	Average Utilization	Comments
PROCESSOR Servers	 30% 50%	 Normal loading Peak loading
LOCAL AREA NETWORKS		
	15% 40%	Normal loading Peak loading
Main memory utilisation (avg)	50%	Normal loading
	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

(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 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/ OMS applications	4 on-demand per DMS/OMS 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 IEEEC37.1

(h) One complete run of on-line diagnostics shall be performed on all computers

(i) Communications channel monitoring 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 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

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 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/5FRTUs
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 5 Minute period of peak loading cycles

(e) DMS/OMS applications

3 Network Connectivity Analysis & Reporting of crew of all feeders

(f) Reports

Prepare 5 reports.

The above are indicative, UGVCL align with their Standard operating procedure

End of SCADA/DMS 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

A/U TYPE TOWNS - SCADA/DMS control center (BoQ) SDCC

In U TOWNS , only items with end of life/ spares /faulty can be proposed for refresh or replaced and field equipment due to growth and OMS

S.No.	Equipment	Unit	Quantity	Remarks
C1	**Server/ workstation Hardware**			
	SCADA Server	No.	2	
	DMS Server	No.	2	
	OMS Server	No.	2	
	FEP server with interface switches	No.	2	
	ISR server	No.	2	
	NMS server	No.	2	
	DTS server	No.	1	
	Other Active Devices	no		
	Developmental server	No.	1	
	Commnuication Server	No.	2	
	Web/Directory server	No.	2	
	SMS gaterway	No.	2	
	Workstation with dual TFT Monitors (S/S monitoring)	No.	Ref Remarks	*2minimum and 1 per each 20s/s and maximum upto 5 workstations
	Workstation with dual TFT Monitors (Network monitoring)	No.	Ref Remarks	1minimum *and 1 per each per 100 FRTUs and maximum upto 3 workstations
	Remote VDUs with one TFT Monitors	No.	Ref Remarks	1 per Circle/ div/Sub div

	Developmental console with one TFT	No.	2	
	DTS/Workstation Console with dual TFTs	No.	2	
	DLP/ LED based Video Projection system with 3x4 Module configuration with each module at least 67" diagonal with common projector	No.	1	
	Storage & Backup Devices			
	External RAID Mass storage device (for 24 months online backup)	No.	1	
	Exteranl DAT drive	No.	1	
	Switches			
	Layer II switch (SCADA/DMS LAN)	No.	2	
	Layer II switch (Planning & Development system LAN)	No.	2	
	Routers			
	Router for interfacing IT system & SCADA/DMS DR centre	No.	2	
	Router at remote VDU	No.	0	
	Security system (DMZ)			
	Web server with load balancing	No.	2	
	Mail server	No.	2	
	Router	No.	2	
	Firewall & network IDS/IPS	No.	2	
	Layer II switch	No.	2	
	Other Active Devices			
	GPS Time synchronisation system	Set	2	
	Time, day & date digital displays	Set	1	
	Printers			
	Color inkjet printer	Set	2	
	B/W Laser printer	Set	2	
	Any other items required to meet functional /Performance requirement as per MTS	Lot	1	
	Sub-Total C1 (Hardware)			
C2	**Software for Control Centre**			
	SCADA software	Lot	1	
	ISR Software	Lot	1	
	DMS software	Lot	1	
	OMS Software	Lot	1	

	DTS software	Lot	1	
	Developmental software	Lot	1	
	Network Management Software	Lot	1	
	WEB /Network security software (INCL IN WEBSERVER)	Lot	1	
	RDBMS package	Lot	1	
	GIS Adaptor/Engine for importing data from GIS system under IT system	Lot	1	
	Any other software to meet functional /performance requirement of MTS	Lot	1	
	Sub-Total -B2 (Software)			
C3	**Mandatory spares Max 5% of C1**			
	Mandatory spares	L/S	1	
	Sub -Total C3 spares			
	Grand Total C			

Estimated Bill of Quantity for SCADA/DMS DRR (Disaster Recovery control centre

S.No.	Equipment	Unit	Quantity	Remarks
D1	**Server/ workstation Hardware**			
	SCADA Server	No.	2	
	DMS Server	No.	2	
	OMS Server	No.	2	
	FEP server with interface switches	No.	2	
	ISR server	No.	2	
	NMS server	No.	2	
	DTS server	No.	1	
	Other Active Devices			
	Developmental server	No.	1	
	Commnuication Server	No.	2	
	Web/Directory server	No.	2	
	SMS gaterway	No.	2	

	Workstation with dual TFT Monitors (S/S monitoring)	No.	2	
	Workstation with dual TFT Monitors (Network monitoring)	No.	1	
	Remote VDUs with one TFT Monitors	No.	0	
	Developmental console with one TFT	No.	2	
	DTS/Workstation Console with dual TFTs	No.	2	
	DLP based Video Projection system with 3x4 Module configuration with each module at least 67" diagonal with common projector	No.	0	
	Storage & Backup Devices			
	External RAID Mass storage device (for24 months online backup)	No.	1	
	Exteranl DAT drive	No.	1	
	Switches			
	Layer II switch (SCADA/DMS LAN)	No.	2	
	Layer II switch (Planning & Development system LAN)	No.	2	
	Routers			
	Router for interfacing IT system & SCADA/DMS DR centre	No.	2	
	Router at remote VDU	No.	0	
	Security system (DMZ)			
	Web server with load balancing	No.	2	
	Mail server	No.	2	
	Router	No.	2	
	Firewall & network IDS/IPS	No.	2	
	Layer II switch	No.	2	
	Other Active Devices			
	GPS Time synchronisation system	Set	2	
	Time, day & date digital displays	Set	1	
	Printers			
	Color inkjet printer	Set	2	
	B/W Laser printer	Set	2	

	Any other items required to meet functional /Performance requirement as per MTS	Lot	1	
	Sub-Total D1 (Hardware)			
D2	**Software for DR Centre**			
	SCADA software	Lot	1	
	ISR Software	Lot	1	
	DMS software	Lot	1	
	OMS Software	Lot	1	
	DTS software	Lot	1	
	Developmental software	Lot	1	
	Network Management Software	Lot	1	
	WEB /Network security software	Lot	1	
	RDBMS package	Lot	1	
	GIS Adaptor/Engine for importing data from GIS system under IT system	Lot	1	
	Any other software to meet functional /performance requirement of MTS	Lot	1	
	Sub-Total D2 (Software)			
D3	**Mandatory spares Max 5% of D1**			
	Mandatory spares	L/S	1	
	Sub -Total D3 spares			
	Grand TotalD			

S.No.	Equipment	Unit	Quantity	Remarks
E1	**RTUs**			
	RTU base equipment comprising panels, racks, sub-racks, Power Supply modules, CPU, interfacing equipment, required converters & all other required items/accessories including complete wiring for all modules for locations mentioned at Vol Vi	Set	Ref remarks	Per S/S
	Multifunctuions transducers	No.	Do	As per point count

	Contact Multiplying Relays (CMRs)	No.	Do	As per point count
	Heavy duty relays for Control	No.	Do	As per point count
	Dummy Breaker Latching Relays	No.	Do	Per S/S
	Transformer Transducers	No.	Do	Per PXF
	Single TFT PC for LDMS	No	Do	Per S/S
	Any other hardware to meet functional /performance requirement of MTS	Lot	Do	
	Sub - Total (Hardware) -E1			
E2	**Software for LDMS**			
	LDMS software	No.	Ref remarks	Per S/S
	Any other software to meet functional /performance requirement of MTS	Lot		
	Sub - Total (test equipment) -E2			
E3	**TEST EQUIPMENTS for RTU**			
	RTU Database Configuration & Maintenance Software tool	No.	Ref remarks	Per 20s/s , min 1
	Master Station cum RTU Simulator & Protocol analyser software tool	No.	Ref remarks	Per 20s/s , min 1
	Laptop PC for above software tools along with interfacing hardware including Hub	No.	Ref remarks	Per 20s/s , min 1
	Sub - Total (test equipment) -E3			
E4	**MANDATORY SPARES FOR RTU**			
	5% of E1			
	Sub - Total (mandatory spare) -D4			
	Grand total E			

S.No.	Equipment	Unit	Quantity	Remarks
				Rs.
F1	**FRTUs**			

	Mini pole mounted FRTU base equipment along with enclosure suitable to work in open environment (Adequate protection from water & dust) , racks, sub-racks, Power 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 at Vol Vi	No.	Ref remarks	Per RMU/SECT
	Contact Multiplying Relays (CMRs)	No.	Ref remarks	Point count
	Heavy duty relays for Control	No.	Ref remarks	Point count
	Multifunction transducer	No.	Ref remarks	Point count
	Any other hardware to meet functional /performance requirement of MTS	Lot	-	
	Sub-Total (Hardware) F1			
F2	**Test Equipments for FRTU**			
	FRTU Database Configuration & Maintenance Software tool	No.	Ref remarks	Per 100 FRTU
	Master Station cum FRTU Simulator & Protocol analyser software tool	No.	Ref remarks	Per 100 FRTU
	Laptop PC for above software tools along with interfacing hardware including Hub	No.	Ref remarks	Per 100 FRTU
	Sub-Total (Test equipment) F2			
F3	**MANDATORY SPARES FOR FRTU**			
	5% of E1			
	Sub-Total (Spares) F3			
	Grand Total F			

G1 - Communication system

S.No	Equipment	Unit	Quantity	Remarks

	MPLS			
	Annual charges for 100MBps Links	No.	0	Per RTU/CC/OTH LOCATIONS
	MPLS Router	No.	0	DO
	Any other hardware to meet functional /performance requirement of MTS			
	Sub - Total g1			
	GPRS			
	Annual charges for 2MBps Links with FRTUs /FPI	No.	0	FRTU ,FPI
	Modems	No.	0	FRTU ,FPI
	Any other hardware to meet functional /performance requirement of MTS			
	Sub - Total g2			
	Mandatory spares 5% of g1,g2			
	Grand Total G			

AUX POWER SUPPLY

S.No.	Survey	Type	Unit	Quantity	Remarks
H1	**Main Equipments - Control centre**				
	UPS with suitable rating running in parallel redundant mode*		Set		**Per CC**
	VRLA type Battery banks for above UPS for minimum 30 min. backup duration	incl above	Set		
	Sub- Total H1				
H2	**Main Equipments - DR Centre**				
	Main Equipments				

	UPS with suitable rating running in parallel redundant mode*				**Per DR**
	VRLA type Battery banks for above UPS for minimum 30 min. backup duration	incl above			
	Sub-Total H2				
H3	**II For RTU / Data Concentrator / Communication Eqpts.**				
	DC Power Supply (DCPS) system based on SMPS			-	**PER RTU**
	Battery bank for above DCPS (VRLA Type) for minimum 4 hrs backup	incl above		-	
	Sub-Total H3				
H4	**For FRTU**				
	48V DC Power Supply (DCPS) system based on SMPS			-	**PER FRTU**
	Battery bank for above DCPS (VRLA Type) for minimum 4 hrs backup	incl above		-	
	Sub-Total H4				
H5	**Remote VDU location**				
	UPS (2 kVA)			-	**PER RVDU**
	Sub-Total H5				
H6	**Mandatory Spares for UPS**				
	5% of above H1TO H5			-	
	Sub-Total H6				
	Grand Total (H)				

SCADA ENABLERS

S.No.	ITEM	Type	Unit	Quantity
J1	**RMU (WAY requirement)**	**No of WAYS**		

	RMU		No	-
	Sub- Total J1			
J2	**SECTIONLIZER /RECLOSER**			
	Sectionlizer		No	-
	Recloser		No	
	Sub-Total J2			
J3	**FPI**			
	Commnuicable		No	-
	Sub-Total J3			
J4	**RECONDUTORING (Specify type of each conductor existing & reconductoring in other modernisation WORKS if any)**			
			Km	-
			Km	-
	Sub-Total J4			
J5	**Control/power cable for RTUs from outdoor switchgear,if any at S/S and numerical relays**			
	control /power cable		Km	-
	Numerical relay /BCPU		Nos	-
	Sub-Total J5			
J6	**Mandatory Spares**			
	5% of above J1 TO J5			-
	Sub-Total J6			
	Grand Total (J)			

ZSCC FOR B,C TYPE TOWNS -

S.No.	Equipment	Unit	Quantity	Remarks

C1	**Server/ workstation Hardware**			
	SCADA server	No.	2	
	FEP server with interface switches	No.	2	
	ISR server	No.	2	
	NMS server	No.	2	
	DTS server	No.	1	
	Developmental server	No.	1	
	Commnuication Server	No.	2	
	Web/Directory server	No.	2	
	SMS gaterway	No.	2	
	Workstation with dual TFT Monitors (S/S monitoring)		Ref Remarks	*2minimum and 1 per each 20s/s and maximum upto 5 workstations
	Workstation with dual TFT Monitors (FPI monitoring)	No.	Ref Remarks	1minimum *and 1 per each per 100 FRTUs and maximum upto 3 workstations
	Workstation with dual TFT Monitors (S/S monitoring) -RTDAS		Ref Remarks	*2minimum and 1 per each 20s/s and maximum upto 5 workstations
	Workstation with dual TFT Monitors (FPI monitoring)-RTDAS	No.	Ref Remarks	1minimum *and 1 per each per 100 FRTUs and maximum upto 3 workstations
	Remote VDUs with one TFT Monitors	No.	Ref Remarks	1 per Circle/ div/Sub div
	Developmental console with one TFT	No.	2	
	DTS/Workstation Console with dual TFTs	No.	2	
	DLP based Video Projection system with 3x4 Module configuration with each module at least 67" diagonal with common projector	No.	1	
	Storage & Backup Devices			
	External RAID Mass storage device (for 24 months online backup)	No.	1	
	Exteranl DAT drive	No.	1	

	Switches			
	Layer II switch (SCADA/DMS LAN)	No.	2	
	Layer II switch (Planning & Development system LAN)	No.	2	
	Routers			
	Router for interfacing IT system & SCADA/DMS DR centre	No.	2	
	Router at remote VDU	No.	0	
	Security system (DMZ)			
	Web server with load balancing	No.	2	
	Mail server	No.	2	
	Router	No.	2	
	Firewall & network IDS/IPS	No.	2	
	Layer II switch	No.	2	
	Other Active Devices			
	GPS Time synchronisation system	Set	2	
	Time, day & date digital displays	Set	1	
	Printers			
	Color inkjet printer	Set	2	
	B/W Laser printer	Set	2	
	Any other items required to meet functional /Performance requirement as per UMTS	Lot	1	
	Sub-Total C1 (Hardware)			
C2	**Software for Control Centre**			
	SCADA software	Lot	1	
	ISR Software	Lot	1	
	DMS software	Lot	1	
	DTS software	Lot	1	
	Developmental software	Lot	1	
	Network Management Software	Lot	1	

	WEB /Network security software (Incl in webserver)	Lot	1	
	RDBMS package	Lot	1	
	GIS Adaptor/Engine for importing data from GIS system under IT system	Lot	1	
	Any other software to meet functional /performance requirement of UMTS	Lot	1	
	Sub-Total -B2 (Software)			
C3	**Mandatory spares Max 5% of C1**			
	Mandatory spares	L/S	1	
	Sub -Total C3 spares			
	Grand Total C			

DR

S.No.	Equipment	Unit	Quantity	Remarks
D1	**Server/ workstation Hardware**			
	DR server	No.	2	
	Commnuication Server	No.	2	
	Workstation with one TFT Monitors	No.	2	
	Storage & Backup Devices			
	External storage device	No.	1	
	Exteranl DAT drive	No.	1	
	Switches			
	Layer II switch (DR LAN)	No.	2	
	Routers			
	Router for interfacing at SCADA DMS centre	No.	2	
	Printers			
	Color inkjet printer	Set	1	
	B/w Laser printer	Set	1	

	Any other items required to meet functional /Performance requirement as per UMTS	Lot	1	
	Sub-Total D1 Hardware			
D2	**Software for Control Centre**			
	RDBMS package	Lot	1	
	Any other items required to meet functional /Performance requirement as per UMTS	Lot	1	
	Sub-Total D1 Sofware			
D3	**Mandatory spares Max 5% of D1**			
	Mandatory spares	L/S	1	
	Sub -Total d3 spares			
	Grand Total D			

S.No.	Equipment	Unit	Quantity	Remarks
E1	**RTUs**			
	RTU base equipment comprising panels, racks, sub-racks, Power Supply modules, CPU, interfacing equipment, required converters & all other required items/accessories including complete wiring for all modules for locations mentioned at Vol Vi	Set	Ref remarks	Per S/S
	Multifunctuions transducers	No.	Do	As per point count
	Contact Multiplying Relays (CMRs)	No.	Do	As per point count
	Heavy duty relays for Control	No.	Do	As per point count
	Dummy Breaker Latching Relays	No.	Do	Per S/S
	Transformer Transducers	No.	Do	Per PXF
	Single TFT PC for LDMS	No	Do	Per S/S
	Any other hardware to meet functional /performance requirement of MTS	Lot	Do	
	Sub - Total (Hardware) -E1			
E2	**Software for LDMS**			
	LDMS software	No.	Ref remarks	Per S/S

	Any other software to meet functional /performance requirement of MTS	Lot		
	Sub - Total (test equipment) -E2			
E3	**TEST EQUIPMENTS for RTU**			
	RTU Database Configuration & Maintenance Software tool	No.	Ref remarks	Per 20s/s , min 1
	Master Station cum RTU Simulator & Protocol analyser software tool	No.	Ref remarks	Per 20s/s , min 1
	Laptop PC for above software tools along with interfacing hardware including Hub	No.	Ref remarks	Per 20s/s , min 1
	Sub - Total (test equipment) -E3			
E4	**MANDATORY SPARES FOR RTU**			
	5% of E1			
	Sub - Total (mandatory spare) -D4			
	Grand total E			

G1 - Communication system

S.No	Equipment	Unit	Quantity	Remarks
	MPLS			
	Annual charges for 100MBps Links	No.	0	Per RTU/CC/OTH LOCATIONS
	MPLS Router	No.	0	DO
	Any other hardware to meet functional /performance requirement of MTS			
	Sub - Total g1			
	GPRS			
	Annual charges for 2MBps Links with FRTUs /FPI	No.	0	FPI

	Modems	No.	0	, FPI
	Any other hardware to meet functional /performance requirement of MTS			
	Sub - Total g2			
	Mandatory spares 5% of g1,g2			
	Grand Total G			

AUX POWER SUPPLY

S.No.	Survey	Type	Unit	Quantity	Remarks
H1	**Main Equipments - Control centre**				
	UPS with suitable rating running in parallel redundant mode*		Set		**Per CC**
	VRLA type Battery banks for above UPS for minimum 30 min. backup duration	incl above	Set		
	Sub- Total H1				
H2	**Main Equipments - DR Centre**				
	Main Equipments				
	UPS with suitable rating running in parallel redundant mode*				**Per DR**
	VRLA type Battery banks for above UPS for minimum 30 min. backup duration	incl above			
	Sub-Total H2				
H3	**II For RTU / Data Concentrator / Communication Eqpts.**				
	DC Power Supply (DCPS) system based on SMPS			-	**PER RTU**

	Battery bank for above DCPS (VRLA Type) for minimum 4 hrs backup	incl above		-	
	Sub-Total H3				
H5	**Remote VDU location**				
	UPS (2 kVA)			-	**PER RVDU**
	Sub-Total H5				
H6	**Mandatory Spares for UPS**				
	5% of above H1TO H5			-	
	Sub-Total H6				
	Grand Total (H)				

SCADA ENABLERS

S.No.	ITEM	Type	Unit	Quantity
J3	**FPI**			
	Commnuicable		No	-
	Sub-Total J3			
J5	**Control/power cable for RTUs from outdoor switchgear,if any at S/S and numerical relays**			
	control /power cable		Km	-
	Sub-Total J5			
J6	**Mandatory Spares**			
	5% of above J1 TO J5			-
	Sub-Total J6			
	Grand Total (J)			

5 % MANDATORY SPARE MAY BE CONSIDERED

UTILTY SHALL ATTACH RTU & FRTU
CONNECTIVITY DIAGRAM

STATION	SS	DS	DC	CMR	HDR	MFT	Com module	DI module	DO module	AI module
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

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.

D) BILL OF QUANTITY

FRTU

5 % MANDATORY SPARE MAY BE CONSIDERED

UTILTY 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

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.

Provide Equipment break-up at each location

UTILTY SHALL ATTACH COMMNUICATION 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 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)	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/FPIetc.)		2 Per Town

I)
FM
S

Sl No.	Description	Duration
1a	FMS charges for SCADA/DMS system (maintaining overall system availability as per TS)	Two Years
1b	FMS charges for SCADA/DMS system (maintaining overall system availability as per TS)	5 additional years
3	Total FMS charges	seven Year

The cost of shall not be less than 35 % of total contract value . The cost per year for all 7year 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 5 years will be borne by UGVCL. However, the cost of all 7 years shall be same and will form part of financial evaluation .

J) IMPLEMENTATION SCHEDULE

S. No.	Items	Completion Schedule from the Award of Contract
1	SCADA/DMS/OMS System (Group A)	30 months from award
2	SCADA system (Group BC)	24 months from award
3	SCADA system (Group U)	24 months from award

BIDDER SHALL PROVIDE IMPLEMETATION SCHEDULE INDICATING MILESTONES

Annex 1 - List of locations under Group A & U

SNO	A/U	NAME OF TOWN	Disaster recovery at	Ambient Temperature deg C	Rel Humidity in RH%	Altitude from MSL < 2000 M (Y/N)

Annex 2 - List of locations under Group B

SNO	B / B*	NAME OF TOWN	ZSCC name	Ambient Temperature deg C	Rel Humidity in RH%	Altitude from MSL < 2000 M (Y/N)

B* if existing RT-DAS and upgrading for SCADA

Annex 3 - List of locations under Group C

SNO	C / C*	NAME OF TOWN	ZSCC name	Ambient Temperature deg C	Rel Humidity in RH%	Altitude from MSL < 2000 M (Y/N)

C* if existing RT-DAS and upgrading for FPI

Annex 4 - List of locations under Group A & U

SNO	A/U	NAME OF TOWN	RTU Count	FRTU count	FPI Count	RMU Count	Sectionlizer count

Annex 5- List of locations under Group B

SNO	B / B*	NAME OF TOWN	RTU COUNT	FPI Count

B* if existing RT-DAS and upgrading for SCADA

Annex 6 - List of locations under Group C

SNO	C / C*	NAME OF TOWN	RTU Count	FPT Count

C* if existing RT-DAS and upgrading for FPI

Section VII.
General Conditions of Contract

A. Contract and Interpretation		
1 Definitions	The following words and expressions shall have the meanings hereby assigned to them:	
	(a)	**"Contract"** means the Agreement entered into between the Purchaser and the Supplier, together with the Contract Documents referred to therein, including all attachments, appendices, and all documents incorporated by reference therein.
	(b)	**"Contract Documents"** shall mean the following documents listed, including any amendments thereto be read and construed as part of this Agreement, viz.: i. the Detailed award of contract; ii. the Service level agreement; iii. the Special Conditions of Contract; iv. the General Conditions of Contract; v. the Scope of Work; vi. the Model Technical Specification (MTS) vii. the Instructions to bidders; viii. the Purchaser's Notification to the Supplier for Award of Contract; ix. Supplier's response (proposal) to the RFP, including the Bid Submission Sheet and the Price Proposal submitted by the Supplier; x. Appendix A & D to L; xi. Acceptance of purchaser's notification xii. RFQ document (as mentioned in IFB**)** along with all corrigendum, clarifications and related documents issued by the Nodal Agency.
	(c)	**"Contract Price"** means the price payable to the Supplier as specified in the Agreement, subject to such additions and adjustments thereto or deductions there from, as may be made pursuant to the Contract.
	(d)	**"Day"** means calendar day.
	(e)	**"Delivery"** means the transfer of the Goods and services from the Supplier to the Purchaser in accordance with the terms and conditions set forth in the Contract.
	(f)	**"Completion"** shall mean the completion of the Related Services by the Supplier in accordance with the terms and conditions set forth in the Contract.
	(g)	**"GCC"** mean the General Conditions of Contract.
	(h)	**"Goods"** means all hardware, software, networking equipment and/or other equipment accessories and materials that the Supplier is required to supply to the Purchaser under the Contract.

	(i)	**"Intellectual Property Rights"** means any patent, copyright, trademark, trade name, service marks, brands, propriety information, whether arising before or after the execution of this Contract and the right to ownership and registration of these rights.
	(j)	**"Purchaser's Country"** shall mean India.
	(k)	"**Purchaser or Employer or UGVCL**" means the entities purchasing the Goods and Related Services.
	(l)	**"Project Manager"** means the person appointed by the UGVCL to perform the duties delegated by the UGVCL.
	(m)	**"Related Services"** means the services to be provided as per the requirements / conditions specified in the Contract. In addition to this, the definition would also include other related/ancillary services that may be required to execute this Contract.
	(n)	**"SCC"** means the Special Conditions of Contract.
	(o)	**"Service Level Agreement" (SLA)** shall mean the Service Level Agreement entered into between the Purchaser and the Supplier.
	(p)	**"Subcontractor"** means any natural person, private or government entity, or a combination of the above, including its legal successors or permitted assigns, to whom any part of the Goods to be supplied or execution of any part of the Related Services is subcontracted by the Supplier, as per the provisions of Clauses 18 of the GCC.
	(q)	**"Supplier or Bidder"** means the eligible Implementation Agency (IA) whose bid to perform the Contract has been accepted by the Purchaser and is named as such in the Agreement, and includes the legal successors or permitted assigns of the Supplier.
	(r)	**"Contractor's Representative"** means any person nominated by the Contractor and approved by the UGVCL hereof to perform the duties delegated by the Contractor.
	(s)	**"The MoP"** is the Ministry of Power, Government of India.
	(t)	**"The Site,"** shall mean all identified locations within the State of <UGVCL to Define>, where the Supplier carries out any installation of Goods or is required to provide any Related Services.
	(u)	**"OEM"** means the Original Equipment Manufacturer of any equipment / system / software / product that are providing such goods to the Purchaser under the scope of this Tender / Contract.
	(v)	**"Kick Off Meeting"** means a meeting convened by the Purchaser to discuss and finalize the work execution plan and procedures with the Supplier.
	(w)	the term **"in writing"** means communicated in written form with proof of receipt[S11]
2	**Contract Documents**	

	2.1 Subject to the order of precedence set forth in the Agreement, all documents forming the Contract (and all parts thereof) are intended to be correlative, complementary, and mutually explanatory. The contract shall be read as a whole.
3	**Interpretation**
	3.1 **Language**
	(a) All Contract Documents, all correspondence and communications to be given, and all other documentation to be prepared and supplied under the Contract shall be written in English, and the Contract shall be construed and interpreted in accordance with that language.
	(b) If any of the Contract Documents, correspondence or communications are prepared in any language other than the governing language under GCC Sub-Clause 3.1.1 above, the English translation of such documents, correspondence or communications shall prevail in matters of interpretation.
	(c) The English Translation of the documents shall be carried out by professional translators and the translator shall certify that he is proficient in both languages in order to translate the document and that the translation is complete and accurate. Further, translation shall be authenticated by the Indian Consulate located in the Country where the documents have been issued or the Embassy of that Country in India.
	3.2 (a) In case of any conflict with any provision relating to the MTS document and the RFP document, the provisions of the RFP document shall prevail for all intents and purposes. (b) unless otherwise specified a reference to a clause number is a reference to all of its sub-clauses;
	3.3 **Singular and Plural** (a) The singular shall include the plural and the plural the singular, except where the context otherwise requires.
	3.4 **Headings** (a) The headings and marginal notes in the General Conditions of Contract are included for ease of reference, and shall neither constitute a part of the Contract nor affect its interpretation.
	3.5 **Persons** (a) Words importing persons or parties shall include firms, corporations and government entities.
	3.6 **Incoterms** (a) Unless inconsistent with any provision of the Contract, the meaning of any trade term and the rights and obligations of parties thereunder shall be as prescribed by Incoterms. Incoterms means international rules for interpreting trade terms published by the International Chamber of Commerce (latest edition), 38 Cours Albert 1er, 75008 Paris, France.
	3.7 **Entire Agreement** (a) The Contract constitutes the entire agreement between the Employer and Contractor with respect to the subject matter of Contract and supersedes all communications, negotiations and agreements (whether written or oral) of parties with respect thereto made prior to the date of Contract.
	3.8 **Amendment** (a) No amendment or other variation of the Contract shall be effective unless it is in writing, is dated, expressly refers to the Contract, and is signed by a duly authorized representative of each party hereto.

	3.9 **Independent Contractor** (a) The Contractor shall be an independent contractor performing the Contract. The Contract does not create any agency, partnership, joint venture or other joint relationship between the parties hereto. Subject to the provisions of the Contract, the Contractor shall be solely responsible for the manner in which the Contract is performed. All employees, representatives or Subcontractors engaged by the Contractor in connection with the performance of the Contract shall be under the complete control of the Contractor and shall not be deemed to be employees of the UGVCL, and nothing contained in the Contract or in any subcontract awarded by the Contractor shall be construed to create any contractual relationship between any such employees, representatives or Subcontractors and the UGVCL.
	3.10 **Non-Waiver** (a) Subject to GCC Sub-Clause 3.10(b) below, no relaxation, forbearance, delay or indulgence by either party in enforcing any of the terms and conditions of the Contract or the granting of time by either party to the other shall prejudice, affect or restrict the rights of that party under the Contract, nor shall any waiver by either party of any breach of Contract operate as waiver of any subsequent or continuing breach of Contract. (b) Any waiver of a party's rights, powers or remedies under the Contract must be in writing, must be dated and signed by an authorized representative of the party granting such waiver, and must specify the right and the extent to which it is being waived.
	3.11 **Severability** (a) If any provision or condition of the Contract is prohibited or rendered invalid or unenforceable, such prohibition, invalidity or unenforceability shall not affect the validity or enforceability of any other provisions and conditions of the Contract.
	3.12 **Joint Venture or Consortium** (a) If the Contractor is a joint venture or consortium of two or more firms, all such firms shall be jointly and severally bound to the UGVCL for the fulfilment of the provisions of the Contract and shall designate one of such firms to act as a leader with authority to bind the joint venture or consortium. The composition or the constitution of the joint venture or consortium shall not be altered without the prior consent of the UGVCL.

4	**Notices**	4.1 Unless otherwise stated in the Contract, all notices to be given under the Contract shall be in writing, and shall be sent by personal delivery, airmail post, special courier, or e-mail to the address of the relevant party set out in the Contract Coordination Procedure to be finalised pursuant to GCC Sub-Clause 17.2, with the following provisions. (a) Any notice sent by airmail post or special courier shall be deemed (in the absence of evidence of earlier receipt) to have been delivered ten (10) days after dispatch. In proving the fact of dispatch, it shall be sufficient to show that the envelope containing such notice was properly addressed, stamped and conveyed to the postal authorities or courier service for transmission by airmail or special courier. (b) Any notice delivered personally or sent by e-mail shall be deemed to have been delivered on date of its dispatch. (c) Either party may change its postal or e-mail address or addressee for receipt of such notices by ten (10) days' notice to the other party in writing. 4.2 Notices shall be deemed to include any approvals, consents, instructions, orders and certificates to be given under the Contract.
5	**Governing Law**	5.1 The Contract shall be governed by and interpreted in accordance with the laws of the India. The High Court of Judicature at **UGVCL Head Quarters** and Courts subordinate to such High Courts shall have exclusive jurisdiction in respect of any disputes relating to the tendering process, award of Contract and execution of the Contract.
6	**Settlement of Disputes**	6.1 The UGVCL and the Contractor shall make every effort to resolve amicably by direct informal negotiation any disagreement or dispute arising between them under or in connection with the Contract. 6.2 If the parties fail to resolve such a dispute (The date of commencement of the dispute shall be taken from the date when this clause reference is quoted by either party in a formal communication clearly mentioning existence of dispute or as mutually agreed) or difference by mutual consultation within twenty-eight (28) days from the commencement of such consultation, either party may require that the dispute be referred for resolution to the formal mechanisms specified in the SCC. 6.3 In the event of any dispute or difference relating to the interpretation and application of the provisions of commercial contract (s) between Central Public Sector Enterprises (CPSEs)/ Port Trusts inter se and also between CPSEs and Government Departments/ Organizations (excluding disputes concerning Railways, Income Tax, Customs & Excise Departments), such disputes or difference shall be taken up by either party for resolution through Administrative Mechanism for Resolution of CPSEs Disputes (AMRCD) as mentioned in DPE Office Memorandum No. 4(1)/2013- DPE(GM)/FTS-1835 dated 22.05.2018 or any amendments thereof.

B Subject Matter of Contract		
7	**Scope of Work**	7.1 The Goods and Related Services to be supplied are specified in Appendix-C3. At the time of awarding the contract, the UGVCL shall specify any change in the Scope of Work. Such changes may be due for instance, if the quantities of goods and related services are increased or decreased at the time of award.
		7.2 Unless otherwise stipulated in the Contract, the Scope of Work shall include all such items not specifically mentioned in the Contract but that can be reasonably inferred from the Contract as being required for attaining Delivery and Completion of the Goods and Related Services as if such items were expressly mentioned in the Contract.
8	**Delivery**	8.1 Subject to GCC Sub-Clause 33, the Delivery of the Goods and Completion of the Related Services shall be in accordance with the Implementation Schedule specified in the Appendix-K. The details of shipping and other documents to be furnished by the Contractor are specified in the SCC.
9	**Contractor's Responsibilities**	9.1 The Supplier shall supply all the Goods and Related Services included in the Scope of Work and Appendix-C3 in accordance with GCC Clause 7, and the Implementation Schedule, as per GCC Clause 8. 9.2 The Contractor confirms that it has entered into this Contract on the basis of a proper examination of the data relating to the Facilities provided by the UGVCL and on the basis of information that the Contractor could have obtained from a visual inspection of the Site (if access thereto was available) and of other data readily available to it relating to the Facilities as at the date **fifteen (15) days** prior to deadline set for price bid submission. The Contractor acknowledges that any failure to acquaint itself with all such data and information shall not relieve its responsibility for properly estimating the difficulty or cost of successfully performing the Facilities. 9.3 The Contractor shall acquire in its name all permits, approvals and/or licenses from all local, state or national government authorities or public service undertakings in the country where the Site is located that are necessary for the performance of the Contract, including, without limitation, visas for the Contractor's and Subcontractor's personnel and entry permits for all imported Contractor's Equipment. The Contractor shall acquire all other permits, approvals and/or licenses that are not the responsibility of the Employer under GCC Sub-Clause 10 hereof and that are necessary for the performance of the Contract. 9.4 The Contractor shall comply with all laws in force in the country where the Facilities are installed and where the Installation Services are carried out. The laws will include all national, provincial, municipal or other laws that affect the performance of the Contract and bind upon the Contractor. The Contractor shall indemnify and hold harmless the Employer from and against any and all liabilities, damages, claims, fines, penalties and expenses of whatever nature arising or resulting from the violation of such laws by the Contractor or its personnel, including the Subcontractors and their personnel, but without prejudice to GCC Clause 9 hereof.
10	**UGVCL's Responsibilities**	10.1 Whenever the supply of Goods and Related Services requires that the Supplier obtain permits, approvals, and import and other licenses from local public authorities, the UGVCL shall, if so required by the Supplier, make its best effort to assist the Supplier in complying with such requirements in a timely and expeditious manner. 10.2 The Purchaser shall bear all costs involved in the performance of its responsibilities, in accordance with GCC Sub-Clause 14.1.

	10.3 The Project Manager [S12] or any other person designated by the UGVCL, as defined in SCC, shall act as the nodal point for implementation of the contract and for issuing necessary instructions, approvals, commissioning, acceptance certificates, payments etc. to the Supplier. 10.4 The Project Manager or any other person designated by the UGVCL shall approve all such documents within 15 working days. 10.5 Purchaser may provide on Supplier's request, particulars/ information / or documentation that may be required by the Supplier for proper planning and execution of Scope of Work under this contract. 10.6 Purchaser shall provide to the Supplier sitting space and infrastructure and utilities, in the Purchaser's offices at such location as may be mutually decided by the Parties.
C. Payment	
11 Contract Price	11.1 The Contract Price shall be as specified in the Agreement subject to any additions and adjustments thereto, or deductions there from, as may be made pursuant to the Contract as also subject to provisions of Clause 14.5.
	11.2 Prices charged by the Supplier for the Goods delivered and the Related Services performed under the Contract shall not vary from the prices quoted by the Supplier in its bid, with the exception of any price adjustments authorized in the SCC.
	11.3 In the event any approval required for imports and/ or use of imported equipment is denied in accordance with all applicable laws including those in relation to testing issued by Ministry of Power (Order No No.12/34/2020-T&R dated 08 June 2021, as amended and/ or modified from time to time), the same shall neither entitle revision of Contract Price nor shall result in revision of the Project Implementation Plan.
12 Terms of Payment	12.1 The Contract Price shall be paid in the manner specified in the SCC. No invoice for extra work/change order on account of change order will be submitted by the Supplier unless the said extra work /change order has been authorized/approved by the UGVCL in writing.
	12.2 The Contractor's request for payment shall be made to the UGVCL in writing, accompanied by invoices describing, as appropriate, the Goods delivered and Related Services performed, accompanied by the documents submitted.
	12.3 Payments shall be made promptly by the UGVCL, no later than forty five (45) days after submission of an invoice or request for payment by the Contractor, and the UGVCL has accepted it.
	12.4 If any excess payment has been made by the Purchaser due to difference in quoted price in proposal and Supplier's invoice, the purchaser may without prejudice to its rights recover such amounts by other means after notifying the Supplier or deduct such excess payment from any payment subsequently falling due to the Supplier.
	12.5 The currency in which payment shall be made to the supplier under this contract is Indian Rupees (INR).
13 Securities	13.1 **Issuance of Securities** The Contractor shall provide the securities specified below in favor of the Employer at the times, and in the amount, manner and form specified below.

	13.2 **Advance Payment Security** (a) The Contractor shall, within twenty-eight (28) days of the Notification of Award of Contract, provide a security in an amount equal to the advance payment calculated in accordance with Terms and Procedures of Payment to the Contract Agreement, and in the currency or currencies of the Contract, with an initial validity of up to ninety (90) days beyond the schedule date of Completion of the last facility covered under the package. However, in case of delay in completion of the facilities under the package, the validity of this security shall be extended by the period of such delay. The advance payment security shall also cover the amount of GST as applicable on the advance payment to be paid to the contractor. (b) The security shall be in the form of an unconditional bank guarantee as per the proforma provided as Form of Advance Payment Security. The Advance payment Security shall be reduced pro-rata every three (03) months after First Running Account Bill/Stage Payment under the Contract based on the value of the respective equipment/facilities received and applicable GST. The cumulative amount of reduction at any point of time shall not exceed ninety (90%) of the advance and the amount of GST paid on the advance amount corresponding to cumulative value of the respective equipment/Facilities supplied and received as per certificate issued by the Project Manager. The balance shall be released upon release of respective milestone linked payments as identified in Terms of payments of Contract Agreement. In case milestone payment is not envisaged in the package, the balance shall be released after Completion of those Facilities on certification by the Project Manager. It should be clearly understood that reduction in the value of security for advance shall not in any way dilute the Contractor's responsibility and liabilities under the Contract including in respect of the Facilities for which the reduction in the value of security is allowed

	13.3 **Performance Security** (a) The Contractor shall, within twenty-eight (28) days of the Notification of Award, provide securities for the due performance of the Contract for ten percent (10%) of the Contract Price of all the Contracts, with an initial validity up to ninety (90) days beyond the end of scheduled Defect Liability Period of the last equipment covered under the Contract. However, in case of delay in completion of the defect liability period, the validity of all the contract performance securities shall be extended by the period of such delay. (b) The performance security shall be denominated in the currency or currencies of the Contract, or in a freely convertible currency acceptable to the UGVCL, and shall be in the form of unconditional bank guarantee provided as Form of Performance Security of the bidding documents. (c) Unless otherwise stipulated in SCC, the security shall be reduced pro rata to the Contract Price of a part of the Facilities for which a separate time for Completion is provided, twenty one (21) months after Completion of the Facilities or where relevant part thereof, or fifteen (15) months after Operational Acceptance of the Facilities (or the relevant part thereof), whichever occurs first; provided, however, that if the Defects Liability Period has been extended on any part of the Facilities pursuant to GCC Sub-Clause 33 hereof, the Contractor shall issue an additional security in an amount proportionate to the Contract Price of that part. The security shall be returned to the Contractor immediately after its expiration, provided, however, that if the Contractor, pursuant to GCC Sub-Clause 33, is liable for an extended warranty obligation, the performance security shall be extended for the period and up to the amount agreed upon or as specified in the SCC. (d) The Purchaser shall at its sole discretion invoke the Performance Security and appropriate the amount secured there under, in the event that the Supplier commits any delay or default in Delivery of the Goods or Related Services during the contract period (including FMS period) or commits any other breach of the terms and conditions of the Contract.
14 Taxes and Duties	14.1 The prices quoted by the supplier shall be inclusive of all duties/taxes/levies[S13] except GST. Responsibility for including all applicable taxes/duties/levies in the proposal lie with the supplier and the UGVCL shall not be responsible for any error/omission on the part of the bidder. Payment of taxes/duties/levies except GST shall not be made separately. 14.2 For goods supplied from outside the Purchaser's country, the Supplier shall be entirely responsible for all taxes, duties, stamp duties, license fees, and other such levies imposed outside the Purchaser's country. 14.3 For goods supplied from within the Purchaser's country, the Supplier shall be entirely responsible for all taxes, duties, entry tax, license fees, other levies etc, incurred until delivery of the Goods and Related service to the Purchaser.

	14.4 The cost of Entry Tax as applicable will be the liability of the Supplier i.e. the price quoted will be inclusive of Entry Tax. The amount of Entry Tax will be deducted from the Supplier's invoice and remittance to tax dept. will be made by the Purchaser under the TIN number of Purchaser. If any liability is raised by the commercial tax department, Govt. of **<STATE>** on account of Entry Tax at a later date, the same shall be to the Supplier's account and accordingly recovery shall be made from the supplier's pending bills/security deposit as available with the Purchaser. 14.5 For the purpose of the Contract, it is agreed that the Contract Price specified in (Contract Price and Terms of Payment) of the Contract Agreement is based on the taxes, duties, levies and charges prevailing on seven (7) days prior to the deadline set for price bid submission in the country where the Site is located (hereinafter called "Tax" in this GCC Sub-Clause 14.4). If any rates of Tax are increased or decreased, a new Tax is introduced, an existing Tax is abolished, or any change in interpretation or application of any Tax occurs in the course of the performance of Contract, which was or will be assessed on the Contractor in connection with performance of the Contract, an equitable adjustment of the Contract Price shall be made to fully take into account any such change by addition to the Contract Price or deduction therefrom, as the case may be, in accordance with GCC Clause 30 (Change in Laws and Regulations) hereof. However, these adjustments shall not be applicable on procurement of raw materials, intermediary components and intermediary services etc. by the Contractor.
D. Intellectual Property	
15 Copyright	15.1 Purchaser shall own and have a right in perpetuity to use all newly created Intellectual Property Rights which have been developed solely during execution of this Contract, including but not limited to all Source code, Object code, records, reports, designs, application configurations, data and written material, products, specifications, reports, drawings and other documents which have been newly created and developed by the Supplier solely during the performance of Related Services and for the purposes of inter-alia use or sub-license of such Services under this Contract. The Supplier undertakes to disclose all such Intellectual Property Rights arising in performance of the Related Services to the Purchaser and execute all such agreements/documents and file all relevant applications, effect transfers and obtain all permits and approvals that may be necessary in this regard to effectively transfer and conserve the Intellectual Property Rights of the Purchaser. To the extent that Intellectual Property Rights are unable by law to so vest, the Supplier assigns those Intellectual Property Rights to Purchaser on creation.
	15.2 The Supplier shall be obliged to ensure that all approvals, registrations, licenses, permits and rights etc. which are inter-alia necessary for use of the goods supplied / installed by the Supplier, the same shall be acquired in the name of the Purchaser, and the same may be assigned by the Purchaser to the Supplier solely for the purpose of execution of any of its obligations under the terms of this Contract. However, subsequent to the term of this Contract, such approvals, registrations, licenses, permits and rights etc. shall endure to the exclusive benefit of the purchaser.

	15.3	The Supplier shall ensure that while it uses any software, hardware, processes, document or material in the course of performing the Services, it does not infringe the Intellectual Property Rights of any person and the Supplier shall keep the Purchaser indemnified against all costs, expenses and liabilities howsoever, arising out any illegal or unauthorized use (piracy) or in connection with any claim or proceedings relating to any breach or violation of any permission/license terms or infringement of any Intellectual Property Rights by the Supplier or its personnel during the course of performance of the Related Services. In case of any infringement by the Supplier, the Supplier shall have sole control of the defense and all related settlement negotiations.
	15.4	Subject to sub-clauses 16.1 to 16.3, the Supplier shall retain exclusive ownership of all methods, concepts, algorithms, trade secrets, software documentation, other intellectual property or other information belonging to the Supplier that existed before the effective date of the contract.
16 Confidential Information	16.1	Both parties undertake to each other to keep confidential all information (written as well as oral) concerning the business and affairs of the other, which has been obtained or received as a result of the discussions leading upto or the entering of the contract
	16.2	After the entering of the contract the Purchaser and the Supplier shall keep confidential and shall not, without the written consent of the other party hereto, divulge to any third party any documents, data, or other information furnished directly or indirectly by the other party hereto in connection with the Contract, whether such information has been furnished prior to, during or following completion or termination of the Contract. Notwithstanding the above, the Supplier may furnish to its Subcontractor such documents, data, and other information it receives from the Purchaser to the extent required for the Subcontractor to perform its work under the Contract, in which event the Supplier shall obtain from such Subcontractor an undertaking of confidentiality similar to that imposed on the Supplier under this Clause.
	16.3	The Purchaser shall not use such documents, data, and other information received from the Supplier for any purposes unrelated to the Contract. Similarly, the Supplier shall not use such documents, data, and other information received from the Purchaser for any purpose other than the design, procurement, or other work and services required for the performance of the Contract.
	16.4	The obligation of a party under GCC Sub-Clauses 16.1 and 16.2 above, however, shall not apply to information that: a. the Purchaser or Supplier need to share with the institutions participating in the financing of the Contract; b. now or hereafter enters the public domain through no fault of that party; c. can be proven to have been possessed by that party at the time of disclosure and which was not previously obtained, directly or indirectly, from the other party; or d. Otherwise lawfully becomes available to that party from a third party that has no obligation of confidentiality.
	16.5	The above provisions of GCC Clause 16 shall not in any way modify any undertaking of confidentiality given by either of the parties hereto prior to the date of the Contract in respect of the Supply or any part thereof.

	16.6	Each of the parties to this contract, undertakes to the other to take all such steps as shall from time to time be necessary to ensure compliance with the provisions of the above clauses by it's employees, agents and sub-contractors.
	16.7	The provisions of GCC Clause 17 shall survive completion or termination, for whatever reason, of the Contract.
E. Work Execution		
17 Representatives	17.1	**Project Manager** If the Project Manager is not named in the Contract, then within fourteen (14) days of the Effective Date, the Employer shall appoint and notify the Contractor in writing of the name of the Project Manager. The Employer may from time to time appoint some other person as the Project Manager in place of the person previously so appointed, and shall give a notice of the name of such other person to the Contractor without delay. The Employer shall take reasonable care to see that no such appointment is made at such a time or in such a manner as to impede the progress of work on the Facilities. The Project Manager shall represent and act for the Employer at all times during the currency of the Contract. All notices, instructions, orders, certificates, approvals and all other communications under the Contract shall be given by the Project Manager, except as herein otherwise provided. All notices, instructions, information and other communications given by the Contractor to the Employer under the Contract shall be given to the Project Manager, except as herein otherwise provided.
	17.2	**Contractor's Representative** (a) The Contractor shall appoint the Contractor's Representative within fourteen (14) days of the Effective Date or before start of work whichever is earlier and shall request the Employer in writing to approve the person so appointed. i. The Contractor's representative shall be a regular Employee/ Partner/ Director only and the Contractor shall be required to submit a Power of Attorney in original in favour of its representative. ii. In case, the Contractor's representative is also doing some other Contract(s)/ Work(s) as nominee of the same contractor, the Contractor shall give a declaration citing list of all works where the Contractor's representative is the nominee. iii. If the Employer objects to the appointment giving the reason therefore, then the Contractor shall appoint a replacement within
18 Subcontracting	18.1	The Implementation Agency shall not be permitted to sub-contract its obligations under the Contract with the utilities. However, scope of work related to auxiliary power supply ,communication (i.e. only in case of new infrastructure like FO/Radio etc. is being set up by UGVCL) and SCADA Enabler Works may be subcontracted after seeking prior approval of the UGVCL.

19	**Conflict of Interest**	19.1 The Implementation Agencies shall not engage, and shall cause their Personnel not to engage, either directly or indirectly, in any business or professional activities which would conflict with the activities assigned to them under this Contract. 19.2 The UGVCL considers a conflict of interest to be a situation in which a party has interests that could improperly influence that party's performance of official duties or responsibilities, contractual obligations, or compliance with applicable laws and regulations, and that such conflict of interest may contribute to or constitute a prohibited corrupt practice 19.3 Implementation Agency for a UGVCL cannot participate in the bidding process of <Project Name> Consultant of the same UGVCL. 19.4 If the <Project Name> Implementation Agency is found to be involved in a conflict of interest situation with regard to the present assignment, the UGVCL may choose to terminate this contract as per Clause 34 of GCC
20	**Specifications and Standards**	20.1 Technical Specifications and Drawings (a) The Supplier shall ensure that the Goods and Related Services comply with the technical specifications and other provisions of the Contract. (b) The Supplier shall be entitled to disclaim responsibility for any design, data, drawing, specification or other document, or any modification thereof provided or designed by or on behalf of the Purchaser, by giving a notice of such disclaimer to the Purchaser. (c) The Goods and Related Services supplied under this Contract shall conform to the standards mentioned in Section VI, Scope of Work and, when no applicable standard is mentioned, the standard shall be equivalent or superior to the official standards whose application is appropriate to the country of origin of the Goods with express approval of the UGVCL. 20.2 Wherever references are made in the Contract to codes and standards in accordance with which it shall be executed, the edition or the revised version of such codes and standards shall be those specified in the Section VI, Scope of Work. During Contract execution, any changes in any such codes and standards shall be applied only after approval by the Purchaser and shall be treated in accordance with GCC Clause 31.
21	**Packing and Documents**	21.1 The Supplier shall provide such packing of the Goods as is required to prevent their damage or deterioration during transit to their final destination, as indicated in the Contract. During transit, the packing shall be sufficient to withstand, without limitation, rough handling and exposure to extreme temperatures, salt and precipitation, and open storage. Packing case size and weights shall take into consideration, where appropriate, the remoteness of the final destination of the Goods and the absence of heavy handling facilities at all points in transit. The Purchaser shall not be responsible in any manner for any loss or damage caused to the Goods during Transit.
		21.2 The packing, marking, and documentation within and outside the packages shall comply strictly with such special requirements as shall be expressly provided for in the Contract and in any other instructions ordered by the Purchaser.

22	**Insurance**	22.1 The Goods supplied under the Contract shall be fully insured by the Supplier, in INR, against loss or damage incidental to manufacture or acquisition, transportation, storage, and delivery, in accordance with the applicable Incoterms or in the manner specified in the SCC.
23	**Transportation**	23.1 Obligations for transportation of the Goods shall be borne by the Supplier and shall be in accordance with the Incoterms specified in Sections VII
24	**Inspections and Tests**	24.1 The Supplier shall at its own expense and at no cost to the Purchaser carry out all such tests and/or inspections of to ensure that the Goods and Related Services are complying with the functional parameters, codes and standards specified in the Scope of Work at Section VI, to the satisfaction of the Purchaser.
		24.2 The inspections and tests may be conducted on the premises of the Supplier, at point of delivery, and/or at the final destination of the Goods, or in another place in the Purchaser's country as per the requirement of Section VI. Subject to GCC Sub-Clause 24.3, if conducted on the premises of the Supplier or its Subcontractor, all reasonable facilities and assistance, including access to drawings and production data, shall be furnished to the inspectors at no charge to the Purchaser.
		24.3 The Purchaser or its designated representative shall be entitled to attend the tests and/or inspections referred to in GCC Sub-Clause 24.2, provided that the Purchaser bear all of its own costs and expenses incurred in connection with such attendance including, but not limited to, all traveling and board and lodging expenses.
		24.4 Whenever the Supplier is ready to carry out any such test and inspection, it shall give a reasonable advance notice, including the place and time, to the Purchaser.
		24.5 The Purchaser may require the Supplier to carry out any test and/or inspection to verify that the characteristics and performance of the Goods or Related Services comply with the technical specifications, codes and standards under the Contract.
		24.6 The Supplier shall provide the Purchaser with a report of the results of any such test and/or inspection.
		24.7 The Purchaser may reject any Goods / Related Services or any part thereof that fail to pass any test and/or inspection or do not conform to the specifications. The Supplier shall either rectify or replace such rejected Goods/ Related Services or parts thereof or make alterations necessary to meet the specifications at no cost to the Purchaser, and shall repeat the test and/or inspection, at no cost to the Purchaser, upon giving a notice pursuant to GCC Sub-Clause 24.4.
		24.8 The Supplier agrees that neither the execution of a test and/or inspection of the Goods / Related Services or any part thereof, nor the attendance by the Purchaser or its representative, nor the issue of any report pursuant to GCC Sub-Clause 24.6, shall release the Supplier from any warranties or other obligations under the Contract.
	E. Guarantees & Liabilities	
25		**Completion Time Guarantee**
		25.1 The Contractor guarantees that it shall attain Completion of the Facilities (or a part for which a separate time for completion is specified in the SCC) within the Time for Completion specified in the SCC pursuant to GCC Sub- Clause 8, or within such extended time to which the Contractor shall be entitled under GCC Clause 33 (Extension of Time for Completion) hereof.

	25.2	If the Contractor fails to attain Completion of the Facilities or any part thereof within the Time for Completion or any extension thereof under GCC Clause 33 (Extension of Time for Completion), the Contractor shall pay to the Employer liquidated damages in the amount computed at the rates specified in the GCC Clause 26.
	25.3	No bonus shall be given for earlier completion of the facilities or part thereof.
26 Liquidated Damages and Penalty	26.1	Except as provided under GCC Clause 33, if the Supplier fails to deliver any or all of the Goods or perform the Related Services within the period specified in the Contract, the Purchaser may without prejudice to all its other remedies under the Contract, deduct from the Contract Price, as liquidated damages, a sum equivalent to 0.5% of the value of the Goods or Related Services, supplied beyond stipulated delivery schedule for each week or part thereof of delay until actual delivery or performance, subject to a maximum of 10% of value of such goods and services.
	26.2	In addition, the Supplier is liable to the Purchaser for payment penalty as specified in the SLA.
	26.3	If the Goods and Related Services supplied do not meet the minimum specifications as per the Contract, and the same is not replaced/modified by the Supplier to meet the requirements within 14 days of being informed by the UGVCL, the UGVCL shall be free to impose any penalty as deemed fit. In addition, the UGVCL shall reserve the right to terminate the contract and recover liquidated damages by forfeiting the performance guarantee submitted by the Purchaser.
27 Warranty	27.1	The Supplier warrants that all the Goods are new, unused, and of the most recent or current models, and that they incorporate all recent improvements in design and materials, unless provided otherwise in the Contract.
	27.2	Subject to GCC Sub-Clause 20.1, the Supplier further warrants that the Goods shall be free from defects arising from any act or omission of the Supplier or arising from design, materials, and workmanship, under normal use in the conditions prevailing in the country of final destination.
	27.3	The warranty shall remain valid for the period Specified in the SCC.
	27.4	The Purchaser shall give Notice to the Supplier stating the nature of any such defects together with all available evidence thereof, promptly following the discovery thereof. The Purchaser shall afford all reasonable opportunity for the Supplier to inspect such defects.
	27.5	Upon receipt of such Notice, the Supplier shall, within the period specified in the SCC, expeditiously repair or replace the defective Goods or parts thereof, at no cost to the Purchaser.
	27.6	If having been notified, the Supplier fails to remedy the defect within the period of warranty specified in the SCC; the Purchaser may proceed to take within a reasonable period such remedial action as may be necessary, at the Supplier's risk and expense and without prejudice to any other rights which the Purchaser may have against the Supplier under the Contract.

28	**Liability/ Indemnity**	28.1 The Supplier hereby agrees to indemnify the Purchaser, for all conditions and situations mentioned in this clause, in a form and manner acceptable to the Purchaser. The supplier agrees to indemnify the Purchaser and its officers, servants, agents (**"Purchaser Indemnified Persons"**) from and against any costs, loss, damages, expense, claims including those from third parties or liabilities of any kind howsoever suffered, arising or incurred inter alia during and after the Contract period out of: a. any negligence or wrongful act or omission by the Supplier or its agents or employees or any third party associated with Supplier in connection with or incidental to this Contract; or b. any infringement of patent, trademark/copyright or industrial design rights arising from the use of the supplied Goods and Related Services or any part thereof.
		28.2 The Supplier shall also indemnify the Purchaser against any privilege, claim or assertion made by third party with respect to right or interest in, ownership, mortgage or disposal of any asset, property, movable or immovable as mentioned in any Intellectual Property Rights, licenses and permits.
		28.3 Without limiting the generality of the provisions of this clause 28.1 and 28.2, the Supplier shall fully indemnify, hold harmless and defend the Purchaser Indemnified Persons from and against any and all suits, proceedings, actions, claims, demands, liabilities and damages which the Purchaser Indemnified Persons may hereafter suffer, or pay by reason of any demands, claims, suits or proceedings arising out of claims of infringement of any domestic or foreign patent rights, copyrights or other intellectual property, proprietary or confidentiality rights with respect to any Goods, Related Services, information, design or process supplied or used by the Supplier in performing the Supplier's obligations or in any way incorporated in or related to the Project. If in any such suit, action, claim or proceedings, a temporary restraint order or preliminary injunction is granted, the Supplier shall make every reasonable effort, by giving a satisfactory bond or otherwise, to secure the suspension of the injunction or restraint order. If, in any such suit, action, claim or proceedings, the Goods or Related Services, or any part thereof or comprised therein, is held to constitute an infringement and its use is permanently enjoined, the Supplier shall promptly make every reasonable effort to secure for the Purchaser a license, at no cost to the Purchaser, authorizing continued use of the infringing work. If the Supplier is unable to secure such license within a reasonable time, the Supplier shall, at its own expense, and without impairing the specifications and standards, either replace the affected work, or part, or process thereof with non-infringing work or part or process, or modify the same so that it becomes non-infringing. **Survival on Termination** The provisions of this Clause 27 shall survive Termination.
		28.4 **Defense of Claims:** (a) If any proceedings are brought or any claim is made against the Purchaser arising out of the matters referred to in GCC Sub-Clause 27.1, 27.2, or 27.3 the Purchaser shall promptly give the Supplier a notice thereof, and the Supplier may at its own expense and in the Purchaser's name conduct such proceedings or claim and any negotiations for the settlement of any such proceedings or claim.

		(b) If the Supplier fails to notify the Purchaser within twenty-eight (28) days after receipt of such notice that it intends to conduct any such proceedings or claim, then the Purchaser shall be free to conduct the same on its own behalf (c) The Purchaser shall, at the Supplier's request, afford all available assistance to the Supplier in conducting such proceedings or claim, and shall be reimbursed by the Supplier for all reasonable expenses incurred in so doing.
29	**Limitation of Liability**	29.1 Except in cases of gross negligence or willful misconduct : (a) neither Party shall be liable to the other Party, whether in contract, tort, or otherwise, for any indirect or consequential loss or damage, loss of use, loss of production, or loss of profits or interest costs, which may be suffered by the other Party in connection with the Contract, provided that this exclusion shall not apply to any obligation of the Contractor to pay liquidated damages to the Employer and (b) the aggregate liability of the Contractor to the Employer, whether under the Contract, in tort or otherwise, shall not exceed the total Contract Price, provided that this limitation shall not apply to any obligation of the Contractor to indemnify the Employer with respect to patent infringement. (c) the aggregate liability of the Employer to the Contractor except for GCC sub-clause 28.3, whether under the Contract, in tort or otherwise, at any point of time during the execution/performance of the Contract, shall not exceed the 'total Contract Price less payments already released to the Contractor'.
		G. Risk Distribution
30	**Change in Laws and Regulations**	30.1 Unless otherwise specified in the Contract, if after the date of the Invitation for Bids, any law, regulation, ordinance, order or bylaw having the force of law is enacted, promulgated, abrogated, or changed in the place of the Purchaser's country where the Site is located (which shall be deemed to include any change in interpretation or application by the competent authorities) that subsequently affects the Delivery Date, then such Delivery Date shall be correspondingly increased or decreased, to the extent that the Supplier has thereby been affected in the performance of any of its obligations under the Contract. Additional clause of AMISP Bid Document creates a ambiguity w.r.t. clause Contract Prices
31	**Force Majeure**[AG14]	31.1 The Supplier shall not be liable for forfeiture of its Performance Security, liquidated damages, or termination for default if and to the extent that it's delay in performance or other failure to perform its obligations under the Contract is the result of an event of Force Majeure.
		31.2 For purposes of this Clause, "Force Majeure" means an event or situation beyond the control of the Supplier that is not foreseeable, is unavoidable, and its origin is not due to negligence or lack of care on the part of the Supplier. Such events may include, but not be limited to wars or revolutions, earthquake, fires, floods, epidemics, quarantine restrictions, and freight embargoes.

		31.3 If a Force Majeure situation arises, the Supplier shall promptly and no later than seven days from the first occurrence thereof, notify the Purchaser in writing of such condition and the cause thereof. Unless otherwise[S15] directed by the Purchaser in writing, the Supplier shall continue to perform its obligations under the Contract as far as is reasonably practical, and shall seek all reasonable alternative means for performance not prevented by the Force Majeure event.
		31.4 The decision of the Purchaser with regard to the occurrence, continuation, period or extent of Force Majeure shall be final and binding on the Supplier.
H. Change in Contract Elements		
32	**Change Orders and Contract Amendments**	32.1 The Purchaser may at any time order the Supplier through Notice in accordance GCC Clause 4, ("Change Order") to make changes within the general scope of the Contract in any one or more of the following: (a) drawings, designs, or specifications, where Goods to be furnished under the Contract are to be specifically manufactured for the Purchaser; (b) Specifications for hardware, software and Related Services (c) the method of shipment or packing; (d) the place of delivery; and (e) the Related Services to be provided by the Supplier.
		32.2 If any such Change Order causes an increase or decrease in the cost of, or the time required for, the Supplier's performance of any provisions under the Contract, an equitable adjustment shall be made in the Contract Price or in the Delivery and Completion Schedule, or both, and the Contract shall accordingly be amended. Any claims by the Supplier for adjustment under this Clause must be asserted within twenty-eight (28) days from the date of the Supplier's receipt of the Purchaser's Change Order.
		32.3 No variation or modification of the terms of the contract shall be made except by written amendment signed by the parties.
33	**Extensions of Time**	33.1 If at any time during performance of the Contract, the Supplier or its Subcontractors should encounter conditions impeding timely delivery of the Goods or completion of Related Services pursuant to GCC Clause 10, the Supplier shall promptly notify the Purchaser in writing of the delay, its likely duration, and its cause. As soon as practicable after receipt of the Supplier's notice, the Purchaser shall evaluate the situation and may at its discretion extend the Supplier's time for performance, in which case the extension shall be ratified by the parties by amendment of the Contract.
		33.2 Except in case of Force Majeure, as provided under GCC Clause 31 or where the delay in delivery of the Goods or completion of Related Services is caused due to any delay or default of the Purchaser, any extension granted under clause 32.1 shall not absolve the Supplier from its liability to the pay of liquidated damages pursuant to GCC Clause 26.
34	**Termination**	34.1 **Termination for Default**
		(a) The Purchaser may, without prejudice to any other remedy for breach of Contract, by Notice of default sent to the Supplier, terminate the Contract in whole or in part: i. if the Supplier fails to deliver any or all of the Goods or Related Services within the period specified in the Contract, or within any extension thereof granted by the Purchaser pursuant to GCC Clause 32; or

	ii. if the Supplier, in the judgment of the Purchaser has engaged in corrupt, fraudulent, collusive, or coercive practices, as defined in ITB Clause 4, in competing for or in executing the Contract; or iii. Any representation made by the bidder in the proposal is found to be false or misleading iv. if the Supplier commits any breach of the Contract and fails to remedy or rectify the same within the period of two weeks (or such longer period as the Purchaser in its absolute discretion decide) provided in a notice in this behalf from the Purchaser. v. as specified in the SLA
	(b) In the event the Purchaser terminates the Contract in whole or in part, pursuant to GCC Clause 34.1(a), the Purchaser may procure, upon such terms and in such manner as it deems appropriate, Goods or Related Services similar to those undelivered or not performed, and the Supplier shall be liable to the Purchaser for any additional costs for such similar Goods or Related Services. However, the Supplier shall continue performance of the Contract to the extent not terminated.
	34.2 **Termination for Insolvency** (a) The Purchaser may at any time terminate the Contract by giving Notice to the Supplier if the Supplier becomes bankrupt or otherwise insolvent. In such event, termination will be without compensation to the Supplier, provided that such termination will not prejudice or affect any right of action or remedy that has accrued or will accrue thereafter to the Purchaser.
	34.3 **Termination for Convenience** (a) The Purchaser, by Notice sent to the Supplier, may terminate the Contract, in whole or in part, at any time for its convenience. The Notice of termination shall specify that termination is for the Purchaser's convenience, the extent to which performance of the Supplier under the Contract is terminated, and the date upon which such termination becomes effective. (b) The Goods that are complete and ready for shipment within twenty-eight (28) days after the Supplier's receipt of the Notice of termination shall be accepted by the Purchaser at the Contract terms and prices. For the remaining Goods, the Purchaser may elect: (i) To have any portion completed and delivered at the Contract terms and prices; and/or (ii) to cancel the remainder and pay to the Supplier an agreed amount for partially completed Goods and Related Services and for materials and parts previously procured by the Supplier.

	34.4 **Consequences of Termination** Upon Termination of the Contract, the Supplier shall: (i) Prepare and present a detailed exit plan within five calendar days of termination notice receipt to the Project Manager or authorized representative ("Exit Plan"). (ii) The Project Manager or authorized representative and along with designated team will review the Exit plan. If approved, Supplier shall start working on the same immediately. If the plan is rejected, Supplier shall prepare alternate plan within two calendar days. If the second plan is also rejected, Project Manager or authorized representative or the authorised person will provide a plan for Supplier and it should be adhered by in totality. (iii) The Exit Plan should cover at least the following :- a. Execute all documents that may be necessary to effectively transfer the ownership and title, including OEM warranties in respect of all equipment; b. Handover all developed codes, related documentation and other Configurable Items, if any in his possession; c. Handover the list of all IT Assets, passwords at all locations to the Purchaser. (iv) The supplier and Project Manager or authorized representative will sign a completion certificate at the end of successful completion (all points tracked to closure) of the Exit Plan. 34.5 Whether to include payment clauses in the event of termination.
35 Assignment	35.1 The Contractor shall not, without the express prior written consent of the Employer, assign to any third party the Contract or any part thereof, or any right, benefit, obligation or interest therein or thereunder, except that the Contractor shall be entitled to assign either absolutely or by way of charge any monies due and payable to it or that may become due and payable to it under the Contract.
36 Disclaimer	36.1 Purchaser reserves the right to share, with any consultant of its choosing, any resultant Proposals in order to secure expert opinion. 36.2 Purchaser reserves the right to accept any proposal deemed to be in the best interest of the UGVCL.
I. Other Conditions	
37 Public Disclosure	37.1 All materials provided to the Purchaser by bidder are subject to Country and <STATE> public disclosure laws such as RTI etc. 37.2 The Supplier's Team shall not make or permit to be made a public announcement or media release about any aspect of this Contract unless the Purchaser first gives the Supplier its written consent.
38 SLA Audit	38.1 A designated team / person from <UGVCL> will review the performance of Supplier against the SLA each month. The review / audit report will form basis of any action relating to imposing penalty on or breach of contract of the Supplier.

39	**Adherence to safety procedures, rules regulations and restriction**	39.1	Supplier shall comply with the provision of all laws including labour laws, rules, regulations and notifications issued there under from time to time. All safety and labour laws enforced by statutory agencies and by Purchaser shall be applicable in the performance of this Contract and Supplier's Teamshall abide by these laws.
		39.2	Access to the Datacenter Sites and Purchaser's locations shall be strictly restricted. No access to any person except the essential personnel belonging to the Supplier who are genuinely required for execution of work or for carrying out management/maintenance who have been explicitly authorised by the Purchaser shall be allowed entry to the Datacenter Sites and some Purchaser's locations. Even if allowed, access shall be restricted to the pertaining equipment of the Purchaser only. The Supplier shall maintain a log of all activities carried out by each of its personnel.
		39.3	The Supplier shall take all measures necessary or proper to protect the personnel, work and facilities and shall observe all reasonable safety rules and instructions. Supplier's Team shall adhere to all security requirement/regulations of the Purchaser during the execution of the work. Purchaser's employee also shall comply with safety procedures/policy.
		39.4	The Supplier shall report as soon as possible any evidence, which may indicate or is likely to lead to an abnormal or dangerous situation and shall take all necessary emergency control steps to avoid such abnormal situations.
		39.5	The Purchaser will be indemnified for all the situations mentioned in this clause in the similar way as defined in GCC clause 28.
40	**Non-Solicitation of Staff**	40.1	For the purpose of this contract, both parties to this contract agree, not to solicit either directly or indirectly with a view to provide or offer employment to, offer to contract with or entice a staff member of the other party to leave without the consent of the other during he term of this agreement and for an additional period of 180 days after termination.
41	**Survival**	41.1	The clauses of this contract, which by nature are intended to survive termination of this contract, shall remain in effect after such termination.

Section VIII.
Special Conditions of Contract

The following Special Conditions of Contract (SCC) shall supplement the General Conditions of Contract (GCC). Whenever there is a conflict, the provisions herein shall prevail over those in the GCC.	
GCC 1.1(j)	The Purchaser's country is: **The Union Of India**
GCC 1.1(k)	The Purchaser is: <***Name and address of UGVCL***>, India
GCC 3.1	The language shall be: English
GCC 4.1	For notices, the Purchaser's contact details shall be: ***<Address, Phone, Fax, Email, etc.>***
GCC 5.1	The governing law shall be: Laws applicable in exclusive jurisdiction of The High Court Of Judicature at ***<UGVCL HO>***, India and all courts subordinate to its exclusive Jurisdiction.
GCC 6.2	The formal mechanism for the resolution of disputes shall be: If the parties fail to resolve such a dispute or difference by mutual consultation within twenty-eight (28) days from the commencement of such dispute and difference, either party may require that the dispute be referred for resolution to the formal mechanisms, described below (The date of commencement of the dispute shall be taken from the date when this clause reference is quoted by either party in a formal communication clearly mentioning existence of dispute or as mutually agreed) : a. The mechanism for resolution of disputes for bidders shall be in accordance with the Indian Arbitration and Conciliation Act of 1996. The Arbitral Tribunal shall consist of 3 (Three) Arbitrators. Each Party shall nominate an Arbitrator and the two nominated Arbitrators shall mutually agree and nominate a third Presiding Arbitrator. b. The Arbitrators shall necessarily be retired High Court Judges and the umpire shall be a retired Chief Justice. c. The place for arbitration shall be <to be mentioned by UGVCL>
GCC 12	**Payment Schedule:** **Please refer Annexure-I to SCC**
GCC 12.2	Details of shipping and documents to be furnished by the Supplier shall be: FOR GOODS SUPPLIED FROM ABROAD AS PER INCOTERMS CIF : • Upon shipment, the Supplier shall notify the Purchaser and the Insurance Company by telex or fax the full details of the shipment (Consignment through air is also possible), including Contract number, description of Goods, quantity, the vessel, the

	bill of lading number and date, port of loading, date of shipment, port of discharge, etc. The Supplier shall send the following documents to the Purchaser, with a copy to the Insurance Company. (a) Copy of the Supplier's invoice showing the description of the Goods, quantity, unit CIF price and total amount; (b) Copy of on-board bill of lading marked "freight prepaid". (c) Copy of the packing list identifying contents of each lot. (d) Insurance certificate; (e) Copy of test certificate approval and dispatch instructions issued by the purchaser (combined or separately). (f) Certificate of Origin. (g) Manufacturer's or supplier's Warranty Certificate The Purchaser shall receive the above documents at least two weeks before arrival of the Goods at the port or place of arrival and, if not received, the Supplier will be responsible for any consequent expenses. **For goods from within the Purchaser's country as per INCOTERMS EXW basis including freight and insurance charges:** Upon delivery of the Goods to the transporter, the Supplier shall notify the Purchaser and send the following documents to the Purchaser; a) Copy of the Supplier's invoice showing the description of the Goods, quantity, unit Ex-works price and total amount; b) Copy of Motor Transport Receipt (MTR) of a transport contractor approved by Indian Bankers Association or material receipt certificate from consignee. c) Copy of test certificate approval and dispatch instructions issued by the purchaser combined or separately. d) Copy of packing list identifying contents of each lot. e) Insurance certificate; f) Certificate of Origin. g) Manufacturer's or supplier's Warranty Certificate The Purchaser shall receive the above documents before the arrival of the Goods and, if not received, the Supplier will be responsible for any consequent expenses.
GCC 12.5	The currencies for payments shall be in Indian Rupees (INR).

GCC 13.3	The Supplier shall provide Performance Security of three (03) percent of the total Contract Price. The Performance Security shall be in the form of Bank Guarantee issued by a Scheduled Bank as notified by Reserve Bank of India (RBI). *A model format of Performance Bank Guarantee is provided, utilities to modify the format as per there standard practices*.
GCC 14.5	The price adjustment shall be: Prices shall not be subject to any upward/downward revision on any account whatsoever throughout the period of contract, except as provided in GCC Sub Clause 14.5. The UGVCL reserves the right to increase or decrease the number of towns under the contract subject to the limit of 30% of the number of towns covered under the contract. It is clarified that this increase or decrease of 30% shall not entitle either party to claim revision of the unit price of the goods supplied. In case of services where lump-sum prices are quoted, the increase or decrease of 30% of the number of towns shall be subject to mutual negotiations.
GCC 21.2	The packing, marking and documentation within and outside the packages if applicable shall be: As specified (if any) in Technical Specification
GCC 22.1	The insurance coverage: Goods supplied under the contract shall be also fully insured on all risk basis during inland transit up to destination store in the purchaser's country. The supplier must insure the Goods in an amount equal to 110% of CIF/EXW price of Goods.
GCC 27.3	The period of validity of the warranty shall be 12 (Twelve) months from the date of commissioning.
GCC 27.5	In case of any damage or defect is found during verification after receipt of material at Purchaser's stores or material develops defects within warranty period, the supplier shall attend/replace such defects free of all charges within 30 days of being notified by the Purchaser, of the occurrence of such defects. In case the defect is not attended or replacement of material is not received within specified period, then apart from encashing the performance security deposit, the Purchaser may also take suitable penal action including debarring from all future business.

Annexure I to SCC – Payment terms

Payment Schedule

- 10% of total value of contract as (excluding FMS and Bandwidth Charges) "Mobilization Advance" after signing the contract. The following shall be ascertained before release of payment :-
  - Opening of site office in project area
  - Submission of necessary Bank Guarantee for the 110% of Initial Advance (Interest bearing)
  - Submission of the necessary Contract Performance Bank Guarantee. The same will be released on completion of contract/assignment.
  - Submission of agreed project implementation schedule

- Progressive /Milestone based payment for Each Project Area excluding DR Centre

SCADA /DMS/ OMS system (Control center wise) For Group A&U towns

S.No.	Description/Milestone	% Value
A	Software 1.0 Approval of Functional Design document , BOQ , DRS	10 % of software component of contract
	2.0Pro-rata basis after Successful Completion of Factory Acceptance Tests (FAT as defined in MTS) and Delivery of necessary software to UGVCL as per Bill of Quantities for Software Installation based on certification by the UGVCL	10 % of software component of contract
	3.0 Pro-rata basis after successful completion of End to End Tests (as defined in MTS) at Site based on certification by the UGVCL (Pro rata payment based on 0.25(FRTU E TO E tested /TOTAL FRTU) +0.7(RTU E TO E tested /TOTAL RTU)+ 0.05 (FPI end to end tested/ Total FPI)	20 % of software component of contract
	4.0 After successful completion of Field Performance Tests (as defined in MTS)	25 % of software component of contract
B	Hardware***	10 % of Hardware component of contract
	1.0Approval of Functional Design document , BOQ , DRS 2.0Pro-rata basis on the receipt of equipment at site along with submission of : a. Detailed Packing list identifying contents of each consignment (3 copies) b. Manufacturer's/contractor's Guarantee certificate of Quality c. Insurance Policy/certificate (3 Copies) d. Material Inspection Clearance or equivalent Certificate for dispatch issued by the UGVCL e. Test Certificates	30 % of hardware component of contract 25 % of hardware component of contract

	3.0 Pro-rata basis on successful completion of end to end testing at site based on certification by the UGVCL(Pro rata payment based on = 0.25(FRTU E TO E tested /TOTAL FRTU) +0.7(RTU E TO E tested /TOTAL RTU)+ 0.05 (FPI end to end tested/ Total FPI)	
C	Installation, Testing and Commissioning Cost to Integrate Entire SCADA & IT (relevant to SCADA) Infrastructure (Please refer Form:1 Project management cost) (Pro rata payment based on = 0.25(FRTU E TO E tested /TOTAL FRTU) +0.7(RTU E TO E tested /TOTAL RTU)+ 0.05 (FPI end to end tested/ Total FPI)	• 40% after successful completion of Field Installation Test (as defined in MTS) • 25% after successful completion of end to end test (as defined in MTS)
D	Training: Pro-rata payment on the basis of completion of training of required personnel as mentioned in MTS (Please refer Form F-8)	• 65% of total value of Training Cost
E	Spares and Test Equipment	65% of receipt of material and physical verification of material by UGVCL at the site
F	Final Payment after Operational Acceptance (on successful completion of system availability tests) and Cyber security audit by CERT.IN empanelled agency proof of submission of the required number of reproducible, O&M Manuals, approved drawings, data sheets, test reports and manuals etc. of spares, maintenance & testing equipment , training etc.	25% software, hardware, installation, testing and commissioning + 100% of payment for Integration with legacy applications & Data Migration + 25% payment for training + 25% of spares and test equipment
G	Bandwidth Charges	Based on actual claim and verification by the UGVCL
H	FMS Charges	FMS charges shall be paid quarterly based on SLA

** Payment for Disaster Recovery Centre

In case of common Disaster Centre , First part of payment for Disaster Centre shall be towards satisfactory completion of Operational Acceptance Test (as defined in MTS) for any project area with Disaster Recovery Centre, which will be equivalent to 50% of the total value under this head. The rest of the payment shall be done on basis of satisfactory completion of Operational Acceptance Test (as defined in MTS) for other project areas apportioned on basis of number of project areas (Control centre) .

In case of Disaster centre is individual for town then , the same shall be considered with hardware software etc mile stone defined for Control centre cost

*** Hardware also includes power supply equipment and communication equipment. SECTIONLIZER/ RMU/FPIs /Numerical relays

SCADA system (Distt Control center wise) (B/C)

S.No	Description/Milestone	% Value
A.	**Software** 1.0 Approval of Functional Design document , BOQ , DRS 2.0Pro-rata basis after Successful Completion of Factory Acceptance Tests (FAT as defined in MTS) and Delivery of necessary software to UGVCL as per Bill of Quantities for Software Installation based on certification by the UGVCL 3.0 Pro-rata basis after successful completion of End to End Tests (as defined in MTS) at Site based on certification by the UGVCL (Pro rata payment based = (0.9 *RTU E TO E tested /TOTAL RTU) + 0.1* FPI END TO END TESTED /Total FPI) 4.0 After successful completion of Field Performance Tests (as defined in MTS)	10 % of software component of contract 10 % of software component of contract 20 % of software component of contract 25 % of software component of contract
B.	**Hardware***** 1.0Approval of Functional Design document , BOQ , DRS 2.0 Pro-rata basis on the receipt of equipment at site along with submission of : a. Detailed Packing list identifying contents of each consignment (3 copies) b. Manufacturer's/contractor's Guarantee certificate of Quality c. Insurance Policy/certificate (3 Copies) d. Material Inspection Clearance or equivalent Certificate for dispatch issued by the UGVCL e. Test Certificates 2.0 Pro-rata basis on successful completion of end to end testing at site based on certification by the UGVCL(Pro rata payment based on = 0.3(FRTU E TO E /TOTAL FRTU) +0.7(RTU E TO E /TOTAL RTU)	10 % of hardware component of contract 30 % of hardware component of contract 25 % of hardware component of contract
C	Installation, Testing and Commissioning Cost to Integrate Entire SCADA & IT (relevant to SCADA) Infrastructure (Please refer Form:1 Project management cost) (Pro rata payment based on = 0.3(FRTU E TO E /TOTAL FRTU) +0.7(RTU E TO E /TOTAL RTU)	• 40% after successful completion of Field Installation Test (as defined in MTS) • 25% after successful completion of end to end test (as defined in MTS)

D.	**Training:** Pro-rata payment on the basis of completion of training of required personnel as mentioned in MTS (Please refer Form F-8)	• 65% of total value of Training Cost
E.	Spares and Test Equipment	65% of receipt of material and physical verification of material by UGVCL at the site
F.	Final Payment after Operational Acceptance (on successful completion of system availability tests) and Cyber security audit by CERT.IN empanelled agency proof of submission of the required number of reproducible, O&M Manuals, approved drawings, data sheets, test reports and manuals etc. of spares, maintenance & testing equipment etc.	25% software, hardware, installation, testing and commissioning + 100% of payment for Integration with legacy applications & Data Migration + 25% of balance payment for training + 25% of spares and test equipment
G.	Bandwidth Charges	Based on actual claim and verification by the UGVCL
H.	FMS Charges	100% of the annual FMS charges at the end of each year based on SLA

****** Payment for Data Recovery Centre

First part of payment for Data Recovery Centre shall be towards satisfactory completion of Operational Acceptance Test (as defined in MTS) for any project area with Data Recovery Centre, which will be equivalent to 50% of the total value under this head. The rest of the payment shall be done on basis of satisfactory completion of Operational Acceptance Test (as defined in MTS) for other project areas apportioned on basis of number of project areas (Control centres) .

*** Hardware also includes power supply equipment and communication equipment. and FPIs