Notice Inviting Tender

(Tender invited through e-Tendering mode only)

For

Supply, Implementation and Maintenance of SCADA System for Smart Grid Pilot Project at Chandigarh Electricity Department (CED)

No. RECPDCL/TECH/SCADA-CED/e-Tender/2016-17/3931 Dated: 09.03.2017

REC Power Distribution Company Limited

(A wholly owned subsidiary of REC, a *'Navratna CPSE'*

Under the Ministry of Power, Govt of India)

Corporate office

A10, 4th Floor, Kribhco Bhawan,

Sector-1, Noida – 201301

Tele : 0120-4383783

Website : www.recpdcl.in

Description of task, Pre-qualifying criteria, e-tender submission format and procedure is available on RECPDCL website (www.recpdcl.in), REC website (www.recindia.com), Central Publication Portal (www.eprocure.gov.in)

Important Dates for E- Tendering mode	
Date of Release of NIT	**10.03.2017**
Last date for queries / seeking clarification	**20.03.2017 at 1800 Hours**
Pre Bid Meeting	**21.03.2017 at 1300 Hours**
Last date of submission of Tender	**27.03.2017 upto 1430 Hours**
Date of Opening of Technical bid	**27.03.2017 at 1500 Hours**
Date of Opening of Financial bid	**To be intimated later**

Note:

Online registration shall be done on e-tendering website i.e. www.tenderwizard.com/REC & in general, activation of registration may takes 24 hours subject to the submission of all requisite documents required in the process.

-Sd-

(S.C. Garg)

Addl. C.E. O.

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SECTION-I

TENDER INFORMATION

Name of the assignment:

Supply, implementation and Maintenance of SCADA System for Smart Grid Pilot Project at Chandigarh Electricity Department (CED)

Important information

Sl. No.	Event	Information to the agencies
1	Date of Release of NIT	**10.03.2017**
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4	Last date of submission of Tender	**27.03.2017 upto 1430 Hours**
5	Date of Opening of Technical bid	**27.03.2017 at 1500 Hours**
6	Date of Opening of Financial bid	**To be intimated later**
7	Pre- Bid Meeting Address	REC Power Distribution Company Limited, A10, 4th Floor, Kribhco Bhawan, Sector-1, Noida – 201301 Telefax : 011-4128768,44128760/67
8	Tender Document	The details can be downloaded free of cost from the websites www.recpdcl.in (or) portal.recpdcl.in (or) www.recindia.com (or) www.eprocure.gov.in (or) www.tenderwizard.com/REC
9	EMD #	Rs. 5,11,400/-
10	Address for Bid submission	**Shri. Subhash Chandra Garg,** Addl. Chief Executive Officer, REC Power Distribution Company Limited, A10, 4th Floor, Kribhco Bhawan, Sector-1, Noida – 201301 Tele : 0120-4383755 Email- ced.projects@recpdcl.in/scgarg@recpdcl.in
11	Contact Person	**Shri Sunil Bisht ,** Deputy Manager (Technical) REC Power Distribution Company Limited (RECPDCL) Phone:0120-4383759/773 Email- ced.projects@recpdcl.in/sunil.bisht@recpdcl.in

 # The EMD (Earnest Money Deposit) is to be submitted by all the participating bidders in the form of demand draft of an amount of Rs 5,11,400/- (Rupees Five Lakh Eleven Thousand and Four Hundred Only) of any schedule Indian bank in favor of REC Power Distribution Company Limited, Payable at

New Delhi .The EMD of unsuccessful bidder will be returned within 180 days from the contract and EMD of successful bidder will also be returned after acceptance of work order and submission of PBG (Performance Bank Guarantee) i.e. 10% of the Contract Value.

➢ The bid shall remain valid for a period of 180 days from the last date of bid opening

SECTION-II

PREFACE

Chandigarh Electricity Department (CED) has recently awarded Smart Grid Pilot Project Works under National Smart Grid Mission (NSGM) to M/s REC Power Distribution Company Limited (RECPDCL) with Tata Power Delhi Distribution Limited as its Technology Partner.

Chandigarh is a union territory in the northern part of India that serves as the capital of the states of Punjab and Haryana. The Local Distribution of electricity in Chandigarh was taken over by the Chandigarh Administration from the PSEB on 2nd May, 1967. Chandigarh Electricity Department is responsible for Transmission and Distribution of power supply up to consumer's door-step for making quality and continuous power supply available to each and every resident.

Distribution system at Chandigarh has AT&C losses of 14.63%. There are areas which can be improved using Smart Grid technologies:

i. Online visualization of energy consumption up to consumer level.
ii. Continuous two way communication facility between utility and consumers.
iii. Monitoring of Outage & Quality of power up to consumer level.
iv. Online information for utilization of assets like distribution transformer, LT lines etc.
v. Preventive maintenance of distribution transformer.
vi. Control and monitoring of sub-station equipment.

The Scope of Services includes implementation of reliable, secure and economically viable Smart Grid technologies which broadly categorized as mentioned below.

i. Advanced Metering Infrastructure (AMI)
ii. Sub-station Automation System(SAS)
iii. Integration of Roof top solar through net meter
iv. Distribution Transformer Monitoring Unit

Smart Grid technologies, which would facilitate efficient, accurate & effective online recording & monitoring of the energy exchanges in distribution system to reduce operational errors viz. reading error, bias error, typographical errors etc. caused by involvement of human element.

i. Timely raising of bills
ii. Actuate empowerment of consumers to participate in the energy management process.
iii. Implement technologies that will help in proper monitoring of assets for extended life.
iv. Efficient system operation by better load management
v. Tempers and alarms monitoring.
vi. Online energy audit to overcome theft problem.

vii. Enable high level of customer satisfaction and increased awareness.
viii. Planning for new electricity connections.
ix. Utilization of renewable resources towards sustainability & green energy benefits by net metering.

Smart Meters and communication systems shall be installed for 29,433 consumers scalable to approx. 2,00,000 consumers, which will include 100 nos. of Smart Meters with net-metering feature. IT infrastructure consisting of Servers, MDAS, MDAM and SCADA software etc. shall be installed in control Centre for monitoring, collection of data, storage and analysis.

This RFP is being floated on behalf of CED to appoint System Implementation Agency (SIA) for Supply, Implementation & Maintenance of Communication system or AMI for Smart Grid Pilot Project at Chandigarh Electricity Department (CED). The activities for BA are described in the detailed scope of work.

Profile of UT Chandigarh

1. **Demographic Stats**

Table 1 - Demographic statistics

Location	Area in sqkm	Population (Nos.)			Population Density (Nos./km^2)
		Total	% Urban	% Rural	
Proposed Project Area, Chandigarh	32	2.5 Lacs (approx.)	80%	20%	7812

 # above data is only for reference and may vary in actual

2. Chandigarh Electricity Department (CED) has decided to implement a pilot smart grid project in operation subdivision no. 5 comprising of Sector 29,31,47,48. Industrial Area Phase I and Phase II, Ram Darbar Phase I & Phase II, Vill. Halomajra, Behlana, Raipur, Bairmajra, Faidan, Makhanmajra, BRD Airforce station which is named as project area. Map of the proposed project area is shown in Figure 1.

Figure 1

3. **Electricity Profile of UT Chandigarh**

   The electricity profile of Chandigarh, in the year 2014-15 is as under:

   1. The peak demand of Chandigarh Electricity Department is around 282 MW which is being met from different Central/State Generating stations.
   2. UT Chandigarh has no generating capacity of its own.
   3. At present, the City is receiving 47% of its power through Mohali (PSEB), about 3% through Dhulkote (BBMB) and remaining 50% through Nalagarh.
   4. The city has a transmission network which comprises of one no. 220 kV Sub Station at Kishangarh Manimajra, 11 nos. 66 kV Sub Stations and 6 nos. 33 kV Sub Stations.
   5. At present the city has 2,00,000 consumers which includes 1,72,653 domestic consumers, 21,428 commercial consumers and about 2,300 industrial consumers.
   6. The average power requirement is around 32.49 lac units per day.
   7. UT has an allocation of 166 - 236 MW of power from different Central/State Generating Stations during different hours of the day.
   8. Per capita consumption is 1168 units per person per annum.
   9. Besides this, Chandigarh administration is maintaining 19437 numbers of street light points within sectors roads.

4. **Electricity Profile of Project Area**

   Existing electrical network in the project area is as follows:

   1. The peak demand (met) of project area is around 65 MW which is being met from different Central/State Generating stations.

2. Peak demand timings of the project area in summer season is from 1500 to 1600 hrs. and from 2200 to 2300 hrs.

3. Identified project area for Smart Grid implementation in UT Chandigarh has 17,490 nos. of single phase, 11037 nos. of three phase and 906 nos. of CT operated three phase consumers.

4. The average energy requirement in project area is around 400 MU annually.

5. There are six (06) nos. substations in the project area which include one (01) no. 66/33/11 kV substation, one (01) no. 33/11 kV substation and four (04) on. 66/11 kV substations.

6. Total number of DTs in the project area is 402 with 1,06,500 KVA transformation capacity.

SECTION-III

Instructions to Bidders

3.1 Submission of Bid

Agency shall submit their responses online through e-tendering website www.tenderwizard.com/REC

A. The submission and opening of Bids will be through e-tendering process.

Agency can download Bid document from the RECPDCL web site i.e. http://www.recpdcl.in or portal.recpdcl.in or www.recindia.com or eprocure.gov.in and e-tendering regd. link is given in RECPDCL website i.e. www.tenderwizard.com/REC

(Note: To participate in the e-Bid submission, it is mandatory for agency to have user ID & Password. For this purpose, the agency has to register them self with REC PDCL through tender Wizard Website given below. Please also note that the agency has to obtain digital signature token for applying in the Bid. In this connection vendor may also obtain the same from tender Wizard.)

Steps for Registration

(i)   Go to website http://www.tenderwizard.com/REC
(ii) Click the link 'Register Me'
(iii) Enter the details about the E-tendering as per format
(iv) Click 'Create Profile'
(v)   E-tender will get confirmation with Login ID and Password
(vi)

Note- Online registration shall be done on e-tendering website i.e. **www.tenderwizard.com/REC** & in general, activation of registration may takes 24 hours subject to the submission of all requisite documents required in the process. It is sole responsibility of the bidder to register in advance.

B. Steps for application for Digital Signature from Bid Wizard:

Download the Application Form from the website http://www.tenderwizard.com/REC free of cost. Follow the instructions as provided therein. In case of any assistance you may contact RECPDCL officers whose address is given at the Bid.

Bid to be submitted through online mode on website www.tenderwizard.com/REC in the prescribed form.

C. The Agency qualifying the criteria mention in section VI should upload Bid document with duly signed scanned soft copy of the documents given below for the prequalifying response:

Pre- Qualifying Criterion Documents/Technical Bid)

1   Form-I ------------Letter of submission of Tender
2   Form-II ------------Pre-Qualifying Criteria Details
3   Form-IV -----------Format for No-Deviation Certificate
4   Form-V ----------- Manufacturer Authorization Form
5   Form-VI ---------- Format of Curriculum Vitae
6   Form-VII ---------- Letter of Transmittal
7   Form-VIII ---------- Format for Integrity Pact
8   Annexure-A ----- Performance Bank Guarantee
9   Annexure-B ----- Acceptance form for participation in reverse auction event
10   Annexure-C ----- EMD Bank Guarantee
11   Section-X ------- Detailed Technical Specification
12   Section-XI ------- Bill of Material
13   EMD of Rs. 5,11,400/- in form of DD or Bank Guarantee may be drawn from a scheduled commercial bank in favour of The "REC Power Distribution Company Ltd", New Delhi and scanned copy to be uploaded and original to be submitted before the last date & time of Submission of Tender.
14   Documents required in supporting of pre-qualification criteria details.

Financial Bid

1.   Form-III---------Financial Proposal (to be submitted through online mode only)

Financial bid to be submitted in the specific format designed same may be downloaded from website www.tenderwizard.com/REC and after filling the form it is to be uploaded through digital signature.
The all document should be addressed to.

Addl. Chief Executive Officer REC Power Distribution Company Ltd. A10, 4th Floor, Kribhco Bhawan, Sector-1, Noida – 201301

(Note: All papers that comprise the Bid document of the concerned Bid must be numbered. An index of each page should also be provided)

SECTION-IV
Scope of work & Service Level Agreement

Introduction

Under this project new SCADA system shall be established at Control Centre, New RTU & IEC-61850 based Numerical relays commissioning at 6 No's substations and setup of the network connectivity over MPLS system as per the intent given above.

The scope of work under this package shall include in complete conformity with the subsequent sections of this volume Survey, Planning, Design, Engineering, Integration, Supply, Delivery to site, Unloading, Insurance, Storing, Handling, transportation to final locations, Installation, Termination, Testing, Documentation and Commissioning including overall Project Management of following:

Scope of Work

a) Deployment of SCADA system for 6 nos. of grid substation including computer hardware and software along with associated items at respective Control Centre. The new system shall be deployed in such a way that the operation of the existing system is not disturbed.

b) Selected bidder will propose & establish the solution initially for approx. 6 Nos. Sub stations but it should be horizontally & vertically scalable to cover the entire utility S/stn i.e. approx. 25 Nos.

c) The equipment shall be supported by the OEM for a minimum period of next 5 years. Bidder will submit OEM MAF form as per FORMAT-V from OEM for all the equipment being proposed under this tender.

d) Integration of New RTUs / SASs/DTMUs with Control Centre System for Real time data acquisition over IEC 60870-5-104

e) Distribution Management Systems with following functions: -
   - Network Connectivity Analysis (NCA)
   - Jumper, Ground cut

f) Supply and installation of VPS (video projection system) at Control center.

g) Supply, installation, testing of RTU & BCPU at grid substations.

h) Installation & integration of MFT & DCPS at grid substations

i) Preparation of real time reports as per utility requirement.

j) Integration with Market Applications: The employer intends to separately procure IT Applications such as Open Access Application, Metering Applications and Scheduling Applications. SCADA System shall exchange data with these applications including database and models. Integration with various OT/IT systems like GIS, MDM, AMI etc. on Interface over SOA.

k) Providing complete System Documentation and User Manual

l) Training & Hand Holding

m) Providing necessary tools & licenses for all the software & hardware

n) Providing and maintenance of MPLS network connectivity for control center to RTU connections

o) Conduction of Inspections, FAT & SAT of all project deliverables.

The Contractor is encouraged to offer standard products and designs. However, the Contractor must conform to the requirements and provide any special equipment necessary to meet the requirements stated herein. The conceptual Architecture for the SCADA system is enclosed at Figure 2 (SCADA-Conceptual configuration). Bidder can suggest any changes in the architecture as per the device connectivity and interoperability.

It should be noted that design information and Bill of Quantity (BOQ) are provisional only. The Contractor shall verify the design data during the site surveys & detail engineering and finalize the BOQ as required for ultimate design & system performance. The employer reserves the right of execution of works within the stipulated quantity variation provision other than those indicated in the appendices at the same rates, terms and conditions.

The Bidder's proposal shall address all functional 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. The Bidder's proposal shall clearly identify all features described in the specifications or in any supporting reference material that will not be implemented; otherwise, those features shall become binding as part of the final contract.

The bidders are advised to visit sites (at their own expense), prior to the submission of proposal, and make surveys and assessments as deemed necessary for proposal submission. The successful bidder (Contractor) is required to visit sites. The site visits shall include all necessary surveys to allow the contractor to perform the design and implementation functions. The Contractor shall inform their site survey schedule to the Employer and Owner well in advance. The site survey schedule shall be finalized in consultation with the Employer and Owner.

Detailed Scope of Work

SCADA FUNCTIONS

1. General requirements

This section describes the functions to be performed by the SCADA applications for distribution system for the project area. Bidders are encouraged to supply standard, proven & tested products that meet or exceed the Specification requirements. This chapter describes the requirements of ISR functions also. Unless specified as optional functions/ features all functions/ features mandatory for the project area.

1.1. Design requirements

The software shall be modular in nature. The software shall be able to work platform based on minimum 64-bit architecture. All the variable parameters of SCADA 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.

Figure 2 (SCADA- Conceptual configuration)
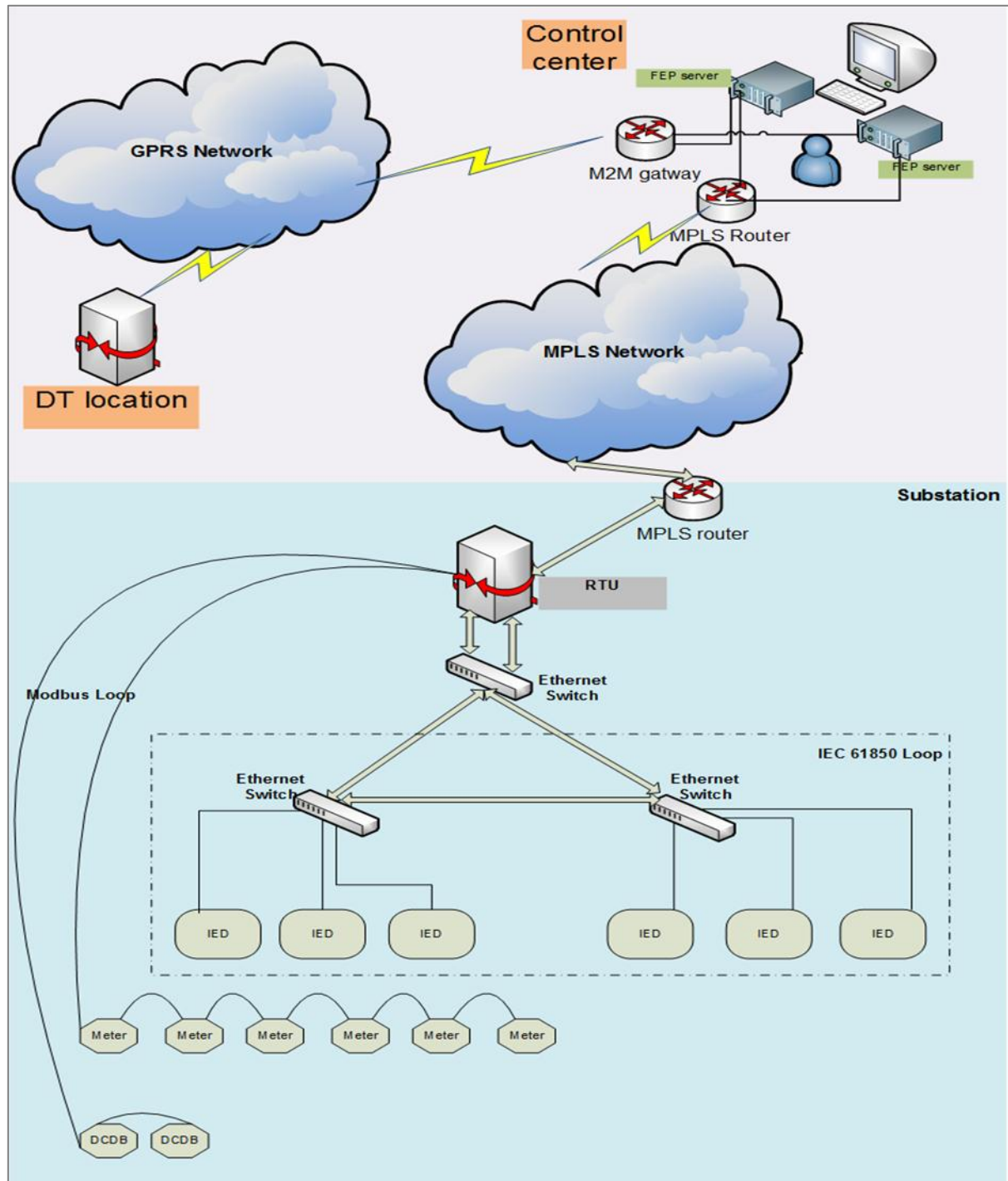
1.2. SCADA Function Access

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

1.3. 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) Trace and JGC functionality for DMS application
    d) Web server applications, Security applications
    e) Network Management system (NMS)

The following are Non-Critical functions

    a) Database modification and generation
    b) Display modification and generation
    c) Report modification and creation

2. SCADA Functions

The following SCADA functions are envisaged under this specification.

    i.   Data Acquisition from RTUs and IED's at S/S, DTMU at DT locations.
    ii.   Time synchronization of RTUs, DTMU, Relays, IED Data Exchange among the contractor supplied SCADA system, IT system establishment
    iii.   Data Processing
    iv.   Continuous real-time data storage and playback
    v.   Sequence of event processing
    vi.   Supervisory Control
    vii.   Failsoft capability
    viii.   Remote database downloading, diagnostics & configuration
    ix.   Information Storage & Retrieval (ISR)

The System Design Parameters of SCADA functions, the power system sizing, Performance requirements for complete SCADA system are specified are specified in **Design Parameters and**

Performance Tables ()The SCADA system shall have capability to accept data from the following sources:

a) Telemetered data received from RTUs, DTMUs
b) Data received from IT system established.
c) Data exchange
d) Calculated data
e) Pseudo-data (Manually entered data)

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.

2.1. Communication protocol.

SCADA system shall use the following protocols to communicate

a) for RTU - IEC 870-5-104 protocol
b) for MFTs – MODBUS
c) for IT Systems - (in specified format (OPC / CIM-XML/ICCP/ ODBC Format) Model & Data Exchange over IEC 61968-1 Enterprise SOA Based BUS)
d) For DTMU – IEC 104 Protocol

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. Data Acquisition

SCADA system shall acquire data from Remote Terminal Units (RTUs), Distribution Transformer Monitoring Units (DTMUs)

a) RTU & DTMU
The type of data to be acquired through RTUs, DTMUs shall include analog values, digital status data (Double point and single point indications) and SOE data from the substation, DTs 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, from the   MFTs.

b) DTMU
The proposed DTMU system will meet following requirements and shall be integrated with SCADA system on real time basis

- Monitor and transmit distribution transformer instantaneous and energy parameters at set periodical time intervals.
- Monitor and transmit following parameters from distribution transformer.
    i. Electrical analogue (V, I, KW, KVAR, pF etc.) and energy parameters.
    ii. Transformer oil temperature via thermostat (with required high temperature set point).
    iii. Transformer oil low level via digital input.
- Monitor abnormal conditions and send alarm messages.
- Generate alarms and events on following conditions:
    i. Transformer overload
    ii. Load unbalance in the transformer.
    iii. Low transformer oil level
    iv. High transformer oil temperature.
    v. High harmonics

2.3. Polling method

Digital status data from RTU shall be reported by exception and shall be updated and displayed within 4 seconds. Digital status data from DTMU shall be also be reported by exception and shall be updated and displayed within 6 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 & DTMU. The analog value, when reported by exception, shall be updated & displayed within 5sec from S/S & 10sec from DT locations at the Control Centre. 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 Control Centre, S/S shall not be more than 0.1sec at each location & latency shall not be more than 0.5 sec 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 & DTMU at scan rate of 15 minute/1 hours (configurable up to 24 hours). Alternatively, the energy values shall be calculated for each 15 minute/1 hour blocks at SCADA level from the acquired energy values of MFTs through RTU.

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 computer system shall also be able to collect any and all analog & digital data from its RTUs/DTMU on demand. Apart from the periodic integrity scan, the integrity scan shall also be initiated automatically for an RTU/DTMU whenever the following situations arise:

i. Upon startup of the system
ii. RTU/DTMU status change is detected such as RTU/DTMU restart, Communication Link restoration
iii. On demand by SCADA functions
iv. On request by the user

The TCP/IP Communication for RTU/DTMU 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, DTMU 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.

2.4. Telemetry Failure

If data is not received from an RTU/DTMU 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/ DTMU or RTU/ DTMU module or MFT etc. Only a single alarm shall be generated if an entire RTU/ DTMU 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/DTMUI) 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/DTMU is enabled, the data is scanned in normal fashion and control command execution is allowed.

b) *Disable*

When RTU/DTMU is disabled, the data scanning & control execution is disabled. This is equivalent to" delete from scan "of complete RTU.

c) *Test /Maintenance*

Placing an RTU/DTMU in test mode shall generate an appropriate event message. When an RTU/DTMU is in the test mode, the real-time database shall retain the last value from all points collected via the RTU/DTMU 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/DTMU 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/DTMU 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/DTMU, the database values shall resume updating on each scan, and any controls for the RTU/DTMU shall be enabled.

2.5. Time synchronization of RTUs

The SCADA system will be synchronized from the GPS based Time and frequency system. The SCADA system shall synchronize the time of all connected RTUs/DTMU every 15 minutes (user configurable from 5 minutes to 24 hrs.) using time synchronization message in the IEC 870-5-104 protocol /NTP/SNTP. The servers /Workstations at SCADA control center shall be synchronized using NTP/SNTP.

2.6. Data Exchange

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

2.7. Data Processing

The SCADA 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 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 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 RTUs/DTMU etc.)
b) Calculated data
c) Manually entered data
d) Sequence of events data
e) Alternate data sources

2.7.1. Analog Data Processing

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

a) **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 & B are programmer-adjustable constants assignable as database attributes on a per point basis.

b) Zero dead band processing

The SCADA system at Control Centre 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.

c) 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.

d) Limit Monitoring

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

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

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

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

resulting from a change in limit value shall be reported. Contractor shall finalize & take approval from utility for limit values.

e) Rate of change /Gradient
All telemetered and calculated analog points shall be also processed for rate of change of / 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.

f) 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 functions. All imports to bus bars shall be represented with + sign and all exports from bus bars shall be with –ve sign.

g) 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.

2.7.2. 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/DTMU 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

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 re closer.

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

2.7.3. 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.

2.7.4. Substation Topology Processing

The SCADA 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 define the configuration of the substation for display. The energization of lines, transformers, bus sections and generating units shall be determined so that the associated displays may correctly show the status of these power system elements. The configuration shall be re-evaluated and updated whenever a switching device status change & analog value change beyond dead band is detected.

2.7.5. 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.

2.7.6. 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.

Table 2 (Quality Codes- Reason)

Quality code	Code	Reason
Telemetry Failure (RTU Link)	T	Telemetry has failed
Manual Replaced	M	Manual updation
Delete from Scan (RTU/point)	D	User disabled the scan of the of data/point

Questionable data	Q	Analog values of the de-energized elements
Calculated	C	Calculated data
Estimated	E	Estimated data from state estimator
Limit Override	L	Limits are overridden
Primary /secondary source	P/S	Primary or secondary source
Reasonability Limit Exceeded	R	Value beyond reasonability limit
Alarm Inhibit	A	Alarm processing is inhibited
Test or maintenance mode	X	Point is in test /maintenance mode

2.8. 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.

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.

2.9. Sequence-of-Events data

Sequence-of-events (SOE) data shall be chronological listings of 'status change events with time stamp' acquired from RTUs /DTMUs. The SOE data shall be collected from all RTUs/DTMUs 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/DTMU 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/DTMU is defined in respective sections for RTU/DTMU. SCADA system at Control Centre shall have 1ms SOE resolution. However, as SOE time stamping is done at RTU/DTMU level, the same shall be in line with resolution defined for RTU/DTMU.

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

2.10.   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 initiates control execution, the RTU/DTMU shall be addressed for verification that the correct point has been selected at the RTU/DTMU and then the control action shall be executed.

It shall be possible to issue control commands as a group control from SCADA where switching devices pertaining to different RTUs/DTMU or a RTU/DTMU 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/DTMU, using the Selection Check before operate (SCBO) of prior–to-execution. The control commands pertaining to different RTUs /DTMUs 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 /DTMU 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 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 /DTMU data acquisition function.

Functional requirements for the various types of supervisory control are given below. A supervisory control request shall be sent from Control Centre 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;
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 Centre shall occur before any transmission is made for control purposes. A control rejection message shall be displayed for the Dispatcher

2.10.1. Digital Status Control

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

Successful completion of the control request shall be recorded as an event. Failures to complete shall be handled as specified in UI section. Control requests shall be canceled and the selection of the point shall be terminated when the user cancels a request, does not perform the next step of the control procedure within the selection time-out period from the previous step of the procedure, or the request is rejected.

1. **Breakers**

   The user shall be able to select and operate the two state controllable switching device i.e. Circuit breakers/ isolators

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.

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 Centre 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.

2.10.2. Set point Control

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

2.10.3. Auto execution sequence /Group control

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

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

After executing a supervisory control action, the SCADA 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 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 shall not introduce any other delays in the execution of a 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.

2.10.4. Control Inhibit Tag

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

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

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

b) **Tag priority**: Further the user shall be able to place at least 4 tags per device. Only the highest priority tag shall be displayed. Any combination of tags shall be supported, including multiple tags of the same type. The combined effect of multiple tags shall be to inhibit a type of control if it is inhibited by any of the tags.
When a tag is placed on a device, the user shall be prompted to enter tag number and comment. An event message shall be generated each time a control inhibit tag is placed or removed with information on user ID, type of tag, time of placement or removal of tags.

2.10.5. Control Permissive interlocks

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

2.10.6. Control Action Monitor

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

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

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

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

For commands issued as part of a group control 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.

2.10.7. 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%.

2.11. Remote database downloading, diagnostics & configuration:

The SCADA system shall be able to download database run diagnostics & create/modify /delete configuration/ parameterization from centralized Control Centre locations to RTU/DTMU etc. using ASDU/ messages of respective protocols or file transfer.

2.12. Information Storage and Retrieval

Information Storage and Retrieval (ISR) function shall allow collection of data from real-time SCADA 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 computer system through backups on storage medias viz. tapes /MO disks etc.

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 to external systems for analytics over SOA / ESB for Integration with IT Systems, over the Enterprise Services Bus & SOA Architecture provided as part of IT SRS. 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 System.

In ISR should also support ad-hoc queries, and define display and report formats for selected data via interactive procedures from operator workstations. Formatted reports and responses

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

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

The System Design Parameters of ISR system is given in the **Design Parameters and Performance Tables.**

2.12.1. Circuit breaker status Table

The ISR function shall maintain a table in RDBMS database where real-time status of all Circuit breakers, 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. For expected duration of outages due to protection tripping, the same shall be user enterable field. Such daily tables for two months' duration shall be stored on auxiliary memory.

2.12.2. 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 two months' duration shall be stored on auxiliary memory.

2.12.3. Hourly Data tables

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

a) Selected analog values along with their associated quality codes
b) Selected status values along with their associated quality codes

c) Results of hourly calculations for selected analog points (at least maxima & minima with associated time and average) along with their associated quality codes.

d) In addition to above a separate hourly energy data table exclusively for energy values (Export and Import Active and reactive Energy values for each feeder) shall be created in ISR along with their associated quality codes.

Hourly data tables shall be created on daily basis. Such daily tables for two months' duration shall be stored on auxiliary memory.

2.12.4. Missed Hourly Data Storage

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

(a) Store zero and a telemetry failure quality code for each missed hour.

(b) Store the last good data value, with a questionable data quality code, for each missed hour.

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

2.12.5. 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

2.12.6. 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.

2.12.7. 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 months' duration shall be stored on auxiliary memory. For the purpose of sizing of table, daily 4 changes per SOE point may be considered. All CBs, protection and alarm contacts shall be considered as SOE.

2.12.8. Historical Information (HI) Data Retrieval

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

(a) The user shall be able to view and edit HI data on displays/Forms and reports. The user shall be able to edit HI data, request recalculation of all derived values, and regenerate and print any daily, weekly or monthly HI report for the current and previous month.

(b) The user shall be able to view tabular trend and graphical trend of multiple data points simultaneously by specifying the start date and time, the end date and time, and the time period between displayed samples. The duration of viewable tabular trend and graphical trend could be up to 24 hours. The features of Tabular/graphic trend is mentioned in the specification for User interface.

(c) The retrieval shall provide 100% accuracy and fidelity of data

2.12.9. System Message Log Storage and Retrieval

System message log, which shall consist of the chronological listing of the SCADA 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. System message log data for previous months shall be backed up on Magnetic tapes/ MO disks by the user for which ISR function shall prompt the user every hour with suitable message to remind user for taking the backup on the 10th of every month. This message shall be disabled once the backup is taken.

2.13. 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 modelled.

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

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

(a)   Bus connectivity (Live/ dead status)

(b)   Feeder connectivity

(c)   Network connectivity representing S/S bus as node

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

(e)   Representation of Loops (Possible alternate routes)

(f)   Representation of parallels

(g)   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 colours 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.

2.13.1. Tracing

NCA function shall also have the capabilities of network tracing when requested by the dispatcher. Dedicated colours 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 colour.

(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 colour.

(c)   **Between Tracing**: This feature shall enable the operator to select any two components of the network and shall able to trace all components connected in between them.

(d)   **Downstream Trace** – from a selected circuit element the trace identifies all devices that are downstream of the selected element. In the case where a downstream trace is

performed on a de-energized section of the network, the trace highlights all devices electrically connected to the element.

2.13.2. 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.

a) **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.

b) **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.

c) **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.

SYSTEM SOFTWARE REQUIREMENTS

3. 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 applications. This section also describes the standards to be followed for all supplied software. 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.

3.1. Software Standards

All SCADA 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 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. 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

3.1.1. Design and Coding Standards for SCADA applications

All SCADA applications shall be maintainable by employer using the supplied software utilities and documentation. The SCADA software design and coding standards shall also address the following:

(a) Expansion/ scalability: software shall be dimensioned to accommodate the ultimate size of SCADA 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 C, C++, VB, JAVA 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

3.2. 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.

3.3. Time and Calendar Maintenance

The SCADA system shall maintain Time and date for use by various software applications. The GPS based time receiver shall be used for synchronizing the SCADA system time. All Servers and Operator workstation clocks shall be synchronized within the accuracy of +/-100 milliseconds. The SCADA system shall not be dependent on a particular server for time /calendar maintenance. The SCADA shall include two redundant time and frequency standards. Failure of the online unit shall result in automatic switching to the redundant unit. The SCADA 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 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.

3.4. Network Software

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

3.4.1. Network Communication

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

3.4.2. 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.

3.4.3. Network services

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

3.4.4. 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, and 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 – SAS 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

3.4.4.1. *Features:*

Followings are the features specific to each component of security system

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.

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 executables and/or attempts to access privileged services,
   - In an event where user accounts are added, deleted, or modified changes to key system files and executables 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:
       a) Terminate user Login (intruder)
       b) Disable user Account (intruder)
       c) Administrator can define the action to be taken
       d) Forge a TCP FIN Packet to force an 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.

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.

3.4.4.2. Other aspects of security
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.

Security Alarms

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

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.

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.

Data Access through intranet

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

The external users shall be licensed users of the employer.

The following features are required:

a) The Web servers shall be sized to support at least 20 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 protected LAN.

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

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.

Network Management system (NMS)

A network monitoring and administration tool shall be provided. The interface of this tool shall show the SCADA SAS 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 servers, workstations, devices, communication interface equipment, and all SCADA gateways and routers, switches etc.

The network management software shall be based on the Simple Network Management Protocol (SNMP-Internet RFC 1157) over TCP/IP (CMOT), with additional proxy software extensions as needed to manage SCADA 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 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. up to 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.

3.5. Database structure

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

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

The SCADA 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.

3.6. Software Maintenance and Development Tools

3.6.1. 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 files
- 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:

3.6.2. 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.

3.6.3. 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.

3.6.4. 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.

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

3.6.6. 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. 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.

3.6.7. Code Management

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

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

An integrated source code development subsystem supporting C, Fortran, Java, VB and C++, other programming languages used in the SCADA shall provide a software configuration management system to define the elements and the associated attributes of the applications provided in the SCADA. 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

3.7. 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 initialization data to support the generation of all relational, real time database (RTDB) non-relational run-time databases required to implement the functions of SCADA system. All the facilities required for generating, integrating and testing of the database shall be provided with the SCADA system. The delivered SCADA 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 executables shall be downloaded to all respective machines. Executing the database generating functions shall not interfere with the on-line SCADA 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 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 initialize 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/DTMUI.
(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.

3.7.1. 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.

Data Retention

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

Making Database Online

After an error-free database generation, the user shall be able to test the database 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 server to ensure that all databases are consistent. Inconsistencies shall be annunciated to the user.

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

Tracking Database Changes

The database manager utility shall maintain Audit trail files for all changes made by all users. The audit trails shall identify each change including date and time stamp for each change, and identify the user making the change. An audit trail of at least last 2 months shall be maintained and another audit trail maintaining records of who/when performed the edit operation shall be maintained for a period at least 2 months.

Initial Database Generation

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

3.8. Display Generation and Management

SCADA 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 executables 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 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 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 functions.

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

3.9. Report Generation Software

The SCADA system shall include report generation software to generate new report formats for SCADA 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 functions.

3.10. Software Utilities

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

3.10.1. Auxiliary Memory Backup Utility

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

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

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

3.10.2. Failure Analysis Utility

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

3.10.3. Diagnostic Utility

The system shall have suitable auto diagnostic feature, on line & offline diagnostic Utility for on-line and off-line monitoring for equipment of SCADA system shall be provided.

3.10.4. System utilization Monitoring Utility

Software utility shall be provided in each server and workstation to monitor hardware and software resource utilization continuously and gather statistics. The monitoring shall occur in real-time with a minimum of interference to the normal SCADA 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.

3.10.5. Other Utility 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 applications shall be provided with computer system.

SCADA Hardware Requirement

4. Hardware Requirements

This section describes the technical requirements of all the hardware envisaged in the BOQ for the SCADA system. The minimum hardware specifications (RAM, Aux. Memory, interfaces etc.) for all equipment are specified in the Table A (end part of this document) and the bidder has to submit the details of the supplied hardware along with the bid as per format attached in Table A. The Bidder shall assess the adequacy of hardware specified in the BOQ & if any additional hardware or higher end hardware configurations are required to meet all the requirements of the technical specifications, the same shall be included in the offer. The Bidder's proposal shall include necessary calculations to clearly establish that the proposed hardware meets the functional and performance requirements of the technical specification.

The bidders are encouraged to optimize the requirement of hardware for servers and processors where one or more applications can be combined or distributed in any combination with adequate redundancy without impacting the performance. 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 Supplier. All hardware components shall be new and suitable for the purposes specified.

4.1. General Requirement for Hardware

Delivered hardware shall include all engineering changes and field changes announced by the manufacturer since it was produced. The hardware shall be audited for change orders immediately prior to the factory performance test and unimplemented change orders shall be installed at this time. As part of the field performance test, the Supplier shall have all hardware inspected and certified as acceptable for service under a maintenance contract by the local service offices representing the equipment manufacturers.

All hardware features described in the Proposal shall be fully supported by the SCADA applications. The hardware shall be CE/FCC or equivalent international standard compliance.

All hardware shall include self-diagnostic features. On restoration of power after interruption they shall resume operation. All servers, workstations and network equipment's (Switches, routers, firewall etc.) shall be compatible for remote monitoring using secure SNMP Ver. 3.0. All hardware shall support both IPv6 and IPv4 simultaneously.

The configuration of the SCADA shall comprise of distributed computing environment with an open systems architecture. The system architecture should be designed in such a manner that it can adapt to hardware/software additions, whether supplied by the original supplier of the SCADA or obtained from third party vendor. Additional hardware/software may be required for capacity expansion or for up-gradation, the changes made should not affect the existing SCADA components or its operation.

To be recognized as a true open computer system, all internal communications among the SCADA Servers and all external communications between the SCADA 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 shall ensure that at the time of final approval of hardware configuration and BOQ, all the hardware is as per the current industry standard models and that the equipment manufacturer has not established a date for termination of its production. Any hardware changes, except version upgrade in same series, proposed after contract agreement shall be subject to the following: -

a) Such changes/updates shall be proposed and approval shall be obtained from CED along with the approval of Drawings/documents.
b) The proposed equipment shall be equivalent or with better features than the equipment included in the Contract.
c) Complete justification along with a comparative statement showing the original and the proposed hardware features/parameters including brochures shall be submitted to the CED for review and approval.
d) Changes/updates proposed will be at no additional cost to CED.
e) The porting of software shall be at no additional cost in case of replacement of hardware during the warranty period by bidder.

In this technical specification all hardware has been broadly classified as "Server" and "Peripheral device". The term "server" (also referred as "processor") is defined as any general-purpose computing facility used for hosting application functions as defined in the specification. The servers typically serve as the source of data, displays and reports. The term "Peripheral Device" is used for all equipment other than servers. Peripheral device includes Workstation consoles, WAN router, LAN, printer, Time & Frequency system, External Cartridge Magnetic tape drive, VPS, Firewalls etc.

The redundant hardware such as Servers, Firewall etc. shall work in hot standby manner. All the servers and networking equipment (Firewalls, LAN switches etc.) shall be mounted in rack panel.

4.1.1. Servers

The Servers shall have provision for expansion of the Processor, auxiliary memory and Main memory (RAM). Servers shall be mounted in a rack and a management console should be provided for centrally accessing all the servers implemented at that particular location. Proposed servers should allow hardware assisted virtualization and processor multithreading.

All servers shall have dual redundant power supplies, capable to operate on single power supply module. And there shall not be any interruptions in the operation of servers when there is a failover between the two AC Power Supply of the server.

The minimum hardware configuration of the servers shall be as per **Design Parameters and Performance Tables.**

4.1.2. Communication Servers

FEP (CFE) Server

The redundant FEP server shall be a functional unit that offloads the task of communication & preprocessing between RTUs/DTMUs & SCADA servers. All RTUs/DTMUs shall be connected to CFE through IEC 60870-5-104 link. For any existing RTUs/DTMUs that 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/DTMUs connected either through single channel or redundant channels. In both cases, one FEP server shall be able to take control of all RTUs/DTMUs 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 based security for connecting with IEC 60870-5-104 node 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 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.

The Communication Servers shall be able to process time – stamped data and can be directly connected to GPS device for time synchronization. FEP servers shall have a suitable interface for time synchronization from the GPS based time synchronizing system. This interface shall have the time synchronization accuracy of 1millisecond. The FEP server shall further synchronize the time of the RTUs on IEC 60870-5-104 protocols.

FEP server shall have feature to show the online process of raw data from the RTUs/DCUs as a protocol test analyzer.

Web servers with Firewalls and IPS

Redundant Web servers shall be provided to allow the access of SCADA system data, displays by outside users. One router shall be provided which shall be connected to the external

LAN/WAN communicating SCADA system. The external LAN/WAN users shall be able to access SCADA 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 dual LAN and DMZ dual LAN. All necessary hardware & software for Web Servers with firewalls and IPS shall be supplied by the contractor.

Firewall

Two firewalls shall be provided, one between Web servers & SCADA dual LAN and another between Web servers & Web server dual LAN. Specification of the firewall is given in the chapter for software requirements. Contractor shall provide equivalent tools such as Apache etc. for Web servers if UNIX or LINUX O/s is used to meet the security requirement as envisaged in the specification

Redundant Web servers shall be provided

4.1.3. Development system server

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

4.1.4. Router

Router shall be required for data exchange of SCADA Control Centre with RTU's, DTMU's and respective IT system (IT Data Centre,). The router shall have the following features:

(a) support the OSI and TCP/IP protocols
(b) support X.21/V.35/G.703 interface for interfacing communication links

Routers shall be required for data exchange of SCADA Control Centres with RTUs at various locations. The data exchange between the two centres 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. The router shall support the OSI and TCP/IP protocols. 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**
   a. Flash: Minimum 8MB and upgradable up to 72MB
   b. SDRAM: Minimum 64MB and upgradable up to 320MB
2. **Console Port**: 01 No. for configurations and diagnostic tests

3. **LAN/WAN Port**: The router shall support variety of interfaces as per the concerned utility's requirement at site like V.24, V.35, E1, Channelized E1 etc. along with following minimum number of ports:

   - Two fixed 10/100/1000M 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, 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, fttp 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 (Intergroup Management Protocol Version 2 as per RFC 2236), Multicast Routing support like PIM-SM (RFC 2362), PIM-DM etc., Policy based routing (It shall be possible to affect the normal routing process for specific mission critical traffic through specified alternate routes in the network). A class based scheduling, Priority Queuing mechanism that shall provide configurable minimum Bandwidth allocation to each class and IP Precedence. Congestion Avoidance – Random Early Detection (RED). Support for Differentiated Services as per RFCs 2474, 2475, 2598 & 2597.

12. **Switching Performance**: 200 Kbps or higher as per utility requirement at site

The 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.

4.2. Archive Storage

Archive storage devices shall be used for backup of the SCADA data and software and archival storage for the Information Storage and Retrieval functions. CED prefers an archive storage solution that is an integral part of a hierarchical storage management system.

LTO (Linear Tape-Open) media storage shall be provided for general back-up purposes and short-term archiving. The LTO drive shall have sufficient capacity for a complete backup of the SCADA data and software (including all source code) without requiring user action to replace filled recording media. A media changer that accepts industry-standard media handling commands is preferred. External 4mm DAT, 160/320 GB Cartridge magnetic tape drive shall be supplied for taking Backups and performing restores of the Hard disks of any computer. The external tape drive shall have hot-pluggable port for connection to any computer. Bidder may also provide equivalent Magneto Optical (MO) –disk in place for DAT drive (Cartridge magnetic tape drive).

4.3. Local and Wide Area Networks

The Supplier is responsible for implementing the SCADA LAN and the connections to the IT-Enterprise LAN/WAN.

SCADA Network

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. Dual LAN shall be formed for complete SCADA system. LAN shall have the following characteristics:

- shall conform to the 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 forty-eight (48) ports of 10/100/1000Mbps per LAN switch   for SCADA LAN
- CAT 6 or better cables shall be used for LAN

4.4. Time and Frequency Facility

A time and frequency facility to determine Universal Coordinated Time (UTC), power system time, time deviation, power system frequency, and power system frequency deviation shall be provided. UTC shall be obtained from the Global Positioning System (GPS) satellite constellation. The time receiver shall include propagation delay compensation to provide an overall accuracy of ±1.5 ms and shall also include an offset to permit correction to local time.

Upon loss of the time signal, the time and frequency facility shall revert to an internal time base. The internal time base shall have a stability of 1 ms per hour or better. The time shall return to within ±1.5 ms of UTC within five minutes of reacquisition of signal.

The local frequency input shall be separate from the time and frequency facility's power input. The CED will supply 220 Vac local frequencies input.

The time and frequency facility shall include digital displays for:

1. UTC time and date in the format HH:MM: SS (the hour display shall be in 00 to 23-hour format)
2. Time deviation in the format ±xx.xx seconds
3. Power system frequency in the format xx.xxx Hz
4. Frequency deviation in the format ±x.xxx Hz.

The time and frequency facility shall include a digital display of local time suitable for mounting on the wall. The display shall be in 24-hour time, showing time in HH:MM:SS format. Each digit shall be at least 5 cm (2 inches) in height, and shall be bright enough to be read at a distance of 15 meters (50 feet) under ambient room lighting levels of 50 lumens (75 foot-candles).

4.5. User Interface

The user interface shall include all hardware necessary to facilitate optimum user communication with the SCADA and to efficient operational control and monitoring of the power system.

4.5.1. Consoles

A console consists of the following equipment:

- One or more LCD monitors.

- One alphanumeric keyboard.
- One audible alarm.
- One cursor control device.
- A workstation.

4.5.2. Monitors

Each monitor shall have the following characteristics; however, CED expects to receive monitors that conform to the latest technology.

The TFT monitor shall have flat panel color screen

Table 3 (Monitor Specification)

S. No	Specification	For 24"monitor
1	Diagonal Viewable size	24"
2	Viewing angle	Sufficiently wide horizontal & vertical viewing angles
3	Dot Pitch	0.28 mm
4	Resolution	1920x1080 minimum
5	Color support	16 million
6	Refresh rate	Minimum 75Hz
7	On screen control	yes
8	Anti-glare & anti-static	yes
9	Tilt , Swivel	yes

4.5.3. Workstations

The operator Workstation console shall be used as a Man Machine Interface (MMI) by despatcher for interacting with all SCADA system. Operator Workstation consoles shall also be used as development console to take up developmental/maintenance activities such as generation/up-gradation of database, displays etc. Each workstation shall consist of two/three 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.

4.5.4. Keyboard and Cursor Control

One keyboard shall be provided at each console. The keyboard shall include an alphanumeric keyboard, numeric keyboard, four-key cursor control, and twelve function keys.

The cursor control device shall be a mouse. One device shall be provided at each console. The device shall facilitate movement of the displayed cursor in any direction and at varying speeds without the use of function keyboard controls.

The keyboard and cursor control device shall be shared among all monitors at each console. The cursor control device shall move across all monitors without switching by the user. Keyboard output shall be directed to the active viewport (as determined by the user interface techniques).

4.5.5. Audible Alarm

Each console shall be equipped with an audible alarm tone generator that is capable of producing a minimum of four (4) different distinct sounds. Tone volume shall be adjustable by the user from inaudible (off) to full maximum output (90 dB minimum) at one meter (36 inches) from the console.

4.5.6. KVM switch

Suitable rack mounted KVM (Keyboard, video and mouse) shall also be supply. That shall allow user to control multiple server in the server rack panel.

4.6. Video Projection System

The contractor shall provide a video projection system based on modular DLP (Digital Light Processing) based high resolution Laser-lit rear-projection video wall technology. The VPS will be used to project displays of SCADA system independently of workstation console monitors. All the operations envisaged from workstation console (dispatcher) shall be possible from the VPS also. The VPS shall also be able to display Video signals (CCTV/DTH) and other Laptop Computer Feeds.

The VPS shall enable users to display inputs from multiple sources/applications simultaneously in freely resizable and repositionable windows on entire display area to enable effective collaboration and faster decision making.

The Contractor shall supply all necessary hardware and software, including modesty panel, 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, cooling system and cabling. Design & installation of the video projection systems shall be coordinated with the Employer during project implementation.

The VPS controller shall have SNTP clients for synchronizing its time with the SCADA system. A panel shall be supplied for installation of VPS Controller as well as Time and Frequency Display System.

4.6.1. VPS Module

The requirements for each modular VPS wall are as follows:

- The VPS wall shall be a seamless rectangular array wall, formed using modules in curved arrangement up to 15 degrees. The screen shall not contain any holes, or screws in the active viewing area.
- The screens shall be capable of displaying full resolution of the source.
- The configuration of the VPS wall (no. of cubes and size of each cube) is defined in the Bill of Quantity. The height of VPS above the ground level shall be decided during detailed engineering based on the layout of the control room and available clear height.
- The VPS wall should be rugged in nature and shall be designed for 24X7 operational environments. Necessary cooling arrangement for VPS shall be provided with the VPS. The air-conditioned environment in the Control room shall be provided by the Owner/Employer.
- The VPS shall be designed to prevent dust ingress.

4.6.2. VPS wall Management Software

The VPS wall Management Software shall have the following features:

- The management software shall be able to pre configure various display layouts (arrangement of different windows) and access them at any time with a simple mouse click. The window can be of different size and could contain display from different applications/sources.
- The management software shall enable the users to see the desktop of the VPS wall remotely on any Windows based PC connected with the Display Controller over the Ethernet and change the size and position of the various windows being shown.
- The management software shall enable various operators to access the display wall from local keyboard and mouse of their Windows workstation connected with the VPS Controller over the LAN.
- The management software shall be able to push the screen content of a Windows PC / workstation to be shown on the Display wall in scalable and moveable windows in real time environment. The Windows PC/workstation shall be connected to the local Display Controller over LAN.
- The Wall Management software shall allow display of video/data windows inside other graphic windows and it should be possible to configure the video/data windows to always remain on top while the operator works on the windows below.
- The wall management software shall support open APIs to enable system integrators to integrate it with their Software. These APIs shall be provided for from the SCADA system.

4.6.3. VPS diagnostics and maintenance

The Diagnostic software shall perform health monitoring that allows timely detection of faults and provide at least the following:

- Cube health
- expected life left

- Monitoring of critical Cooling and cooling components
- Selected inputs and presence of sources on either input

The VPS maintenance Software shall allow commands on wall level or cube level or a selection of cubes for at least the following:

- Switching the entire display wall or display cube or a selection of cubes ON or OFF.
- Provide manual adjustments to keep the wall picture uniform over time. The auto adjusting of color and brightness shall not require downtime or image loss at any time.
- Changing the active input (of the two present DVI inputs).
- Fine tune color of each cube
- The VPS must allow easy removal of the components for maintenance.

4.7. Printers

Except for the output capabilities unique to any printer type (such as extended character sets, graphic print and coloring features), there shall be no limitations on the use of any printer to perform the functions of any other printer. All the SCADA system printers except Logger shall have dual LAN interface either directly or through internal/external print servers. The characteristics for each type of printer are described below:

A. **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

B. **Colour Laser Printer:** It is a multipurpose printer used to take prints of displays, reports etc. The colour laser printer shall have the following features.
   - shall be colour laser printer
   - have speed of at least 10 pages per minute for A3 & 17 pages for A4 in color
   - 600 X 600 dpi
   - Landscape and portrait output orientation
   - Duplex printing
   - Memory buffer of at least 128 Mbyte

4.8. Other Peripheral Devices

The Supplier shall supply any other peripheral devices or equipment normally provided for operation, software support, and maintenance of the SCADA.

4.9. Panels

In case the equipments are mounted in panel type of enclosures, then such enclosures shall be finished inside and out. All cabinet metal shall be thoroughly cleaned and sanded to obtain a clean,

smooth finish. All surfaces shall be treated to resist rust and to form a bond between the metal and the paint.

Moving assemblies within the enclosure, such as swing frames or extension slides, shall be designed such that full movement of the assembly is possible without bending or distortion of the enclosure or the moving assembly. Enclosures shall not require fastening to the floor to preclude tipping of the enclosure when the moving assembly is extended. No cables shall be visible, all cables shall be properly clamped, and all entries shall be properly sealed to prevent access by rodents.

Cooling air shall be drawn from the conditioned air within the room. Ducted or directed cooling air to the enclosures will not be supplied by Employer.

All wiring shall use copper conductors. Conductors in multi ¬core cables shall be individually colour coded.

Wiring within the enclosures 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.

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.

The finish colours of all enclosures/panels shall be finalized during detailed engineering.

4.10. Table A

4.10.1. Servers

SCADA, FEP

(Please fill for each server as per BOQ)

S.No	Description of the Features	Minimum Quantity of the features	Offer by the Contractor
1	Processor	2*3.0 GHZ 8core processor or more (should allow SMT and Processor partition capabilities) The servers shall be enterprise level SMP RISC / Itanium / x-86 -64 based processor based systems.	
2	Operating System	Latest version of OEM operating system shall be provided for each server, with required number of user license on each server	
3	SPECint & SPECfp	As per the base runtime requirements of SPEC CPU 2006 Benchmarking Standards.	
4	L3 cache	8MB minimum	
5	Memory	32 GB of ECC DDR3 Memory and scalable up to 512 GB memory(Memory slots free for expansion)	

6	Hard Disk Drives	2*300GB SAS delivered, scalable upto 1 TB	
7	Integrated SAS/RAID Controller	Integrated hardware RAID controller and should support hardware RAID 0, 1, 10, 5. Offered controller should have 512 MB battery backed cache.	
8	Optical Drive	Server should be configured with single DVD-RW drive/ Blu-ray R/W drive	
9	Gigabit Ethernet Ports	Server should be configured with 4*1Gigabit Ethernet ports	
10	USB ports	For connecting i/o devices	
11	Redundant Power Supply	Server should be configured with Dual redundant power supplies with 80 PLUS Platinum certification	
12	Failure Alerting Mechanism	The server should be able to alert impending failures on server component to administrator in order to avoid any downtime on the server due to actual failure	
13	Management Console	Should support integrated management with remote presence, Server should be supplied with OEM Server Management software/hardware and required ports	
14	Warranty	Onsite Warranty 24*7 response time	
15	RAS feature	Should have RAS features such as Hot swappable disks, Hot pluggable/replaceable PCI Controllers, Power Supplies, Cooling fans etc.	

4.10.2. Workstation consoles

S.No	Description of the Features	Minimum Quantity of the features	Offer by the Contractor
1.	Specint & Specfp	As per the base runtime requirements of SPEC CPU 2006 Benchmarking Standards.	
2.	RAM	4 GB delivered, expandable upto 8GB	
3.	Processor speed	3.0 GHZ each processor	
4.	Internal Auxiliary memory	500GB delivered, expandable upto 1TB	
5.	Speakers	Two internal speakers	
6.	Interfaces	1 GB dual Ethernet ports Min 4 USB Ports Port for cartridge magnetic tape drive Graphic adapter cards(HDMI)	
7.	User interface	Three/Two(as per BOQ) 24" wide screen (16:9 aspect ratio), HD Resolution (1920x1080) TFT Colour monitors, keyboard & optical mouse	
8.	Mounting	Desktop mounting	

S.No			
9.	Dual AC Power Supply (in Watts)		
10.	Heat Load		

4.10.3. TFT Color Monitors

Monitor for Work Stations:

S.No	Description of the Features	Minimum Quantity of the features	Offer by the Contractor
1.	Diagonal Viewable size	24"	
2.	Color support	16.7 million	
3.	On screen control	Required	
4.	Anti-glare & anti-static	Yes	
5.	Tilt , Swivel	Yes	
6.	Aspect ratio	16:9	

4.10.4. Color Laser Printer

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Functions	Print,	
4.	Paper size	A3, A4	
5.	Print speed	17 Colour pages/minute of A4 size & 10 Colour pages/minute of A3 size.	
6.	Print resolution	1200x1200 dpi	
7.	Paper weight	75-200 GSM	
8.	First page out time	4 sec for Black & White, 7 sec for Colour	
9.	Duty cycle	100000 pages per month	
10.	Paper handling capacity	Minimum 500 sheets for input tray & 500 sheets for output tray.	
11.	Landscape and portrait orientation	Yes	
12.	Interface	1GB dual LAN ports	
13.	Heat Load		

4.10.5. Black & White Laser Printer (Multifunction Device)

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor

1.	Manufacturer		
2.	Model No.		
3.	Functions	i) Print, ii) Scan iii) Copy iv) Fax	
4.	Paper size	A3, A4	
5.	Print speed	30 Colour pages/minute of A4 size & 15 Colour pages/minute of A3 size.	
6.	Print resolution	1200x1200 dpi	
7.	Scan resolution	600x600 dpi	
8.	Paper weight	75-200 GSM	
9.	First page out time	4 sec	
10.	Duty cycle	100000 pages per month	
11.	Paper handling capacity	Minimum 500 sheets for input tray & 500 sheets for output tray.	
12.	Automatic Duplex printing	Yes	
13.	Landscape and portrait orientation	Yes	
14.	Interface	1GB dual LAN ports	
15.	Heat Load		

4.10.6. Video Projection System (VPS) / Tower type Video Wall

S.No	Description of the Features	Minimum Quantity of the features required	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Display technology (DLP)	LASER based rear projection	
4.	Each VPS module size	70" Diagonal	
5.	Aspect ratio	16:9	
6.	Colours	16.7 million	
7.	VPS projector resolution	Minimum 1920x1080	
8.	Inter modular gap	< 1.0 mm	
9.	Screen border	0 mm (No border)	
10.	Horizontal & Vertical viewing angle	+1600 (approx.)	
11.	Horizontal & Vertical Half gain angle	+300 with tolerance of +50	
12.	Overall brightness of each module	Minimum 550 ANSI Lumens	

13.	Luminance measured at the screen	Minimum 170 candelas/sq. m	
14.	Median LED life	Minimum 55000 Hours	
15.	Centre to corner uniform brightness	> 90%	
16.	Brightness adjustable through software	Yes	
17.	Contract ratio	1500:1	
18.	Operating temperature range	16 – 300 C	
19.	Operating Relative Humidity	20-80% non-condensing	
	VPS Controller Features:		
20.	Specint & Specfp	As per the base runtime requirements of SPEC CPU 2006 Benchmarking Standards.	
21.	RAM	4 GB expandable to 16GB	
22.	Internal Auxiliary Memory	160 GB	
23.	Optical Drive	DVD+R	
24.	User Interface	Keyboard & Optical Mouse with 15 meter extension cable	
25.	Interface with VPS	Audio video signal input module with 2 video, 2 audio & 2 RGB inputs each.	
26.	Types of video signal to be supported by VPS Controller	PAL SECAM NTSC HDTV 720p, 1080i, 1080p (Component) RGB Analog up to 1920x1200 (up to 165 MHz pixel clock) DVI up to 1920x1200 (up to 165 MHz pixel clock).	
27.	Time synchronisation	SNTP	
28.	Dual AC Power Supply (in Watts)		
29.	Heat Load		

4.10.7. GPS based time facility

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor

1.	Manufacturer		
2.	Model No.		
3.	Time stability of internal time base	Minimum 2ppm	
4.	Propagation delay compensation	Yes	
5.	Include an offset to permit correction to local time	Yes	
6.	Reverting to internal time base upon loss of signal from UTC source	Yes	
7.	Resynchronization Delay	Not more than 5 minutes.	
8.	Accuracy of resynchronization	< 1.5 Micro Sec	
9.	Interfaces	Ethernet ports - 2 IRIG-B port - 2	
10.	Power Supply (in Watts)		
11.	Heat Load		

4.10.8. Digital Displays for GPS Based Time facility

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Functions	For viewing UTC day of the year and time and frequency	
4.	Day display format	XXX (MON through SUN)	
5.	Time Display format	24 Hours, HH:MM:SS, where hour display will be from 00 to 23 hours format.	
6.	Date format	MM: DD: YY	
7.	Frequency display format	XX.XX Hz	
8.	Display digit requirements	Display Digit height >7.5cm	
9.	Mounting of displays	Wall/panel mounting	
10.	SCADA Interfaces	Frequency	
11.	Power Supply (in Watts)		
12.	Heat Load		

4.10.9. LAN Switch (Layer II Switch)

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		

2.	Model No.		
3.	Functions	For connecting all servers & peripheral devices on Local Area Network (LAN).	
4.	Conform to standards	ISO8802 or IEEE 802 Series Standards	
5.	Switching capability	Layer-3 switching & VLAN	
6.	Interface ports	** Minimum 48- 1GBps Ethernet ports	
7.	Cable standard	Cat 6 or higher bandwidth cable	
8.	Mounting	Rack mountable	
9.	Power Supply (in Watts)		
10.	Heat Load		

** However, the no of ports in a LAN switch shall be as per the network architecture & the no of servers/devices on that LAN.

4.10.10. Desktop Cartridge Magnetic Tape Unit

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Capacity	Minimum 160/320 GB	
4.	Sustained transfer rate	Minimum 3MB/second	
5.	Recording media	Tape	
6.	Interface ports	Suitable port for interfacing with servers/workstations.	
7.	Power Supply (in Watts)		
8.	Heat Load		

4.10.11. Panels

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Functions	For mounting or placement of equipment's	
4.	Mounting	Floor mounted with front & rear access to hardware and wiring	
5.	Cable entry	Bottom	
6.	Internal lighting lamp	Yes, with door interlock	
7.	230V AC, 15/5 A Internal power socket with switch	Yes	
8.	All material used in the panel are flame retardant	Yes	
9.	All Louvers provided with suitable wire mesh	Yes	

| 10. | Dual AC Power Supply (in Watts) | Dual Power Supply | |
| 11. | Heat Load | | |

4.10.12.   Minimum Specifications of FIREWALL

Firewalls shall be provided as per BOQ. It is required that both side firewalls (Internal and External) are supplied from two different manufacturers. All firewalls shall be hardware box firewall as per the requirements mentioned in **below table.**

Sr. No	Parameter Name	Minimum requirement	Bidder Response (Compliant / Non-Compliant) Remarks	
1	Specification	8 Ethernet Ports (1gbps) and 4 Fiber Optic Ports		
2	Data encryption support	3DES (168 bits), AES 128-, 192-, 256- bit and hashing algorithm like MD5 , SHA-1, IKE, PKI (X.509) and IKEv2 with EAP		
3	Support Active-Active mode	Yes		
4	High Availability & Load balancing	Yes		
5	Support NAT, PAT & Policy based NAT/PAT, Mapped IP (MIP), Virtual IP(VIP) & MIP/VIP grouping	Yes		
6	IP address assignment features	PPPoE, DHCP		
7	Support VoIP protocols	H.323, SIP, MGCP, SCCP		
8	IPv6 features	Syn Cookie, Syn-proxy DoS attack detection, SIP, RSTP, Sun-RPC, ALG's, RIPng, BGP4, DHCPv6 Relay, IPv4 to IPv6 translations & Encapsulations		

9	System management	Using web UI, Command Line interface (console/telnet/SSH).		
10	Filtering of packets based on Source address, destination address, protocol type, user, port number, URL	Yes		
11	Filtering of protocols	FTP, SMTP, HTTP, HTTPS, SNMP, UDP, ICMP, RPC, DNS, DHCP, ARP, TCP, POP3		
12	Authentication protocols	RADIUS, LDAP and PKI methods		
13	Dynamic routing protocols	RIP v2, OSPF, & BGP		
14	DoS & DDoS prevention	Yes		
15	TCP reassemble for fragmented packet protection	Yes		
16	Brute Force attack mitigation	Yes		
17	SYN cookie protection	Yes		
18	Zone based IP spoofing	Yes		
19	Malformed packet protection	Yes		
20	DNS guard features	Yes		
21	Content filtering	JAVA & ActiveX blocking		

22	Antivirus, anti-worm, anti-spam and anti-spyware protection	Yes		
23	System Logging & monitoring	Syslog, Email, SNMPv2 and VPN Tunnel Monitor		
24	Stateful packet inspection	Yes		
25	Assign zones to virtual & physical interfaces	Yes		
Sizing Parameters for Each Firewall				
1	No. of unique users	Unlimited		
2	Minimum number of concurrent sessions	500		
3	Minimum new sessions per second processing	500		
4	Minimum Firewall throughput	1 Gbps or higher		
5	Minimum 3DES/AES VPN throughput	250 Mbps		
6	No of VLANs	100		
7	Minimum IPSec VPN peers	100		
8	Number of 1 Gbps LAN ports	12		

[With Technical Bid in Stage 1, Bidder to submit the above table with response in respective column. Any higher specification, shall be acceptable but any deviation in minimum requirement shall make bid non-responsive]

DESIGN PARAMETERS AND PERFORMANCE TABLES

The SCADA system shall be designed as per the technical parameters defined in the specification and the tables specified here. The SCADA system (such as databases, network elements etc.) shall be sized to accommodate the requirement mentioned

The system shall be tested with the doubled present power system size (ultimate capacity) & measure the various performance of the system as defined in the tables and technical specification including peak and average load scenarios.

The SCADA 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 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- MAINTENANCE ACTIVITIES

TABLE 4- DESIGN PARAMETERS FOR USER INTERFACE

TABLE 5- OTHER PERFORMANCE REQUIREMENTS

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.

SL. No.	Function Description	Design capacity	Execution rate
1.0	**Data Acquisition from RTU**	As per specification	
	a) Status data	All status points	• By exception, updated & displayed within 4sec from data collection from RTU at S/s 6 sec from data collection from DTMU • Integrity check of all status at every 10 Minutes (configurable) • On demand
	b) Analog data	All analog points	• By exception, updated & displayed within 5 sec & 10sec • Integrity check for all analog at every 10 Minutes (configurable) • provision for all analog update at periodicity of 10 sec configurable up to 1 hour. • Energy values periodically configurable from 5 min to 24 hours • On demand The time skew at SCADA control centre, S/S 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, DTMU at scan rate of 15 minute/1 hours (configurable up to 24 hours). Alternatively, the energy values shall be calculated for each 15 minute/1 hour blocks at SCADA level from the acquired energy values of MFTs through RTU & DTMU.
1.1	**Time synchronisation of**	All RTUs shall be	every 5 Minutes (Configurable from

	RTU	synchronised from Master station	5-60 minutes)
2.0	**Data Processing**		
2.1	**Analog data processing:**		
	a) Conversion to engineering units	Per analog points	Each time the value is received in SCADA
	b) Zero dead band processing	Per analog points	Each time the value is received in SCADA
	c) Reasonability Limit checking	High and Low reasonability limits per analog point	Each time the value is received in SCADA
	d) Limit Monitoring (Operational, Alarm and Emergency limits)	High and Low for each of the limits	Each time the value is received in SCADA
	e) Rate Of Change	per analog point	Each time the value is received in SCADA
	f) Sign conventions		Each time the value is received in SCADA
	g) Accumulator processing	per analog point	Each time the value is received in SCADA
2.2	**Calculated Data Processing:**		
	a) Arguments for analog calculations	32	Each time the value is received in SCADA
	b) Arguments for status calculations	32	Each time the value is received in SCADA
	c) No. of calculated data (Min / Max with time stamp and Average)	3 X no. of analog point for max /min/avg and 1x no. of max/min/avg for other calculations	Each time the value is received in SCADA
2.3	**Digital Input data processing**	As per specification	As per specification
2.4	**Substation Topology Processing**	For no. of status, refer RTU/DTMU point counts in the technical specification. within 1 sec response after updation in SCADA database	Triggered by status change.
2.5	**Alternate source of data**	For all status , analog telemetered parameters	Each time the value is received in SCADA
2.6	**Quality codes**	As per specification	Each time value is received by SCADA
2.7	**Sequence-of-Events data**	1000 events circular buffer in the SCADA database	SOE retrieval Periodically (5 minutes) or by exception and On demand

3.0	**Supervisory Control**		
	a) Control Inhibit Tag Types	4	On demand by Dispatcher initiated
	b) Control inhibit Tags Per Device	4	On demand by Dispatcher initiated
	c) Control Action Monitor	10 timer periods (1 to 60 sec)	On demand by Dispatcher initiated
	d) Control permissive	For all control points	Each time supervisory control is requested
4.0	**Failsoft capability**	Critical functions	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%..

TABLE 2 – DESIGN PARAMETERS FOR ISR FUNCTIONS

SL. No	Function Description	Design capacity	Execution rate	Response time
1	**Circuit breaker status table**	Data as per spec for all CBs	Updation on change in CB status or any of the associated information	2 sec after updation in SCADA database
		Data storage on Auxiliary memory	2 months retention	
2	**Data Snapshot table**	a) Volume of data = Total telemetered status and analog points and max/min with time stamp and average for each analog point with quality codes	Snapshot - 5 minutes periodicity	
		b) Data storage On Auxiliary memory	2 months retention	
3	**Hourly data table**	a) Volume of data = Total telemetered points and max/min with time stamp and average for each analog point with quality code	Hourly	
		b) Data storage On Auxiliary memory	2 months retention	
4	**Hourly Energy data table/ Missed hourly data table**	a) Volume of data = Export/Import KWh & Export/Import KVARh for all energy meters with quality code	Energy values of 15 minute blocks of each Hour	
		b) Data storage on Auxiliary memory	2 months retention	
5	**Daily Energy data table**	a) Volume of data = Export/Import KWh & Export/Import KVARh for all energy meters with quality code	Energy values of 15 minute blocks of each Hour	
		b) Data storage on Auxiliary memory	2 months retention	
6	**SOE data table**	Daily 4 changes per SOE point	Each time the SOE is received from RTU/DTMU in SCADA	

			database	
7	**Historical information data retrieval**	Retrieval of all stored data	On demand	
8	**System message Log Storage**	a) 20,000 entries /month		
		b) Data storage on Auxiliary memory	2 months retention	

TABLE 3- MAINTENANCE ACTIVITIES

Action	Performance
Complete database regeneration	2 hours
Complete system software build, including operating system, applications, and databases	6 hours
Software build or all applications and databases	3 hours
Software build of a single applications and databases	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 4 - DESIGN PARAMETERS FOR USER INTERFACE

SL No.	Name	Design capacity	Execution rate
1	SCADA SYSTEM ACCESS SECURITY		
	Function and Data Access Security Operating jurisdictions	10	
2	Windows Environment		
	Rooms	32	
	Layers	8	
	Declutter Levels	16	
	Panning and Zooming	Supported	
3	TREND		
	a) Trend files	10	
	b) Variables per trend file	4	
	c) Samples per trend variable	5000	
	d) Sampling rate	Configurable from 5 sec to 15 minutes	
4	Alarms		Triggered by Event

	a) Alarm priority levels	16	
	b) Alarm Message Recording	2 Months	
	c) on auxiliary memory - alarms		
5	EVENTS		
	Event Message Recording on Auxiliary memory - events	2 Months	

Table 5- PERFORMANCE REQUIREMENTS

USER INTERFACE REQUIREMENTS

At no time the SCADA 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 with an indication of request is being processed	Within 2 sec
Any real time display and application display (except RDBMS DB displays) on workstation console, Complete display & data 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 4 displays together
Panning of a world display from one end of screen to other end of screen in a continuous manner	Within 2 sec
Supervisory control action shall be completed with result 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 system
Alarm and event acknowledgement	Within 2 sec
Requests for printing of displays shall be acknowledged with an indication of request is being processed	Within 2 sec
Requests for generation of reports shall be acknowledged with an indication of request is being processed	Within 2 sec

5. TECHNICAL REQUIREMENTS OF RTU

The Remote Terminal Unit (RTU) shall be installed at primary substation to acquire data from IED's/Relays/BCPU's & Multifunction Transducers (MFTs), 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.

5.1. 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.

5.2. 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 IED's/BCPU's 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), IEC 61850 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 control center.

g) Internal battery backup to hold data in SOE buffer memory & also maintaining the time & date.

h) Shall have SNMP or network status/diagnostics through IEC protocol.

i) Capability of time synchronization with GPS receiver which shall be required future.

j) Data concentrator should have the cyber security features.

k) The input auxiliary power supply for the RTU/DC should have in the range of 24VDC/48VDC or 220VDC depends upon Station DC Supply.

l) It should have redundant CPU and Power supply.

m) Should provide latest Microsoft Windows based maintenance and configuration tools. The tools should have functionality of both remote and local access. The minimum functionalities to be provided through these tools are device configuration, security settings, log files, communication traces and system statistics.

5.3. Communication ports

The RTUs shall have following communication ports to communicate with master station, existing /MFTs and configuration & maintenance terminal.

The communication protocol for RTU to control center must be open protocol and shall support IEC 60870-5-104 and IEC 61850 for all levels of communication for sub-station automation such as Bay to station HMI, gateway to remote station etc. In addition, the Data Concentrator is expected to have serial ports RS 485 for communication to Meters, DCDBs and other IEDs on Modbus RTU Protocol (Modbus TCP/IP preferred).

Data Concentrator to Bay Control Units/Relays	IEC 61850
Data Concentrator to Remote Control Centers	IEC104
Data Concentrator to Meters	Modbus
Data Concentrator to DCDB	Modbus
Data Concentrator and Transformer Monitoring Unit	IEC 61850
Between Bay Control Units, Relays and Transformer Monitoring Units	IEC 61850

- RTU shall have two TCP/IP Ethernet ports for communication with Master station(s) using IEC 60870-5-104.
- 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 104 protocol to communicate with RTU.
- VPN, NERC/CIP or international equivalent standard compliance.

5.4. 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 secs 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).

5.5. 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 protocol.

5.6. 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.

5.7. 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 software shall check for memory, processor, and input/output ports errors and failures of other functional areas defined in the specification of the RTU.

5.8. Input DC Power Supply

The RTU will be powered from a 220/48/24 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

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.

5.9. 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 0 to +55-degree C with rate of temperature change of 20-degree C/hour and relative humidity less than 95%, non-condensing.

5.10. RTU Size and Expandability

RTU shall be equipped for the point counts defined in the BOQ (Basic+20% spare). 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.

5.11. 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.

6. Communication Network

The communication network between Control Center and RTU location shall be on MPLS network.

The DTMU shall communicate with control center on 3G/4G network. The bandwidth provision shall be RTU location will be 2 MBPS and Control center location minimum 20 MBPS.

7. 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 up to 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 220V DC/24V DC/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 IEC60870-5-104 can be used.

The MFTs shall be suitable for mounting on DIN rails. The MFT terminals shall accept up to two 2.5 mm2 / 4 mm2 for PT/CT circuit terminations as applicable.

The MFT shall be programmable with password protection thru suitable fascia 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.

8. TEST EQUIPMENTS FOR RTU

8.1. RTU Configuration and Maintenance Tool

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

8.1.1. RTU Data base configuration & Maintenance software tool

The RTU 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.

8.1.2. Master station-cum-RTU simulator & protocol analyzer software tool

The Master station cum RTU simulator tool shall be used to test the communication interfaces of Master station, RTU and Electronic MFT. The Master station simulator tool shall be capable of emulating the master station for IEC 60870-5-104, IEC 61850 for relays and MODBUS protocols. The RTU simulator shall be capable of emulating the slave protocols for both the IEC 60870-5-104, IEC 61850 for Relays and MODBUS protocols for MFTs. It shall also be possible to prepare illegal messages for transmission, such as messages having invalid checksum.

The Protocol Analyser shall be used to monitor all communication traffic on a channel (between Master station & RTU and between RTU & MFT/Relays without interfering channels operation. Channel traffic captured in the active or passive modes of operation shall be displayed.

The Master station simulator and Protocol Analyser 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.

8.1.3. Laptop PC for above software tools

A laptop PC (on latest OS and hardware configuration) 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 and MFT. A suitable USB to serial convertor 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.

9. DC POWER SUPPLY SYSTEM

The DC Power Supply system shall be capable of meeting the load requirements for various Telecom equipment's, RTUs and other associated equipment located at indoor, i.e. at the substations, the control centers. 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	Iimp ≥ 50 kA, 10/350 µS for each phase
N & PE	Iimp ≥ 100 kA, 10/350 µS

Where Iimp= Value of Lightning Impulse Current

b) Low Voltage Surges (Class C)

Between	**Requirement**
Ph & N	In ≥ 10 kA, 8/20 µS for each phase
N & PE	In ≥ 20 kA, 8/20 µS

Where In = Value of Nominal Discharge Current.

9.1. 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.

9.2. 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 3 (conceptual Configuration of DC Power Supply System - DCPS).

The DCPS shall be suitable for operation at ambient temperature of 0-50° C and relative humilities up to 95 %.
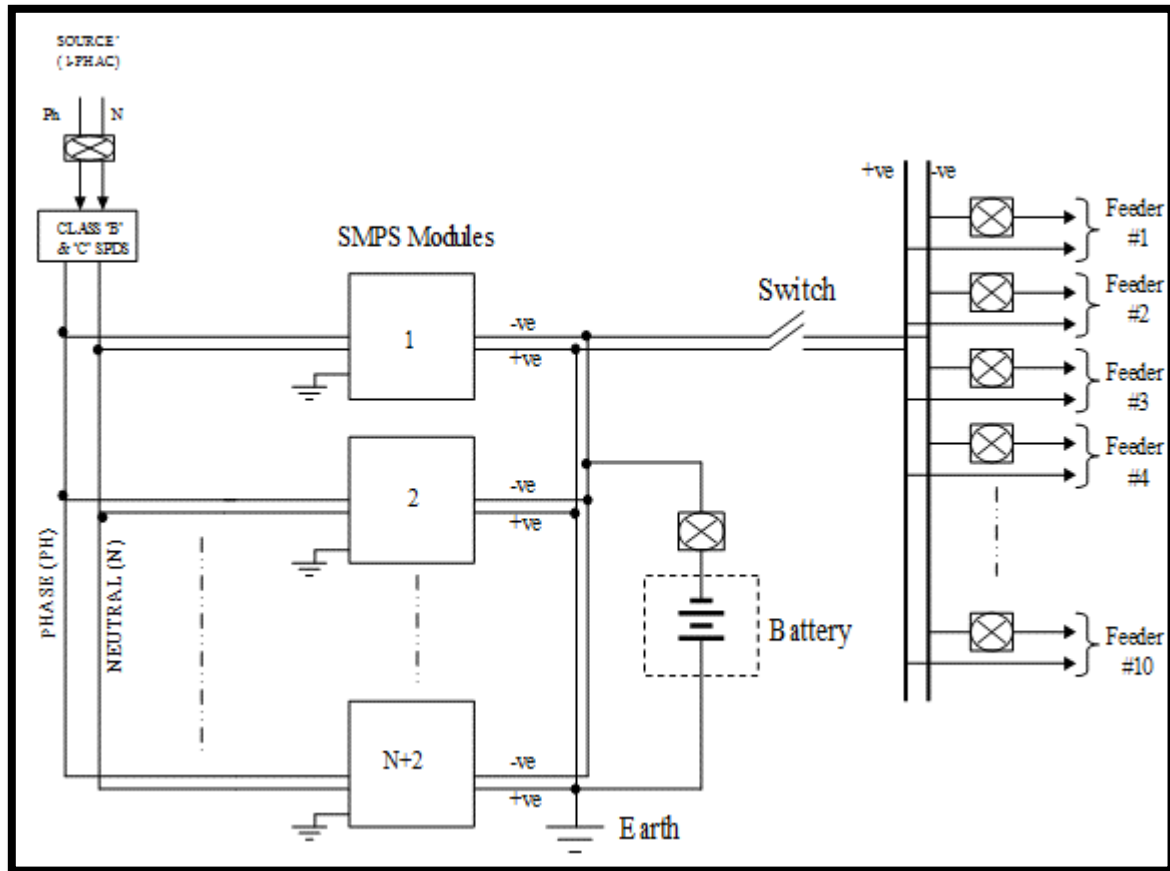
Figure 3 (conceptual Configuration of DC Power Supply System -DCPS)

10. Technical Specifications of BCPU

Required for Protection for Lines, Power Transformers, Bus Couplers and Bus Sections

10.1. LINE PROTECTION

Each 66 and 33 kV incoming and tie Lines shall be provided with O/C and E/F protection.

A numerical three phase O/C and E / F & directional IED shall be used as a protection of line. PS class CTs shall be used. This IED shall have the following features:

a) Non Directional (50/51 & 50N/51N) OR Directional O/C and E/F (each element shall have one IDMTL and three   high   set definite time IED) (67 R, Y, B and 67N)
b) Negative sequence current (unbalance current) (46)
c) Overload IED (49).
d) VT/fuse failure supervision IED and Trip circuit supervision IED.
e) Integrated CB failure protection.
f) Configurable LEDs shall also be provided to indicate the IED operation and the alarm / status change of a bay equipment e.g.   Phase Fault operated / Earth Fault operated/CB open / CB close /spring charge etc.
g) Auto reclose (79) Protection element feature to be incorporated in the back up IED.
h) IED should have Circuit Breaker monitoring ∑ KA square feature for online monitoring of the breaker.
i) The IEDs shall have synchro-check facility.
j) Electrically reset type high speed, heavy duty relay shall be used for tripping on operation of main and BCPU IEDs. The two trip coils where ever provided shall be provided with independent potential free contacts from different fused DC supplies. The trip relay shall be supervised.
k) Breaker counter logic shall be there on fault opening.
l) Under Frequency IED.
m) Disturbance Recorder and Event Logger.

10.2. POWER TRANSFORMER PROTECTION:

Each Power Transformer Protection System shall be provided with:

a) One current differential IED as a main protection. PS class CTs shall be used.
b) O/C non-directional numerical IED shall provide the backup protection, for HV side of Transformer. A 5P20 class CT shall be used.
c) *Main protection of Power Transformer*: This protection shall be a biased current differential   numerical IED which should include the following features:
   a. Vector group compensation.
   b. CT ratio correction.
   c. Biased differential protection.
   d. High-set. Element of suitable setting range
   e. 2nd and 5th Harmonic restrains.

f. Over Flux Protection
g. Redistricted earth fault
h. Disturbance Recorder and Event Logger

IED shall be able to display all the Alarms and field status change on the LCD panel of the IED at the time of occurrence and it should be possible to accept the alarms locally from the IED.

10.3. 11KV INCOMER & BUS-SECTION PROTECTION:

Non directional numerical 3 Phase O/C and E/ F Protection IED shall be used. These IEDs shall be able to give a trip command to the shunt trip coil of the CB through a high speed electrically reset type trip IED.

The numerical IED shall have the following inbuilt function:

a) Non directional O/C and E/F (each element shall have one IDMTL and   three high set definite times IED) 51 /50 R, Y, B, N.
b) Negative sequence current (unbalance current) 46
c) Overload IED (49).
d) CB Failure protection IED, 50 LBB
e) The IED shall provide all necessary interlocking for Grid station within the bay
f) VT/fuse failure supervision IED and Trip circuit supervision IED
g) Disturbance Recorder, Under Frequency Relay and Event Logger.
h) PT operated (110 V Secondary) Power pack to be provided in 11 KV Incomer panel to provide DC Backup to the tripping circuit including protection unit IED in the event of grid station DC failure.

Electrically reset type high speed, heavy duty IED shall be used for tripping on operation of main or b/u protection IEDs of the Line. Trip IED shall be supervised.

10.4. 11KV O/G FEEDER PROTECTION:

A non- directional numerical 3 Phase O/C and E/ F Protection IED shall be used as Bay control and Protection unit. This IED shall be able to give a trip command through a high speed electrically reset type trip IED to the shunt trip coil of CB. This IED shall have the following inbuilt function:

a) Non directional 3 phase O/C and E/F (each element shall have one IDMTL three high   set definite time IED
b) Negative sequence current (unbalance current)
c) Overload IED (49).
d) CB Failure protection IED.
e) This Numerical O/C Protection may be provided with inbuilt in the Bay Control Unit of the 11kV Feeders
f) Reverse interlocking and CBFP shall be implemented for all 11kV o/g breakers.
g) Auto reclose (79) Protection element feature to be incorporated in the IED.

h) IED should have Circuit Breaker monitoring ∑ KA square feature for online monitoring of the breaker.

i) Disturbance Recorder and Event Logger.

Electrically reset type high speed, heavy duty IED shall be used for tripping on operation of protection IEDs. Trip IED along with tripping circuit shall be supervised. Master trip relay should be such that on resetting its flag should be automatically reset.

10.5. 66 /33/11KV CAPACITOR BANK (double star) PROTECTION

Each Capacitor feeder shall be provided with following

A composite numerical capacitor bank protection IED with the following features Shall be provided as back up and additional Protection:

- A Dedicated High speed Numerical Current operated Neutral Unbalance IED with Provision of two stages of definite time elements
- One directional 3 phase O/C and E/F (each element shall have one IDMTL and two high set definite time IED
- Negative sequence current (unbalance current)
- over voltage IED
- under voltage IED
- Efficacy time (5 mins) to be provided in the Capacitor bank relay and during this period there should be closing interlock and no closing command be executed either from Relay or TNC in service position.
- In Cap bank relay, it will be mandatory to provide 10% Spare I/O's by the vendor with proper wiring up to terminal blocks
- Door OPEN tripping to be provided in the relay via status input and the tripping will be extended through Master 86 relay.
- The protection scheme should have Disturbance Recorder and Event Logger.

Automatic power factor controller module embedded in the IED for auto switching of breaker taking into consideration the bus voltage, pf and 11 kV I/C current Input to the

Neutral current unbalance IED shall be from CT installed on the connection between two star points of the capacitor bank. Electrically reset type high speed IED shall be used for tripping & the trip IED shall be supervised.

11. IEC 61850 compliance Ethernet switch

The 61850 compliance Ethernet switch shall meet the demands of power system automation systems (IEC 61850-3, IEEE 1613 compliance).

- Ethernet switch shall operate at 24 to 220 VDC/VAC dual isolated redundant power supplies.
- Operating Temperature: -5° to +85°C.
- All port shall be at least 10Mbps/100Mbps

- LED indicators on each RJ 45 ports shall be blinking with data transfer.
- It should support remote user setting configuration.
- Warranty for the switch must be 5 years.
- It should own separate maintenance/console port
- Latency shall be not more than 10ms.
- Should be KEMA Certified or equivalent certified
- 48 port RJ45 connector switch, 16 port Rx/Tx (The final configuration shall be depending on the physical port connectivity of Relays.)

12. General Requirements of Numerical Protection IED:

All numerical IEDs, auxiliary IEDs and devices comprising the Bay Protection Units shall be of types, proven for the application, satisfying the requirements specified in technical specifications and shall be subject to the Owner's approval. Numerical IEDs shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide the required sensitivity to the satisfaction of the Owner.

The Protection IED offered shall be suitable for both 1A and 5A analogue inputs, also the offered IEDs should be based on IEC: 61850 protocols. Bidder shall provide necessary certificates to ascertain the communication capability (Interoperability) with other make IED in 61850 protocol for interlocks/logic through GOOSE messaging if required. The relays provided for any project must have self-diagnostic feature to enable us to know about component failure. If not possible then necessary software to detect the same must be provided.

Equipment shall be designed for a working life of at least fifteen years in the specified environment and application. Components, component ratings and all other factors determining equipment life shall take this into account. Normal routine and breakdown maintenance shall be assumed and it is accepted that certain Consumable components and modules may need periodic replacement or adjustment. However, the Bidder shall state in his bid, the expected frequency of such replacement or adjustment and life expectancy. Bidder need to furnish the expected life of IEDs. While submitting the performance reports of the concerned IEDs. Bidders need to provide life cycle support and supplies to ensure necessary support in terms of services and spares for next 15 years.

Numerical IEDs shall be suitable for efficient and reliable operation of the protection scheme. The necessary auxiliary IEDs, trip IEDs, etc. required for complete scheme, interlocking, alarm, logging, etc. shall be provided. No control IED, which shall trip the circuit breaker when the IED is de-energized, shall be employed in the circuits. Any connectors, terminals, switches Required to extend or isolate the wiring to IEDs to be provided by bidder.

IEDs shall be provided with self-reset contacts except for the trip lockout, which shall have contacts with an electrical reset feature.

Suitable measures shall be provided to ensure that transients present in CT & VT connections due to extraneous sources in the HV system do not cause damage to the numerical and other IEDs. CT saturation shall not cause mal-operation of numerical IEDs.

Hardware selection should be done in such a manner that all power supply requirements could be met with the available grid voltages.

DC batteries in protective IEDs necessary for IED operation shall not be acceptable. Equipment shall be protected against voltage spikes in the auxiliary DC supply.

The numerical IEDs shall have continuous self-monitoring & cyclical test facilities. The internal clock of the system shall be   synchronized through the GPS Time Synchronizing System to be provided by Owner at later date.

Each numerical IED shall have a serial interface on the front for local communication to a Personal Computer.

Facilities shall be provided to access each discrete protection function including modification in IED settings and monitoring of the IED from a HMI. A print out of all settings, scheme logic, event records etc. shall be accessible through the HMI. The display of various measured parameters during normal as well as fault conditions on a segregated phase basis shall be provided.

LEDs and a backlit LCD screen shall be provided for visual indication and display of messages related to major trips / alarms. Necessary multilevel password protection shall be provided.

The sampling rate of analog inputs, the processing speed and processing cycle of digital values shall be selected so as to achieve the operating times of various protection functions specified. In case the Bidder does not have all the protection functions specified as a part of the standard numerical IED, separate discrete numerical IEDs can be provided for such protection. The reasons for providing such discrete IEDs shall be clearly outlined in the bid.

The numerical IEDs shall be provided with built-in disturbance recording functionality. The data from DR function shall be available in IEEE/COMTRADE format and shall be compatible with the dynamic IED test system being supplied under this contract.

The manufacturer of the numerical protection system offered shall carry out the complete engineering, testing and commissioning on site of the offered protection equipment including the associated IEDs and protection panels. The testing and commissioning protocols for the numerical protection systems offered shall be approved by the owner before commissioning on site.

The numerical IEDs offered shall have self-diagnostic features to reduce the down time of the IED and to provide useful diagnostic information upon detection of an internal fault so as to speed up the maintenance. The necessary support documentation explaining In detail the self-diagnostic features of the numerical IEDs shall be furnished for the Owner's use.

There should also be separate logic in IED to cater breaker operation counter on faults only.

Fault currents sensed by relay to be mapped to SCADA. Proper programming to be done for the same.

All the protection signals along with corresponding LEDs to be latched at SCADA, so suitable logic to be built in the relay.

On resetting the BCPU/PU from SCADA or Locally from relay all the protection signals must be get reset both at SCADA and at relay with relay output in one go.

11 KV IEDs must have same order codes irrespective of panel types. For 11 KV Incomer panel both BCPU and PU will be the same. Same needs to be followed for 33 and 66 KV level. The binary input/ output list for BCPU and PU are given below including spares.

Voltage level	BCPU
11 KV	BI-20
	BO-10
33 KV	BI-24
	BO-12
66 KV	BI-24
	BO-12
Transformer Differential	BI-7
	BO-6

13. Software License and Upgrades

The bidder shall provide all software licenses for all the software being used in Protection IED offered for engineering, IED setting uploading and FDR down loading etc. The license shall be provided on a site license basis and shall be valid for the plant /Equipment life cycle. In the case of anti-virus software, the   license shall include regular updates.

The Bidder Shall guarantee that all software are defect free and meet the System specifications, and undertake to fix any defects Which may arise during the life of the system at no cost to the Owner.

In case offered IEDs require any additional software for its integration to RTU then the bidder shall provide the same.

All software versions in components shall be the latest official   releases as on the date of shipment from works and shall include all software updates etc. released till that date.   A certificate to this effect shall be furnished by the bidder at the time of pre-dispatch inspection for each software package. All new software revisions and/or patch updates that are released before the end of the warranty period which addresses system defects shall be implemented on site and the system re-tested to validate system integrity by the bidder at no cost to the owner

(This excludes new revisions which provides additional functionality). The bidder shall periodically inform the designated officer of the Owner about software updates / new releases that would be taking place after the system is commissioned.

Bidder shall train our engineers to guide the upgrading procedures of project files with respect to latest releases.

Two nos. of communication cords for uploading and down loading data from the front port of Protection IED shall be supplied by the bidder.

14. Type Test Requirements

Test reports for following type tests shall be submitted for the Protection IED along with the Bid:

14.1. Insulation Tests:

Sl. No.	Description	Standard
1	Dielectric Withstand Tests	IEC 60255-5 2kV rms for 1 minute between all case terminals connected together and the case earth. 2kV rms for 1 minute between all terminals of independent circuits with terminals on each independent circuit connected together. ANSI/IEEE C37.90-1989 1kV rms for 1 minute across the open contacts of the watchdog IEDs. 1kV rms for 1 minute across open contacts of changeover output IEDs. 1.5kV rms for 1 minute across open contacts of normally open output IEDs.
2	High Voltage Impulse Test, class III	IEC 60255-5 5 kV peak; 1.2/50 ꠸sec; 0.5 J; 3 positive and 3 negative shots at intervals of 5 sec

14.2. Electrical Environment Tests:

Sl. No.	Description	Standard

1	DC Supply Interruption	IEC 60255-11 The unit will withstand a 20ms interruption in the auxiliary supply, in its quiescent state, Without de-energizing.
2	AC Ripple on DC supply	IEC 60255-11 The unit will withstand a 12% ac ripple on the dc supply.
3	AC voltage dips and short Interruptions	IEC 61000-4-11 20ms interruptions/dips.
4	High Frequency Disturbance	IEC 60255–22–1, class III At 1MHz, for 2s with 200 ohms source impedance: 2.5 kV peak; 1 MHz; T = 15 sec; 400 shots/sec; duration 2 sec between independent circuits and independent circuits and case earth. 1.0kV peak across terminals of the same circuit.
5	Fast Transient Disturbance	IEC 60255-22-4, class IV 4kV, 2.5kHz applied directly to auxiliary supply 4kV, 2.5kHz applied to all inputs.
6	Surge Withstand Capability	IEEE/ANSI C37.90.1 (1989) 4kV fast transient and 2.5kV oscillatory applied directly across each output contact, optically isolated input and power supply circuit.
7	Radiated Immunity	C37.90.2: 1995 25MHz to 1000MHz, zero and 100% square wave modulated. Field strength of 35V/m.
8	Electrostatic Discharge	IEC 60255-22-2 Class 4 15kV discharge in air to user interface, display and exposed metal work. IEC 60255-22-2 Class 3 8kV discharge in air to all communication ports. 6kV point contact discharge to any part of the front of the product.
9	Surge Immunity	IEC 61000-4-5: 1995 Level 4 4kV peak, 1.2/50ms between all groups and

		case earth. 2kV peak, 1.2/50ms between terminals of each group.
10	Capacitor Discharge	No change of state or any operation shall occur when a capacitor of capacitance shown below, charged to 1.5 X Vn volts, is connected between any combination of terminals and any combination of terminals and ground. Master trip circuits - 10 µF Other protection & control circuits - 2 µF Carrier/channel interface - 0,2 µF

14.3. EMC Tests:

Sl. No.	Description	Standard
1.	Radio-Frequency Electromagnetic Field, Non-Modulated	IEC 60255–22–2, class III 10 V/m; 27 MHz to 500 MHz
2.	Radio-Frequency Electromagnetic Field, Amplitude Modulated	ENV 50140, class III 10 V/m; 80 MHz to 1000 MHz; 80% AM; 1 kHz
3.	Radio-Frequency Electromagnetic Field, Pulse Modulated	ENV 50140/ENV 50204 10 V/m; 900 MHz; repetition frequency 200 Hz; duty cycle 50 %
4.	Disturbances Induced by Radio Frequency fields, Amplitude Modulated	ENV 50141, class III 30 A/m continuous; 300 A/m for 3 sec; 50 Hz
5.	Power Frequency Magnetic Field	EN 61000-4-8, class IV 30 A/m continuous; 300 A/m for 3 sec; 50 Hz
6.	Interference Voltage, Aux. Voltage	EN 50081-* 150 kHz to 30 MHz
7.	Interference Field Strength	EN 50081-* 30 MHz to 1000 MHz

14.4. Atmospheric Environment Tests:

Sl. No.	Description	Standard
1.	Temperature	IEC 60255-6 Operating –25°C to +55°C Storage and transit –25°C to +70°C IEC 60068-2-1 for Cold IEC 60068-2-2 for Dry heat

2.	Humidity	IEC 60068-2-3 56 days at 93% RH and +40°C

14.5. Mechanical Stress Tests:

Sl. No.	Description	Standard
1.	Vibration (during Operation and Transportation)	IEC 255-21-1; IEC 68-2-6 Response Class 2 Endurance Class 2
2.	Shock (during Operation and Transportation)	IEC 255-21-2, class 1, IEC 68-2-27 Shock response Class 2 Shock withstand Class 1 Bump Class 1
3.	Seismic Vibration (during Operation)	IEC 60255-21-3 Class 2
4.	Continuous Shock (during Transportation)	IEC 255-21-2, class 1, IEC 68-2-27

15. WIRING

- All wiring shall be with 660/1100 V grade, single core, PVC insulated stranded copper conductor.
- Wires shall be vermin proof. Minimum size of conductor shall be 1.5 sq. mm in general, but for CT & VT circuits it shall be 2.5 sq.mm.
- Contractor shall be solely responsible for completeness and correctness of all the wiring, and for proper functioning of the connected equipment.
- Specification for Auxiliary IEDs/ MCB's
    a) Fuse Failure IED and trip Circuit Supervision IED shall be suitably selected, considering burden and auxiliary voltage. External circuitry like compensating resistances will not be accepted.
    b) Auxiliary contact multiplier IEDs should be of reputed make, and selected on the basis of continuous current carrying capacity and rated voltage. The fluctuation in voltage level must be accounted for (+/-) 10% continuously.
    c) DC MCB's should not be substituted by AC MCB's for DC Distribution, irrespective of manufacturer's individual multi usage recommendations.
    d) DC Fail Supervision IED (80) shall be provided on all control and IED panels.

TESTING & DOCUMENTATION

16. General

This section describes the specific requirements for testing and documentation of the SCADA system. The general requirements of testing and documentation are covered in this section.

16.1. Type testing

Equipment's 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 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.

16.2. Factory Acceptance Tests (FAT)

The SCADA system shall be tested at the Contractor's facility. All hardware and software associated with the SCADA system and at least two RTUs along with, BCPU, Relays shall be staged for the factory testing.

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 system. The factory tests, requiring site environment, shall be carried out during the Field Tests after mutual agreement for the same from owner.

16.3. Hardware Integration Test

The hardware integration test shall be performed to ensure that the offered computer hardware, conforms to these Specification requirements and the Contractor-supplied hardware documentation. All the SCADA system hardware shall be integrated and staged for testing. Applicable hardware diagnostics shall be used to verify the hardware configuration of each equipment. The complete hardware & software bill of quantity including software licenses & deliverables on electronic media shall also be verified.

16.4. System Build test

After completion of hardware integration test, the SCADA system shall be built from the backup software on electronic media (CDs/Magnetic 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.

16.5. Functional Performance Test

The functional performance test shall verify all features of the SCADA 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 & other software application software/s in line with the requirements of various sections of technical specification.

b) Simulation of field inputs (through RTU) 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 communication Protocol IEC60870-5-104 etc.

f) Verification of MFT communication Protocol MODBUS etc.

g) Verification of compliance of supporting interfaces such as IEC61850, IEC60870-5-103 etc.

h) Testing of all user interface functions, including random tests to verify correct database linkages

i) Simulation of hardware failures and input power failures to verify the reaction of the system to processor and device failure

j) 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.

k) Demonstration of the software utilities, libraries, and development tools.

l) Verification that the SCADA computer system meets or exceeds employer's performance requirements

m) Verification of Development system

n) Unstructured testing of the SCADA 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)

16.6. Continuous operation Test (48 hours)

This test shall verify the stability of the SCADA hardware and software after the functional performance test has been successfully completed. During the test, all SCADA functions shall run concurrently and all Contractor supplied equipment shall operate for a continuous 48 (forty-eight) hour period. 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, un-commanded 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.

16.7. Field Tests (Site Acceptance tests -SAT)

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

16.8. Field Installation Tests

The equipment which has undergone the factory testing shall be installed at site and integrated with the RTUs 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 equipments
(d)   Interconnection with power supply
(e)   Diagnostic tests to verify the operation of all hardware
(f)   Random checking of SCADA software basic functions

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

16.9. 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/DTMU/MFTs with SCADA system

b)   the RTU /DTMU communication channel monitoring in the SCADA system

c)   the mapping of SCADA database with RTU /DTMU database for all RTU /DTMU

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.

16.10. Field Performance Test

The field performance test shall concentrate on areas of SCADA 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/DTMU 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) Verify that all the variances observed during the Factory test are fixed and implemented.
(b) Conduction of the Factory tests deferred (tests requiring site environment)
(c) Functional tests of SCADA system
(d) Verify the execution rates of all SCADA application
(e) Verify update rate & time for data update & control command execution as per specification requirements
(f) Verify the response time of all SCADA applications.

(g) Verify the response time for User interface requirements

(h) 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.

(i) Conduction of unstructured tests as decided by the Employer

16.11. 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 system (hardware and software) integrated with its RTUs/DTMU. However, the non-availability of RTUs/Data Concentrators/ DTMU & Communication System shall not be considered for calculating system availability. However, RTU communication equipments, Auxiliary power supply shall be tested as per the provisions given in their chapters.

The SCADA system (hardware and software systems) shall be available for 99.5% 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 99.5%, the contractor shall be allowed to repeat the system availability test after fixing the problem, failing which the system shall be upgraded by the contractor to meet the availability criteria without any additional cost implication to the owner.

Availability tests of RTUs shall be conducted along with System availability test for 360 hours. Each RTU shall exhibit minimum availability of 98%. In case the RTU availability falls short of 98%, the contractor shall be allowed to repeat the RTU availability test (for failed RTU 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 system and RTUs 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 system shall be considered as available if

a) One of the redundant hardware is available so that all the SCADA 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) All SCADA applications are available

d) All SCADA functions described in the specification are executed at periodicities specified in the specification. without degradation in the response times

e) Requests from available Operator Consoles & VPS are processed

f) Information Storage and Retrieval applications 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

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.

16.12. 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.

16.13. 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 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 CIM/XML Adapters & Messaging Interfaces.

y) Cyber Security Plan & Mitigation document 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 system on electronic media and two copies of these backup software shall be submitted to the owner.

(FMS) & SUPPORT SERVICES

This section describes general requirements describes the project's spares and maintenance requirements

17. INTRODUCTION

The Contractor shall be required to provide the services through Facility Management Service provider so as to manage SCADA & SAS system including all equipments, installations including hardware, software & networks installed & commissioned by Contractor for the utility in order that they meet the availability requirement as specified in the document.

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

18. 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 post Go Live 12 months warranty period followed by Three Year[*] Facility Management Services (FMS) along with Supervision & Operationalizing of the SCADA & SAS System.

The maintenance of the SCADA & SAS 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 which would include checking of functionality of hardware and software,
- Services to bring up any or all SCADA-SAS systems upon its failure and to restore the functioning of SCADA-SAS system including Control Centres, substations etc.
- The support for the RTU's /Relays/BCPU's
- All Software modules under the SCADA & SAS System and the associated Hardware supplied under this project.

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[*] Initially the FMS will be for 3 years after 1 year warranty period, however FMS may be extended further for 2-3 years on same terms and conditions on mutual agreement between Utility & Vendor.

Routine works like database building, addition of analog and status points and other such day-to-day operational activity would primarily be the responsibility of Utility and in case of any difficulty in this regard the same shall be referred to the Contractor for support. Contractor

19.   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 one Engineers including Site Manager Along with One on-site support personnel for Hardware and one on-site personnel for Software shall be deployed. The support personnel so deployed shall be qualified personnel having experience in the delivered SCADA & SAS system. The Contractor shall submit the CV's of all such personnel to Utility for approval before deployment at site.

The Contractor shall be responsible for 24*7*365 management of all the systems as per scope of work with services rendered at least as per Service Level Agreement between utility & Contractor. The Scope does not include management of physical security for access to the said facilities, the following facilities will be provided at the start of contract to FMS Contractor by Utility for carrying out the FMS responsibilities:

- Appropriately secured lockable storage/setup area
- Sufficient Sitting/office space in neat & clean environment
- PC (other communication facilities like telephone & internet facility are to be arranged by FMS Contractor)

20.   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.

20.1. 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

20.1.1. PROJECT MANAGEMENT

FMS Contractor will assign a Project Manager who will provide the management interface facility and has the responsibility for managing the complete service delivery during the contractual arrangement between utility and the FMS Contractor. Project Manager will be responsible for preparation and delivery of all monthly/weekly reports as well as all invoicing relating to the service being delivered. Project Manager's responsibilities should essentially cover the following:

- Overall responsibility for delivery of the Statement of Work/s (SOW) and Service Level Agreement (SLA).
- Act as a primary interface to Utility for all matters that can affect the baseline, schedule and cost of the services project.

- Maintain project communications through Utility's Project Leader.
- Provide strategic and tactical recommendations in relation to technology related issues
- Provide escalation to FMS Contractor's senior management if required
- Resolve deviations from the phased project plan.
- Conduct regularly scheduled project status meetings.
- Review and administer the Project Change Control Procedure with utility Project Leader.
- Identify and resolve problems and issues together with utility Project Leader.
- Responsible for preparation and delivery of all monthly reports as well as all invoicing relating to the services being delivered

20.1.2. Transition Management

During initial two weeks viz. initial period of taking over by FMS Contractor after completion of all installation & commissioning jobs by consortium members, FMS Contractor shall provide minimum agreeable services. Formal SLA shall be enforced only after initial transition period.

20.1.3. Contractor Management Services

As part of this activity, for efficient and effective warranty implementation, the FMS Contractor's team will:

1. Manage the vendors for escalations on support
2. Logging calls and co-ordination with Contractors
3. Contractor SLA tracking
4. Management of assets sent for repair
5. Maintain database of the various vendors with details like contact person, Tel. Nos., response time and resolution time commitments. Log calls with vendors, Coordinate and follow up with the vendors and get the necessary items exchanged.
6. Analyze the performance of the Contractors periodically (Quarterly basis)
7. Provide MIS to utility regarding tenure of completion of warranty/FMS with outside vendors for software, hardware & networks maintenance in order that utility may take necessary action for renewal of warranty/FMS. FMS Contractor shall also provide MIS regarding performance of said Contractors during existing warranty/FMS.
8. Since during initial Three years, warranty is in scope of OEM vendors there will be no FMS for SCADA & SAS system. During such period, FMS Contractor has to interact with such vendors for maintenance services and spares. After warranty period, if required Utility can award the suitable FMS Contractor has to interact with Contractors as selected by utility for providing FMS for the said system on mutually agreed terms & conditions.

20.1.4. FMS Contractor's Responsibilities

1. Provide a single-point-of-contact for responding to Utility's queries or accepting its problem management requests. FMS Contractor's specialist will respond to utility's initial request within agreed service level objectives set forth.
2. Monitor availability & Escalate to service provider and Notify Utility for communication failures.

3. Review the service levels of the service provider (as per pre-defined schedules on SLA performance) along with utility.
4. Provide network availability incident reports severity wise to utility in a format mutually agreed.
5. Provide SLA performance management report of the Service Provider.
6. **Fault Detection and Notification**: The Contractor shall diagnose problems that could arise as part of the LAN/WAN network. These include connectivity problems due to failures in communication transport links, routing configuration points, or from software bugs etc.
7. **Fault Isolation and Resolution**: All faults that have been identified need to be isolated and rectified appropriately. The resolution measures undertaken by the Contractor and results produced accordingly shall be documented in the report.
8. **Carrier Coordination**: Carrier Coordination implies providing a single point of contact to resolve network related problems involving carrier circuits, whether equipment or circuit related. When a problem is diagnosed because of a WAN circuit, the Contractor must coordinate with the corresponding carrier to test and restore the circuit. The Contractor must take the responsibility and ensure that the problem is resolved.
9. **Hardware/Software Maintenance and Monitoring**: This would include problem determination, configuration issues, and hardware and software fault reporting and resolution. All such issues would need to be recorded and rectified.

20.1.5. Backup/Restore management

FMS Contractor will perform backup and restore management in accordance with mutually FMS Contractor shall ensure:

1. Backup and restore of data in accordance to defined process / procedure.
2. 24 x 7 support for database restoration requests
3. Maintenance and Upgrade of infrastructure and/or software as and when needed.
4. Performance analysis of infrastructure and rework of backup schedule for optimum utilization.
5. Generation and publishing of backup reports periodically.
6. Maintaining inventory of onsite tapes.
7. Forecasting tape requirements for backup.
8. Ensuring failed backups are restarted and completed successfully within the backup cycle.
9. Monitor and enhance the performance of scheduled backups
10. Real-time monitoring, log maintenance and reporting of backup status on a regular basis.
11. Management of storage environment to maintain performance at optimum levels.
12. Periodic Restoration Testing of the Backup
13. Periodic Browsing of the Backup Media
14. Management of the storage solution including, but not limited to, management of space, volume, RAID configuration, configuration and management of disk array etc.,
15. Interacting with Process Owners in developing / maintaining Backup & Restoration Policies / Procedures
16. To provide MIS reports as per agreement

20.1.6. Performance Monitoring & Reporting

- Regularly monitor and maintain a log of the performance monitoring of servers including but not limited to monitoring CPU, disk space, memory utilization, I/O utilization, Central Storage etc.
- Regular analysis of events and logs generated in all the sub systems including but not limited to servers, operating systems, databases, applications etc. The system administrators shall also ensure that the logs are backed up and truncated at regular intervals.
- The administrators shall undertake actions in accordance with the results of the log analysis to ensure that the bottlenecks in the infrastructure are identified and fine-tuning is done for optimal performance
- Reporting to utility for all system performance monitoring

21. SERVICE MANAGEMENT CONTROLS

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 section must be provided by the Contractor. The Contractor is expected to have the following system management controls in place:

21.1. AVAILABILITY MANAGEMENT

a) 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:

b) Ability to create an escalation for an SLA.

c) Ability to workflow the SLAs.

d) Ability to create new action types, if needed.

e) Ability to define sets of actions that are grouped together in a specific sequence.

f) Ability to associate an escalation point with one or more actions through the action group.

21.2. PERFORMANCE MANAGEMENT

The recording, monitoring, measuring, analyzing, reporting, and forecasting of current levels, potential bottlenecks, and enhancements of performance characteristics for the services, networks, applications, system software, and equipment within the scope shall be required. System tuning and optimization is an inherent part of this contract. Where warranted, the Contractor will utilize capacity management data in combination with performance management data to identify ways to improve performance levels of the resources, extend their useful life, and request utility to approve revisions/upgrades to the computing and communications hardware, software and other equipments such that higher levels of performance of the resources are obtained.

21.3. SECURITY MANAGEMENT

The protection from unauthorized usage, detection of intrusions, reporting as required and proactive prevention actions are to be provided by the Contractor.

22. Problem Severity Levels

The problems will be categorized as follows:

Table 4 (Severity of the system under different Severity level)

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 22.1).
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 22.2.) 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 22.3.)
Severity 4 – General/ Technical Help	Request for information, technical configuration assistance, "how to" guidance, and enhancement requests. (as described at 22.4)

The details of the system under different severity level are as below: -

22.1. 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 & SAS system, failure of both LAN system, outage of both main and backup servers of any system, all RTU's, All BCPU's, firewall would be included under this category. Initially Utility's Engineers shall attempt to restore the system. In case the system does not come up and/or the problem is not resolved then Utility's Engineer shall intimate the problem to the Contractor. Upon receiving intimation, the representative of the Contractor would immediately attend to the problem and if required, any other authorized representative the Contractor may log on to the system. The problem shall be attended by the Contractor at the earliest, within the response/Resolution time as specified in the Agreement. The Contractor shall take all steps to restore the SCADA functionality at the earliest to avoid data loss.

22.2. Severity-2

The support services not defined under Severity-1 are included under this category. Failure of one SCADA/FEP Server, failure of VPS, Stoppage of data collections for archiving, real time calculations, failure in Acquisition of SOE, Single RTU, Single BCPU and other applications are

included in this category. 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 Man-power at Control Centre during working hours will also be covered under this category.

22.3. 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.

22.4. Severity-4 (General Technical Help)

Request for information, technical configuration assistance, "how to" guidance, and enhancement requests are included under this category.

23. 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.

24. 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 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 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.

Table 5 (Emergency Support Response/Resolution Time)

Severity	Initial Response Time	Action Resolution Time	Action
1	30 minutes	2 hours	An urgent or emergency situation requiring continuous attention from necessary support staff until system operation is restored – may be by workaround.
2	1 day	2 days	Attempt to find a solution acceptable to Utility/ Employer as quickly as practical. Resolution time is dependent on reproducibility, ability to gather

			data, and Utility prioritisation. Resolution may be by workaround.
3	2 days	5 days	Evaluation and action plan. Resolution time is dependent on reproducibility, ability to gather data, and Utility prioritisation. 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.

25. Preventive Maintenance

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

Activities shall include but not limited to

(a) Patch Management for OS and Application Software
(b) Automatic update of Antivirus and firewall signatures.
(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/Relays/BCPUs etc.- once every 3 months

Exclusions:

(a) Maintaining dust free environment and protection from rodents and vermin is the responsibility of Utility.
(b) Regular cleaning of computer furniture and surroundings is the responsibility of Utility.

Equipment shutdown during preventive maintenance shall be deemed as available.

26. Availability and Payment Charges Calculation

It is the endeavor of both the Contractor and Utility to maximize system availability to the extent possible. The Contractor shall provide guaranteed availability for various types of

Severity levels as specified in clause 2.3 above. The non-availability hours for availability calculation may be reckoned from the end of the allowed Action Resolution time. A standardized register shall be maintained at each site containing full details of each outage, actions taken by Utility to correct the problem, applicable Severity level, time of reporting to the Contractor support engineer/support centers pursuant to the appropriate methods in the Agreement, allowed Response time as per the Response times defined in clause 2.5, actual Resolution time, and signature of Engineer-in-charge as well as the Contractor's support engineer of the site. Duration of outages over and above the Action Resolution time in each of the Severity levels shall be counted for the non- availability computation and shall be clearly brought out in the register. The resolution may be accomplished by a work around, and such solution shall mark the end of non-availability. In the event of multiple failures at a site, due to a common cause, the first FPR (Field Problem, Report) logged shall be used for the purpose of availability calculation. However, simultaneous multiple outages due to unrelated cause would be counted separately.

26.1. Availability computation for SCADA System

Availability would be on per quarter basis. The formula to be used for availability computation would be as under:

$$\text{Availability per quarter} = \frac{THQ - (S1 \times 1 + S2 \times 0.4 + S3 \times 0.1)}{THQ} \times 100\%$$

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

26.2. Payment of maintenance charges (based on SCADA System availability)

In the event of availability below a certain level, the maintenance charges would be proportionately reduced as follows:

For overall system availability

Availability per quarter	Deduction as % of the apportioned price of total FMS for SCADA portion of the contract applicable for that site
$\geq$ 99%	NIL
Less than 99%	Deduction of 2% of the apportioned price of the apportioned quarterly FMS for every 1% or part there of decrease in availability under 99%.

For individual hardware & non critical functions

Availability per quarter	Deduction as % of the apportioned price of total FMS for SCADA portion of the contract applicable for that site
$\geq$ 98%	NIL

Less than 98%	Deduction of 2% of the apportioned price of the apportioned quarterly FMS for every 1% or part there of decrease in availability under 98%.

While calculating Availability following shall be considered:

The Overall SCADA/DMS System shall be considered as available if:

(a) All SCADA applications are available

(b) All SCADA functions described in the specification are executed at periodicities specified in the specification. without degradation in the response times

(c) Requests from available Operator Consoles & VPS are processed

(d) Information Storage and Retrieval applications are available

(e) One of the redundant hardware is available so that all the SCADA applications are functional to ensure the design & performance requirement.

Further, Non-Availability of RTU/Data Concentrators/BCPU's System shall not be considered for calculating Overall SCADA System Availability.

However, each device, including RTU, BCPU & 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 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

26.3. Computation of availability

The computation of Availability / Non-availability would be rounded up to 2 decimal places on quarterly basis and any deduction in the maintenance charges thereof would be calculated as stated above in Clause Payment of maintenance charges (based on SCADA System availability)26.2 on pro-rata basis.

27. 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 Utility 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 Utility. Also, any software updates/upgrades released till the

completion of warranty period /FMS shall be provided and installed & commissioned free of cost as per instructions from Utility.

The Contractor shall ensure that all components (Hardware & Software) covered under Three 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.

28. Responsibility Matrix

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

Item	Task
0.0	PROBLEM IDENTIFICATION
0.1	Root cause analysis to determine whether the fault is attributable to Hardware or Software.
0.2	Resolution of problems involving third party maintainer where there is uncertainty whether the root cause is hardware or software.
1.0	SOFTWARE PROBLEM RESOLUTION
1.1	Report problem and assist with problem identification
1.2	Provide or recommend corrections, temporary patches, workarounds or other fixes to system problems
1.3	Install and test corrections, temporary patches, workarounds or other fixes to system problems
2.0	ROUTINE SOFTWARE SUPPORT
2.1	Build and maintain database, displays and reports
2.2	Perform system back-ups
2.3	Restore or reinstall software from back-ups
2.4	Monitor system logs (part of remote monitoring service)
2.5	Maintain system logs
2.6	Maintain user accounts
3.0	HARDWARE PROBLEM RESOLUTION
3.1	Report problem and assist with defining problem
3.2	Troubleshoot problem to diagnose if it is software-related or hardware-related
3.3	Identify failed component, Replace failed components in online system using parts from spares inventory
3.4	Restore operation of repaired/replaced equipment
4.0	HARDWARE SPARE PARTS
4.1	Manage local spares inventory
4.2	Provide appropriate facility for local storage of spares
4.3	Replenish local spares inventory
5.0	Integration and database work

| 5.1 | FEP Card addition/Expansion |
| 5.2 | Database resizing |

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 spares (b) printer paper (c) Printer toner, ink and cartridges (d) Special cleaning material.

29. General scope of work for SCADA System

1. Selected Bidder to establish proposed SCADA SYSTEM in Project Area i.e. operation subdivision no. 5 of CED within 6 months from the award of contract.
2. Selected bidder to provide 12 months "Warranty support" after Go-Live of project area and 36 months "Post implementation support" after the end of warranty period.
3. For the maintenance phase, selected bidder to keep the availability and reliability of the complete SCADA system by at-least 99%.
4. For the maintenance phase, selected bidder to dedicatedly post at-least one support engineer (Diploma in Electrical Engineering with at-least 2 years relevant experience) per circle for resolving field related matters and at-least one dedicated Project – In-charge (B. Tech / B. E. in Electrical Engineering with at-least 5 years relevant experience) at the Data Centre for application management and overall system maintenance.
5. Integrating the proposed SCADA system with other necessary software being implemented under this project.
6. User Acceptance Testing and Sign-Off from CED would require for declaration of Go-Live. RECPDCL and its Technology Partner i.e. TPDDL will provide necessary support for coordination with CED.
7. Bidders to provide complete year wise plan for post implementation phase with deployment of resources year wise.
8. Proposed SCADA Software should be scalable in nature taking into consideration an average growth rate of consumers and associated infrastructure to be 7.5% per annum for the complete project duration from the date of award of contract to selected bidder. Enterprise-wide license for the software components is a mandatory requisite. Proposed SCADA Software and associated equipment's should be capable of handling at-least 50000 connections, without any additional infrastructure and cost implication to RECPDCL and CED.
9. The Proposed SCADA solution/SCADA system should have complete interoperability for accommodating all types of hardware, software and communication systems and vice-versa should also be there for any future up gradation of hardware / software.
10. Selected Bidder to setup a Project Management Office in CED, Chandigarh within 30 days from the date of award of contract. This office shall remain operational till the successful completion of this project i.e. Implementation stage (6-10 Months), Warranty Stage (12 months post implementation and Go-live) and O&M Stage (36 Months after end of warranty

stage). All the dedicated resources are to be deployed in Chandigarh for day-to-day coordination with Utility.

11. All supplied items must conform to the detailed technical specifications mentioned in this tender document.

12. Packaging and transportation from the manufacturer's work to the site including ports and customs clearance will be borne by the bidder.

13. The equipment shall be highly reliable providing 99% uptime and ensuring availability of the network of 99%

14. Unloading, Receipt, storage, preservation and conservation of equipment at the site.

15. The Bidder in consultation with RECPDCL/TPDDL Project In-charge and CED Local In-charge shall determine the exact positioning of equipment Installation, housing of equipment.

16. Insurance of all equipment from manufacturer's site till installation, commissioning, handing over and user acceptance will be borne by the bidder.

17. The bidder shall make his own necessary arrangements at Chandigarh to maintain mandatory and recommended (a minimum of 5%) spares during warranty and FMS period and provide the list of the same.

18. Install the equipment, obtain CED acceptance and submit a copy of the same to designated authority of RECPDCL.

19. Whenever a material or article is specified or described by the name of a particular brand, manufacturer or trade mark, the specific item shall be understood as establishing type, function and quality desired. Products of other manufacturers may also be considered, provided sufficient information with necessary certificates and documents are furnished so as to enable the RECPDCL to determine that the products are equivalent to those named. The Decision of RECPDCL shall be final and binding on the bidder in this regard. In case bidder proposes the products of other manufacturer, necessary certificates and documents shall be submitted along with the bid.

20. Post completion of installation and commissioning works, the selected bidder shall provide a complete and final location table and spreadsheet indicating all locations including all the relevant following information.

21. The proposed solution must efficiently enable all required interfaces and integration, including integration with the existing software as detailed in existing IT infrastructure.

22. Provide ongoing product information and documentation such as User manuals, System administrator manuals, Technical manuals, Installation guides etc. as applicable.

23. The Bidder shall be responsible for providing all material, equipment and services specified or otherwise, which are required to fulfil the intent of ensuring operability, maintainability and the reliability of the complete work covered under this specification.

24. It is not the intent to specify all aspects of design and installation of associated systems mentioned herein. The systems, sub-systems and equipment/devices shall conform in all respect to high standards of engineering, design and workmanship, and shall be capable of performing continuous commercial operation.

25. The bidder shall make his own necessary arrangements for the following and for those not listed anywhere else :

- Office and store.
- Transportation.
- Boarding & lodging arrangement for their personnel.

26. The supplier shall submit the data sheets for each of the equipment model detailing the specifications of the equipment.

27. The equipment models shall be supported by the OEM for a minimum period of next five years.

28. Technical Specifications of various type SCADA equipment, Hardware & Softwares shall have full compliance with NSGM guidelines and its amendment, which is available on website www.nsgm.gov.in. However any higher specifications are acceptable in case of any technical specification has become obsolete.

29. **Software Solution:**

    Software should provide following unique features:

    1. Collects, archives and analyses collected parameter from all sites.
    2. Can handle thousands of remote sites.
    3. Multiple users are able to view the data in required formats for graphs, trends, tables and reports. This enables better monitoring and control of transformers.
    4. Can be customized based on requirement and number of user clients.
    5. Each user can be assigned individual passwords and rights.
    6. Graphic user interface.
    7. View location of transformers on map
    8. Real time instantaneous parameters.
    9. Log energy parameters for energy reports.
    10. View all parameters and reports via web clients.
    11. Trends.
    12. Alarms and events
    13. required log sheets
    14. Required reports can be configured by the user.
    15. Send alarm messages via e-mails to pre-defined users in case on events.
    16. Send reports to pre-defined user at set intervals.
    17. Results in saving capital equipment by early detection of expected faults.
    18. Based on alarm messages received from remote DT sites.
    19. Detect location of transformer faults.
    20. Detect energy loss based on energy through DT and actual energy billed.

30. **SYSTEM DESIGN AND ENGINEERING**

    i The Bidder shall be responsible for detailed design and engineering of overall system, subsystems, elements, system facilities, equipment, services, including systems application software etc.

ii   It shall include proper definition and execution of all interfaces with systems, equipment, material and services of Owner for proper and correct design, performance and operation of the project.

iii   Bidder shall provide complete engineering data, drawings, reports, manuals and services offered etc. for Owner's review, approval and records

31. **SPECIAL TOOLS AND ACCESSORIES**

i   The bidder's proposal shall include the list of special tools, testing equipment and accessories required during development stage, for day to day operation and maintenance of the system.

ii   The bidder's proposal shall include the list of special tools, testing equipment and accessories required for day to day operation and maintenance of the system. All such tools shall be supplied by the bidder. The bidder should clearly bring out the list of such tools in their technical proposal. However the prices of these special tools shall be included in the related equipment price in the price template given in this RFP.

32. **INSTALLATION & IMPLEMENTATION**

i   The bidder shall be responsible for installation of all identified hardware and associated equipments at Data Centre, DR centre, Control Centre, Substations, DT locations, HT and selected LT Consumers and Communication network covered under the specification.

ii   The bidder shall be responsible for provisioning of all required manpower and tools/kits for safe, reliable, proper and correct installation and providing support services for IT infrastructure created for a period of five years.

iii The successful bidder shall be responsible for installation and configuration of software, hardware and other equipment supplied to the satisfaction of the owner. This shall include but not be limited to :

a. Installation of the software at Data Centre, DR Centre and various other locations.

b. Installation of SCADA equipment at Sub stations, DTs, HT and Select LT consumers.

iv   Post Go-Live, the software vendor shall provide support to fix any bug related to implementation. The entire system would be considered as successfully installed when the software will run with actual live data at site for 3 months without any bugs (Bug is lacunae in the system that prevents/ delays an operation or performs a function within the system at suboptimal level/ at performance level lesser than that specified in this specification or provides incorrect operational data or provides incorrect results in any data format in the reports generated by the users).

v   Demonstration of all the features of latest version of software; Acceptance testing of the system thus implemented to the owner's satisfaction.

33. TESTING, COMMISSION AND SUCCESSFUL OPERATION

The scope includes testing and commissioning & implementation of all equipment, sub-systems and systems of the project and putting them into successful technical & commercial operation. The scope shall include but not limited to the requirements given elsewhere in the specification. The bidder shall be responsible to provide all necessary testing and commissioning personnel, tools/kits, test equipment etc.

34. TESTING AND ACCEPTANCE PROCEDURES

Testing and quality assurance in software development is more rigorous since each component has to be more reliable, if it is to be reused. A system is tested at various stages of development and deployment. For example, each component is tested as a unit for checking the correctness of its own code. Further, the component is tested with its dependent components. After final release of the entire set of components, system is tested for the correctness of system functionality. Finally the components are further tested in simulated production load for performance and load analysis.

The Implementation Agency 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) and execution (includes testing at various levels like unit level, integration level, system level and production).

35. TEST PLAN

Test plans are prepared for each phase of testing. The initial test plan is created during the Project Planning phase. The initial test plan describes who performs which type of testing and when. Ideally master test plan covers all types of test i.e. from unit testing to production testing. The Implementation Agency is expected to submit the test plans to Utility for approval. Any changes made to the test plan during the project life cycle should be communicated to UTILITY for approval.

36. TEST SCENARIOS

The Selected Bidder should prepare test scenario for each business scenario. A test scenario when executed should fulfill a business requirement as per the scope of business functionality. Test scenarios include following:

(a) Test Specification - During the test specification phase, the test cases are specified. It consists of description of the input, process to be executed and a prediction of output results.

(b) Test Environment - Component developer does unit testing and integration testing. Integration testing can be delegated to a specialized testing group. Each of the members in the testing group is provided with testing environment according to his/her role and responsibilities.

Following is sample testing environment for testing:

- ▪ A workstation
- ▪ A set of tools and applications required on workstation like access to user interface, browser etc.
- ▪ Access to centralized document database (where all the project related documents are maintained)
- ▪ Access to testing tools and defect logging tools
- ▪ Access to the central database or repository for development and unit testing (this database contains sample test data)
- ▪ Access to deployed components

(c) **Test Data** - Test data is prepared for testing at each stage. The test data should be prepared in such a way that it covers basic path and every alternate path of the code. The basic path and alternate paths are prioritized to capture relevant data. Tools can also be used to generate test data.

37. **Test Execution**

The following testing steps are usually employed in the project lifecycle. The Implementation Agency is expected to follow these steps:

a) **Unit Testing** - In unit testing, each piece of code has to be rigorously tested. At this stage testing is done according to the priority of path of code. All the test results are logged in the defect logging tools. After every the completion of testing, code is corrected for defect logs. This process is iterative till criteria for successful testing is reached.

b) **Integration Testing** - Upon completion of unit testing, integration testing begins. The purpose is to ensure distinct components of the application still work in accordance to customer requirements. Test sets will be developed with the express purpose of exercising the interfaces between the components. This activity is to be carried out by the Test Team. Integration test will be termed complete when actual results and expected results are either in line or differences are explainable/acceptable based on client input.

c) **Incremental Integration Testing** - Continuous testing of an application as new functionality is added.

d) **System Testing -** System testing is performed when all the components are delivered to central repository prior to the release of the software. The testing is done on priority basis of business processes. All the defects are logged and assigned to respective component owners. The component and unit testing is performed after the correction of code. However, it may depend on size and type of individual test specifications. Impact analysis is useful to narrow done testing efforts by identifying critical test cases affected due to code change.

e) **Pre-Production Testing** – Pre-Production testing is done simulating the production load. Test data is either prepared or generated from the tools. This testing is used to evaluate performance, load capacity and concurrency. Load testing tools can also be used for this purpose.

Following special types of testing are done during Pre-production Testing Phase:

i. **Regression Testing** - The objective of regression testing is to ensure software remains intact. A baseline set of data and scripts will be maintained and executed to verify changes introduced during the release have not "undone" any previous code. Expected results from the baseline are compared to results of the software being regression tested. All discrepancies will be highlighted and accounted for, before testing proceeds to the next level.

ii. **Performance Testing** - Although performance testing is described as a part of system testing, it can be regarded as a distinct level of testing. Performance testing will verify the load, volume, and response times as defined by requirements.

iii. **Load Testing** - Testing an application under heavy loads, such as the testing of a web site under a range of loads to determine at what point the systems response time degrades or fails.

iv. **Installation Testing** - Testing full, partial, or upgrade install/uninstall processes. The installation test for a release will be conducted with the objective of demonstrating production readiness. This test is conducted after the application has been migrated to the client's site. It will encompass the inventory of configuration items (performed by the application's System Administration) and evaluation of data readiness, as well as dynamic tests focused on basic system functionality. When necessary, a sanity test will be performed following the installation testing.

v. **Security/Penetration Testing** - Testing how well the system protects against unauthorized internal or external access, willful damage, etc. This type of testing may require sophisticated testing techniques:

vi. **Recovery/Error Testing** - Testing how well a system recovers from crashes, hardware failures, or other catastrophic problems.

f) **Acceptance Testing** – During the test scenarios definition, for each of the business scenario, an acceptance criterion is defined. Acceptance criteria include expected behaviour of the s/w component and the expected results (data). Expected results form a part of the Exit Criteria. In addition to expected result and behaviors, some conditions are also specified in the exit criteria. They can be:
   ▪ Number of bugs to be discovered for a functional module. This depends on size of the functionality and is an indicator of amount of testing done.
   ▪ If any medium or low-priority errors are outstanding - the implementation risk must be signed off as acceptable by UTILITY and Implementation Partner along with consortium partners
   ▪ All High Priority errors from System Test must be fixed and tested

Implementation Agency needs to get the acceptance criteria approved from UTILITY for all the functional components of the system. The Acceptance Criteria for each release into production environment will be agreed upon by Implementation Agency in consultation with UTILITY prior to release from Testing to production environment. After installation, if any bug is reported or there is non-compliance to requirements then a proper procedure should be followed. End-user should report ("Change Request") to his/her supervisor about the bug that will in turn get forwarded to Project Manager (PM). PM will forward the List of change request to Implementation Partner along with consortium partners. After the bug is fixed, it should be reflected in the production copy after testing it.

g) Performance Testing - The bidder has to test and demonstrate the operational performance requirement as defined in the clause 9 of the specification after completion of entire scope.

This will be part of acceptance testing. The system will be taken over by owner only after successful operational performance testing. The bidder has to arrange necessary hardware / software to demonstrate the performance testing.

Bidder should note that RECPDCL/GED can appoint a third party agency for conducting any part of above testing procedures (in addition to the testing carried out by the bidder).

38. **INTEGRATION SCOPE**
All required external systems shall be integrated on a continuous basis using an integration middleware layer. The integration is expected to be on on-line real time basis or batch mode where appropriate and shall operate in an automated fashion without manual intervention.
The scope of external integration will be, but not limited to:
- Integration with other Smart Grid Applications, which are being implemented.
- The integration may use a continuous integration middleware layer as specified by the vendor. This integration middleware layer could then be used to undertake any future integration between applications. The integration middleware shall be based on Service Oriented Architecture (SOA) and shall use publish / subscribe mechanism. Purchaser does not want to build and maintain point to point integration.
- The integration middleware shall be open architecture based.
- Data to be integrated must be validated by the developed interfaces.
- The data to be integrated will be mapped, transformed (if required) and reconciled automatically.
- All interfaces are to be self-checking so that any exceptions or data validation errors are reported by the system. In addition, integration logs should be maintained that confirm the success or otherwise of the interface, complete with control totals.
- The mapping should be manageable through a GUI based administrative interface

39. **TRAINING FOR THE EMPLOYEES –**

The vendor shall be required to organize following training for the owner's personnel. The bidder shall provide training to various user groups of CED, RECPDCL and TPDDL. The bidder shall provide the Training Approach in the response. The training modules shall include but not limited to –

- SCADA Administration & Configuration
- SCADA/SCADA Installation and Trouble-Shooting
- Application Management
- Application Data Analysis

Training arrangements – All trainings must be of minimum 1 day or bidder can propose more no. of days training along with batch size as per requirement. A training calendar with contents and sessions will be also agreed upon between bidder and RECPDCL/TPDDL. The selected bidder shall be required to organize following training for the CED/RECPDCL/TPDDL personnel:-

Professional Training - This is the training for the core Group of implementation team of the CED and RECPDCL/TPDDL. This team will comprise of members from all the Business Functions and IT sections. Each member would be trained in the relevant function / module. This Training would be required to be given to approximately 20-25 personnel. It is the responsibility of implementation agency to deliver this training. Standard curriculum, designed and agreed by the owner for hardware, software and network preferably from the OEM partner or OEM's certified training partner shall be arranged for each group. The vendor is required to quote on per person basis for this training. The Purchaser will prefer if a portion of the training is conducted on-site.

End User Training - The bidder will provide training to the owner's team on a "Train the Trainer" basis. The Owner's team so trained will then train all of the owner's end users. It is estimated that this training will require around 8 groups, with each group comprising of around 12 to 15 persons. These training sessions will be required to be conducted at any of the sites.

- The recommended training material can be in paper / electronic media with courses on BPA software fundamentals, business process overview, job activity training, and delivery options being on-line, CBTs, instructor led class rooms, etc.
- During the course of the implementation, the bidder is expected to complete / be involved in the following activities in terms of skill transfer:
- Testing scripts should be prepared to test the business processes and scenarios of the new system.
- The project team members will further develop these testing scripts into training documents.
- Training material will be organized by functional process that will serve as the training documentation for a particular functional area.
- Assist the Owner's team members in creating procedure documents for use in conjunction with the other training material. A procedure document will list all of the transactions necessary to complete a business scenario whereas a training document lists the steps to execute a transaction. Each step will be a transaction referenced in a training document.

- Procedures will be listed for all the online steps needed to complete a scenario.
- In addition to functional training document binders and procedures, the project team members will create training courses and exercises. The training courses will contain all the training documents and necessary to train an end-user in his / her role. The training exercises will list common business scenarios and input data that the user will enter to practice with the newly developed BPA software.
- Vendor will assist in administering training to project team members and / or power users, to "train the trainers".
- Vendor should assist in administering training to the rest of the users / peers in functional areas based on the course documentation developed by the project team and vendor.

The training will consist of a curriculum of courses to address the issues of system operation, business-wide application, changed business processes and general use of the new system.

Representatives from the successful vendor, 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.

The roll out of the training program will be coordinated with the overall project implementation strategy.

40. **SUPPLY OF MEDIA -**
The successful bidder shall supply two copies of media of SCADA applications and its related software's solution against the specifications.

41. **DOCUMENTATION SCOPE –**
The following documents (one set each) will be required for smooth functioning of the system. The successful vendor will provide ongoing product information for referential purposes and facilitating self-education by CED/RECPDCL personnel. Key aspects shall include:

What documentation is included in the standard license fee, for example:
- User Manuals
- System Administrator Manuals
- Technical Manuals
- Installation Guides
- Business Process Guides
- Program Flow Descriptions
- Sample Reports
- Screen Formats
- Toolkit Guides

- Troubleshooting Guides
- Frequently Asked Question (FAQ) Guides

The clarity, comprehensiveness and accuracy of the documentation (an example document should be made available):

- The media upon which documentation is made available.
- The frequency of documentation updates and distribution mechanism of the updates.
- The ability for documentation to be customized for or by RECPDCL/CED

Hard copy and soft copy of user manuals are expected to be provided by the successful vendor. These should include information on the application concepts in addition to transaction and field level documentation. Additionally the Technical Users Information manual provides information on the BPA software's table structures.

Selected Bidder will be expected to assist in developing operational procedure manuals. If the user manuals are provided in Word format, the client should have the ability to customize their own manual to include specific business processes or operational procedures.

Selected Bidder can also be required to provide context sensitive on-line help, which includes all materials provided in the hard copy manuals. Where possible, users should be able to add their own on-line help documentation.

30. Post Implementation Support & Warranty Requirements

   The bidder shall be responsible for providing the support after go live of the system for next 3 years after warranty period of 01 year. The scope shall include the following but not limited to the following

   a. Warranty of software which include bug fixing, patches, upgrade etc. and same shall be provided.
   b. Helpdesk/ticket handling/tracking of request (Bug/Issue/New Development)
   c. Trouble shooting of applications
   d. Maintenance of system and application response time.
   e. System and database administration
   f. Existing Application maintenance, correction, enhancement, new development, bug fixing etc.
   g. Maintenance, modification, enhancement and new integrated business processes.
   h. Post implementation support and management shall be governed by performance parameters as mentioned in this NIT.
   i. Post implementation shall also cover the new requirement of tools, application, reports etc. of utility.
   j. The bidder shall provide the off-site support of experts also to resolve the issues in shortest time.

31.   Timelines for Delivery and Installation

The bidder is expected to complete the Enterprise Wide - implementation of SCADA system on all connections within 6 months from the date of award of contract by the RECPDCL.

Bidder shall submit a detail Gantt chart along with the following implementation schedule. Bidders shall drill down these activities into sub/sub-sub activity in the chart. The chart shall also detail out time and resource effort required to execute each activity. The detailed bar charts for all the work activity shall however, be discussed and agreed to by the successful Bidder with the owner before start of the execution of work.

Sr. No	Activity Name	Start Date	Weekly Plan						End Date
			W1	W2	W3	W4	W5	.....	
1	Resource Mobilization and establishment of site office								
2	System Design and approval from Owner								
3	Proof of concept of the Overall Solution								
4	Establishment of SCADA System								
5	Roll Out in Project Area								
6	Warranty Services (12 months)								
7	FMS Services (36 months)								

32. Payment Criteria

The payment terms for SCADA system establishment and related services milestones in sequence are given below:

S. No.	Milestone	Payment
1	After Sign off of SRS, design document and Data model and Factory Acceptance test (FAT) and Delivery of Materials at Project site	10% of quoted Price**
2	Installation, commissioning and integration of all SCADA Hardware, Software, field material in Project Area and Site Acceptance test (SAT)	40% of quoted Price**
3	Go Live & User Acceptance	20% of quoted Price**
4	After 3 months of Go Live of SCADA System performance as per utility satisfaction	10% of quoted Price**
5	Successful completion of all responsibilities and obligations and handing over of SCADA system to Utility	15% of quoted Price**
6	Completion of 1 year warranty + 3 years[†] FMS period. The payment may be released earlier provided the supplier submits the Bank Guarantee (BG) for an amount equivalent to 5% of contract value. This BG shall remain in force up to and including 6 months after FMS period.	5% of quoted Price**
7	Charges towards FMS during FMS period of 3 years after 1 year warranty period.	On half yearly basis at the end of six months on satisfactory completion of Facility Management Services (50% of quoted price for per year FMS).

*** Price is sum total of all-inclusive cost for software, hardware supply and implementation cost.*
Payment procedure:

Method of payment: All invoices/claims shall be raised by the bidder in the name of Chandigarh Electricity Department (CED), Chandigarh (owner) C/O RECPDCL. All the payment shall be released directly to the bidder by RECPDCL within 30 days of submission of invoices on receipt of funds from CED. Further tax will be deducted as per applicable law by RECPDCL from the payment made on behalf of CED.

[†] Initially the FMS will be for 3 years after 1 year warranty period, however FMS may be extended further for 2-3 years on same terms and conditions on mutual agreement between Utility & Vendor.

The completion time of the project shall be monitored as per milestones mentioned above. Any delay in compliance to the milestone timelines shall lead to Penalty, and shall be deducted from the payments due under the Contract or by invoking the Contract Performance Bank Guarantee and/or otherwise, as per the following Penalty table

Milestone	Timelines	% age penalty on Price
On installation, commissioning and integration of all SCADA Hardware, Software, field material in all Project Area, completion of trainings and user acceptance by RECPDCL and CED Project In-charge.	Within 6 months	Not Applicable
	Beyond 6 months	0.5% of Contract Value (excluding Post Implementation phase Value) per week or part-thereof with maximum 5% of the contract value may be levied from the bill of the contractor.

33. Service Level Agreement (SLA)

1. Maintenance & Support services

1.1. Introduction

The scope of maintenance work shall include a comprehensive maintenance of all the software and hardware provided by the contractor for the various systems and components of SCADA system under this project. The maintenance practices to be followed shall be as per ISO 20000 Standard. The essence of the maintenance services is to provide maintenance support for the designated hardware and software, with the goal of meeting the availability as set forth herein. SI is to hand hold the EMPLOYER/UTILITY team to take over maintenance and support services after completion of SI's FMS period. The project/ system devices should allow their functionalities to be upgraded without disruption to the existing functionalities by downloading new software and configuration information.

1.2. Maintenance support

The period of maintenance support shall be the 1 year Warranty (Defect Liability) period commencing from Operational Acceptance and 3 year Maintenance period thereafter.

The nature of maintenance support required for the different type of systems and components are described in the Table 6 Maintenance support and Availability requirements below:

Table 6 Maintenance support and Availability requirements

Sl.no.	System	System Availability requirements
1	Supervisory Control and Data Acquisition System (SCADA System) / Substation Automation (SAS)	99.5%

The system availability shall be measured for entire System. Similarly, the availability of various systems of SCADA elements Hardware and Software, Field devices, Communication & Networking Systems shall be considered separately control Centers wise. Individual device availability shall be at least 98%.

For all third party equipment (Hardware & Software) and services (communications) Contractor shall have back to back support along with supply of spare and service level agreement with appropriate response time from OEM/OEM Authorized representatives.

Contractor shall be responsible for coordination with the OEM for all matter related to that equipment. But the Contractor shall be responsible for meeting the overall response times and availability requirements specified below.

The maintenance of the System shall be comprehensive and shall comprise of the following category of works which is further elaborated for each of the different subsystems:

(a) Preventive Maintenance Activity (performance monitoring, system backup, patch management, updates and troubleshooting)

(b) Maintaining a minimum no. of specified spares.

(c) Integration of new equipment (Field devices, central systems, Communication & networking systems) and integration of a new or existing central system.

1.2.1. Preventive Maintenance Activity

The preventive maintenance activity are be performed by the Contractor to keep the system running at optimum level by diagnosis and rectification of all hardware and software issues and would broadly include.

- There should not be any unnecessary and unscheduled downtime of system services.

- Configuration of the replaced hardware and 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,

- Monitoring of the performance of the system and doing necessary tuning for optimum performance to accommodate any changes such as addition of new components.

- Providing all necessary assistance to Employer/Utility for addition and modification of database and displays, Database sizing activities including Backup and restore of the system

- Restoration of the systems upon its failure and to restore the functioning of the various systems at the central systems

- Log analysis to zero in developing issues

Routine works and other day-to-day operational activity would primarily be the responsibility of Owner and in case of any difficulty in this regard the same shall be referred to the contractor for support.

1.9.1. Hours of Cover

The Contractor shall provide engineers who have an experience and skill to maintain the Smart Grid System to the desired level of availability. The contractor's on-site support for central systems, shall be standard hours of service i.e. Monday to Saturday- 9:00 am to 5:30 pm local time (IST), excluding public and Owner Company holidays, throughout a year. At least one experienced personnel having expertise in SCADA System shall be available during the standard hours of service. The timings for Emergency Support would be 24 hours a day, 7 days a week throughout the year.

The support personnel so deployed shall be qualified personnel having at least 3 years of experience in the delivered SCADA elements/parts. The contractor shall submit the CV's and recommendation letter from customers for all support personnel(s) to Employer/Utility for approval before deployment at site. The Employer/Utility can ask the Contractor to replace the personnel deployed for maintenance support if his performance is not found to be satisfactory.

2. **Service Response requirements**

The severity levels are defined in coming sections and the requirement of response time for various severity levels is defined below:

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 shall comprise of experienced technical staff that are skilled in troubleshooting of the various systems covered under FMS. Severity 1 problems shall be reported by telephone for rapid response; target response times are defined in this section. 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 Owner/Employer/Utility through a call tracking system to be provided by the contractor. Resolution of problems may also be provided by an individual fix that will be installed by the contractor at no extra cost to Owner.

2.9. Monitoring

The operation and performance of the various systems under FMS shall be monitored on a bi-weekly basis; the contractor shall review the following, analyze the results, and submit report to Owner. The contractor shall conduct at least the following monitoring, for the all Control Centres.

2.9.1. *Log Monitoring*

- System logs for a selected day
- System history log
- Aggregate data collection
- Events Collection

During monitoring if any defect/ abnormality is found, the contractor shall undertake corrective maintenance for the same.

2.9.2. *Resource Monitoring*

Resource Monitoring services comprises checking the system's major node resources, gather log data, analyze results, and advise Owner/Employer/Utility on the appropriate actions to be taken and undertake any agreed upon actions. The supplied system tools shall be used to continuously collect the following information:

- CPU loading (Peak and Average)

- Memory utilization (Peak and Average)

- Disk utilization (Peak and Average)

- LAN/WAN utilization (Peak and Average)

- Operating system resource utilization

- System error log

The SI shall submit the procedures details to meet the above along with the offer.

2.9.3.   *Cyber security System monitoring*

The Contractor shall also be responsible for monitoring of the cyber security system, if provided. The logs of the system shall be analyzed for exceptions and the possible incident of intrusion/trespass shall be informed to the Employer/Utility.

The monitoring shall encompass the various cyber security devices installed at Control Centre such as firewalls, Intrusion prevention system (both network based and host based), routers. The Centralized Monitoring Console (CMC) shall monitor and continuously collect the above logs. The Cyber security system shall also be subjected to Annual Security Audit from CERT-In listed auditors at the cost of the Contractor. Contractor shall implement the recommendations/remedial actions suggested by the Auditor after audit.

2.10.   Patch Management

The contractor shall also be responsible for providing updates/patches for the software products supplied under the project. All other patches of third party product like Operating System and Anti-virus shall be tested by the Contractor prior to installing in the Employer/Utilitys network. Other products like IPS, Network IPS, Host based IPS, Firewalls shall also be provided with secure patch management. A secure patch management and deployment system is to be established which shall be provided with single point of Internet connectivity. All the patches shall be downloaded through this single point of connection. Internet connection shall also be provided and shall be shown in System Architecture diagram submitted during Bid submission.

Software updates and patches shall be applied while the system is in operation and shall not require a reboot (e.g. applied to one processor in a dual processor configuration). A secure (e.g.

https) remote method of initiating a rollback to the software prior to the update or patch shall be provided.

SI to describe the method proposed to securely apply software updates and patches. SI to also specify the method proposed to use to securely initiate a rollback to the software state prior to an update or patch.

The Contractor shall describe a mechanism for patch management so that it is known that what patches have been applied, what all patches are pending but available with us and what is the recent release of patches for the various products as part of cyber security documentation. Any patch shall be applied only with express permission of the Employer/Utility's representative.

2.11.   Physical maintenance

The contractor shall undertake physical maintenance of all equipment/modules under the scope of this contract, in accordance with this section. The physical maintenance shall include cleaning, dusting, inspection of equipment for loose connections, damage to insulation, pest infections etc. Equipment shutdown approval for preventive maintenance shall be required from Employer/Utility.

2.12. Spares inventory

The Contractor shall maintain a spares inventory at his own cost to meet the spare availability requirements of the system. The spares shall be used as and when required and no separate charges are payable except the maintenance charges. The Contractor shall decide the items and components to be maintained as spare but a minimum number of spares and shall be kept at the respective Centers. This shall be periodically verified by the Employer/Utility. If the replenishment of the spare takes more than 30 days then it will be considered as non- availability as per **Severity-2**.

Note: One of each Type Supplied as part of system. Wherever one configuration can replace multiple type of elements supplied only 2% (Minimum one) such equipment shall be taken as spare

(a)   Integration of new equipment
All future Field devices & other System integration shall be the responsibility of contractor and shall be part of the maintenance charges.

(b)   Problem/Defect Reporting
The SI shall propose an appropriate problem/defect reporting procedure to   meet the requirement of all severity level cases along with the offer.

The problems will be categorized as follows:

Table 7 Severity Levels

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
Severity 2 – Serious	Degradation of services or critical functions such as to negatively impact system operation. Failure of any redundant system component such that the normal redundancy is lost Non-availability of Man-power at Central system during working hours, non-availability of spares
Severity 3 – Minor	Any other system defect, or unexpected operation not covered under severity 1 or 2
Severity 4 – General/Technical Help	Request for information, technical configuration assistance, "how to" guidance, and enhancement requests.

2.4. Severity levels

The detail of the systems under different severity levels is as below:

1. 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 central system. For example, loss of data to the operator due to any problem software/Hardware-related in SCADA/SMART GRID System, outage of any important software functionality which is required to discharge operational functions, outage of both main and standby routers, and loss of data exchange with other computer systems or other Central systems would be included under this category. The failure of complete UPS (uninterrupted Power Supply) system resulting into loss of UPS output supply at both Output ACDB is covered under this category.

Upon receiving intimation, the representative of the contractor would immediately attend to the problem. The problem shall be attended by the contractor at the earliest, and it

shall arrange all resources and take all steps to restore the data availability and functionality at the earliest.

2. Severity-2

Degradation of services or critical functions such as to negatively impact system operation. Failure of one Data Server, stoppage of data collections for archiving, at the respective Central system, and outage of other applications not covered under severity-1 are included in this category.

Failure of one UPS system, Failure of Battery System and failure of any other system of Auxiliary
Power supply not covered under Severity-1 are included in this
category.

Coverage under this severity would be outages that do not immediately cause on line 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 would also be included in this category.

Non-availability of designated contractor's Man-power at central system as well as required inventory of spares specified here will also be covered under this category.

3. Severity-3 (Standard support)

The support services included under this category are when the outage or loss of functionality is neither of an emergency nor priority functionalities as indicated in severity level 1 or 2 above.

4. Severity-4 (General Technical Help)

Request for information, technical configuration assistance, "how to" guidance, and enhancement requests are included under this category.

2.13. Response and Resolution Time

This section describes the target times within which the contractor should respond to support requests for each category of severity. The Initial Response Time is defined 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 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.

Table 8 Support Response/Resolution Time

Severity	Initial Response time(Working Hours)	Initial Response Time(Non-working hours)	Action Resolution Time	Action
1	5 minutes	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	5 minutes	2 Hours	24 Hours	Attempt to find a solution acceptable to Owner/ Employer/Utility (dependent on reproducibility), as quickly as practical.
3	2 hours	1 day	2 days	Evaluation and action plan. Resolution time is dependent on reproducibility, ability to gather data, and Owner/ Employer/Utility's prioritization. Resolution may be by workaround.
4	2 hours	1 day	2 days	Report on the problem/query is to be furnished.

(c)   Availability and maintenance charges payment Calculation

It is the endeavor of both the contractor and Owner to maximize system availability to the extent possible. The contractor shall provide guaranteed availability for various types of Severity levels as specified in section above.

The non-availability hours for availability calculation shall be counted from the end of the allowed Action Resolution time. A standardized register shall be maintained at each site containing full details of each outages, actions taken by Owner to correct the problem, applicable Severity level, time of reporting to the contractor support engineer/support center pursuant to the appropriate methods in the Agreement, allowed Response time as per the Response times defined in above section, 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.

2.14.   Availability computation for System

Availability computation shall be done on per quarter per site basis. The formula to be used for availability computation shall be as under:

Availability per quarter (per site) = $\underline{\text{THQ- (S1 x 1+S2 x0.8+S3 x 0.5)}}$

x 100% THQ

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

2.15. Payment of maintenance charges (based on SCADA availability)

In the event of availability below a certain level, the maintenance charges would be proportionately reduced as follows: The same shall be applicable for the Auxiliary Power supply system with the availability specified for the respective systems.

For Software:

Availability of central system / quarter	Deduction as % of the apportioned price of total FMS (Software Portion) for central system portion of the contract applicable (quarterly software price)
≥99.5%	NIL
Less than 99.5%	Deduction of 2% of the apportioned quarterly FMS charges for every 0.5% or part there of decrease in availability under 99.5%.

For Hardware:

Availability for each elements per quarter	Deduction as % of the apportioned price of total FMS (Hardware portion) for central system portion of the contract applicable for that site (quarterly hardware price)
>98%	NIL
Less than 98%	Deduction of 2% of the apportioned quarterly FMS charges for every

2.16. Computation of Availability / Non-availability

The computation of Availability / Non-availability would be rounded up to 2 decimal places on quarterly basis and any deduction in the maintenance charges thereof would be calculated as stated above in aforementioned Section on pro-rata basis.

2.17. Contractor's Obligations

In order to optimize and improve the response of the system, the contractor may re-install the program modules in consultation with and after making the Owner / Employer/Utility engineer aware of the consequence (like data loss, database rebuild etc.)

Any modification of Field devices, software/Operating System required to restore functionality due to hardware upgrades, patches, or arising out of a necessity to fix FPRs (Field problem reports), would be done by the contractor at no extra cost to Owner / Employer/Utility.

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

2.18. Responsibilities of Owner /Employer/Utility

The responsibilities of the owner during the maintenance period are as follows:

(a)   Employer/Utility shall ensure that proper Environmental conditions are maintained for the system.

(b)   Employer/Utility shall ensure that the System is kept and operated in a proper and prudent manner as described in the system documentation provided by the Contractor and only trained Employer/Utility representatives (or persons under their supervision) are allowed to operate the system.

(c)   Employer/Utility shall provide access to the sites of installation for purposes of providing Support Services.

(d)   Employer/Utility shall provide the contractor with Space for Office for their maintenance staff and storage for spares.

2.18.1. Responsibility Matrix

The table in this section provides a summary definition of the roles and responsibilities of the contractor.

Table 9 Responsibility Matrix

Item	Task
0.0	PROBLEM IDENTIFICATION
0.1	Root cause analysis to determine whether the fault is attributable to Hardware or Software.
0.2	Resolution of problems involving third party maintainer where there is uncertainty whether the root cause is hardware or software.
1.0	SOFTWARE PROBLEM RESOLUTION
1.1	Report problem and assist with problem identification
1.2	Provide or recommend corrections, temporary patches, workarounds or other fixes to system problems
1.3	Install and test corrections, temporary patches, workarounds or other fixes to system problems
2.0	ROUTINE SOFTWARE SUPPORT
2.1	Build and maintain database, displays and reports
2.2	Perform system back-ups
2.3	Restore or reinstall software from back-ups
2.4	Monitor system logs (part of remote monitoring service)
2.5	Maintain system logs
2.6	Maintain user accounts
3.0	HARDWARE PROBLEM RESOLUTION
3.1	Report problem and assist with defining problem
3.2	Troubleshoot problem to diagnose if it is software-related or hardware-related
3.3	Identify failed component, Replace failed components in online system using parts from spares inventory
3.4	Restore operation of repaired/replaced equipment

4.0	HARDWARE SPARE PARTS
4.1	Manage local spares inventory
4.2	Provide appropriate facility for local storage of spares
4.3	Replenish local spares inventory
5.0	Integration and database work
5.1	FEP Card addition/Expansion
5.2	Database resizing

SECTION-V
GENERAL CONDITIONS OF TENDER

1. The bidder must fulfil the above eligibility criteria/pre-qualifying conditions for evaluation of their bids. Bids of bidders fulfilling the above eligibility/pre-qualifying conditions will only be evaluated by the duly constituted evaluation committee. Bids of the bidders not fulfilling the eligibility/pre-qualifying conditions given above may be summarily rejected. Undertaking for subsequent submission of any of the above documents will not be entertained under any circumstances.

2. RECPDCL reserves the right to conduct the reverse auction (if required) for the products/ services being asked in the tender. The terms and conditions for such reverse auction event shall be as per the Acceptance Form attached as Annexure B of this document. The bidders shall mandatorily submit a duly signed copy of the Acceptance Form along with the tender document as a token of acceptance.

3. RECPDCL reserve the right to verify/confirm all original documentary evidence submitted by the bidder in support of above mentioned clauses of eligibility criteria, failure to produce the same within the period as and when required and notified in writing by RECPDCL shall result in summarily rejection of the bid.

4. Engagement with RECPDCL does not confer any right to the agencies to be invited for participating in any bids, tender etc. floated by RECPDCL. RECPDCL reserves the right to call bids/assign work/associate the agency/agencies in any area as may be deemed fit by RECPDCL depending upon the profile provided by the agencies and requirement of assignment.

5. RECPDCL reserves the right to accept or reject any or all requests for engagement without assigning any reason or to accept in parts and engage more than one agencies at its sole discretion.

6. Acceptance of the application(s) constitutes no form of commitment on the part of RECPDCL. Furthermore, this acceptance of the application confers neither the right nor an expectation on any application to participate in the proposed project.

7. RECPDCL reserve the right to waive off any shortfalls; accept the whole, accept part of or reject any or all responses to the Tender.

8. RECPDCL reserve the right to call for fresh tenders at any stage and /or time as per the present and /or envisaged RECPDCL requirements even if the tender is in evaluation stage.

9. RECPDCL reserve the right to modify, expand, restrict, scrap, and re-float the tender without assigning any reason for the same.

10. The responder shall bear all costs associated with the preparation and submission of its response, and RECPDCL will in no case be responsible or liable for these costs, regardless of the conduct or the outcome of the tender process.

11. Consortium and joint venture responses are not allowed, in any case. Also, bidders have to note that no sub-contracting / sub-letting is allowed

12. RECPDCL reserves the right to increase or decrease the RC quantity (on same rate and terms and conditions) by another 20% if required.

13. For all equipment, the bidder shall provide warranty for a period of 12 months from the date of commissioning. After the completion of warranty period, the bidder shall provide 3 years (36

months) Facility Management Services (FMS) support for all supplied, installed and commissioned equipment.

14. **Performance Security:** The agency need to deposit within fifteen (15) working days from the date of acceptance of work order, a Performance Security in the form of Bank Guarantee or Demand Draft (DD), for an amount of 10% (Ten per cent) of the Tender value for the due performance and fulfilment of the contract by your firm which is valid for 60 months in the format placed at Annexure – A.

   a The Performance Bank Guarantee may be drawn from a scheduled commercial bank in favour of The "REC Power Distribution Company Ltd", New Delhi.

   b The Performance Bank Guarantee may be discharged/ returned by the RECPDCL after the completion of the contract upon being satisfied for the performance of the obligations of your firm under the contract.

   c Failing to comply with the above requirement, or failure to enter into contract within 30 days or within such other extended period, as may be decided by the CEO, RECPDCL shall constitute sufficient grounds, among others, if any, for the annulment of the award of the tender.

   d In the event the firm being unable to provide the services, during the engagement period as per the contract for whatever reason, the Performance Bank Guarantee would be invoked by RECPDCL.

   e No Bank Charges/ interest shall be payable for the Performance Bank Guarantee.

15. **Rates and Prices**

   f Bidders should quote item-wise rates/ prices including all taxes and duties as mentioned in Form-III by explicitly mentioning the breakup of basic prices and applicable taxes.

   g Price quoted by bidder shall be firm for entire contract period.

   h Price quoted shall be firm and any variation in rates, prices or terms during validity of the offer shall lead to forfeiture of the EMD of said bidder.

   i The quoted prices shall be for delivery and installation at Chandigarh. The prices shall be FOR destination and shall include all charges, levies and duties for delivery and installation at the specified locations in Chandigarh UT. The exact details of location address etc. shall be provided along with the release order.

16. In case of default in services or denial of services, RECPDCL, at its sole discretion, will be free to avail services of other service providers at your "Risk & Cost".

17. All other terms and conditions of the GENERAL CONDITIONS OF CONTRACT shall be applicable.

18. Bidders are advised to refrain from taking any deviations on this TENDER. Still in case of any deviations, all such deviations from this tender document shall be set out by the Bidders, Clause

by Clause in the format as mentioned in Form IV and submit the same as a part of the Technical Bid. Please note that in case of deviations to the tender terms, bids may be liable for rejection.

19. All the licenses shall be procured in the name of "Chandigarh Electricity Department"

20. The source code of the customized part of the application software will remain the exclusive property of the Chandigarh Electricity Department (CED), even after the termination or expiry of the contract. The ownership shall also remain with the CED in case the selected vendor fails to execute tasks to the satisfaction of the CED.

21. The proposed solution should have the provision for integration with near future systems like Automated Metering Infrastructure (SCADA), SCADA, etc. Bidder would be sole responsible for providing the necessary touch points in required technology for integrating future solutions with proposed systems during the complete contract period.

22. Bidder to provide sizing of servers, storage and network bandwidth in the technical proposal. Although, supply of servers, storage and network is not part of bidder scope of work.

23. The bidder shall provide enterprise wide license without constraint of number of CPU / Core / Number of Users / Number of Consumers for SCADA Software. However, licensing requirement is indicative only for computation of immediate requirement but not limiting the requirement of Enterprise Wide License in any way.

24. The RECPDCL/CED shall be at liberty to deploy the solution anywhere within the Chandigarh UT and at any other location (Outside Chandigarh).

25. All Post implementation support period shall start from the date of sign off of Go Live of complete project area.

26. Sub-contracting of the work is not permitted. In case of minor or field work, sub-contracting shall be permitted subject to RECPDCL prior approval.

27. **INTEGRITY PACT (Form-VIII):-**The bidders have to submit integrity pact as per prescribed format on a non-judicial stamp paper of Rs. 100/- in 2 copies duly signed by the person signing the bid. The bidder shall not change the contents of "Integrity Pact".

28. In a tender either the Indian agent on behalf of the Principle /OEM or Principle / OEM itself can bid but both cannot bid simultaneously for the same item/product.

29. If an agent submits bid on behalf of the principal /OEM, the same agent shall not submit a bid on behalf of another principal /OEM in the same tender for the same item/product.

SECTION-VI

ELIGIBILITY CRITERIA

1. Pre-Qualifying Criteria for Bidder

S. No.	Qualification Criteria	Documents Required
1	The bidder shall be a private/public Company registered under Company Act 1956	Certificate of Incorporation and Registration needs to be submitted along with the bid.
2	The Bidder should be an ISO 9001:2008 certified company	A valid ISO certificate on the date of publication of the tender
3	The average annual turnover of the bidder shall be a minimum of ₹ 5 crore during the last 3 years ending 31st March of the previous financial year.	Copy of CA certified Audited Balance Sheet and P&L Account for the respective financial years to be submitted in this regard

4	The Bidder must have successfully implemented similar type of SCADA/DMS projects (meeting any of the below criteria) in a Power Distribution Utility in the last 7 years (i.e. FY 2009-10 to till the previous date of publication of this tender).
	
	a. One SCADA/DMS (11 KV or above) project covering design, engineering, supply, installation, testing, commissioning and implementation of minimum 20 nos. RTUs/Data Concentrator (DC)/ Bay controller Unit (BCU) with required hardware, software and other associated accessories with following functionalities either in a single or in combinations:
	  i. SCADA Software supporting alarm, tagging, trending, SOE, real time data acquisition & calculations.
	  ii. DMS software supporting at least two functions out of load flow, loss minimization via feeder reconfiguration, FMSR (Fault Management and System Restoration).
	  iii. Software functional redundancy for SCADA and DMS functions.
	
	Or
	
	b. Two SCADA/DMS (11 KV or above) project each covering design, engineering, supply, installation,
		Necessary Purchase order/LOI/Contract/Certification on client letterhead/Performance certificate as proof of services provided for the last 7 years needs to be submitted

testing, commissioning and implementation of minimum 10 nos. RTUs/Data Concentrator (DC)/ Bay controller Unit (BCU) with required hardware, software and other associated accessories with following functionalities either in a single or in combinations:

i. SCADA Software supporting alarm, tagging, trending, SOE, real time data acquisition & calculations.

ii. DMS software supporting at least two functions out of load flow, loss minimization via feeder reconfiguration, FMSR (Fault Management and System Restoration).

iii. Software functional redundancy for SCADA and DMS functions.

Or

c. Three SCADA/DMS (11 KV or above) project each covering design, engineering, supply, installation, testing, commissioning and implementation of minimum 8 nos. RTUs/Data Concentrator (DC)/ Bay controller Unit (BCU) with required hardware, software and other associated accessories with following functionalities either in a single or in combinations:

i. SCADA Software supporting alarm, tagging, trending, SOE, real time data acquisition & calculations.

ii. DMS software supporting at least two functions out of load flow, loss minimization via feeder reconfiguration, FMSR (Fault Management and System Restoration).

iii. Software functional redundancy for SCADA and DMS functions.

5	The Bidder should have at least 5 personnel on its rolls with a minimum SCADA implementation experience of 2 years (either in his/her own or other organization). The roles & responsibilities of the personnel should include development and/or customization of SCADA System.	Signed resume of employees need to be submitted. Scanned signatures shall be accepted

| 6 | The bidder needs to provide authorization letter from OEM for next 5 years back to back support of as per the format attached at Form V. | Authorization letter from OEM for next 5 year support |

2. **Pre-Qualifying Criteria for OEM**

S. No.	Qualification Criteria	Documents Required
1	The OEM shall have ISO 9001:2008 and ISO-14001 certifications	A valid ISO certificate on the date of publication of the tender
2	The minimum average annual turnover of the OEM shall be Rs. 30 Crores last 3 financial years (FY 2013-14, 2014-15, 2015-16) and till the previous date of publication of this tender.	Copy of CA certified Audited Balance Sheet and P&L Account for the respective financial years to be submitted in this regard
3	Service center should be located in India, however bidder has to adhere with the timelines to provide response and resolution as per SLA.	Self-Certify on OEM letterhead the list of service centers across India.

RECPDCL reserves the right to counter check any of the supporting documents directly from the respective client for their authenticity.

Format to provide details of Successful Completion of Projects by Bidder

Year of Completion	SCADA Supplied (make & Model)	Number of Units Supplied	Order no.	Client Name and Location of Project	Completion certificate attached (Yes/No)

Mandatory Technical Specifications

The Bidder should provide documentary proof of compliance of following specification. Where it is not possible to submit any certified proof for the same, bidder shall self-certify that it would comply with the specification during implementation.

S. No.	Solution Specifications	Validation Through (Certificate/ Document/ Self Certify)	Available / Not Available
A.1	The solution shall be designed with Service Oriented Architecture. The solution shall be designed based on Component-based approach. It shall be highly granular and loosely coupled to ensure that the failure of one component does not cascade to others.	Self-Certify	
A.2	The solution shall be designed on web based architecture.	Self-Certify	
A.3	The solution shall be horizontally and vertically scalable and also have virtualization capability.	Self-Certify	
A.4	The solution shall be designed with Open Industry Standards and not with Supplier's proprietary protocol.	Self-Certify	
A.5	The directory services shall be based on commonly accepted application protocol like LDAP.	Self-Certify	
A.6	The proposed solution should be based on WS-* specifications (Web services specifications) & unified access framework compliant to W3C (World Wide Web Consortium) specifications.	Self-Certify	
A.7	The application shall provide the functionality to configure the parameters to define the business rules with the application. **These parameters shall not be hard-coded in the application.**	Self-Certify	
A.8	The solution shall provide the	Self-Certify	

	functionality to configure the roles & responsibilities and grant role based access to the users. Also, the system shall have the capability to integrate with various standard SSO (Single Sign-On) or IDM (Identity Management) applications.		
A.9	The solution shall use an integration middleware layer so that all required external systems shall be integrated on a continuous basis.	Self-Certify	
A.10	The solution shall provide the functionality to encrypt the data stored or transmitted data.	Self-Certify	
A.11	The solution shall provide the functionality to maintain the audit trail of all critical transactions.	Self-Certify	
A.12	The solution shall be able to interoperate with: • standard RDBMS platforms like Oracle, MS SQL, MY SQL, DB2, Informix, Sybase or any other RDBMS confirming to ANSI/ISO SQL-200n standards • Operating systems like Windows, UNIX, and Solaris etc. • web browsers like Internet explorer, Mozilla Firefox, Opera etc.	Self-Certify	
A.13	The solution shall be installed with the latest security updates provided by software Supplier.	Self-Certify	
A.14	The software version shall be supported by the software vendor for a minimum period of next five years.	Self-Certify	
A1	**Module: SCADA**		
A1.1	The SCADA Solution shall be capable of collecting and analyzing data on a common data structure/ format from system/ consumer meters of various makes and models. The solution shall be compatible with	Self-Certify	

	present modbus compliant meters installed in utilities as well as future meters likely to be introduced in Indian market complying with MODBUS/DLMS /COSEM/IEC-62056/ANSI C-12.19/IEEE P-1377 Standards.		
A1.2	The regional hierarchy and network topology shall be specific to the Indian context and flexible enough to account for different voltage levels in Indian sub-transmission and distribution networks e.g. 66/33/22/11/ 0.4 KV.	Self-Certify	

SECTION-VII

TENDER EVALUATION METHODOLOGY

OPENING OF BID:

The Bidder or his authorized representative may be present at the time of opening of bid on the specified date, but a letter in the form annexed at (Form – I) hereto must be forwarded to this office along with bid and a copy of this letter must be produced in the office by the person attending the opening of bid. Unless this letter is presented by him, he may not be allowed to attend the opening of bid.

In case of unscheduled holiday on the closing/opening day of bid, the next working day will be treated as scheduled prescribed day of closing/opening of bid; the time notified remaining the same.

EVALUATION OF BID

PRE-QUALIFIYING CRITERIA

Evaluation and comparison of bids will be done as per provisions of Pre-qualifying Criteria supporting documents as proof of pre-qualifying criteria at section – VI. RECPDCL reserves the right to verify the site of operation for above activity and list of persons provided as per qualifying criteria and accordingly decide upon meeting the requirement.

The RECPDCL will examine the bids to determine whether they are complete, whether any computational errors have been made, whether required sureties have been furnished, whether the documents have been properly signed and whether the bids are generally in order qualifying to which bids shall be summarily rejected.

PRICE EVALUATION CRITERIA

1.1 Bidders should quote their rates/prices in Indian Rupees only which shall be inclusive of all applicable taxes, duties, levies, insurance, transportation etc., applicable for entire scope of work as per Price Schedule included to Form - III of this tender document.

1.2 Bids shall be evaluated on the basis of the total evaluated value as per the quoted rates for the services mentioned in Scope of Work. The total evaluated price as per the evaluation methodology mentioned as under at Form - III of this tender document and the other details mentioned therein will be the basis for the evaluation purposes and for arriving at inter-se ranking of the various bidders of the tender.

1.3 Bid shall be evaluated as per the "Total Price of the Bidder for this tender" as mentioned in Form-III, which shall be filled by the bidder as a Financial Bid.

AWARD CRITERIA

The purchaser will award the contract to the successful bidder whose bid has been determined to be in full conformity to the bid documents and has been determined as the lowest evaluated bid.

SECTION-VIII

TENDER FORMATS

FORM-I

Letter for Submission of Tender

To,
Addl. Chief Executive Officer
REC Power Distribution Company Ltd.
A10, 4th Floor, Kribhco Bhawan,
Sector-1, Noida – 201301

Sub.: **Engagement of Service Agency**

Sir,

1.   With reference to your Tender No. --------------- dated ------------ for **Supply, Implementation & Maintenance of SCADA System for Smart Grid Pilot Project at Chandigarh Electricity Department (CED),** I wish to apply for engagement with RECPDCL as service provider for "**Supply, Implementation & Maintenance of SCADA System for Smart Grid Pilot Project at Chandigarh Electricity Department (CED)**"

   Further, I hereby certify that

   I have read the provisions of the all clauses and confirm that notwithstanding anything stated elsewhere to the contrary, the stipulation of all clauses of Tender are acceptable to me and I have not taken any deviation to any clause.

2.   I further confirm that any deviation to any clause of Tender found anywhere in my Bid, shall stand unconditionally withdrawn, without any cost implication whatsoever to the REC PDCL.

3.   Our bid shall remain valid for period of 90 days from the last date of bid submission.

Date: Signature   …………………
Place: Full Name   ………………..
                                                                                    Designation ………………….
                                                                                    Address   …………………

 Note: In absence of above declaration/certification, the Bid is liable to be rejected and shall not be taken into account for evaluation.

REC Power Distribution Company Limited	

Form-II

PRE QUALIFICATION CRITERIA DETAILS

Supply, Implementation & Maintenance of SCADA System for Smart Grid Pilot Project at Chandigarh Electricity Department (CED)

1. **THE FIRM**
2. **Name** _____
Regd. Address _____
 a) **Address of Office at Delhi/NCR** _____

 b) **Contact Person's**

 i) **Name & Design.** _____

 ii) **Address** _____

 iii) **Tel No. Landline**_____**Mobile** _____

 iv) **Email ID** _____

3. **Type of Firm:**   **Private Ltd./ Public Ltd./ Cooperative/**
     (Please tick)   **Partnership/ Proprietor**

4. **PAN** _____

5. **Service Tax Reg. No.:**

6. **E.M.D. Details**   **Rs._**
             DD No._
             Name & Address of Bank

Please upload duly signed copies by authorized signatory of documentary evidence e.g. work order, corresponding satisfactory job completion certificates from clients with amount of work order in support of above and any other document indicated in prequalifying criteria)

<div align="right">

Signature…………..………

Full Name………..………

Designation……………….

Address …………………..

</div>

Form-III

Financial Bid (To be submitted through online mode only)
PROFORMA OF SCHEDULE OF RATES

Bidder Name:

	Form: 1 SCADA/DMS Control Center Cost (BOQ)						
S. No.	Equipment	Unit	Quantity	Per Unit Cost	taxes & duties	Total Unit Cost	Total Cost (Incl. taxes & duties)	FMS Cost for 01 year
A	B	C	D	F	G	H=F+G	I=DxH	J
1	**SERVER/WORKSTATIONS**							
1.1	SCADA Server (Application)	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
1.2	FEP server	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
1.3	ISR server	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
1.4	Development server	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
1.5	Workstation with dual TFT Monitors	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
1.6	Development console with one TFT	No.	1	₹ -	₹ -	₹ -	₹ -	₹ -
1.7	Laser based Video Projection system with 2x3 Module configuration with each module at least 70" diagonal with common projector *(Optional)*	No.	1	₹ -	₹ -	₹ -	₹ -	₹ -
1.8	External DAT tape drive	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
1.9	Racks 42U- OEM	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 1						₹ -	₹ -
2	**SWITCHES**							
2.1	Layer II switch (SCADA/DMS Dual LAN) (48 ports)	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 2						₹ -	₹ -
3	**SECURITY SYSTEM (DMZ)**							
3.1	Web server with load balancing	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
3.2	Router with Minimum 8 Ethernet ports	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -

				₹	₹	₹	₹	₹
	(1 Gbps) and 4 Fiber Optic Ports							
3.3	Firewall & network IDS/IPS for Iinterface system	No.	1	₹ -	₹ -	₹ -	₹ -	₹ -
3.4	Layer II switch (24 ports)	No.	2	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 3						₹ -	₹ -
4	**OTHER ACTIVE DEVICES**							
4.1	GPS Time synchronization system	Set	2	₹ -	₹ -	₹ -	₹ -	₹ -
4.2	Time, day & date digital displays	Set	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 4						₹ -	₹ -
5	**PRINTERS**							
5.1	Color laser printer	Set	1	₹ -	₹ -	₹ -	₹ -	₹ -
5.2	Black and White laser printer with Multifunction devices	Set	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 5						₹ -	₹ -
6	**CABLING SYSTEMS**							
6.1	Cable, Jacks etc.	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
6.2	Any other hardware to meet functional /performance requirement	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 6						₹ -	₹ -
7	**Software for Control Centre**							
7.1	SCADA software	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
7.2	ISR Software	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
7.3	Development software	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
7.4	NMS software	No.	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 7						₹ -	₹ -
8	**Recommended Spares**							
8.1	5% of Sub total 1+2+3+4+5+6	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 8						₹ -	₹ -

	GRAND TOTAL					₹ -	₹ -

Form: 2 RTU							
S.No.	Equipment	Unit	Quantity	Per Unit Cost	taxes & duties	Total Unit Cost	Total Cost (Incl. taxes & duties)	FMS Cost for 01 year
A	B	C	D	F	G	H=F+G	I=DxH	J
1	**RTUs**							
1.1	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 all locations and Communication modules for interfacing energy meters/multi-function transducers using RS 485, MODBUS protocol & 2 ethernet port. (assuming 2 nos. RS485 ports per module)	Nos.	6	₹ -	₹ -	₹ -	₹ -	₹ -
1.2	Multifunction Transducers (15 Nos Transformer Panel + 61 Nos Feeders)	Nos.	76	₹ -	₹ -	₹ -	₹ -	₹ -
1.3	DC Transducer for monitoring DCDB analogs and communicable on IEC 104/Modbus protrocol (6 Nos S/Stn)	Nos.	6	₹ -	₹ -	₹ -	₹ -	₹ -
1.4	Router (6 Nos)	Nos.	6	₹ -	₹ -	₹ -	₹ -	₹ -
1.5	Any other hardware to meet functional /performance requirement	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -

	Sub Total 1						₹ -	₹ -
2	**TEST EQUIPMENTS for RTU**							
2.1	RTU Database Configuration & Maintenance Software tool	No.	1	₹ -	₹ -	₹ -	₹ -	₹ -
2.2	Master Station cum RTU Simulator & Protocol analyser software tool	No.	1	₹ -	₹ -	₹ -	₹ -	₹ -
2.3	Laptop PC for above software tools along with interfacing hardware including USB to serial convertor	No.	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 2						₹ -	₹ -
3	**Recommended Spares**							
3.1	5% of subtotal 1+2	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 3						₹ -	₹ -
	GRAND TOTAL						₹ -	₹ -

Form: 3 Communication system - VPN (MLLN/ MPLS) Broadband							
S.No.	**Equipment**	**Unit**	**Quantity**	**Per Unit Cost**	**taxes & duties**	**Total Unit Cost**	**Total Cost (Incl. taxes & duties)**
A	B	C	D	F	G	H=F+G	I=DxH
1	**Bandwidth Charges**						
1.1	Network Connectivity Charges for 2.0 MBPS MPLS-broadband Link for 6 Nos. S/stn for 36 months	No.	6	₹ -	₹ -	₹ -	₹ -
1.2	Network Connectivity Charges for 6.0 MBPS	No.	1	₹ -	₹ -	₹ -	₹ -

MPLS-broadband Link for Control Center for 36 months							
GRAND TOTAL							₹ -

Form: 4 Auxiliary Power supply								
S.No.	**Equipment**	**Unit**	**Quantity**	**Per Unit Cost**	**taxes & duties**	**Total Unit Cost**	**Total Cost (Incl. taxes & duties)**	**FMS Cost for 01 year**
A	B	C	D	F	G	H=F+G	I=DxH	J
1	**II For RTU / Data Concentrator / Communication Eqpts.**							
1.1	For RTU / Data Concentrator / Communication Equip- 24V/48V/220V DC Power Supply (DCPS) system based on SMPS along with Battery bank for above DCPS (VRLA Type) for minimum 4 hrs backup	Nos.	6	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 1						₹ -	₹ -
2	**Recommended Spares**							
2.1	5% of Sub total 1	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 2						₹ -	₹ -
3	**Other Items**							
3.1	Any other required items	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 3						₹ -	₹ -
	GRAND TOTAL						₹ -	₹ -

Form: 5 : BCPU

S. No.	Equipment	Unit	Quantity	Per Unit Cost	taxes & duties	Total Unit Cost	Total Cost (Incl. taxes & duties)	FMS Cost for 01 year
A	B	C	D	F	G	H=F+G	I=DxH	J
1	**Trf. Diff. Relays**							
1.1	SITC of of Trf. Diff. Relays alongwith follwing item Supply of metal sheets of colour similar to existing C&R Panel to cover the left out cut-outs Supply of CAT-6 Cable from BCPU to Ethernet Switch Supply of Double Pole DC MCB of suitable rating (for each IEDs) Supply of 1.5 sq.mm. and 2.5 sq.mm. Control Cables Supply of Terminal Blocks Supply of Pin Type, U-Type, Ring Type Lugs & Sleeves with Printed Ferrules Supply of any miscellaneous accessories required for commissioning Any other hardware to meet functional /performance requirement (for 15 Nos Transformers)	Nos.	15	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 1						₹ -	₹ -
2	**BCPU's**							
2.1	SITC of BCPU alongwith following items: Supply of metal sheets of colour similar to existing C&R Panel to cover the left out cut-outs. Supply of CAT-6	Nos.	76	₹ -	₹ -	₹ -	₹ -	₹ -

	Cable from BCPU to Ethernet Switch Supply of Double Pole DC MCB of suitable rating (for each IEDs) Supply of 1.5 sq.mm. and 2.5 sq.mm. Control Cables Supply of Terminal Blocks Supply of Pin Type, U-Type, Ring Type Lugs & Sleeves with Printed Ferrules Supply of any miscellaneous accessories required for commissioning (15 Nos Transformer + 61 Nos of Feeders)						
	Sub Total 2					₹ -	₹ -
3	**Ethernet Switches**						
3.1	SITC of Industrial Grade Ethernet Switches IEC-61850 Complaince along with accessories i.e. CAT-6 Cable from Ethernet Switch to RTU and Router Panel, Double Pole DC MCB of suitable rating (for each IEDs),1.5 sq.mm. Control Cables, Supply of Terminal Blocks,Pin Type, U-Type, Ring Type Lugs & Sleeves with Printed Ferrules and any miscellaneous accessories required for commissioning.	N os .	12	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 3					₹ -	₹ -

4	**Disturbance Evaluation Unit**							
4.1	Disturbance Evaluation Unit	Nos.	6	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 4						₹ -	₹ -
5	**Recommended Spares**							
5.1	5% of Sub total 1+2+3+4	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 5						₹ -	₹ -
6	**Other Items**							
6.1	Any other required items	Lot	1	₹ -	₹ -	₹ -	₹ -	₹ -
	Sub Total 6						₹ -	₹ -
	GRAND TOTAL						₹ -	₹ -

Form: 6 Training							
S.No.	**Equipment**	**Unit**	**Quantity**	**Per Unit Cost**	**taxes & duties**	**Total Unit Cost**	**Total Cost (Incl. taxes & duties)**
A	B	C	D	F	G	H=F+G	I=DxH
A.	**Operator's Training**						
1	Operator for SCADA Control Centre	Mandays	15	₹ -	₹ -	₹ -	₹ -
B.	**Maintenance Training**						
1	Computer Hardware & System Software	Mandays	5	₹ -	₹ -	₹ -	₹ -
2	RTU	Mandays	5	₹ -	₹ -	₹ -	₹ -
3	BCPU/Relays	Mandays	5	₹ -	₹ -	₹ -	₹ -
4	Database & display development	Mandays	5	₹ -	₹ -	₹ -	₹ -
5	Auxiliary Power Supply	Mandays	3	₹ -	₹ -	₹ -	₹ -
6	Communication System	Mandays	3	₹ -	₹ -	₹ -	₹ -
	GRAND TOTAL						₹ -

Form: 7 FMS		
S.No.	**Equipment**	**FMS Cost**
A	B	C
1	FMS charges for Control Center (Form 1) for 01 year	₹ -
2	FMS charges for RTU (Form 2) for 01 year	₹ -

3	FMS charges for Aux. Power Supply (Form 4) for 01 year	₹	-
4	FMS charges for Relays (Form 5) for 01 year	₹	-
	Grand Total	₹	-

	Form: 8 Total		
S.No.	**Equipment**	**Total Duration for 3 Years + 2 years (Optional) years after warranty**	**Total Cost for 3 years**
A	**B**	**C**	**D**
1	Total Cost for Control Center (Form 1)	1	₹ -
2	Total Cost for RTU (Form 2)	1	₹ -
3	Total Cost for Communication (Form 3)	1	₹ -
4	Total Cost for Aux. Power Supply (Form 4)	1	₹ -
5	Total Cost for Relays (Form 5)	1	₹ -
6	Total Cost for Training (Form 6)	1	₹ -
7	FMS charges for Control Center (Form 1) for 3 years	3	₹ -
8	FMS charges for RTU (Form 2) for 3 years	3	₹ -
9	FMS charges for Aux. Power Supply (Form 4) for 3 years	3	₹ -
10	FMS charges for Relays (Form 5) for 3 years	3	₹ -
11	FMS charges for Control Center (Form 1) for additonal 2 years (Optional)*	2	₹ -
12	FMS charges for RTU (Form 2) for additonal 2 years (Optional)*	2	₹ -
13	FMS charges for Aux. Power Supply (Form 4) for additonal 2 years (Optional)*	2	₹ -
14	FMS charges for Relays (Form 5) for additonal 2 years (Optional)*	2	₹ -
	Grand Total		₹ -

* - Initially the FMS will be for 3 years after 1 year warranty period, however FMS may be extended further for 2-3 years on same terms and conditions on mutual agreement between Utility & Vendor.

Note:-

▪ The rates are invited for entering into an RC valid for one year from the date of issue of contract. Prices are to be quoted accordingly. The quantities mentioned above are for

evaluation purposes only. Actual Quantities may vary as per site requirement and Release Orders against this Rate Contract (RC) shall be placed accordingly.

- The quoted rates must be inclusive of all taxes as applicable at the time of bidding.
- Bidders are to quote their rates strictly as per above format.

REC Power Distribution Company Limited	

FORMAT FOR NO-DEVIATION CERTIFICATE

Unless specifically mentioned in this schedule, the tender shall be deemed to confirm the RECPDCL's specifications:

S. No.	Clause No.	Details of deviation with justifications

By signing this document we hereby withdraw all the deviations whatsoever taken anywhere in this bid document and comply to all the terms and conditions, technical specifications, scope of work etc. as mentioned in the standard document except those as mentioned above.

Seal of the Company:

Signature
Name

Note: In absence of above declaration/certification, the Bid is liable to be rejected and shall not be taken into account for evaluation.

REC Power Distribution Company Limited	REC POWER DISTRIBUTION

MANUFACTURER AUTHORIZATION FORM
(To be submitted on OEM's Letter Head)

Date: …………….

ICB No.:   …………….

Invitation for Bid No.:   …………..

Alternative No.:   …….

To,

The Nodal Officer (Smart Grid Pilot Project)

Electricity 'OP' Division No. 2,

Opp. Transport Area, New Power House

Industrial Area Phase – 1, UT Chandigarh

Sir,

WHEREAS M/s. *[name of OEM]*, who are official manufacturers of ………… having factories at *[address of OEM]* do hereby authorize M/s *[name of bidder]* to submit a Bid in relation to the Invitation for Bids indicated above, the purpose of which is to provide the following Goods, manufactured by us

…………………………………………………………………………………………………….

and to subsequently negotiate and sign the Contract.

We hereby extend our full guarantee and warranty in accordance with Clause 26 of the General Conditions of Contract or as mentioned elsewhere in the Tender Document, with respect to the Goods offered by the above firm in reply to this Invitation for Bids.

We hereby confirm that in case, the channel partner fails to provide the necessary services as per the Tender Document referred above, M/s *[name of OEM]* shall provide standard warranty on the machines supplied against the contract. The warranty period and inclusion / exclusion of parts in the warranty shall remain same as defined in the contract issued to their channel partner against this tender enquiry.

Yours Sincerely,

For ……………..

Authorized Signatory

Note: In absence of above declaration/certification, the Bid is liable to be rejected and shall not be taken into account for evaluation.

	REC Power Distribution Company Limited	

Format of Curriculum Vitae

1	PROPOSED POSITION:			
2	NAME OF FIRM			
3	NAME OF STAFF:			
4	DATE OF BIRTH:		Nationality:	
5	EDUCATION:			
	DEGREE/EXAMINATION	YEAR	INSTITUTE	Board
6	MEMBERSHIP OF PROFESSIONAL ASSOCIATIONS:			
7	OTHER TRAINING:			
8	COUNTRIES OF WORK EXPERIENCE:			
9	LANGUAGES:			
	LANGUAGE	SPEAKING	READING	WRITING
10	EMPLOYMENT RECORD:			
	FROM	TO	EMPLOYER	POSITIONS HELD
11	DETAILED TASKS ASSIGNED:			
12	WORK UNDERTAKEN THAT BEST ILLUSTRATES CAPABILITY TO HANDLE THE TASKS ASSIGNED:			
13	Certification:			
	I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes myself, my qualifications, and my experience. I understand that any wilful misstatement described herein may lead to my disqualification or dismissal, if engaged.			
	Signature of authorised representative of the staff			
	Full name of authorised representative:			

FORM-VII

LETTER OF TRANSMITTAL

To: [Name and address of Client]

……………………………………………………………………

………………………………………………..…

……………………………………………….

Dear Sir/s,

I/We, the undersigned, have examined the details given in your NIT dated [**Insert Date**] for **Engagement of bidder for implementation of Primary and Secondary MPLS Connectivity Links at various Sub-Stations at Goa Electricity Department**. We accept all the terms & conditions of the bid document without any deviation and submit the Bid. We hereby certify that M/s _____ or its group companies have not been awarded any work for **Engagement of bidder for implementation of Primary and Secondary MPLS Connectivity Links at various Sub-Stations at Goa Electricity Department** & shall not be a competitor to RECPDCL within the **Goa Electricity Department** during contract period in case the contract is awarded.

Also, M/s _____or its group companies is not executing or providing any type of services either directly or as a sub-contractor for the particular work for which Bid is submitted.

It is confirmed that M/s. _____ is not banned or blacklisted by any Govt./Pvt. Institutions in India.

Authorized Signature [In full and initials]:

Name and Title of Signatory:

Name of Firm:

Address:

FORM-VIII

(To be executed on non-judicial paper)

INTEGRITY PACT

Between

REC Power Distribution Company Limited (REC PDCL) hereinafter referred to as "The Principal",

And

………………………………….hereinafter referred to as "agency for carrying out interior work"

Preamble

The Principal intends to award, under laid down organization procedures, contract/s for

………………..The Principal values full compliance with all relevant laws and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder/s, agency/s.

In order to achieve these goals, the Principal cooperates with the renowned international Non-Governmental Organisation "Transparency International" (TI). Following TI's national and international experience, the Principal will appoint an Independent External Monitor who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1 – Commitments of the Principal

(1) The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles:

    a) No employee of the Principal, personally or through family members, will in connection with the tender, or the execution of the contract, demand, take a promise for or accept, for himself/herself or third person, any material or immaterial benefit which he/she is not legally entitled to.

    b) The Principal will, during the tender process, treat all Bidders with equity and reason. The Principal will, in particular, before and during the tender process, provide to all Bidders the same information and will not provide to any Bidder confidential / additional information through which the Bidder could obtain an advantage in relation to the tender process or the contract execution.

    c) The Principal will exclude from the process all known prejudiced persons.

(2) If the Principal obtains information on the conduct of any of its employees which is a criminal offence under the relevant Anti-Corruption Laws of India, or if there be a

substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section 2 – Commitments of the Bidder / agency.

(1) The Bidder / agency commits itself to take all measures necessary to prevent corruption. He commits himself to observe the following principles during his participation in the tender process and during the contract execution.
   a) The Bidder /agency will not, directly or through any other person or firm, offer, promise or give to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person, any material or immaterial benefit which he/she is not legally entitled to, in order to obtain in exchange, any advantage of any kind whatsoever during the tender process or during the execution of the contract.
   b) The Bidder / agency will not enter with other Bidders into any undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelisation in the bidding process.
   c) The Bidder / agency will not commit any offence under the relevant Anti-Corruption Laws of India; further the Bidder / agency will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.
   d) The Bidder / agency will, when presenting his bid, disclose any and all payments he has made, is committed to, or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.
(2) The Bidder / agency will not instigate third persons to commit offences outlined above or be an accessory to such offences.

Section 3 – Disqualification from tender process and exclusion from future contracts

If the Agency, before contract award, has committed a transgression through a violation of Section 2 or in any other form such as to put his reliability or credibility as Bidder into question, the Principal is entitled to disqualify the Bidder from the tender process or to terminate the contract, if already signed, for such reason.

(1) If the agency has committed a transgression through a violation of Section 2 such as to put his reliability or credibility into question, the Principal is also entitled to exclude the agency from future contract award processes. The imposition and duration of the exclusion will be determined by the severity of the transgression. The severity will be determined by the circumstances of the case, in particular the number of transgressions, the position of the

transgressors within the company hierarchy of the Bidder and the amount of the damage. The exclusion will be imposed for a minimum of 6 months and maximum of 3 years.

(2) A transgression is considered to have occurred if the Principal after due consideration of the available evidences, concludes that no reasonable doubt is possible.

(3) The Bidder accepts and undertakes to respect and uphold the Principal's absolute right to resort to and impose such exclusion and further accepts and undertakes not to challenge or question such exclusion on any ground, including the lack of any hearing before the decision to resort to such exclusion is taken. This undertaking is given freely and after obtaining independent legal advice.

(4) If the agency can prove that he has restored / recouped the damage caused by him and has installed a suitable corruption prevention system, the Principal may revoke the exclusion prematurely.

Section 4 – Compensation for Damages

(1) If the Principal has disqualified the Bidder from the tender process prior to the award according to Section 3, the Principal is entitled to demand and recover from the Bidder liquidated damages equivalent to Earnest Money Deposit/Bid Security.

(2) If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to Section 3, the Principal shall be entitled to demand and recover from the Consulting agency/Architect/Supplier liquidated damages equivalent to Security Deposit / Performance Bank Guarantee.

(3) The Bidder agrees and undertakes to pay the said amounts without protest or demur subject only to condition that if the agency can prove and establish that the exclusion of the Bidder from the tender process or the termination of the contract after the contract award has caused no damage or less damage than the amount of the liquidated damages, the agency shall compensate the Principal only to the extent of the damage in the amount proved.

Section 5 – Previous Transgression

(1) The Bidder declares that no previous transgression occurred in the last 3 years with any other Company in any country conforming to the TI approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.

(2) If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason.

Section 6 – Equal treatment of all agency

(1) The agency undertakes to demand from all sub-consulting agency a commitment in conformity with this Integrity Pact, and to submit it to the Principal before contract signing.

(2) The Principal will enter into agreements with identical conditions as this one with all agency and Sub-consulting agency.

(3) The Principal will disqualify from the tender process all Bidders who do not sign this Pact

or violate its provisions.

Section 7 – Punitive Action against violating agency /Sub-consulting agency/

If the Principal obtains knowledge of conduct of a agency or Sub-consulting agency, or of an employee or a representative or an associate of a agency, Sub-consulting agency\ which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 – Independent External Monitors

(1) The Principal has appointed competent and credible Independent External Monitors for this Pact. The task of the Monitor is to review independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.

(2) The Monitor is not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the Chairperson of the Board of the Principal.

(3) The agency accepts that the Monitor has the right to access without restriction to all Project documentation of the Principal including that provided by the agency. The agency will also grant the Monitor, upon his request and demonstration of a valid interest, unrestricted and unconditional access to this project documentation. The same is applicable to Sub-consulting agency. The Monitor is under contractual obligation to treat the information and documents of the agency or Sub-consulting agency with confidentially.

(4) The Principal will provide to the Monitor sufficient information about all meetings among the parties related to the Project provided such meetings could have an impact on the contractual relations between the Principal and the agency. The parties offer to the Monitor the option to participate in such meetings.

(5) As soon as the Monitor notices, or believes to notice, a violation of this agreement, he will so inform the Management of the Principal and request the Management to discontinue or heal the violation, or to take other relevant action. The Monitor can in this regard submit non-binding recommendation. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action or tolerate action. However, the Independent External Monitor shall give an opportunity to the agency to present its case before making its recommendations to the Principal.

(6) The Monitor will submit a written report to the Chairperson of the Board of the Principal within 8 to 10 weeks from the date of reference or intimation to him by the 'Principal' and, should the occasion arise, submit proposals for correcting problematic situations.

(7) If the Monitor has reported to the Chairperson of the Board a substantiated suspicion of an offence under relevant Anti-Corruption Laws of India, and the Chairperson has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the Monitor may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

(8) The word 'Monitor' would include both singular and plural.

Section 9 – Pact Duration

This Pact begins when both parties have legally signed it. It expires for the agency 12 months after the last payment under the respective contract, and for all other Bidders 6 months after the contract has been awarded.

If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this pact as specified above, unless it is discharged / determined by Chairperson of the Principal.

Section 10 – Other provisions

(1) This agreement is subject to Indian Law. Place of performance and jurisdiction is the Registered Office of the Principal, i.e. Mumbai. The Arbitration clause provided in the main tender document / contract shall not be applicable for any issue / dispute arising under Integrity Pact.

(2) Changes and supplements as well as termination notices need to be made in writing. Side agreements have not been made.

(3) If the Bidder/Consulting agency/Architect/Supplier is a partnership or a consortium, this agreement must be signed by all partners or consortium members.

(4) Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

………………..………   .……………………………

For the Principal For the Bidder/Consulting agency/Architect/Supplier

Place ……………….……   Witness1:   (Signature/Name/Address)

Date ……………….………   Witness2:   (Signature/Name/Address)

REC Power Distribution Company Limited	

<div align="center">

ANNEXURE-A

PERFORM ANCE BANK GUARANTEE

</div>

M/s. REC Power Distribution Company Ltd.

A10, 4th Floor, Kribhco Bhawan,

Sector-1, Noida – 201301

(With due Rs.100/- stamp duty, if applicable)

OUR LETTER OF GUARANTEE No. : ………..................   **Date: ………………**

Amount: ………………….   **Valid Date: ………….**

Bank Name & Address: ……………………………………………………………………………………

In consideration of REC Power Distribution Company Ltd. having its office at REC Power Distribution Company Ltd. A10, 4th Floor, Kribhco Bhawan, Sector-1, Noida – 201301 (hereinafter referred to as "RECPDCL" which expression shall unless repugnant to the content or meaning there of include all its successors, administrators and executors) and having entered into an agreement dated _____/issued Work Order No._____ dated _____with/on as_____ (hereinafter referred to as "The service" which expression unless repugnant to the content or meaning thereof, shall include all the successors, Administrators and executors).

WHEREAS the Agency having unequivocally accepted to supply the materials as per terms and conditions given in the Agreement accepted to providing service as per terms and conditions given in the Agreement dated _____ /Work Order No. _____ dated _____ and RECPDCL having agreed that the Agency shall furnish to RECPDCL a Performance Guarantee for the faithful performance of the entire contract, to the extent of 10% (ten percent) (or the percentage as per the individual case) of the value of the Work Order i.e. for _____.

We, _____ (The Bank) which shall include OUR successors, administrators and executors herewith establish an irrevocable Letter of Guarantee No. _____ in your favour for account of _____ (The Agency) in cover of performance guarantee in accordance with the terms and conditions of the Agreement/work Order.

Hereby, we undertake to pay upto but not exceeding _____ (say _____ only) upon receipt by us of your first written demand accompanied by your declaration stating that the amount Claimed is due by reason of the Agency having failed to perform the Agreement and despite any contestation on the part of above named Agency.

This Letter of Guarantee will expire on _____ including 30 days of claim period and any claims made hereunder must be received by us on or before expiry date after which date this Letter of Guarantee will become of no effect whatsoever whether returned to us or not.

_____
Authorized Signature
Chief Manager/Manger

Seal of Bank

Annexure B
ACCEPTANCE FORM FOR PARTICIPATION IN REVERSE AUCTION EVENT
(To be signed and stamped by the bidder)

In a bid to make our entire procurement process more fair and transparent, RECPDCL intends to use the reverse auctions as an integral part of the entire tendering process. All the bidders who are found as technically qualified based on the tender requirements shall be eligible to participate in the reverse auction event.

The following terms and conditions are accepted by the bidder on participation in the bid event:

1. RECPDCL shall provide the user id and password to the authorized representative of the bidder. *(Authorization Letter in lieu of the same shall be submitted along with the signed and stamped Acceptance Form).*

2. RECPDCL decision to award the work would be final and binding on the supplier.

3. The bidder agrees to non-disclosure of trade information regarding the purchase, identity of RECPDCL, bid process, bid technology, bid documentation and bid details to any other party.

4. The bidder is advised to fully make aware themselves of auto bid process and ensure their participation in the event of reverse auction and failing to which RECPDCL will not be liable in any way.

5. In case of bidding through Internet medium, bidders are further advised to ensure availability of the infrastructure as required at their end to participate in the auction event. Inability to bid due to telephone line glitch, internet response issues, software or hardware hangs, power failure or any other reason shall not be the responsibility of RECPDCL.

6. In case of intranet medium, RECPDCL shall provide the infrastructure to bidders. Further, RECPDCL has sole discretion to extend or restart the auction event in case of any glitches in infrastructure observed which has restricted the bidders to submit the bids to ensure fair & transparent competitive bidding. In case an auction event is restarted, the best bid as already available in the system shall become the basis for determining start price of the new auction.

7. In case the bidder fails to participate in the auction event due any reason whatsoever, it shall be presumed that the bidder has no further discounts to offer and the initial bid as submitted by the bidder as a part of the tender shall be considered as the bidder's final no regret offer. Any offline price bids received from a bidder in lieu of non-participation in the auction event shall be out rightly rejected by RECPDCL.

8. The bidder shall be prepared with competitive price quotes on the day of the bidding event.

9. The prices as quoted by the bidder during the auction event shall be inclusive of all the applicable taxes, duties and levies and shall be FOR at site.

10. The prices submitted by a bidder during the auction event shall be binding on the bidder.

11. No requests for time extension of the auction event shall be considered by RECPDCL.

12. The original price bids of the bidders shall be reduced on pro-rata basis against each line item based on the final all-inclusive prices offered during conclusion of the auction event for arriving at Contract amount.

REC Power Distribution Company Limited	

BID BANK GUARANTEE (EARNEST MONEY)
(To be stamped in accordance with Stamp act)

This deed of Guarantee made this _____ day of _____**2016**
by_____
__

((*Name of the Bank)*

having one its branch at _____
acting through its Manager (hereinafter called the "Bank") which expression shall wherever the
context so requires includes its successors and permitted assigns in favour of REC Power
Distribution Company Ltd., registered under the Companies Act, 1956, having its office at
_____(hereinafter
called) ("RECPDCL") which expression shall include its successors and assigns.

WHEREAS RECPDCL has invited tender vide their Tender Notice No.
_____ Dated _____ to be opened on
AND   WHEREAS   M/s
_____
(Name of Tenderer)
having its office at _____
(hereinafter called the "Tenderer"), has/have in response to aforesaid tender notice offered to
supply/ do the job _____ as contained in the tender.

AND WHEREAS the Tender is required to furnish to RECPDCL a Bank Guarantee for a sum of
Rs. _____ (Rupees_____
_____Only) as Earnest Money for participation in the Tender aforesaid.

AND WHEREAS, we _____
(Name of Bank) have at the request of the tenderer agree to give RECPDCL this as hereinafter
contained.

NOW, THEREFORE, in consideration of the promises we, the undersigned, hereby covenant
that, the aforesaid Tender shall remain open for acceptance by RECPDCL during the period of
validity as mentioned in the Tender or any extension thereof as RECPDCL and the Tenderer
may subsequently agree and if the Tenderer for any reason back out, whether expressly or
impliedly, from his said Tender during the period of its validity or any extension thereof as
aforesaid or fail to furnish Bank Guarantee for performance as per terms of the aforesaid
Tender, we hereby undertake to pay RECPDCL, New Delhi on demand without demur to the
extent of Rs._____(Rupees_____ only).

We further agree as follows:-

01. That RECPDCL may without affecting this guarantee extend the period of validity of the
    said Tender or grant other indulgence to or negotiate further with the Tenderer in regard
    to the conditions contained in the said tender or thereby modify these conditions or add

thereto any further conditions as may be mutually agreed to in between RECPDCL and the Tender AND the said Bank shall not be released from its liability under these presents by an exercise by RECPDCL of its liberty with reference to the matters aforesaid or by reason of time being given to the Tenderer or any other forbearance, act or omission on the part of the RECPDCL or any indulgence by RECPDCL to the said Tenderer or any other matter or thing whatsoever.

02. The Bank hereby waive all rights at any time in consistent with the terms of this Guarantee and the obligations of the Bank in terms thereof shall not be otherwise affected or suspended by reason of any dispute or dispute having been raised by the Tenderer (whether or not pending before any arbitrator, tribunal or court) or any denial of liability by the Tenderer stopping or preventing or purporting to stop or prevent any payment by the Bank to RECPDCL in terms thereof.

03. We the said Bank, lastly undertake not to revoke this Guarantee during its currency except with the previous consent of RECPDCL in writhing and agree that any charges in the constitution, winding up, dissolution or insolvency of the Tenderer, the said Bank shall not be discharged from their liability.

NOTWITHSTADING anything contained above, the liability of the Bank in respect of this Guarantee is restricted to the said sum of Rs. _____ (Rupees _____ only) and this Guarantee shall remain in force till _____ unless a claim under this guarantee is filed with the bank within 30 (thirty) days from this date or the extended date, as the case may be i.e. upto _____ all rights under Guarantee shall lapse and the Bank be discharged from all liabilities hereunder.

In witness whereof the Bank has subscribed and set its name and seal here under.

Note: - The date shall be thirty (30) days after the last date for which the bid is valid.

List of Abbreviations

Abbreviation	Meaning
AMR	Automated Meter Reading
B/W	Black & White
BCPU	Bay Control protection Unit
BDS	Bid Data Sheet
BG	Bank Guarantee
CT	Current transformer
CV	Curriculum Vitae
DNS	Domain Name Server
DTMU	Distribution transformer Monitoring Unit
EMS	Enterprise Management System
ExW	Ex-Works
FMS	Facility Management Services
FoB	Freight on Board
GCC	General Conditions of Contract
GIS	Geographical Information System
GoI	Government of India
GPS	Geographic Positioning System
GSP	GIS Solution Provider
HQ	Head Quarter
HT	High Tension
ICB	International Competitive Bidding
INR	Indian Rupee
IP	Internet Protocol
IPR	Intellectual Property Rights
IST	Indian Standard Time
IT	Information Technology
ITB	Instructions to Bidders
LAN	Local Area Network
LDAP	Lightweight Directory Access Protocol
LoI	Letter of Intend
LP	Lowest Prize
LT	Low Tension
MD	Managing Director
MDASP	Meter Data Acquisition Solution Provider
MFT	Multi-Functional Transducer

MoP	Ministry of Power
MTR	Motor Transport Receipt
NIT	Notice Inviting Tender
NMS	Network Management System
NSGM	National Smart Grid Mission
NSP	Network Solution Provider
OEM	Original Equipment Manufacturer
OS	Operating System
PC	Personal Computer
PFC	Power Finance Corporation
RFP	Request for Proposal
RFQ	Request for Qualification
RTU	Remote Terminal Unit
SAS	Substation automation System
SCADA	Supervisory Control and Data acquisition system
SCC	Special Conditions of Contract
SI	System Integrator
SLA	Service Level Agreement
T/O	Turnover
TS	Technical Section
UPS	Uninterrupted Power Supply
VAT	Value Added Tax
VPN	Virtual Private Network
VPS	Video Projection System
WAN	Wide Area Network