RFQ No.: CC25VKD002

OPEN TENDER NOTIFICATION

FOR

DESIGN ENGINEERING, SUPPLY, INSURANCE, TRANSPORTATION, DELIVERY AT SITE, INSTALLATION, INSPECTION, TESTING AND COMMISSIONING OF THE NEW SCADA & ADMS SYSTEM FOR TATA POWER MUMBAI DISTRIBUTION

Tender Enquiry No.: CC25VKD002

Due Date for Bid Submission: 07.06.2024 [17:00 Hrs.]

The Tata Power Company Limited
Mumbai, Maharashtra

RFQ No.: CC25VKD002

CONTENTS OF THE ENQUIRY

1.0 Event Information

1.1 Scope of work

Open Tenders are invited in e-tender bidding process from interested Bidders for entering into a Outline Agreement valid for a period of 3 Years as defined below:

S. No.	Description	EMD Amount (Rs.)	Tender Fee (Rs.)
1	**Design Engineering, Supply, Insurance, Transportation, Delivery at site, Installation, Inspection, Testing and Commissioning of the New SCADA & ADMS System for Tata Power Mumbai Distribution**	2,00,000/-	2000/-

1.2 Availability of Tender Documents

Non-transferable tender documents may be purchased by interested eligible bidders from the address given below on submission of a written application to the under-mentioned and upon payment of a non-refundable Tender fee.

Chief (Corporate Contracts)
The Tata Power Company Limited
Smart Center of Procurement Excellence, 2nd Floor, Sahar Receiving Station
Sahar Airport Road, Andheri East, Mumbai-400059

Tender documents may be downloaded by interested eligible bidders from the TPC website www.tatapower.com with effect from 16.05.2024. In the event, detailed tender documents are downloaded the from TPC website or are received through email from TPC, the Tender Fee shall be compulsorily submitted online through NEFT/ RTGS in favor of "The Tata Power Company Limited". Any such bid submitted without this Fee shall be rejected.

Bidders are requested to visit TPC website www.tatapower.com regularly for any modification/ clarification to the bid documents. For Limited Tenders issued by TPC, the tender document shall be shared through e-mail as the case may be.

1.3 Calendar of Events

(a)	Date of availability of tender documents from TPC Website	From 16.05.2024 to 07.06.2024, 17:00 Hrs
(b)	Date & Time of Pre-Bid Meeting (If any)	24.05.2024 at 3 PM (MS Teams)
(c)	Last Date of receipt of pre-bid queries, if any	27.05.2024 up to 17:00 Hours
(d)	Last Date of Posting Consolidated replies to all the pre-bid queries as received	30.05.2024 up to 17:00 Hours
(e)	Last date and time of receipt of Bids	07.06.2024 up to 17:00 Hrs
(f)	Date & Time of opening of Price of qualified bids	Will be notified to the successful bidders through our website/e-mail.

Note :- In the event of last date specified for submission of bids and date of opening of bids is declared as a closed holiday for TPC Mumbai office, the last date of submission of bids and date of opening of bids will be the following working day at appointed times.

1.4 Mandatory documents required along with the Bid

1.4.1 EMD of requisite value and validity
1.4.2 Tender Fee in case the tender is downloaded from website
1.4.3 Requisite Documents for compliance to Qualification Criteria mentioned in Clause 1.7.
1.4.4 Drawing, Type Test details along with a sample of each item as specified at Annexure I (as applicable)
1.4.5 Duly signed and stamped 'Schedule of Deviations' as per Annexure III on bidder's letter head.
1.4.6 Duly signed and stamped 'Schedule of Commercial Specifications' as per Annexure IV on bidder's letter head.
1.4.7 Proper authorization letter/ Power of Attorney to sign the tender on the behalf of bidder.
1.4.8 Copy of PAN, GST, PF and ESI Registration (In case any of these documents is not available with the bidder, same to be explicitly mentioned in the 'Schedule of Deviations')

Please note that in absence of any of the above documents, the bid submitted by a bidder shall be liable for rejection.

1.5 Deviation from Tender

Normally, the deviations to tender terms are not admissible and the bids with deviation are liable for rejection. Hence, the bidders are advised to refrain from taking any deviations on this Tender. Still in case of any deviations, all such deviations shall be set out by the Bidders, clause by clause in the 'Annexure III - Schedule of Deviations' and same shall be submitted as a part of the Technical Bid.

1.6 Right of Acceptance/Rejection

Bids are liable for rejection in absence of following documents:-

1.6.1 EMD of requisite value and validity
1.6.2 Tender fee of requisite value
1.6.3 Price Bid as per the Price Schedule mentioned in Annexure-I
1.6.4 Necessary documents against compliance to Qualification Requirements mentioned at Clause 1.7 of this Tender Document.
1.6.5 Filled in Schedule of Deviations as per Annexure III
1.6.6 Filled in Schedule of Commercial Specifications as per Annexure IV
1.6.7 Receipt of Bid within the due date and time

TPC reserves the right to accept/reject any or all the bids without assigning any reason thereof.

1.7 Pre- Qualification Criteria

Description of the Criteria	Documents to be Submitted
General : The Bidder/Principal must have a presence in India for last 5 years, meeting requirement as specified below: Bidder/Principal should Registered in India under the Companies Act of India, as on Techno-Commercial Bid submission date for supply of the SCADA/ ADMS System.	Self-undertaking to be submitted in this regard. Tata Power reserves the right to inspect the said manufacturing facility as a proof of compliance to this parameter. Technical support facilities including qualified man-power, testing tools and instruments and integration facilities available within India.
Technical: At Least Two (2) Integrated SCADA & ADMS/DMS & OMS system for Power Utility Control Centre at Metro / District / Regional level during the last ten (10) years. Above project(s) should have interface of at least 50 Primary Substations (33KV/22KV to 11KV) RTU/500000 SCADA IO point. Out of the two (2) systems, at-least one (1) system should be in satisfactory service condition for last one year in India as Bidder/Principle. OR In case Bidder is not manufacturer of offered SCADA/ADMS/OMS system then bidder shall comply to following requirement i. The Bidder shall have been duly authorized by the manufacturer or producer of the SCADA/ADMS/OMS system to supply and/or install that item in the Utility. Bidder shall submit letter of Authorization of SCADA/ADMS/OMS.System manufacturer. Bidder shall also submit letter from OEM agreeing to take responsibility of the supplied and deployed hardware and software system for the entire life of the system as per contract, in case bidder is unable to deliver the services. ii. The bidder shall submit Letter of Undertaking from SCADA/ADMS/OMS system manufacturer to take responsibility to provide full range of support services (including hardware and software system design, installation, maintenance, modifications and upgradation support) for the entire life as per contract, of the delivered SCADA/ADMS/OMS system including Communication interfaces.	Supply List & Performance Certificates from the Utilities / Clients to be submitted. In case, bidder uses experience of parent organization based out-side India to meet the QR, then bidder shall submit concurrence from the parent organization to support the supply and experience criteria. Both Parent Company and Subsidiary Company shall provide a Deed of Joint Undertaking (DJU) and will be jointly and severally responsible for the execution of contract (If applicable). The Bidder shall share responsibility matrix, division of works etc. between Parent Company and Bidder.

Description of the Criteria	Documents to be Submitted
Financial : The annual average turnover of the bidder for the last three financial year ending should be Rs. 150 Crs. (as per the last published audited balance sheets / CA certified provisional balance sheet)	Profit and Loss Statements, Balance Sheet, Cash Flow Statements for the Three (3) preceding financial years duly audited and approved by Authorized Audit Firm / CA

Note: Apart from the above PQR bidder must also qualify in Safety evaluation.

1.8 Marketing Integrity

We have a fair and competitive marketplace. The rules for bidders are outlined in the General Conditions of Contracts. Bidders must agree to these rules prior to participating. In addition to other remedies available, TPC reserves the right to exclude a bidder from participating in future markets due to the bidder's violation of any of the rules or obligations contained in the General Condition of Contracts. A bidder who violates the marketplace rules or engages in behavior that disrupts the fair execution of the marketplace may result in restriction of a bidder from further participation in the marketplace for a length of time, depending upon the seriousness of the violation. Examples of violations include, but are not limited to:

- ☐ Failure to honor prices submitted to the marketplace.
- ☐ Breach of terms as published in TENDER/ NIT

1.9 Supplier Confidentiality

All information contained in this tender is confidential and shall not be disclosed, published or advertised in any manner without written authorization from TPC. This includes all bidding information submitted to TPC. All tender documents remain the property of TPC and all suppliers are required to return these documents to TPC upon request. Suppliers who do not honor these confidentiality provisions will be excluded from participating in future bidding events.

2.0 Evaluation Criteria

- ☐ The bids will be evaluated technically on compliance with tender terms and conditions.
- ☐ The bids will be evaluated commercially on the overall all-inclusive lowest cost for overall BOM and individual line items as per price bid format . TPC however, reserves the right to award the contract. Hence all bidders are advised to quote their most competitive rates against each line item.
- ☐ Bidder has to mandatorily quote against each item of the Schedule of Items. Failing to do so, TPC may reject the bids.

NOTE: In case of a new bidder not registered, factory inspection and evaluation shall be carried out to ascertain bidder's manufacturing capability and quality procedures. However TPC reserves the right to carry out factory inspection and evaluation for any bidder prior to technical qualification. In case a bidder is found as Disqualified in the factory evaluation, their bid shall not be evaluated any further and shall be summarily rejected. The decision of TPC shall be final and binding on the bidder in this regard.

2.1 Price Variation Clause:

The prices shall remain firm during the entire contract period.

3.0 Submission of Bid Documents

3.1 Bid Submission

Bidders are requested to submit their offer in line with this Tender document. TPC shall respond to the clarification raised by various bidders and the replies will be sent to all participating bidders through e-mail.

Bids shall be submitted in 3 (Three) parts

FIRST PART: "EMD" of Rs. 2,00,000/- (Rupees Two Lacs only) shall be submitted. The EMD shall be valid for 210 days from the due date of bid submission in the form of BG / Bankers Pay Order favoring "The Tata Power Company Limited". The EMD has to be strictly in the format as mentioned in General Condition of Contract, failing which it shall not be accepted and the bid as submitted shall be liable for rejection. A separate non-refundable tender fee of stipulated amount also needs to be transferred online through NEFT/ RTGS in case the tender document is downloaded from our website.

TPC/ TPC Bank Details for transferring the Tender Fee and EMD is as below:

Account Name: The Tata Power Co. Ltd.
Bank Name: HDFC Bank, Fort Branch, Mumbai
Bank Account No. : 00600110000763

IFSC Code: HDFC0000060

SECOND PART: "TECHNICAL BID" shall contain the following documents:

a) Documentary evidence in support of qualifying criteria
b) Technical literature/GTP/Type test report etc. *(if applicable)*
c) Qualified manpower available
d) Testing facilities *(if applicable)*
e) No Deviation Certificate as per the Annexure III – Schedule of Deviations
f) Acceptance to Commercial Terms and Conditions viz Delivery schedule/period, payment terms etc. as per the Annexure IV – Schedule of Commercial Specifications.
g) Quality Assurance Plan/Inspection Test Plan for supply items *(if applicable)*

The technical bid shall be properly indexed and is to be submitted in Soft Copy through Ariba Portal only. Hard Copy of Technical Bids need not be submitted.

THIRD PART: "PRICE BID" shall contain only the price details and strictly in format as mentioned in Annexure I along with explicit break up of basic prices, Taxes & duties, Freight etc. In case any discrepancy is observed between the item description stated in Schedule of Items mentioned in the tender and the price bid submitted by the bidder, the item description as mentioned in the tender document (to the extent modified through Corrigendum issued if any) shall prevail.

FOR BIDS INVITED THROUGH E-PROCUREMENT PORTAL:

The interested bidders are requested to obtain user name and password for purpose of bid submission through Ariba portal of TPC, Mumba.

Bids have to be mandatorily submitted only through Ariba portal of TPC. Bids submitted through any other form/ route shall not be admissible

The EMD in the form of BG shall be submitted in original hard copy and then placed in sealed envelope which shall be clearly marked as below:

EMD

" Design Engineering, Supply, Insurance, Transportation, Delivery at site, Installation, Inspection, Testing and Commissioning of the New SCADA & ADMS System for Tata Power Mumbai Distribution."

Please mention our Enquiry Number:- CC25VKD002 on the Tender and drop the same at The Tata Power Company Limited, Smart Center of Procurement Excellence, 2nd Floor, Sahar Receiving Station, Sahar Airport Road, Andheri East, Mumbai-400059.

The envelope shall be addressed to:

Chief (Corporate Contracts)
The Tata Power Company Limited
Smart Center of Procurement Excellence, 2nd Floor, Sahar Receiving Station
Sahar Airport Road, Andheri East, Mumbai-400059

The envelope shall also bear the Name and Address of the Bidder along with our Tender No. and subject.

SIGNING OF BID DOCUMENTS:

The bid must contain the name, residence and place of business of the person or persons making the bid and must be signed and sealed by the Bidder with his usual signature. The names of all persons signing should also be typed or printed below the signature.

The Bid being submitted must be signed by a person holding a Power of Attorney authorizing him to do so, certified copies of which shall be enclosed.

The Bid submitted on behalf of companies registered with the Indian Companies Act, for the time being in force, shall be signed by persons duly authorized to submit the Bid on behalf of the Company and shall be accompanied by certified true copies of the resolutions, extracts of Articles of Association, special or general Power of Attorney etc. to show clearly the title, authority and designation of persons signing the Bid on behalf of the Company. Satisfactory evidence of authority of the person signing on behalf of the Bidder shall be furnished with the bid.

A bid by a person who affixes to his signature the word 'President', 'Managing Director', 'Secretary', 'Agent' or other designation without disclosing his principal will be rejected.

The Bidder's name stated on the Proposal shall be the exact legal name of the firm.

3.2 Contact Information

All the bidders are requested to send their pre-bid queries (if any) against this tender through e-mail within the stipulated timelines. The consolidated reply to all the queries received shall be shared on respective registered mail ID by the stipulated timelines as detailed in calendar of events.

Communication Details:

Contracts – T&D

Name: Ms Vaishali Kachare
Contact No: 022- 67173930
E-Mail ID: vaishali.kacharel@tatapower.com

Group Head Contracts – T&D:

Name: Mr. Selva Ganesh S P
Contact No.: 022- 67173925
E-Mail ID: selva.ganesh@tatapower.com

Distribution Network Management Group

Name: Mr Santosh Wangde
Contact No: 8879935012
E-Mail ID: vaishali.kacharel@tatapower.com

3.3 Bid Prices

Bidders shall quote for the entire Scope of Supply/ work with a break up of prices for individual items and Taxes & duties. The bidder shall complete the appropriate Price Schedules included herein, stating the Unit Price for each item & total price with taxes, duties & freight up to destination at various sites of TPC. The all-inclusive prices offered shall be inclusive of all costs as well as Duties, Taxes and Levies paid or payable during the execution of the supply work, breakup of price constituents.

The quantity break up shown else-where other than Price Schedule is tentative. The bidder shall ascertain himself regarding material required for completeness of the entire work. Any items not indicated in the price schedule but which are required to complete the job as per the Technical Specifications/ Scope of Work/ SLA mentioned in the tender, shall be deemed to be included in prices quoted.

3.4 Bid Currencies

Prices shall be quoted in Indian Rupees Only.

3.5 Period of Validity of Bids

Bids shall remain valid for 180 days from the due date of submission of the bid.

Notwithstanding clause above, the TPC may solicit the Bidder's consent to an extension of the Period of Bid Validity. The request and responses thereto shall be made in writing.

3.6 Alternative Bids

Bidders shall submit Bids, which comply with the Bidding documents. Alternative bids will not be considered. The attention of Bidders is drawn to the provisions regarding the rejection of Bids in the terms and conditions, which are not substantially responsive to the requirements of the bidding documents.

3.7 Modifications and Withdrawal of Bids

The bidder is not allowed to modify or withdraw its bid after the Bid's submission. The EMD as submitted along with the bid shall be liable for forfeiture in such event.

3.8 Earnest Money Deposit (EMD)

The bidder shall furnish, as part of its bid, an EMD amounting as specified in the tender. The EMD is required to protect the TPC against the risk of bidder's conduct which would warrant forfeiture.
The EMD shall be denominate in any of the following form:

- ☐ Banker's Cheque/ Demand Draft/ Pay order drawn in favor of The Tata Power Company Limited, payable at Mumbai.
- ☐ Online transfer of requisite amount through NEFT/ RTGS.
- ☐ Bank Guarantee valid for 210 days after due date of submission.

The EMD shall be forfeited in case of:

a) The bidder withdraws its bid during the period of specified bid validity.

Or

b) The case of a successful bidder, if the Bidder does not
i) accept the purchase order, or
ii) furnish the required performance security BG

3.9 Type Tests (if applicable)

As per attached Annexures

4.0 Bid Opening & Evaluation process

4.1 Process to be confidential

Information relating to the examination, clarification, evaluation and comparison of Bids and recommendations for the award of a contract shall not be disclosed to Bidders or any other persons not officially concerned with such process. Any effort by a Bidder to influence the TPC's processing of Bids or award decisions may result in the rejection of the Bidder's Bid.

4.2 Technical Bid Opening

Bids will be opened at TPC Office Mumbai as per the schedule mentioned in Calendar of Events. In case of limited tenders, the bids shall be opened internally by TPC. In case of Open Tenders, the bids shall be opened in the presence of accredited representatives of bidders who may choose to be present at the time of tender opening. Technical bid must not contain any cost information whatsoever.

First the envelope marked “EMD” will be opened. Bids without EMD/cost of tender (if applicable) of required amount/ validity in prescribed format, shall be rejected.

Next, the technical bid of the bidders who have furnished the requisite EMD will be opened, one by one. The salient particulars of the techno commercial bid will be read out at the sole discretion of TPC.

4.3 Preliminary Examination of Bids/Responsiveness

TPC 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. TPC may ask for submission of original documents in order to verify the documents submitted in support of qualification criteria.

Arithmetical errors will be rectified on the following basis: If there is a discrepancy between the unit price and the total price per item that is obtained by multiplying the unit price and quantity, the unit price shall prevail and the total price per item will be corrected. If there is a discrepancy between the

Total Amount and the sum of the total price per item, the sum of the total price per item shall prevail and the Total Amount will be corrected.

Prior to the detailed evaluation, TPC will determine the substantial responsiveness of each Bid to the Bidding Documents including production capability and acceptable quality of the Goods offered. A substantially responsive Bid is one, which conforms to all the terms and conditions of the Bidding Documents without material deviation.

Bid determined as not substantially responsive will be rejected by the TPC and/or the TPC and may not subsequently be made responsive by the Bidder by correction of the non-conformity.

4.4 Techno Commercial Clarifications

Bidders need to ensure that the bids submitted by them are complete in all respects. To assist in the examination, evaluation and comparison of Bids, TPC may, at its discretion, ask the Bidder for a clarification on its Bid for any deviations with respect to the TPC specifications and attempt will be made to bring all bids on a common footing. All responses to requests for clarification shall be in writing and no change in the price or substance of the Bid shall be sought, offered or permitted owing to any clarifications sought by TPC.

4.5 Price Bid Opening

Price bids will be opened at the stipulated date and time. The EMD of the bidder withdrawing or substantially altering his offer at any stage after the technical bid opening will be forfeited at the sole discretion of TPC without any further correspondence in this regard.

4.7 Reverse Auctions

TPC reserves the right to conduct the reverse auction (instead of public opening of price bids) for the products/ services being asked for in the tender. The terms and conditions for such reverse auction events shall be as per the Acceptance Form attached as Annexure VI of this document. The bidders along with the tender document shall mandatorily submit a duly signed copy of the Acceptance Form attached as Annexure VI as a token of acceptance for the same.

5.0 Award Decision

TPC will award the contract to the successful bidder whose bid has been determined to be the lowest-evaluated responsive bid as per the Evaluation Criterion mentioned in Clause 8.3 of Specifications. The Cost for the said calculation shall be taken as the all-inclusive cost quoted by the bidder in Annexure I (Schedule of Items) subject to any corrections required in line with Clause 4.3 above. The decision to place a purchase order/LOI solely depends on TPC on the cost competitiveness across multiple lots, quality, delivery, and bidder's capacity, in addition to other factors that TPC may deem relevant.

TPC reserves all the rights to award the contract to one or more bidders so as to meet the delivery requirement or nullify the award decision without assigning any reason thereof.

In case any supplier is found unsatisfactory during the delivery process, the award will be canceled and TPC reserves the right to award other suppliers who are found fit.

6.0 Order of Preference/Contradiction:

In case of contradiction in any part of various documents in the tender, the following shall prevail in order of preference:

1. Schedule of Items (Annexure I)
2. Technical Specifications/ Scope of Work and SLA (Annexure II)
3. Schedule of Commercial Specifications (Annexure III)
4. Schedule of Deviations (Annexure IV)
5. Document Check List (Annexure V)
6. Acceptance Form for Participation in Reverse Auction (Annexure VI)
7. Inspection Test Plan (Annexure VII)
8. General Conditions of Contract (Annexure VIII)
9. BG Format (Annexure IX)

7.0 Post Award Contract Administration

7.1 Special Conditions of Contract

☐ The rate shall remain FIRM till the validity of the Contract.

☐ TPC appreciates and welcomes the engagement/employment of persons from SC/ ST community or any other deprived section of society by their BAs.

☐ Any change in statutory taxes, duties, and levies during the contract period shall be borne by TPC. However, in case of delay in work execution owing to reasons not attributable to TPC, any increase in total liability shall be passed on to the Bidder, whereas any benefits arising owing to such statutory variation in taxes and duties shall be passed on TPC.

☐ All the terms and conditions of TPC GTC shall be applicable.

7.2 Drawing Submission & Approval

As per Annexure - II

7.3 Contract Period

15 Months from the date of award of PO.

7.4 Warranty Period

As per Specifications / Job Scope

7.5 Payment Terms

100% Payment within 45 Days (MSME)/ 90 Days (Non- MSME) at actual after completion of the job & submission of monthly Invoice with supporting documents. Credit period for all payment due will be 90 days from when payment is due and submission of all requisite documents. Pls refer details as per Specification clause No 9.3.

7.6 Liquidated Damages

As per the Tata Power Scope of Work & General Terms and Conditions shall be applicable.

7.7 Contract Performance Bank Guarantee (CPBG)

One-time Submission of CPBG cum PBG for 10% of PO value within 15 days from the date of PO/ WO valid till the Completion of the warranty period (7 Years after the complete handover of the system) with a further claim period of 6 months.

7.8 SLA / Performance Requirement and penalties

AS per Scope of Work.

7.9 Safety Retention

Safety Retention as per the Tata Power General Terms and Conditions shall be applicable and shall be released based on the safety performance score after work completion.

7.10 Climate Change

Significant quantities of waste are generated during the execution of the project and an integrated approach for effective handling, storage, transportation, and disposal of the same shall be adopted. This would ensure the minimization of environmental and social impact in order to combat climate change.

7.11 Ethics

TPC is an ethical organization and as a policy TPC lays emphasis on ethical practices across its entire domain. Bidder should ensure that they should abide by all the ethical norms and in no form either directly or indirectly be involved in unethical practice.

TPC work practices are governed by the Tata Code of Conduct which emphasizes on the following:

☐ We shall select our suppliers and service providers fairly and transparently.

☐ We seek to work with suppliers and service providers who can demonstrate that they share similar values. We expect them to adopt ethical standards comparable to our own.

☐ Our suppliers and service providers shall represent our company only with duly authorized written permission from our company. They are expected to abide by the Code in their interactions with, and on behalf of us, including respecting the confidentiality of information shared with them.

☐ We shall ensure that any gifts or hospitality received from, or given to, our suppliers or service providers comply with our company's gifts and hospitality policy.

☐ We respect our obligations on the use of third-party intellectual property and data.

Bidder is advised to refer GTC attached at Annexure VIII for more information.

Any ethical concerns with respect to this tender can be reported to the following e-mail ID: mrpatel@tatapower.com.

8.0 Specification and standards

As per Annexure II.

9.0 General Condition of Contract

Any condition not mentioned above shall be applicable as per GCC for Supply attached along with this tender at Annexure IX.

10.0 Safety

Safety related requirements as mentioned in our safety Manual put in the Company's website which can be accessed by:

http://www.tatapower.com

All Associates shall strictly abide by the guidelines provided in the safety manual at all relevant stages during the contract period.

Annexure – I

(Schedule of Items)

1. Hardware for MCC & BCC

S.No	Equipment	Unit	Quantity
A	**Server & workstation Hardware for MCC & BCC with 7 years comprehensive warranty**		
SCADA, DMS and other system			
1	Server 1) SCADA- 4 nos (2 at MCC and 2 at BCC) 2) FEP- 4 nos (2 at MCC and 2 at BCC) 3) DMS- 4 nos (2 at MCC and 2 at BCC) 4) ICCP- 4 nos (2 at MCC and 2 at BCC) 5) Active directory- 4 nos (2 at MCC and 2 at BCC) 6) ISR (time series historian) server with report functionality software- 4 nos (2 at MCC and 2 at BCC 7) DTS- 2 nos (at MCC) 8) Developmental server- 2 nos (at MCC) 9) Quality Assurance Server - 2 (at MCC) 10) Web server with load balancing (50 concurrent client)- 4 nos (2 at MCC and 2 at BCC) 11) Interface Server (Main & Standby) for Third Party and Other System Integration on Secured ICCP, OPC, ODBC, Web Services, CIM-XML, Mail and SMS gateway etc.- 4 nos (2 at MCC and 2 at BCC) 12) On-Line Backup Server with pool of storage media- 4 nos (2 at MCC and 2 at BCC)	No.	42
2	Work-Station w 2 x 24" LED Monitors (with RGB Provision for LVS) with WINDOW OS and external speaker Operator Workstation MCC- 2 nos Operator Workstation BCC- 2 nos DTS Workstation - 4 nos Developmental console - 6 nos	No.	14
3	Remote VDUs with one 24"LED Monitors with WINDOW OS and external speaker	No.	10
OMS System with 7 years comprehensive warranty			
4	OMS Server - 4 nos (2 at MCC and 2 at BCC)	No.	4
Storage & Backup System with 7 years comprehensive warranty			
5	SAN Box (30TB or higher) for log storage (2 at MCC and 2 at BCC)	No.	4

6	LTO-9 OR better Tape Drive with Auto Loader (1 at MCC and 1 at BCC)	No.	2
Rack and network devices with 7 years comprehensive warranty			
7	Modular Rack for Servers and networking devices with all necessary accessories (Cables, Connectors etc. required at MCC and BCC)- 8 nos (4 at MCC and 4 at BCC)	NO.	8
8	Rack-Mount Sliding Monitor with inbuilt Keyboard and Mouse along with Rack mounted KVM Switch- 4 nos (2 at MCC and 2 at BCC)	No.	4
9	Layer II switch (SCADA/DMS LAN, Planning and Development System LAN, Server LAN, etc), Port: 24(Minimum)- 22 nos (12 at MCC and 10 at BCC)	No.	22
Cyber Security with 7 years comprehensive warranty			
10	High Availability NGFW Firewall & network IDS/IPS. External - 4 Qty. (will be provided by Tata Power) & Internal - 4 Qty . Bidder to supply Fortinet make Internal firewall only and same to be integrate with existing FMS- 4 nos (2 at MCC and 2 at BCC)	No.	4
Other Active Devices with 7 years comprehensive warranty			
11	GPS Time synchronisation system- 4 nos (2 at MCC and 2 at BCC)	Set	4
12	GPS Display for Time and Frequency- 1 no at MCC	Set	1
B	**Services**		
1	Services for installation, Commissioning and Testing of MCC and BCC system. This also includes, Services for integration with thrid party system 1) integration with existing System such as PI,GIS,AMI,CYMDIST,SAP,ICCP, mail server and 2) installation of cyber security system and installation & integration of cyber security system with existing infrastucture	Lot	1
2	Additional 3 years comprehensive Warranty & Services for both MCC & BCC infra after completion of 7 years comprehensive warranty period	Per anum	3
3	Resident Engineer Support (1 Engineer) for 7 years after successful completion of SATfor the following acitivites 1) For all Supplied system including sub-vendor equipment & 3rd party Solutions/systems. 2) Hardware & Software - Maintenance, Upgradation and Patch Management Services for all supplied systems.	Per anum	7

S.No.	Equipment	Unit	Quantity
A	**Software for MCC & BCC Centre(For Main & Standby Server with 7 years comprehensive warranty)**		
SCADA, DMS and other system			
1	SCADA Server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
2	FEP server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
3	DMS Server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
4	ICCP Server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
5	Active directory server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
6	ISR (time series historian) server with report software - (1 lot at MCC and 1 lot at BCC)	Lot	2
7	DTS server Software (at MCC)	Lot	1
8	Developmental server Software (at MCC)	Lot	1
9	Quality Assurance Server Software (at MCC)	Lot	1
10	Web server software with load balancing (50 concurrent client)- (1 lot at MCC and 1 lot at BCC)	Lot	2
11	Interface Server software (Main & Standby) for Third Party and Other System Integration on Secured ICCP, OPC, ODBC, Web Services, CIM-XML, Mail and SMS gateway etc.- (1 lot at MCC and 1 lot at BCC)	Lot	2
12	On-Line Backup Server software with pool of storage media- (1 lot at MCC and 1 lot at BCC)	Lot	2
13	Operator Work-Station Software- (2 lot at MCC and 2 lot at BCC)	Lot	4

14	Remote VDUs Software with WINDOW OS	Lot	10
15	DTS Work-Station Software (at MCC)	Lot	4
16	Developmental console Software (at MCC)	Lot	6
OMS System with 7 years comprehensive warranty			
17	OMS Server Software- (1 lot at MCC and 1 lot at BCC)	Lot	2
Cyber security components with 7 years comprehensive warranty			
18	License upgradation of existing cyber security servers to integrate all server and workstation proposed in MCC & BCC.(ref. CH-13 for detail)- (at MCC)	Lot	1

Note: The above Quantities are tentative. Tata Power reserves the right to curtail/enhance the quantities before the placement of the Purchase Order.

- The bidders are advised to quote prices strictly in the above format and for all the line items as mentioned above. Failing to do so, bids are liable for rejection.
- The bidder must fill each column of the above format. Mentioning “extra/inclusive” in any of the columns may lead to the rejection of the price bid.

RFQ No.: CC25VKD002

ANNEXURE II

Technical Specifications/ Job Scope & SLA

Document Title: SCADA & ADMS System

Document No: TS/ADMS-SPEC/01/2024

SECTION – A

PROJECT SPECIFICATIONS

Revision	Date	Description	Approvals		
			Prepared By	Checked By	Approved By
R1	2 March 2024	Final specification	BHS	SAW & RMP	GTJ

Organization of the Specification

Section – A

Section – B

Section – C

Section – D

Section – E

Section – A

Project Specification

CONTENTS:

1.0 Intent of Specification

It is Purchaser's intent to replace the existing SCADA/DMS System and deployment of New SCADA & ADMS System at the Purchaser's Main Control Center (MCC) and Backup Control Centre (BCC). The proposed Centralized SCADA and ADMS System should facilitate Purchaser's operations along with new generation technology. The Main & Backup Control Center shall work as hot redundant Control Center. The SCADA and ADMS System will collect field data on IEC 60870-5-104 from Remote Terminal Units (RTUs) / Data Concentrator / FRTUs / Autoreclosers / Sectionaliser / FPIs etc. and will interface to existing system like GIS, SAP-PM, MM, AMR/AMI, PQM, VMS, CIS, IoT based system, Enterprise Historian and future applications like Asset management systems etc. and also with Transmission SCADA (Main and Backup) over Secured ICCP/TASE.2. The SCADA and ADMS at the MCC & BCC shall be accessible by the authorized personnel. Purchaser intent to commission the proposed system in 2 Phases i.e. Phase - A & Phase – B as described in the scope of work.

The SCADA & ADMS System should be fully redundant in all respect so that the availability requirements specified in this specification are satisfied. The SCADA & ADMS shall provide automatic failover features to survive all single hardware device failures, major & minor communication outages, site power supply and environmental problems. Backup Control Center shall be available in the event the Primary/Main Control Center (MCC) is unavailable.

The Operational Technology systems requires robust Cyber Security implementation; the Cyber Security risks which are compounded due to distributed architecture at multiple interfaces/systems at MCC, BCC, Primary Sub-stations, it is proposed to have Centralized Cyber Security & Communication Network Management System, which shall include the appropriate measures for individual devices at Sub-Station & Control Centre.

This specification describes the technical requirements of the systems to be procured.

1.1 Introduction to Tata Power Company Limited – Mumbai Distribution Limited

The Tata Power Company Limited is the largest private power utility in India, engaged in Generation, Transmission & Distribution. The power is transmitted over 220 KV & 110 KV network and distributed (33 kV / 22 kV) through 32 Nos. of step-down Receiving Stations and 36 Nos. of Distribution Substations situated in Mumbai and suburbs with about 1159 feeders of 110 / 33 / 22 / 11 / 6.6 kV.

Presently, all 36 Distribution sub stations (DSS) and around 490 Consumer sub stations (CSS) of Tata Power are remotely controlled from Power System Control Centre. For disaster management Backup SCADA systems are provided for monitoring and control. MCC and BCC are synchronized through dedicated links.

In view of Centralized monitoring and control of the entire distribution network It is proposed to replace the existing GE make SCADA/DMS system.

1.2 General Information about Tata Power Mumbai Distribution network

Description	UoM	Quantity
Distribution Network	Sq. Km.	4500
Number of Zones	Nos.	8
Number of Distribution substations	Nos.	36
Number of Consumer substations	Nos.	1120
No of feeders at Primary side (Incomer)	Nos.	151
No of 11 KV feeders	Nos.	440
No of 22 KV feeders	Nos.	151
Number of RMUs	Nos.	1480
Number of FPIs	Nos.	1302
Number of Breakers	Nos.	3527
Number of Isolators	Nos.	10223
Number of Power transformers at DSS	Nos.	70
Number of transformers at CSS	Nos.	1072
Number of Consumers	Nos.	767686
Number of RTU	Nos.	36
Number of FRTU	Nos.	490

1.3 **Present SCADA Systems and Operation Philosophy**

Purchaser serves its customers through an extensive Transmission and Distribution network; the entire operation and monitoring is performed through State of the Art Centralized Transmission and Distribution SCADA systems with Energy Management and Distribution Management Applications installed at Power System Control Centre of Purchaser. All the Receiving Stations and Distribution Substations are unmanned, monitored and controlled from the Power System Control Centre, Trombay for faster restoration and decision making on 24X7 basis.

Distribution Management System (DMS) is supplied by GE Alstom e-terra platform. 36 RTUs from various DSS and 490 FRTUs from various CSS are integrated to DMS. The system is integrated with GIS system for Asset information and with PI historian system. It has advanced network analytic tools such as Distribution Power Flow, Bus Load allocation, Fault location identification and supply restoration, Switch order management etc. (Refer Annexure for Overall SCADA, DMS & OMS System Landscape)).

All existing Distribution and Consumer Sub Stations of Purchaser are integrated to the Centralized SCADA system. This system enabled centralized monitoring, control and reporting of the entire transmission and distribution network from Power System Control Centre, Trombay.

The existing SCADA and DMS has now been in service for almost 10 years and has established its place in Tata Power as a very critical system for routine and emergency operations with enhanced operational availability of Distribution System. Since commissioning, all addition / deletion of the Distribution network components and substations were configured in MCC and BCC time to time.

1.4 **Present Communication System**

A strong and reliable communication systems is crucial for reliable and efficient operation and control of power network. Purchaser has designed and implemented an extensive and complex communication network to serve the objective of providing a robust backbone for the unified requirements of electrical protection coordination, monitoring and surveillance of operational assets. It also serves the purposes of carrier of voice, data and video streams.

Fiber Optic is the main medium of communication across Purchaser's Mumbai Operations for Tele-Protection, Data, Voice and Video communication. Purchaser has a fibre optic network consisting of underground and Optical Guard Wire (OPGW) of approximately 800 Kms circuit length.

At present, Purchaser has following major communication networks viz.

a. Corporate IT Wide Area Network (IT-WAN)

b. Automation WAN

c. Time Division Multiplexer (TDM) network

d. Voice Communication Systems

e. Data Communication network and

f. Surveillance video WAN

g. Communication Network outside Mumbai

h. 4G/3G/2G based mobile services for FRTU connectivity and Consumer substation

i. LORA based IoT connectivity for field signal For the purpose of the project requirement only details of Corporate WAN, Automation WAN and Surveillance video WAN are described below:

1.5 **Proposed SCADA Systems and Applications**

The proposed system is a replacement of the existing SCADA & DMS Systems at Mumbai. It should also have additional capacity to handle the expansions planned during next five to seven years. The system is proposed to be operated from the power system control center (PSCC) from where the Transmission and Distribution network will be operated.

The proposed system will have a Main Control Centre (MCC) and fully functional Backup Control Centre (BCC). The MCC is established at Power system control center (PSCC) Trombay and Backup control center (BCC) at Dharavi Receiving station.

The delivered system shall be a fully redundant multisite architecture operating from MCC and BCC Control Centre (BCC).The existing SCADA and DMS system which is presently installed at PSCC Trombay and Dharavi are proposed to be replaced by new hardware, software with the concept of MCC and BCC. The Backup Control Centre will be functionally identical to Main Control Centre. The MCC/BCC Client Operator Workstation will be commissioned at MCC and BCC location. The delivered system shall be a fully redundant multisite architecture operating from MCC and BCC.

Multisite System Synchronization shall allow both Purchaser's Control Centers to share operational responsibility in real-time but also have the capability to manage the power network autonomously.

The new system shall utilize modern facilities and techniques to provide the high-speed data collection, data analysis and decision-making processing. The system shall be designed to augment current operating procedures and interface with existing equipment. The new installation shall support a more extensive data acquisition and control network to communicate with RTUs/Gateways and the hardware and software interfaces to 3rd Party External Interface.

SCADA system would include MCC, BCC and Standalone Common System for effective management and control of the electrical network of the Purchaser's Mumbai operations. MCC & BCC consists of SCADA System, Cyber Security Management, Program Development and Quality, Dispatcher Training Simulator , Communication Network Management, Advanced Distribution Management System and its applications, Interface system for integration of external and other enterprise system. The Operator Workstations at each location can access the data by logging to respective SCADA/ADMS System with proper authorization and area of responsibility and with adequate access protection for local monitoring and control. The Operation and Maintenance engineer's user Log-in will be configured with appropriate Area of Responsibility for monitoring and control of their respective stations.

The proposed system shall be capable of communicating to Purchaser's primary sub-stations (RTUs, IEDs etc.) and field equipment (FRTUs/DCUs/FPI/Autorecloser and Sectionaliser) using MPLS/VPN, GPRS/2G/4G/RF communication network, Fibre Optic LAN connectivity and LORA based Communication.

The proposed system shall take the power system network data from the existing GIS System of the Purchaser. The current version of GIS is GE Smallworld 4.1.2 and same will be upgrade to CIM compliant version of GE Smallworld 5. The proposed system network model shall be built on configured GIS network. The data, which are not available on GIS, will be arranged by the Purchaser for network modelling.

For detailed scope of work, please refer Item3.0 of Section-A of the RFP. For technical details and requirement of each system hardware and software please refer Section-B of the RFP.

The offered system shall be mature, field-proven applications and functionality based on an open, distributed architecture that provides superior performance, enhanced integrated graphics, and high availability. The offered system shall provide a tightly integrated suite of applications that cover all aspects of Power system network management, allowing Purchaser to expand system capabilities as the electrical network grows.

1.5.1 System Sizing

The table below indicates the present and the expected growth in 5-7 years. The offered system shall have the required licenses and hardware sizing to cater to the growth plan.

Sr.No.	Asset/Item	Existing Qty	Expected growth in 5-7 years - To be considered for System Sizing
1	No of Distribution S/S (33KV,22KV/11KV)	38	70
2	No of Consumer S/S (11KV/415V)	1115	2000
3	No of feeders at Primary side (Incomer)	151	250
4	No of 11 KV feeders	440	1000
5	No of 22 KV feeders	151	250
6	No of RMUs	1480	2500
7	No of FPIs	1302	2200
8	No of Breakers	3527	5000
9	No of Isolators	10223	18000
10	No of Power Transformers at DSS	70	140
11	No of transformers at CSS	1072	2000
12	No of Consumers	767686	1500000
13	SCADA Points (inclusive of Analog, Digital, Accumulator(10000),setpoint (1000) and unlimited pseudo points)	300000	500000
14	ICCP Points	10000	13000
15	No of existing RTU	38	100
16	No of existing FRTU	471	2000

1.6 **Operational Philosophy**

MCC and BCC systems shall be operational during normal operation as independent sites. Thus, the primary source of data for MCC and BCC shall be local endpoint source (i.e. RTUs, FRTUs, FPIs etc. or ICCP).

Monitoring and Control of Stations/Gateways/RTUs/ FRTUs or ICCP shall be based on AORs and shall transferred to either control center (MCC & BCC) as per operational needs or communication link failure to either site.

However, proposed system shall support the scenario of operation i.e. operators logged into MCC can control one part of Purchaser's Power network independently , whereas operators logged into BCC can operate another part of the network. Controls for a particular AOR shall be active only at one site at any given time.

Any shift in operational control between sites shall be logged as an event and archived to historian. A tabular display shall be available to identify the following:

a. AORs active at any of the sites (A Historical report shall also be available)
b. Last Synchronisation timestamp
c. Sync status
d. Pause/Un-Pause option for synchronisation

User interface screen/application shall be available to monitor individual server resources and processes, server failovers, synchronizations and site failovers.

The historian data shall be synchronized between MCC and BCC in real-time provided the inter site link is available. Bidder shall submit the minimum bandwidth required for data synchronization between MCC and BCC.

1.6.1 **Operator Data Synchronization**

The following operator actions shall be synchronized between MCC and BCC sites at minimum.

a. Tag Add/Modify/Delete
b. Limit Mode Changes

c. Global Limit Mode Changes

d. Source Selection Override

e. Normal State Override

f. Rate of Change Override

1.6.2 **Multi Master Reporting Gateway / RTU**

Purchaser has mutli master reporting IEC60870-5-1-104 Gateway/RTU which can report to multiple masters (MCC, BCC, PDS & QAS) through redundant FEP systems.

a. **Normal Operation**

With multi master reporting, the communication to the MCC and BCC shall be operational and the FEP at MCC and BCC shall be polling the data from the Gateways/RTUs at a frequency as defined in the specification. The collection of historical data at MCC and BCC shall be collected by the online SCADA server.

b. **Redundant System in MCC/BCC**

In case of failure of one system, redundant system shall automatically take over, seamlessly with no data loss, and any interruption to the operator. Any Changes/modification rolled out from PDS & QAS to redundant system shall be automatically managed.

c. Link Failure to MCC

If a link has failed from the Gateway/RTU to MCC but the link is still healthy to BCC, the source for all these SCADA points (belonging to this failed Gateway/RTU) shall now be shifted to BCC automatically based on the globally defined user configurable period in seconds. This shift shall be denoted by a user configurable Tag/Quality so as to let the operator know that the source is now shifted to the other site.

d. Return to Normal Operation

Once MCC has established the link to the Gateway/RTU, the primary source shall automatically now detect that its initial primary source is now available and remote the Tag/Quality to allow FEP to be the primary source.

1.6.3 **Single Reporting DCU/RTU**

a. **Normal Operation**

Bi-directional data flow shall be available with Gateway/RTU's which are having single reporting master shall communicate to MCC, the data from the SCADA shall be synced from MCC to BCC.

b. **Link failure to MCC**

If a link has failed from the Gateway/RTU to MCC, Changeover to BCC shall be based on IP transfer of the respective Gateway/RTU (e.g. Gateway/RTU shall be IP based and communicate based on Hot IP irrespective of MCC/BCC. This shift shall be denoted by a user configurable Tag/Quality so as to let the operator know that the source is now shifted to the other site.

2.0 Project Information

1.0	Owner	The Tata Power Company Limited, Distribution Division, Senapati Bapat Marg, Lower Parel, Mumbai 400 013, Maharashtra, India
2.0	Consultant	Not Applicable
3.0	Location of the plant	Within the proposed premises of Trombay Thermal Generating Station Mumbai
4.0	Nearest Rail head	Site is connected by rail to the Chembur/Kurla
5.0	Transport	Access roads are available for movement of materials to site. Trombay is accessible by road/rail. Movement of heavy materials would be through existing roads/rail up to service bays of units no. 5 & 6.
6.0	Plant Elevation	About 6 m above mean sea level
7.0	Climatic conditions	
7.1	Temperatures:	
	(a) Maximum dry bulb temperature	45 Degree C
	(b) Minimum dry bulb temperature	18.3 Degree C
	(c) Design temperature for electrical equipment / devices	60 Degree C
	(d) Design humidity	95%
7.2	Relative humidity	
	(a) Maximum during monsoon	100%

	(b)Minimum during December to January	22%
8.0	Rainfall	Annual average rainfall is about 2099 mm (most of which occurs during the monsoon season from June to September)
9.0	Wind data	

Calculations for wind effect shall be in accordance with IS: 875-1987(Part-3) taking into account the following:

(i) Basic wind speed = 44 m/sec

(ii) Factor K1, K2, K3 = as per IS 875 Part-3

(iii) Category of terrain = as per IS 875

10.0	Seismic conditions	The proposed site is located in seismic zone III as per the Indian Standard IS 1893 and importance factor of 1.75
11.0	Air Quality	Atmosphere polluted with industrial gases and wastes because of proximity to petroleum refineries and fertilizer complex.
12.0	Sea water temperature	
	(a) Maximum	40 Degree C
	(b) Minimum	22.8 Degree C
	(c) Average	29.8 Degree C

14.0 Auxiliary Power Supply:

Auxiliary electrical equipment to be supplied against this specification shall be suitable for operation on the following system:

(a)	AC control & protective devices	230V, 1 phase, 2 wire, 50 Hz AC supply with one lead earthed.
(b)	Uninterrupted power supply	230 V, 1-phase, 50 Hz, 2-wire, AC supply from UPS System for Automation

(c)	Lighting fixtures and space Heaters	240V, 1 phase, 2 wire, 50Hz AC supply with neutral lead earthed.
(d)	Construction supply	415V, 3 phase, 3 wire, 50Hz AC supply with resistance earthed.
(i)	FRTU, RTU, DCU and RMU Motorization	24 V / 48 V DC

(j) The above voltages may vary as follows:

All devices shall be suitable for continuous operation over the entire range of voltage and frequency indicated below without any change in their performance.

AC supply	Voltage variation ± 10% Frequency variation ± 5% Combined voltage & frequency variation 10%
(K) DC System	24V / 48V /110V / 220V ± 10%, DC from the Station DC System

3.0 Scope of Work

The specification provides for Design, Engineering, Supply, Insurance, Transportation, Delivery at site, Installation, Testing and Commissioning of SCADA & DMS, and other systems for the Main and Backup Control Centers, Warranty and Post Warranty support as per the detailed specifications. Any item though not specifically mentioned but is required to complete the project shall be considered and the same shall be supplied and installed by the bidder.

The indicative Bill of Material is as per the attached document ***(Refer Annexure-4 of Section-E, Indicative Bill of Material for Proposed SCADA and ADMS System).*** Attached BOM is indicative, Bidder shall submit the detailed BOM along with the offer, as per the System/Architecture offered to meet the specified requirements.

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

a. Reliability

b. High Availability

c. Cyber Security Resilience

d. Seamless Integration with Enterprise and Third Party Systems, and the systems installed in phases.

Purchaser intent to commission the proposed system in 2 Phases i.e. Phase - A & Phase - B as described below:

Phase-A: Installation and commissioning of SCADA , DMS and other Systems at MCC and BCC

Installation & commissioning of SCADA system, DMS system & Other Applications, other systems at MCC, BCC; data migration from existing system and integration with Purchaser's and other systems procured under this RFP. Installation and commissioning of MCC/BCC Client Operator Workstations

Phase-B: Installation, commissioning, and integration of OMS System at MCC and BCC.

a. Installation & commissioning of OMS System at MCC and NCC and integration with respective SCADA and other systems installed under this RFP and other Purchaser's Applications/Systems.

Bidder shall design the system as per the phases for seamless integration of equipment of each phase to meet Purchaser's functional requirement stated in the RFP. Bidder to ensure that the configuration of SCADA system shall take care the requirement of ADMS and OMS applications. No major changes are envisaged in the installed SCADA system for integration of ADMS and OMS applications.

Purchaser is intending to commission the ADMS & OMS System after the Go-live of SCADA System at MCC and BCC , accordingly the Purchaser will inform the bidder for implementation of AMDS and OMS system.

However, Bidder shall ensure the followings for implementation of SCADA, ADMS & OMS System

a. SCADA, ADMS & OMS System Software and Hardware version should be same and tightly integrate with each other and Purchaser's all functional requirement stated in the RFP.

b. If the ADMS, OMS versions are different, then it is bidder's responsibility to match the installed SCADA system with the latest.

c. All network modelling shall be modelled as per the available Purchaser's GIS platform.

The procurement of all the equipment will be carried out together and should be available as one lot for FAT and material delivery will be decided during detailed engineering.

Major components to be included in the proposed solution of SCADA, ADMS, Communication and other systems are given as under, however the final scope would be decided only after the bid opening.

a. Study of existing deployed SCADA and Distribution Management System Applications along with interfaces

b. Demonstration of the system at Purchaser's works before finalizing the order. For the demonstration all the expenses incurred shall be borne by the bidder.

c. Purchaser's personnel (4-5) site visits at Technically Shortlisted Bidder's customer sites, commissioned by the bidder with all applications mentioned in the specification. For the site visits (inclusive of travel, boarding, lodging and conveyance), cost incurred shall be borne by the bidder.

d. Program Development and Quality Assurance System

e. SCADA & ADMS System for MCC and BCC

f. Time Series Information Storage & Retrieval System

g. Automatic On-line Backup System

h. Free Format Reports, Dashboards and Analytics

i. Web Applications, Web Services, Clients (Corporate)

j. Dispatcher Training Simulator (Standalone) – Study Mode Simulator with SCADA & ADMS Application, capable of replicating all the functions of Real-time System (MCC)

k. Real-time Data Acquisition from RTU/Gateway over IEC60870-5-104 to MCC & BCC. Integration with other real-time system on protocol mentioned in the Interface section.

l. The proposed system shall use the existing IP scheme of the sub-stations to follow its connection profile, specifically the inclusion of a custom Originator Address (OA) in the ASDU header. Basically, each domain (PDS & QAS, MCC and BCC) shall use its own Originator address for the RTU/Gateway to identify who is connecting. This parameter shall be configurable via a user interface within the system.

m. Bidder to note that, the communication backbone for the entire system is on MPLS/Fiber/4G/3G/2G. the proposed system shall be capable of redundant communication architecture. Bidder to specify the bandwidth requirement to meet the required functionality and submit the detail application landscape to optimize/enhance the available bandwidth requirement.

n. Communication components and accessories such as Converters, switches, routers, firewall and other accessories such as cables, connectors etc. required to connect the SCADA systems with Purchaser's Sub-Station Automation and other enterprise systems.

o. Other components, Accessories, Hardware, Software and Firmware, to interconnect and integrate the proposed system into a fully functional system as per required functionality stated in this document.

p. Centralized Time Synchronization System with GPS at MCC and BCC. Centralized System at MCC and at each BCC shall ensure the time synchronization of all OT components of the proposed solution including Sub-Station Automation System of all primary sub- stations and field automation equipment of the Purchaser's.

q. Integration with various OT/IT systems mentioned below on existing interfaces and provisioning of ESB interface over SOA

i. Interface to Enterprise Historian System

ii. Interface with Geographical Information System GE Small world 5, Seamless integration with GIS

iii. Secured ICCP interface with SLDC, other utilities and third-party systems (Main & Backup)

iv. Video Streaming Interface for real-time monitoring of the electrical equipment through SCADA GUI during selection / operation

v. SMS Gateway and Email Server

vi. AMR/AMI, IVR, WFM, FFM

vii. Other OPC, ODBC, SFTP, SAP interface, BI Interface, REST JSON API

viii. Interface with Network Planning System (e.g. CYMEDIST)

ix. Antivirus System (Enterprise Antivirus Software)

x. Cyber Security Management System with Purchaser's Enterprise SOC/SIEM System

xi. Integration of IoT devices on protocol such as LORA, NB-IoT etc.xii. Interface of OMS with proposed applications Weather Monitoring through Web sites.

r. **Advance Distribution Management and Other Applications**

i. Network Model

ii. Network Connectivity Analysis

iii. Dynamic Network Coloring

iv. Real-Time Network Analysis

- Real-Time Network Analysis Function Execution
- Real-Time Network Model Builder
- Parameter Adaptation
- State Estimator
- Power Flow Studies
- Contingency Analysis
- Security constrained Dispatch
- Voltage Var Control

v. Load Shedding Application

vi. Switch Order Management

vii. Fault Location, Isolation & Restoration

viii. Load Forecasting

ix. Optimal Feeder Reconfiguration

x. Distribution Power Flow (DPF)

xi. Outage Management, Trouble Call Management

xii. Crew Management, Field Scheduling and Dispatch

xiii. Outage Analysis & Prediction

xiv. Web Portal for Outage Management

xv. Mobile crew management Client

xvi. Quality of Service Indices

xvii. Interactive Voice Response

s. **Other Applications**

i. Advance Analytics – Online / Offline

ii. Power System Analysis Tools

iii. Power Quality Index

iv. Limit Violation Monitoring

v. Integrate DG and DERs

vi. Load Forecasting, Schedule Management

vii. Provide resiliency to natural disasters and other threats

viii. Multi-site Network Management

ix. Online analytics/ intelligence to diagnose and predict incipient faults / developing faults within the equipment & SCADA

x. Capability of building artificial intelligence in the system so as to guide operation Engineers during emergencies interactively.

xi. Vendor shall give the details of applications available on Mobility platform

xii. The bidder shall provide solution for identifying non-reporting of analog/digital data of feeder/line/bus/station on SCADA system with an auto trigger to Maintenance team through SMS/Email notification/SAP-PM for resolution. Records of such failure instances to be displayed in separate tab/mimic. This input should be utilized by SAP for autogenerating defect notification.

t. Preparation of Real-time Reports, Dashboard etc. as per Purchaser's customization and capturing operational requirement of Control Room Engineer.

u. Vendor shall submit the details of all databases proposed and its relationship with application. Data flow diagram with entity relationship shall be submitted for key applications. Vendor shall clearly mention the list of application which are required to build data models manually.

v. Application development for Purchaser's Specific requirements at site

w. Demonstration / Testing of the fully configured system at Bidder's works before dispatch of the system at site (FAT). The factory inspection shall be integrated system at a common work place. FAT will be conducted as per the FAT procedure document to be submitted by the Bidder during detailed engineering and approved by Purchaser after review.

x. Installation, testing & commissioning of the above systems including integration with Purchaser's existing systems, sub-vendors' systems & systems of others and performance of Site Acceptance Test (SAT) in phased manner.

y. Site Acceptance Test (SAT) to the Purchaser's satisfaction as per the SAT document submitted by the Bidder during detailed engineering and approved by the Purchaser after review) with the completion of the following, in minimum:

i. Bidder to note that the SAT will be carried out as per the migration strategy and commissioning plan. Same will be mutually finalized during detailed engineering.

ii. Demonstration of Performance Measure as specified in the RFP

iii. Integration of all supplied equipment under the contract.

z. Providing necessary tools and software licenses for all the Software (OS, Application) and Hardware including of sub-vendor's offered solutions.

aa. Maintenance services for the supplied Hardware, Software package, Software up-gradation, Patch Management services including sub-vendor products and with Resident Engineer support during the warranty period from the date of system handover after SAT, resolution of all punch point of SAT and trouble-free operation of the entire system for a period of one month.

bb. Bidder shall provide maintenance services for the supplied Hardware, Software package, Software up-gradation, Patch Management services including sub-vendor products and with Resident Engineer at site.

cc. Bidder shall provide warranty support and above as mentioned in clause dd and ee for Software Upgrades, Patch Management and any software subscription of all software supplied under this project including sub-vendor products.

ii. All software supplied shall be licensed and shall be in the name of the Purchaser. Bidder should offer the latest software & Firmware of the proposed products which is tested and proven. Bidder shall provide all documentation in soft / hard form about licensing information for each software supplied (OS, application software, configuration, diagnostics, simulation & testing tools).

jj. The offered system shall store the copy of the system configuration, user configurable database, tools and relevant software as a backup at Purchaser's identified location for restoration under a disaster recovery plan.

kk. The Documents shall be submitted as proposed. Master Document List (MDL) shall be prepared by Bidder and submitted for Purchaser's approval.

ll. The bidder shall provide complete engineering data, drawings, reports, manuals and services offered etc. i.e. complete set of documentation / drawings / architectures/ Inter-Operability Tables (IOTs) submission of Test Reports, job progress reports etc.

mm. The drawings will be approved in four categories as follows:

i. Code I: Approved

ii. Code II: Approved subject to incorporation of comments as marked. Resubmit for formal approval

iii. Code III: Not Approved. Incorporate comments as marked. Resubmit for review / approval.

iv. Code IVa: Retain for Information.

v. Code IVb: Resubmit after incorporation of comments.

nn. It is the responsibility of the Bidder to handover all project related drawings in AutoCAD formats only. The pdf version of above drawings / documents shall also be submitted for formal approval process.

oo. Submission of technical documentation related to design, installation, testing, operation & maintenance of the equipment and submission of Test Reports, job progress reports etc. in hard copies (3 sets) and soft copies (3 sets, preferably in PDF).

pp. Training of Purchaser's Personnel at site and Bidder's works with all required training setup for each individual trainee.

qq. Supply of recommended and mandatory spares for all supplied items as mentioned in the separate section

rr. Providing complete source code, including customization

Bidder shall refer the entire project specifications of the RFP to understand the execution methodology, supply, services and interface requirement for complete Scope of work of this project.

It is not the intent of this specification to specify completely herein, all details of design & construction of SCADA System. However, the bidder is encouraged to provide latest hardware and software technology used worldwide to meet the specified requirement and at the same time system shall conform in all respects to high standards of engineering, design & workmanship.

4.0 Terminal Points

4.1 **Bidder**

4.1.1 Installation of SCADA, ADMS Applications and other offered systems.

4.1.2 Integration of the existing system field devices (RTU/FRTUs/IEDs/Gateways) to proposed SCADA system, Supply of the required material including cables, erection, installation, cable laying & termination, database and logic development, FAT, pre-SAT testing, SAT and demonstration of the required performance is the sole responsibility of the bidder.

4.1.3 Integration with other system as specified in this documents.

4.1.4 Suitable Earthing system for offered system

4.1.5 Integration with other systems as specified in this document

4.1.6 Bidder shall depute adequate manpower, resources and material to complete the project as per the schedule mentioned in the RFP. If Purchaser feels that the adequate resources and material are not provided, reserves the right to ask the bidder to supply the required material and depute additional resources to complete the project in time.

4.1.7 There shall be only one point of contact for Purchaser, i.e. the bidder who will be awarded the contract will be responsible for delivering the project solely. Any Sub-Contracting of any part of the work will be the responsibility of the Bidder as specified by Purchaser.

4.1.8 All application software, hardware, data, plans, drawings, specifications, designs, reports and other documents procured or developed by the selected Bidder in the execution of the contract shall remain the property of the Purchaser, right from the beginning of the contract, during the whole duration of the project and after the expiry or termination of the contract. Purchaser shall also remain the sole owner of the property (Hardware/software) in case the contract is terminated for any other reason. The source code/Application of the customized part of the application software will remain as exclusive property of Purchaser, even after the termination or expiry of the contract. The ownership shall also remain with Purchaser in case the selected Bidder fails to execute tasks to the satisfaction of the Purchaser.

4.1.9 Any deviation from this RFP / Technical Specification or as per the requirement of Purchaser, if noticed, may be brought forth in the Bid offer / pre-bid meeting / meeting before award of contract. Any such deviation, if informed thereafter bidder will supply Hardware and Software as per the site and functional requirement free of cost to the Purchaser. The decision of Purchaser will be final.

4.1.10 The selected bidder, after award of contract, will finalize the actual quantities to be deployed after approval from Purchaser, before initiating the purchase process of such items. All the hardware and software shall be procured and delivered after taking prior approval of Purchaser for each consignment.

4.1.11 Engineering and technical assistance during the contract and warranty and maintenance period.

4.1.12 Provide calculation for power requirement for each cabinet and equipment

4.1.13 Full system backup of all installed software for all machines.

4.1.14 Provide a Quality Assurance Plan and access to the manufacturing process.

4.1.15 The bidder shall provide all additional equipment and services required to ensure compatibility with Purchaser's systems.

4.1.16 The bidder shall demonstrate a specified level of performance of the offered system during FAT and SAT.

4.1.17 Bidder shall submit the project plan with major mile stone prior to the start of the execution of the project

4.2 **Purchaser**

4.2.1 Will assist the bidder to provide the necessary work permits for working in operational area

4.2.2 Participation of Purchaser's engineers during database development, however bidder shall be responsible for validation of this database.

4.2.3 Providing all the necessary data regarding the electrical network

4.2.4 Providing details of the existing systems for specified integration

4.2.5 Providing communication backbone for interconnection with existing systems

4.2.6 Review and approval of the Bidder's designs, drawings, and recommendations

4.2.7 Review and approval of test procedures

4.2.8 Participation in and approval of "Type", factory and site acceptance tests

4.2.9 Review and approval of training plans.

4.2.10 Coordination of the Bidder's activities with the Purchaser's concerned departments

5.0 Exclusions

The Bidder shall be responsible for providing all the hardware and software, development of database and services required for commissioning of project except mentioned below

5.1 Buildings

5.2 Air Conditioning

5.3 Fire Fighting system

5.4 Civil job of any type except for earthing system is not in the scope of the bidder

5.5 Special electronic earthing for server, communication and other systems

Bidder must indicate the space requirements, special earthing requirement (if any) etc. for systems/panels/equipment being supplied under this project, so that Tata Power can provide the same as per bidder's requirement.

6.0 Instruction to Bidders

6.1 **Bidder Confidentiality**

All information contained in this specification is confidential and shall not be disclosed, published or advertised in any manner without written authorization from Purchaser, includes all bidding information submitted. All specification, data and documents submitted by bidder remain the property of Purchaser and all bidders are required to return these documents to Purchaser upon request. Bidders who do not honor these confidentiality provisions will be excluded from participating in future bidding events.

6.1.1 Information relating to the examination, clarification, evaluation and comparison of Bids and recommendations for the award of a contract shall not be disclosed to Bidders or any other persons not officially concerned with such process. Any effort by a Bidder to influence the Purchaser's processing of Bids or award decisions may result in the rejection of the Bidder's Bid.

6.1.2 Prior to the detailed evaluation, Purchaser will determine the substantial responsiveness of each Bid to the Bidding Documents including production capability and acceptable quality of the Goods offered. A substantially responsive Bid is one, which conforms to all the terms and conditions of the Bidding Documents without material deviation.

6.1.3 Bid determined as not substantially responsive will be rejected by the Purchaser and/or the Purchaser and may not subsequently be made responsive by the Bidder by correction of the non-conformity.

6.1.4 The Bid prepared by the Bidder, and all correspondence and documents relating to the Bid exchanged by the Bidder and the Purchaser, shall be written in the English Language. Any printed literature furnished by the Bidder may be written in another Language, provided that this literature is accompanied by an English translation, in which case, for purposes of interpretation of the Bid, the English translation shall govern.

6.1.5 Bidders shall quote for the entire Scope of Supply / work with a break up of prices for individual items and Taxes & duties. The total bid price shall also cover all the Bidder's mentioned in or obligations mentioned in or reasonably to be inferred from the bidding documents in respect of Design, Supply, Transportation to site, all in accordance with the requirement of bidding documents. The bidder shall complete the appropriate Price Schedules included herein, stating the Unit Price for each item & total price with taxes, duties & freight up to destination at various sites of Purchaser. The prices offered shall be inclusive of all costs as well as Duties, Taxes and Levies paid or payable during the execution of the supply work, breakup of price constituents.

6.1.6 The quantity break up shown else-where in Price Schedule is tentative. The bidder shall ascertain himself regarding material required for completeness of the entire work. Any items not indicated but are required to complete the job, shall be deemed to be included in prices quoted.

6.1.7 The bidder is not allowed to modify or withdraw its bid after the Bid's submission.

6.1.8 The Principal & their Indian Representative shall be responsible jointly and severally for the design, supply, erection, commissioning & satisfactory performance of the supplied system and specified Post Warranty Maintenance and activities. The Principal shall also vet the design and participate in the engineering, commissioning at site, Acceptance Tests & Training. The Indian Representative shall have full facilities for design, Supply, erection, commissioning, system integration, factory and site acceptance test, satisfactory performance of supplied system and specified post warranty maintenance.

6.1.9 Bidder/Principal shall demonstrate required functionality and capability in Purchaser's office during technical evaluation before bid submission

6.1.10 In case of agreement dishonored by any party (Bidder/ Principal), during life of the delivered system, Principal shall be responsible for providing the services to the Purchaser. Bidder/ Principal shall submit the address and contact details of the Principal's Purchaser account holder.

6.1.11 The Bidder (including Principal) shall give an undertaking to provide full range of services (including hardware and software maintenance, modifications and upgrade support) for the life of the delivered SCADA & ADMS system including Communication interfaces.

6.2 **Type Tests Reports**

The type tests specified in Purchaser specifications should have been carried out within five years prior to the date of opening of technical bids and test reports are to be submitted along with the bids. If type tests carried out are not within the five years prior to the date of bidding, the bidder will arrange to carry out type tests specified, at his cost. The decision to accept/ reject such bids rests with Purchaser.

6.3 **Technical / Commercial Clarifications**

After scrutiny of qualifying criteria, techno commercial criteria offered by the bidder, clarifications will be sought from the bidders for any deviations with respect to the Purchaser specifications and attempt will be made to bring all bids on a common platform. After all techno commercial issues are clarified, bidder may be asked to re-submit the commercial proposal, which shall include all Hardware, Software and Service requirement as discussed during technical evaluation process, the same will be intimated to the technically accepted bidders by Purchaser's corporate contract team.

6.4 **Bid Evaluation Criteria / Bid Selection / Bid Award Decision**

6.4.1 The decision to place purchase order/LOI solely depends on Purchaser on the cost competitiveness across multiple lots, quality, delivery and bidder's capacity. In addition to other factors that Purchaser may deem relevant.

6.4.2 Purchaser reserves all the rights to award the contract to one or more bidders so as to meet the delivery requirement or nullify the award decision without any reason.

6.4.3 In case any Bidder is found unsatisfactory during the delivery process, the award will be cancelled, and Purchaser reserves the right to award other Bidders who are found fit.

6.5 **Climate Change and Waste Management**

Significant quantities of waste are generated during the execution of project and an integrated approach for effective handling, storage, transportation and disposal of the same shall be adopted. This would ensure the minimization of environmental and social impact in order to combat the climate change.

6.6 **Ethics Policies, Mandates and Considerations**

Purchaser is an ethical organization and as a policy Purchaser lays emphasis on ethical practices across its entire domain. Bidder should ensure that they should abide by all the ethical norms and in no form either directly or indirectly be involved in unethical practice. Bidder is advised to refer GCC attached for more information.

6.7 **Safety Considerations**

Safety related requirements as mentioned in our safety Manual. All Associates shall strictly abide by the guidelines provided in the safety manual at all relevant stages during the contract period. Bidder is advised to refer GCC attached for more information.

a. All the equipment shall be as per IEC / IS standards.

b. As the work has to be carried out in operational area, necessary work permit shall be prepared and approved from authorized persons.

c. While working on site, use of PPE (personal protective equipment) is mandatory.

d. Installation and commissioning of equipment, laying of cables activities shall be done by adequate trained persons with proper procedure including required outages of equipment/system.

e. Bidder shall furnish operating and maintenance manuals clearly bringing out safety aspects of equipment.

f. Bidder’s all site persons have to go through Training at Purchaser’s site

g. Bidder to depute Safety officer, to ensure the activities at site during installation and commissioning of the system as per Purchaser’s safety policy and procedures.

h. The Bidder’s safety officer shall work along with Purchaser’s Safety officer as per the policies and requirement stated in the Safety document.

6.8 **Bidder's Technical and Commercial Proposal**

6.8.1 **General Guideline**

a. Purchaser will select the 'bidder' in accordance with the eligibility criteria indicated in **Item 8.0** of this document.

b. The bidders are invited to submit a Technical Proposal and a Commercial Proposal for goods and related services required for the project as defined in RFP. This proposal will be the basis for finalization of the contract with the successful bidder.

c. The bidders must familiarize themselves with local conditions and take these into account while preparing their proposals. To facilitate the bidders in making the Proposal, the Purchaser shall have a 'Pre-Bid Discussion/meeting as per the schedule mentioned in RFP.

d. Please note that costs involved in preparation of the proposal and of negotiating the contract, including a visit to the Purchaser, are not reimbursable.

e. Bid prices shall be quoted in Indian Rupees only.

6.9 **Risk & Mitigation Planning**

Bidder shall assess underlying risks in implementation of the Project and detail out the methodology to mitigate them. It may include development of a risk assessment matrix indicating severity of the risk, chance of its occurrence and its mitigation approach.

7.0 Codes and Standards Applicable

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

Emissions Standards		
1	EN55011 (CISPR 11)	ISM RF Equipment – Electromagnetic Disturbance Characteristics
2	60255-25	Electromagnetic emission tests for measuring relays and protection equipment

3	61000-3-2:2000	EMC-Limits for harmonic current Emissions.
4	61000-3-3:1994+2001	EMC Limits-Limitations in voltage changes, voltage fluctuations and flicker in public low-voltage supply systems.
Immunity Standards		
1	61000-4-2 1995-01 60255-22-2 IEEE C37.90.3	Electrostatic discharge (ESD) immunity test
2	61000-4-3 1998-11 60255-22-3 IEEE C37.90.2 (10V/m)	Radiated, radio-frequency electromagnetic field immunity test
3	61000-4-4 1995-01 60255-22-4 IEEE C37.90.1	Electrical fast transient/burst immunity test
4	61000-4-5 1995-02	Surge immunity test
5	61000-4-6 1996-03	Immunity to conducted disturbances, induced by radio-frequency fields
6	60255-22-6	Electrical fast transient/burst immunity test
7	61000-4-81993-06	Immunity to power frequency magnetic fields
8	61000-4-12	Oscillatory waves immunity test
9	1995-05 60255-22-1 IEEE C37.90.1	(Damped Oscillatory and Ring wave)
Safety		
1	61010-1	Harmonized Safety Standard

2	60255-5 2000-12	Insulation coordination for measuring relays and protection equipment- Requirements and tests
Power Supply Standards		
1	61000-4-11 1994-06	AC Power supply interruptions
2	61000-4-16 1998-01	Immunity to conducted, common mode disturbances.
3	61000-4-17	Ripple on D.C. power supply
4	61000-4-29+ 2000-08 60255-11	Voltage dips, short interruptions & voltage variations on D.C. input power port immunity test
Environmental Standards		
1	60068-2-1 1994-05	Environmental Testing Cold
2	600068-2-2 1974	Environmental Testing Dry Heat
3	60068-2-6 1995-03 60255-21-1	Environmental Testing Vibration tests (sinusoidal)
4	60068-2-27 1987	Environmental Testing Shock
5	60068-2-29 1987	Environmental Testing Bump
6	60068-2-30 1980	Environmental Damp Heat cyclic (12+12 hour cycle)
7	60068-2-31 1969	Environmental Testing Drop and Topple
8	60255-21-2	Shock and bump tests
Communication Standards		
1	61850-3 IEEE 802.3 CSMA/CD	Substation Comm. Standard access method and physical layer specifications

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

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

8.0 Bidder's Qualification Requirement, Experience, Evaluation Criteria

8.1 Bidder's Qualification Requirement

8.1.1 The Bidder/Principal must have a presence in India for last 5 years, meeting requirement as specified below:

a) Registered in India under the Companies Act of India, as on Techno-Commercial Bid submission date for supply of the SCADA/ ADMS System.

8.1.2 Bidder should have experience of

a) At Least Two (2) Integrated SCADA & ADMS/DMS & OMS system for Power Utility Control Centre at Metro / District / Regional level during the last ten (10) years. Above project(s) should have interface of at least 50 Primary Substations (33KV/22KV to 11KV) RTU/500000 SCADA IO point. Out of the two (2) systems, at-least one (1) system should be in satisfactory service condition for last one year.

b) Having experience and infrastructure to carry-out in-house design, engineering, supply, erection, commissioning, Routine and Acceptance tests, service support during warranty and post warranty duration, training facility of SCADA/ADMS in India as Bidder/Principle.

c) (Self-undertaking to be submitted in this regard. Tata Power reserves the right to inspect the said manufacturing facility as a proof of compliance to this parameter. Technical support facilities including qualified man-power, testing tools and instruments and integration facilities available within India).

(Supply List & Performance Certificates from the Utilities / Clients to be submitted in this regard).

In case, bidder uses experience of parent organization based out-side India to meet the QR, then bidder shall submit concurrence from the parent organization to support the supply and experience criteria.

(Both Parent Company and Subsidiary Company shall provide a Deed of Joint Undertaking (DJU) and will be jointly and severally responsible for the execution of contract (If applicable). The Bidder shall share responsibility matrix, division of works etc. between Parent Company and Bidder.)

In case Bidder is not manufacturer of offered SCADA/ADMS/OMS system then bidder shall comply to following requirement

i) The Bidder shall have been duly authorized by the manufacturer or producer of the SCADA/ADMS/OMS system to supply and/or install that item in the Utility. Bidder shall submit letter of Authorization of SCADA/ADMS/OMS system manufacturer. Bidder shall also submit letter from OEM agreeing to take responsibility of the supplied and deployed hardware and software system for the entire life of the system as per contract, in case bidder is unable to deliver the services.

ii) The bidder shall submit Letter of Undertaking from SCADA/ADMS/OMS system manufacturer to take responsibility to provide full range of support services (including hardware and software system design, installation, maintenance, modifications and upgradation support) for the entire life as per contract, of the delivered SCADA/ADMS/OMS system including Communication interfaces.

8.1.3 Average Annual turnover of the bidder for last three years shall not be less than INR 150 Crores.

(Copy of Audited balance sheet and Profit and Loss Statement to be submitted).

8.2 **Project Experience**

8.2.1 Bidder shall provide details of projects with application modules and other requirements Eligibility Criteria which have been successfully completed during the last 10 financial years. Please do not supply the names of clients who are no longer using your product/system. Bidders need to submit the details as per the format in the table provided and necessary supporting documents should be attached with RFP:

S. No.	Name of the Project	Client Name	Whether the Project was successfully commissioned	Date and Year of Commissioning	Value of the Project	Indicate the SCADA/ADMS modules implemented in the project	Indicate the integration with IT system, if any viz GIS, Billing, Customer Care etc.	Indicate whether interface was included in the project? If Yes, please provide the detail	Indicate the protocol implemented viz IEC60870-5-101/104, IEC61850, Modbus, Secured ICCP

Table: Details of Project Experience

Note: Kindly provide Client Performance Certificates for the completed projects provided for establishing/confirming the requisite details for project experience as mentioned above Or Copy of LoA/ Work Order along with proof of release of final payment.

8.2.2 The Bidder should have atleast 20 personnel on its rolls with a minimum experience of 5 years on offered SCADA/ADMS/Communication System/Cyber Security and Communication Network Management system. Signed resume of employees trained and experienced on offered product to be authenticated & signed by the bidder needs to be submitted.

8.2.3 The offered product shall comply to all open protocols such as CIM, IEC60870-5-xxx, IEC61850, C37.118, Secured ICCP etc. and compatible with all other OEMs product. Any interoperability issues arising during commissioning and during guarantee period, bidder shall undertake to resolve them within maximum 2 months period.

8.2.4 Product shall confirm to Cyber Security norms from product development, design and engineering for Power Utility, compliance to industry standard NERC-CIP, IEC62443, NIST and IEC62351.

8.2.5 Bidder shall agree to comply with minimum quality requirements and Contractor Safety Code of Conduct, defined in bid documents.

8.2.6 Bidder must agree for handing over, to Purchaser, all project related drawings in AutoCAD format only. The pdf versions of above drawings shall be submitted for formal approval process.

8.2.7 Bidder shall have database (Real-time and Historical) migration experience of different vendors SCADA and ADMS Applications (Currently Purchaser hasGE Eterra ADMS system)

8.2.8 Bidder shall have experience of integrating Enterprise Systems such as SAP, MDM, Big Data, Enterprise Historian, LORA IoT system etc.

8.2.9 Bidder shall submit the acceptance of Tata Power preferred list of vendor / sub vendor / OEM, which is shared as part of Technical Specifications and the same shall be acceptable to the bidder. ***(Refer Annexure-3 of Section-E, Preferred/Approved make of Equipment/System).***

8.2.10 Bidder shall confirm the equipment and Spare Support and Availability for the period of 10 years. Bidder shall submit each equipment product life cycle details.

The bidder *may avail credentials of its parent company for fulfillment of eligibility criteria as mentioned above.*

8.3 **Bid Evaluation Criteria**

8.3.1 The Bids will be evaluated technically (in terms of quality, technical merit, functional characteristics, schedule, after-sales service, local support in India and technical back-up). The technical merits and quality and functional characteristics of the offered equipment and work will be evaluated in terms of its ability to meet specific technical requirements included in the Contract Documents. The Bidder shall therefore be prepared to submit at the request of Purchaser adequate information or conduct system demonstration to substantiate that the offered equipment or Work meets the intent of the technical requirements.

8.3.2 Purchaser shall be fully entitled to adopt whatever means it deem fit to evaluate the bids at its sole discretion, which shall not be questioned by the bidder under any circumstances whatsoever.

8.3.3 The evaluation team will thoroughly review the proposals submitted by various bidders. The broad technical evaluation will be based as below

a. Technical Proposal: 60% Weight

b. Price Proposal: 40% Weight

c. Pre-demo meetings will be conducted with all the bidders.

d. Each of the bidder will be requested to demonstrate the product and services

Minimum qualification mark for technical score as mentioned in the RFP shall be 85 out of 100. In case bidder fails to secure minimum marks. The bid shall not be further evaluated.

Strictly apply only and all of the evaluation and qualification criteria specified in the Bid document.

Evaluation and Comparison of bids for awarding :

The bids shall be evaluated by combining technical and commercial scores and will be awarded to the Bidder whose Bid has been determined to be have scored maximum in the composite formula as defined below:

Total Score = Technical Proposal Score + Price Proposal Score

Initially the Supplier's responses are reviewed for compliance with the Commercial terms and conditions. The Suppliers who fail to comply with any of the commercial terms and conditions mentioned may be termed as non-responsive and will not be evaluated further. For those Suppliers who have qualified the commercial terms and conditions Technical evaluation will be conducted followed by the Price-Bid evaluation. The price bids will remain sealed until the technical evaluation is complete.

8.3.4 **Price Evaluation:**

Price Proposal Score: (Price Quoted by the Lowest Bidder / Price Quoted by the Bidder) *40

8.3.5 **Technical Evaluation**

The technical bid has a weightage of 60%. Technical evaluation will happen in two stages.

a. Stage-1: Preliminary Evaluation

In stage-1, the following shall be confirmed: Deviations, Acceptance of terms and conditions, Acceptance to scope of work and compliance to technical specification ***(Scope of work as mentioned in Section A and technical details in section B)***. In case the bid doesn't meet all the mandatory requirements, the bid shall be termed as non-responsive and will not be evaluated further

b. Stage-2: The distribution of weights for bid-evaluation are as follows

Sl. No.	Description	Marks	
A	Technical Proposal		100
1	Project Experience	40	
2	Presence in India	8	
3	Team Details (CV)	7	
4	Pre-Demo	45	
	Total Marks		**100**

Sl. No.	Description	Max Score
Technical Solution Score		100
1	**Project Experience**	**40**
a)	Number of SCADA and ADMS Application projects successfully completed in last 10 years. Similar Technical Requirements as per the Specification 7 marks shall be awarded for a single project meeting the functionality of SCADA and ADMS as mentioned in the QR. In case multiple projects are submitted as a support for meeting the QR, 2 marks shall be awarded for each project subject to a ceiling of 8 marks. The project should have similar or up-graded software product versions offered to Purchaser.	15
b)	Project experience in implementation of modules/applications of SCADA and ADMS Application 1 mark shall be awarded for experience in implementation of modules / applications as mentioned below: • Voltage VAR Control • Load Shedding Application • State Estimator • Fault Isolation & Service Restoration • Outage Management System • Network Connectivity Analysis • Switch Order Management The bidder shall be awarded 1 mark for implementation of above modules in one project or multiple projects put together. For implementation of single module, only 1 mark shall be awarded, irrespective of its implementation in number of projects.	7
c)	Project Experience in integration of IT applications. The distribution of marks for experience integration of IT applications is provided as follows • GIS – 2 marks • AMR/AMI – 2 marks • CIS - 2 marks • Enterprise Historian – 1 marks	7
d)	Project Experience in RTU / Gateway / DC Integration • IEC60870-5-104 – 1 mark • IEC 61850 (ED1 & ED2) – 1 mark • OPC (UA/DA) - 1 mark • MODBUS (RTU, TCP/IP) – 1 mark	4
e)	Experience in implementation of interface used in SCADA and ADMS	7

	Application Systems	
	The distribution of marks for experience in implementation of interface is as follows: • ESB over SOA – 2 marks • Secured ICCP – 2 marks • CIM (IEC-61968) - 3 marks	
2	**Presence in India**	8
	The bidder with existing software design / Engineering / Testing / Maintenance / Patch Management / Timely Upgradation facility as on date of release of RFP	
3	**Team Details (CVs)**	7
	Experience minimum 5 years in area of SCADA/DMS/OMS and other Systems Hardware For submission of CV, 0.5 mark shall be awarded per CV subject to ceiling of 3 marks that can be obtained in this category.	3
	Experience minimum 10 years in area of SCADA/DMS/OMS and other Systems Software For submission of CV, 0.5 mark shall be awarded per CV subject to ceiling of 2 marks that can be obtained in this category.	2
	Experience minimum 5 years in area of Cyber Security and Communication Network Management for OT System For submission of CV, 0.5 mark shall be awarded per CV subject to ceiling of 2 marks that can be obtained in this category.	2

Sl. No.	Description of Demonstration	Max Score
Pre-Demo: The Bidder will set up all required equipment at Purchaser site. The Bidder is expected to demonstrate all standard software and hardware necessary for implementation of SCADA and ADMS Application by simulation under various scenarios. The Bidder is required to set-up their own system/server for demonstration purpose. The application functionalities demonstrated are to be with data relevant to the business of Purchaser. All queries are to be addressed during the demonstration only, and no further opportunities would be presented for subsequent clarifications, if any. Kindly note that the bidders are expected to bring necessary software / hardware required to support such demonstrations. Adherence to the timings is critical and the overall demonstration should not exceed specified hours. Purchaser shall provide GIS/Manual data for Power System network modelling to bidders one month prior to pre-demo		45
a)	GIS data import & interface • Demonstrate CIM compliant GIS interface by importing of Sample Data of GIS into SCADA/ADMS system and navigation between one-line and GIS displays for multiple methods of network updation – 3 marks	9

Sl. No.	Description of Demonstration	Max Score
	• Demonstrate incremental import data validation tools and rule – 3 marks • SCADA System interfaces with other systems like SAP, Enterprise Historian, MDM – 3 marks	
b)	Interactive Navigation techniques Demonstrate the following: • Intelligent Alarm Search like search engine with option of configuring critical alarm window output in desired sequence – 2 marks • Supervisory control techniques from one-line displays, Panning and zooming – 0.5 marks • Differentiation between real time, state estimator, training and study mode data. Display of Dynamic Network Coloring For: Dead Bus, Line one end open and Line both ends open, HT Open, LT Open, Both Open, Grounded – 2 marks • Quick Search mechanism for finding elements, TA, alarms tags and Online History Retrieval for All Analog Parameters from Respective SCADA Mimics – 2.5 marks • User configurable auto popup messages before executing operations on critical equipment – 1 mark • Safety Tag Implementation – Symbol of tag should be clearly visible. If three tags are placed, all should be visible and there should be provision for entering related description which should be displayed after double clicking on respective tags. – 2.5 marks • Navigation using an overview window-0.5 marks	11
C)	Historical Information Subsystem & real time report generation • ISR database queries and reports based on UI menu and ISR data to Excel spreadsheet & trend, Online History Retrieval for All Analog Parameters from Respective SCADA Mimics – 3 marks • Message log storage and retrieval- 0.5 marks • Disturbance data collection and replay – 0.5 marks • Quality indices, Handing Over: Shiftwise/Adhoc report for all operations carried out along with Provision of Manual Entering Special Conditions -2 marks • Customization flexibility through drag & drop reporting by user/reporting engine with provision to retrieve historical data for user defined criteria of station/elements/period/category/other filters – 4 marks	10
d)	ADMS Applications • State Estimator- 1 mark • DPF/OPF – 1 mark • Volt Var Dispatch – 1 mark • Load Shedding & Load Forecasting – 1 mark • Prediction Analysis – 1 mark • Outage, Trouble Call and Work Force Management - 2 marks • Switch Order Management- 1 mark	10

Sl. No.	Description of Demonstration	Max Score
	• Fault Management – 1 mark • Reliability Indices – 1 mark	
e)	• VMS Interface – 1 mark • Mobility Platform – 1 mark • Interface with PowerBI – 1 mark • DTS, PDS & QAS – 2 marks	5
Note: The Purchaser may ask to demonstrate any other functionality also during demonstration		

8.3.6 The bids will be evaluated technically on the compliance to specification terms and conditions as detailed in the various sections of the document.

8.3.7 Bidder must mandatorily quote against each item as per the functional requirement and of indicative bill of material.

8.3.8 Bidder must comply with Qualification requirement and compliance sheet.

8.3.9 Bidder must submit the list of sites and contact details in which similar solution have been developed and successfully running its operation. Purchaser team reserves the right to visit those sites and bidder shall facilitate such visit.

NOTE: In case of a new bidder not registered with Purchaser, facility inspection and evaluation shall be carried out to ascertain bidder's manufacturing capability and quality procedures. However, Purchaser reserves the right to carry out facility inspection and evaluation for any bidder prior to technical qualification.

8.3.10 Bidders shall quote for all items specified including options and all the sub items in the specified format. Bids not complying with this requirement shall be liable for rejection. All bids and combination of bids shall be opened and evaluated simultaneously so as to determine the bid combination offering the most advantageous solution for the Purchaser.

8.3.11 The evaluation shall be made primarily on technical parameters and also the overall cost of the items and quantities mentioned in the schedule of quantities. However, while placing the order, or during the execution, the Purchaser reserves the right to modify the quantities of individual items.

9.0 Project Schedule / Calendar of Events / Milestones

a. The Bidder shall provide a detailed Implementation Schedule indicating major Bidder and Purchaser activities, major completion milestone events, and interdependencies between events. Required Purchaser activities and associated dates must be clearly shown and

include interdependencies to the Bidder's scheduled activities. The schedule shall be in terms of months after Receipt of Order (ARO), not absolute dates.

b. The Bidder shall perform all scheduling activities with Microsoft Project, such that all schedules as periodically transmitted to Purchaser include both hard copy and electronic versions.

c. Following is the expected delivery schedule. Bidders may propose separate delivery schedule; however, the total time for project completion shall not exceed 580 days from the date of placement of firm purchase order by Purchaser.

9.1 **Delivery Schedule**

Milestone	Days following PO Placement
PO placement	0
As is & submission of project execution plan	30
Submittal of Functional Specifications and Design Specifications	60
Submittal of Acceptance Test Plans and Test Procedures	90
Start of Factory Acceptance Tests	120
System shipped from Factory	150
Start of Site Acceptance Tests	180
Start of Availability Tests	210
Project Completion Basic SCADA & DMS	270
Project Start Advanced DMS application	270
Submittal of Functional Specifications and Design Specifications for Advanced DMS and integration with existing systems (CRM,ERP,AMI , Mobile app and SAP-BI/BO) along with test plan	300
Roll out of DMS	330
Complete of site Acceptance Tests of integrated SCADA & DMS	350
Submittal of Functional Specifications and Design Specifications for OMS along with SAT plan	370
Roll out of OMS	400
Complete of site Acceptance Tests of integrated SCADA DMS & OMS	420
Project completion as per RFP	450

9.2 **Calendar of Events**

Sr. No.	Events	Target
1	Detailed bid documents / hosting of detailed bid documents in Purchaser's ARIBA website	Zero Date
2	Pre-Bid Meeting with Bidders	Within 15 days from Sr. No. 1
3	Receipt of pre-bid queries, if any	Within 30 days from Sr. No. 1
4	Posting of Consolidated replies for the pre-bid queries to all bidders	Within 15 days from Sr. No. 3
5	System Demonstration by Bidders at Purchaser's works	Within 30 days from Sr. No. 4
6	Receipt of Bids	Within 15 days from Sr. No. 5
7	Opening of technical bids	Next working day from Sr. No. 6
8	Date & Time of opening of Price of qualified bids	Will be notified to the successful bidders through our website / mail.

9.3 **Mile Stones**

After placement of Purchase order , Payment shall be made as per the milestones mentioned below:

Sl. No.	Milestone Number	Milestone Description	Special Comments / Remarks
1	MS-01	Submission and Approval of: • List of Deliverables • Configuration drawings • Detailed Project Schedule • Database Design Documentation • Design Documentation for Hardware & Software System • Application Overview Document • Software requirements specifications for Custom Designs	5% of Total Contract Price

Sl. No.	Milestone Number	Milestone Description	Special Comments / Remarks
		• Any Other Documentation related to Design Engineering	
2	MS-02	System hardware staging completed in the Factory, Complete installation of all the Bidder standard baseline system and application software • Software Test Review & Signoff • Software Test Execution • Software Test Planning to test SCADA, ADMS and other Applications and required functions • Review and Signoff Requirements • Successful completion of FAT and resolution of all variances to Purchaser's satisfaction	20% of Total Contract Price
3	MS-03	• Shipment of the System, its complete installation at Purchaser's site, and successful completion of system startup activities. • Installation and commissioning of entire scope of work of SCADA, ADMS, PDS & QAS, OTS, Cyber Security and Communication Network Management System and applications as per specification etc. • Interface development with existing systems like SLDC, Enterprise Historian, GIS etc. • Pre-SAT test acceptance	25% of Total Contract Price
4	MS-04	Approval of site acceptance test (SAT) of Phase # A (MCC&BCC), after completion of all test plans and procedures. This includes: • Site Preparation Plan • Witness demonstrations of all custom features • Field Update Period completed • Rectification of Bugs/ Issues if any reported after Pre-SAT • Training on O & M of System • Availability of Complete functionality as specified in the specification and scope of Work • Data Migration (Historical) • Demonstration of Guaranteed Performance Parameters	25% of Total Contract Price
5	MS-05	Approval of site acceptance test (SAT) of Phase # B (MCC,BCC.), after completion of all test plans and procedures. This includes: • Site Preparation Plan • Witness demonstrations of all custom features • Field Update Period completed • Rectification of Bugs/ Issues if any reported after Pre-SAT • Training on O&M of System	15% of Total Contract Price

Sl. No.	Milestone Number	Milestone Description	Special Comments / Remarks
		• Availability of Complete functionality as specified in the specification and scope of Work • Data Migration (Historical) • Demonstration of Guaranteed Performance Parameters	
6	MS-06	Operational Acceptance and submission As-built drawings, spares: • Successful completion of System Availability and Performance tests), • Submission of Operator's User's Manual, Modification if any to the Operator's User's manual and submission of approved manual • Submission of Backup of entire system on secondary media • Delivery of all As-built drawings, database and logic files, source code and final documents Delivery of spares, maintenance & testing equipment's etc.	10% of Total Contract Price

Credit period for all payment due will be 90 days from when payment is due and submission of all requisite documents.

All expenditures related to Travel, lodging and boarding of Tata Power Representatives, shall be borne by Tata Power. However, Bidder to arrange for local transport and food arrangement within bidder premises.

Post commissioning (After successful completion of SAT) Resident Engineer -Work Order, will be placed on Annual basis. Bidder shall raise the invoice in the beginning of quarter payment will be done on quarterly basis at the end of quarter.

10.0 Submissions by Bidders

10.1 Mandatory Documents required along with the Bid

Bidders are requested to submit their offer in line with this bid document. Purchaser shall respond to the clarification raised by various bidders and the replies will be sent to all participating bidders through ARIBA.

Bidder shall submit the document as specified in Section-D and as described in various section of this document.

The technical bid shall be properly indexed and is to be submitted in Soft Copy and two nos. Hard Copy.

10.2 Departure from Specifications

Bidder shall necessarily submit a signed and stamped copy of this BID (in original) as a token

of acceptance of all the terms and conditions of this BID. Replication of this BID on bidders' document shall not be acceptable. Normally no deviation is accepted to BID document supplied with the bid & bid with deviation is liable to be rejected. However, in case of any deviations to this BID, all such deviations shall be furnished by the bidders in the Schedule of

Deviations attached as Section-C, Item-C3, and submit the same as a part of the Technical Bid.

10.3 **Right of Acceptance / Rejection of Technical Proposal**

Bids would be rejected in absence of following documents:

a. Details required for PQR not submitted

b. Complete technical details are not enclosed

c. Proposed Architecture not submitted

d. The offer does not contain un-priced detailed Bill of Material as per the proposed architecture

e. Bid is received after due date and time

f. False Information / Details

Purchaser reserves the right to accept/reject any or all the bids without assigning any reason thereof.

10.4 **Documentation & Licenses**

Bidder shall submit the documents as per Section D for bid submission and Post Award. Bidder to ensure that all software procured shall be perpetual license in the name of the Purchaser.

11.0 Layout Requirements

11.1 All systems shall be installed based on the approved equipment layout and plot plan.

11.2 The Switches, Firewalls and other communication accessories shall be mounted in the network panels.

11.3 Network Panel shall be installed in the same row and near to all the server panels.

11.4 The GPS clock with receiver shall be installed in the Server/Network panel. The remote display units for Time and Frequency shall be wall mounted in the Control Room at an appropriate place.

12.0 Project Management

12.1 Project Implementation

This section specifies project implementation requirements, including Purchaser and the Bidder responsibilities, project management procedures, project documents, the activities leading up to shipment of the SCADA/ADMS and other systems, and the installation, commissioning, and site test activities.

12.2 Project Management

The Bidder and Purchaser shall assign a project manager with the authority to make commitments and decisions that are binding on the either side with the following responsibilities:

12.2.1 Purchaser's Project Manager

Purchaser’s project manager shall be responsible for representing Purchaser’s interests throughout the project. Purchaser’s project manager will, from time to time, authorize other staff to act in this regard for specific tasks. The project manager will also change such assignments from time to time. Such actions shall be submitted to the Bidder in writing.

All correspondence with Purchaser shall be addressed to Purchaser's project manager.

12.2.2 The Bidder's Project Manager and Project Personnel

The Bidder shall designate a project manager who shall be responsible for the co-ordination of all project work and for the communications between the Bidder and Purchaser. Except for conditions outside the control of the Bidder, the Bidder's project manager shall not be removed or replaced without the approval of Purchaser.

Bidder shall submit the manpower deployment plan along with the bids, describing the key roles of each person. The project shall be staffed with a core project team. Additional personnel shall be assigned to work under the direction of the core team as required to effectively implement the SCADA/ADMS and Other Systems. Core project team members shall have experience as stated elsewhere in this document.

The Bidder shall inform Purchaser of any pending or possible changes in the use or status of all Bidder project personnel. Any changes to Bidder staff, including work assignments and participation level, shall be announced as soon as practical and shall be subject to

Purchaser's approval. Purchaser shall have the right to have any Bidder staff removed from the project for cause.

12.3 **Project Management Practices**

Bidder shall provide high-level details of the project management practices that will be followed to manage the project. The project management practices would include (but not be limited to) details of:

a. Bidder must provide details of how they envisage the contract being managed and control mechanisms; regular and active review meetings; Project management of individual work streams and overall program management of the entire service; Performance reporting

b. Bidder should outline their proposed governance structure and designate a Service Manager to co- ordinate their activities and provide a focal point of contact to which Purchaser can refer on any matter concerning the service.

c. Reporting lines and decision-making powers within the bidder's organization must be submitted

d. Reporting formats and templates that would be followed by the bidders

e. Outline the proposed escalation procedures if issues arise.

12.4 **Project Schedule**

The project implementation schedule shall be not exceeding 12 months from the date of award. Based upon this schedule the bidder shall submit a preliminary implementation plan along with the bid. The detail project implementation schedule shall be submitted by the bidder after award for Purchaser's approval, which shall include at least the following activities:

a. Site Survey

b. Documents submission and approval schedule

c. Factory & Site Testing Schedule

d. Database development schedule

e. Hardware purchase & Manufacturing, Software development & integration schedule

f. Dispatch Schedule

g. Installation / commissioning schedule

h. Data Migration (Historical)

i. Training schedule

The project schedule shall include the estimated period for completion of and its linkage with other activities.

12.5 **Progress report**

A progress report shall be prepared by the Bidder each month against the activities listed in the project schedule. The report shall be made available to Purchaser on a monthly basis, e.g., the 10th of each month. The progress report shall include all the completed, ongoing and scheduled activities.

12.6 **Transmittals**

Every document, mail, letter, progress report, change order, and any other written transmissions exchanged between the Bidder and Purchaser shall be assigned a unique transmittal number. The Bidder shall maintain a correspondence index and assign transmittal numbers consecutively for all Bidder documents. Purchaser will maintain a similar correspondence numbering scheme identifying documents and correspondence that Purchaser initiates.

12.7 **Implementation Responsibilities**

The general responsibilities of Purchaser and the Bidder are presented below. Other sections in the Specification may also present responsibilities. If the requirements of any other sections conflict with the responsibilities of this section, the responsibilities of the other sections shall take precedence over this section.

12.7.1 **Bidder's Responsibilities**

The Bidder's specific responsibilities shall include:

a. Providing all SCADA/ADMS and other systems equipment and related support materials, including all interconnecting cables and wiring between all Bidder-provided equipment and between the SCADA/ADMS and any equipment furnished by Purchaser

b. Defining the stock of spare parts needed to maintain for system availability

c. Providing all engineering, software design, development, and integration services necessary for SCADA/ADMS and Other Systems implementation

d. Providing and integrating all application software except that to be developed by Purchaser. This responsibility extends to all software developed by Sub-vendors.

e. Providing all SCADA/ADMS and Other Systems displays and reports

f. Import and export of GIS Data

g. Migration of historical data from Purchaser's Systems

h. Using the Development System to create displays and generate reports according to samples and templates provided by Purchaser

i. Implementing the database for Purchaser's network and installing the database into the Development System. In addition, the Bidder shall identify any data elements required in the Bidder's database and shall be responsible for integrating such data elements into the Bidder's database.

j. Interface development like Secured ICCP, SAP-PM, MM, Enterprise Historian, MDM, OMS, CIS, IVR etc.

k. Supplying a display style guide defining all discretionary display parameters used by the Bidder when developing standard displays and reports

l. Defining and coordinating a software and database management methodology that shall ensure synchronization of the system databases and applications software, between the Bidder's factory and Purchaser's site, until acceptance of the entire solution

m. Ensuring that all reasonable security measures have been incorporated in the SCADA/ADMS and Other Systems and all software, upon delivery, is free of viruses, trapdoors, and other software contaminants, contains no software enabled with "electronic self-help", is purged of all sample scripts and sample code, and has had all default accounts and passwords removed or disabled

n. Managing, coordinating, and scheduling the activities of all Sub-vendors employed by the Bidder for this project. This shall include the resolution of all problems that may arise in connection with the hardware, software, and services supplied by the Sub-vendors.

o. Implementing the SCADA/ADMS and Other Systems according to the quality standards acceptable to Purchaser

p. Training Purchaser staff so that they will be self-sufficient and able to operate, maintain, and upgrade the complete SCADA/ADMS and Other Systems

q. Supplying SCADA/ADMS and Other Systems documentation such as instruction manuals, maintenance manuals, drawings, software design and user documentation, and other appropriate material that together fully defines the supplied system and allows Purchaser to operate, maintain, backup, restore, and upgrade the SCADA/ADMS and Other Systems hardware and software

r. Supplying final (“as built”) documentation that is accurate and complete.

s. Providing adequate facilities and resources for, as well as performing, factory testing

t. Providing an environment that allows for reproducible execution of all SCADA/ADMS and Other Systems functional performance tests conducted during factory acceptance testing

u. Transportation and delivery of all Bidder-provided equipment and materials to Purchaser's site or sites

v. Verification of existing infrastructure such as the power distribution, air conditioning, power grounding, seismic protection, dust protection, fire protection, equipment size, and other site requirements as necessary for the proper environmental control and operation of all SCADA/ADMS and Other Systems equipment

w. Performing the installation of the SCADA/ADMS and Other Systems at Purchaser’s site under Purchaser’s supervision

x. Performing, with Purchaser’s assistance, system start-up after satisfactory system installation, i.e. powering up the system, loading correct versions of all software and databases, activating data links, verifying correct operation of the system, and turning over to Purchaser an operational system ready for site testing

y. Performing after delivery and start-up of the system, but prior to any site testing, setting up all functions for proper operation (system and function “tuning”)

z. Performing the test at Purchaser’s site, including correcting all reported variances

aa. Ensuring and periodically demonstrating that the work is progressing according to the approved schedule

bb. Performing historical data migration

cc. Providing office space and services for Purchaser personnel at the Bidder's site

dd. Maintaining the SCADA/ADMS and Other Systems up to the start of the warranty

ee. Providing and implementing all required warranty services

12.7.2 **Purchaser's Responsibilities**

Purchaser will be responsible for the following:

a. Providing input power to equipment enclosures

b. Providing WAN and DCU/RTU communications media from the existing Automation WAN

c. Supplying display conventions and standards to be followed by the Bidder when preparing or customizing displays for this project

d. Reviewing and approving project deliverables such as, but not limited to, detailed implementation schedule, software and hardware functional design documents, user manuals, custom display and report formats, drawings, progress reports, training program, quality assurance plan, test plans and procedures, test results, support services (including maintenance), and as-built system documents

e. Providing documentation, interface details, engineering drawings, and schematic diagrams of Purchaser-furnished equipment to be directly interfaced with the SCADA/ADMS and Other Systems

f. Coordinating and supervising the Bidder's work to be performed at Purchaser facilities

g. Attending pre-factory tests (at Purchaser's discretion)

h. Participating in factory tests and approving test results

i. Assist the Bidder with the installation

j. Monitoring the site tests and approving test results

k. Monitoring the availability test and approving test results

l. Providing test data for processes external to the SCADA/ADMS and Other Systems

m. Preparing variance reports, resolving variance issues, and approving corrected variances

n. Determining if the Bidder's work is progressing in accordance with the schedule

o. Verification of all Bidder materials, installation practices, and workmanship conform to requirements

p. Providing facilities for on-site training and Bidder offices.

12.8 **Third-Party Software**

Where any Bidder-provided applications software or software modules developed by a third-party are integrated into the SCADA/ADMS and Other Systems, the Bidder shall be responsible for integrating, testing, and meeting the functional, security, and performance requirements of this software in the SCADA/ADMS and Other Systems environment. The bidder shall avail all software licenses, warranty and support provided by the OEM in the name of the Purchaser.

12.9 **On-Site Offices**

Both Purchaser and the Bidder shall make available office facilities for use by the other party. Purchaser will provide offices for Bidder staff at Purchaser's offices throughout the project. The same will be reviewed time to time to accommodate additional resources of the bidders and until completion of the site testing.

The Bidder shall provide offices dedicated to Purchaser's use suitable for up to five staff. These offices shall be contiguously located and shall be kept available for the exclusive use of Purchaser throughout the duration of the project such that confidential documents, personal effects, and other materials may be stored. Offices for an additional Purchaser staff shall be made available during factory testing.

13.0 Quality Requirements, Inspection, Installation, Commissioning and Testing

13.1 **Quality Assurance**

Quality of service - Bidder must provide details of their proposed approach to quality assurance to ensure the quality of services in accordance with RFP Document. This should include:

a. Responsibility of quality of service;

b. How the bidder will ensure quality service is provided;

c. How quality will be measured

d. Bidder shall submit their quality certification / Assessment document. Bidder shall provide the following information along with the documents.

Description	Bidder's Response
Certification / Assessment Name	
Who issued the Certification / Assessment?	
When was the Certification / Assessment obtained?	
Does this Certification / Assessment process involve periodic reviews and observations / remarks after such review? If so, please provide details and specify when your company is due for its next quality review?	

Table: Details of Certification

All materials and parts of the Bidder's own and Sub-Vendors System / Sub-System to be supplied under this project shall be current, in line with industry standard.

13.1.1 **Quality Assurance and Testing**

To ensure that the Bidder produces a well-engineered and contractually compliant SCADA/ADMS and Other Systems, a quality assurance program shall be followed and both structured and unstructured tests shall be performed.

13.1.2 **Quality Assurance Program**

The Bidder must employ documented Quality Assurance (QA) techniques and practices throughout this project. This QA program shall be adhered to for the preparation of all Contract deliverables, including documentation, hardware, firmware and software. The program shall provide for the minimization of defects, the early detection of actual or potential deficiencies, timely and effective corrective action, and a method to track all such deficiencies.

13.2 **Inspection**

Purchaser shall be allowed access to the Bidder's facilities during system design, manufacturing and testing and to any facility where hardware or software is being produced. The Bidder shall provide office facilities, equipment, and documentation necessary to complete all inspections and to verify that the SCADA/ADMS and Other Systems is being fabricated and maintained in accordance with the Specification to Purchaser's representatives.

Purchaser shall be allowed to review and verify the functional implementation of SCADA/ADMS and Other Systems software informally in conjunction with scheduled project meetings at the Bidder's facilities. No test plans, procedures, or reports are required to support these informal software demonstrations.

Purchaser shall be allowed to inspect the Bidder's hardware and software quality assurance standards, procedures, and records. Documents identified in the approved software quality assurance plan will be inspected to verify that the Bidder has performed the required quality assurance activities.

The inspection rights described above shall not apply to sub-bidders supplying standard computer or peripheral equipment and third-party software products. However, inspection rights shall apply to Sub-Vendors that are developing new software, offering solutions for inclusion in the SCADA/ADMS and Other Systems.

13.3 **Commissioning**

13.3.1 **Receipt at site, Handling, Storage & Insurance**

Bidder shall make his own necessary arrangements for storage space for the proposed system on receipt at Site.

Delivery and movement of material to site from stores shall be the responsibility of Bidder.

All Insurance including but not restricted to transit, storage, and installation and commissioning till the acceptance of the complete system shall be the responsibility of the Bidder.

13.3.2 **Installation**

Installation of the complete system is under Bidder's scope. Installation work shall be scheduled and carried out in coordination with Purchaser's representatives. All related drawings, installation manuals and recommended practices shall be submitted in advance for Purchaser's approval. Installation shall be certified by the Principal's representative.

13.3.3 **Cabling Scope (Supply & Installation)**

The following shall be in the bidder's scope

a. All cables to and from any equipment supplied by Bidder and uplink connectivity to existing router as per data centre standard

b. All cables between Purchaser's Power Supply Distribution Board to any equipment supplied by the Bidder.

c. Earthing interface to Purchaser's earth grid based on the earthing scheme provided by the Bidder (It shall be completely Bidder's responsibility to ensure proper earthing).

d. The above includes all electrical and fibre-optic cables (if any) and all associated terminals, Connectors, tools, distribution board, MCBs and other accessories.

e. UTP structure cabling for MCC and BCC is in the scope of the bidder.

f. Bidder to ensure all cablings are done as per industry data center standards and should be inline with existing datacentre cabling. Bidder to visit sites of MCC and BCC before quoting structured cabling. Bidder should have prior experience of data center structured cabling.

g. All termination shall be given appropriate tagging for cable identification

13.3.4 **Commissioning Activities**

a. The commissioning of the system (hardware and software) including SAT and one Month Trouble free operation shall be the responsibility of Bidder.

b. Development and customization of all software components shall be in Bidder's scope.

c. Adequate number of qualified engineers (Hardware & Software) as approved by Purchaser shall be posted at site during the entire period of installation & commissioning. In addition, telecom specialists shall be deputed to site for establishing communication systems. The personnel shall be qualified engineers with at least five years' experience respectively in SCADA Systems, RTU interface, power system applications including networking and communication.

d. Daily site work shall be planned and executed as per due approvals from Purchaser's representative.

e. Bidder shall submit detailed site organization chart of Personnel for Purchaser's approval. Purchaser reserve the right to review the same. Bidder's commissioning engineers shall also train purchaser's engineers during commissioning apart from scheduled Training.

f. The responsibility for Installation, Commissioning, Performance guarantee and warranty shall remain with the Bidder.

g. The Bidder shall furnish procedures, protocols and time schedules for commissioning and acceptance test activities.

h. All tools (both hardware and software), test instruments, simulation jigs, documents, programming equipment etc. required for Installation, Testing & Commissioning are in the scope of bidder.

i. All passwords, access keys etc. are the property of the Purchaser and shall be handed over to the Purchaser.

j. All interoperability tables for interfacing to other systems shall be supplied.

k. Principal's qualified representatives including specialists shall participate at site for supervision, & certification of commissioning and Acceptance tests.

The Bidder shall comply and adhere to the safety policy of the Purchaser. Hence necessary safety apparels shall be borne and used by Bidder for their personnel at their cost. Also it is the responsibility of the Bidder to ensure their compliance to statutory requirements of their workmen. All the workmen engaged at the TPCL site should have necessary ESIC and PF registration.

13.3.5 **Parallel Activities for Commissioning**

Bidder shall indicate the parallel activities for expediting commissioning. The following shall also be considered.

a. Bidder to note that the existing system will continue to work as is, till the new system is commissioned, configured in all respect, tested with respect to field, all points closed and approved by the Purchaser, training provided to Purchaser's personals and system is ready to hand over to Operational team.

b. The FEP-RTU/FRTU/Gateway connectivity will be checked using a Laptop with basic SCADA Software.

c. Independent groups shall work on development/customization of SCADA Software and other applications. Immediately on order placement, Bidder shall depute his specialist team to site for engineering activities.

d. Database compilation shall be done independently at Bidder's works prior to FAT.

e. The proposed migration from existing systems to the new SCADA/ADMS system should be such that there is minimum disturbance to the daily activities of the personnel in the CPSCC.

13.4 **Testing**

13.4.1 **Test Responsibilities**

Both Purchaser and the Bidder shall designate, in writing and prior to the start of the factory test, a test coordinator. Each coordinator shall be responsible for insuring that the tests are

conducted in accordance with the requirements of this Contract. The coordinators shall each have the authority to make binding commitments for their Purchaser such as approvals of test results and scheduling for variance corrections or, as a minimum, to cause such commitments to be expeditiously made.

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

13.4.2 **Test Documents**

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

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

13.4.3 **Test Plans**

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

a. The schedule for the test

b. The responsibilities of Bidder and Purchaser personnel, including record-keeping assignments

c. Any forms to be completed as part of the tests and the instructions for completing the forms

d. Procedures for monitoring, correcting, and testing variances

e. Procedures for controlling and documenting all changes made to the hardware and software after the start of testing

f. Block diagrams of the hardware test configuration, including the Bidder- and Purchaser-supplied RTUs, external communication channels, and any test or simulation hardware.

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

13.4.4 **Test Procedures**

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

The test procedures shall include the following items:

a. The name of the function to be tested

b. References to the functional, design, user, and any other documents describing the function

c. A list of test segments to be performed and a description of the purpose of each test segment

d. The set-up and conditions for each segment, including descriptions of the test equipment and data to be supplied by the Bidder and by Purchaser.

e. Descriptions of the techniques and scenarios to be used to simulate system field inputs and controlled equipment

f. Descriptions, listings, and instructions for all test software tools and displays

g. Step-by-step descriptions of each test segment, including the inputs and user actions for each test step

h. Forms for the recording of test results

i. The expected results for each segment, including pass/fail criteria

j. Copies of any certified test data to be used in lieu of testing, if approved by Tata Power.

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

13.4.5 **Test Records**

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

a. Reference to the appropriate test procedure

b. Date of the test

c. Description of any test conditions, input date, or user actions differing from that described in the test procedure

d. Test results for each test segment including a passed/failed indication. All information recorded during the test such as measurements, calculations, or times shall be included in the results.

e. Identification of the Bidder's and Purchaser's representatives performing and witnessing the test

f. Provision for comments by Purchaser's representatives

g. References to all variance reports generated

h. Copies of reports, display copies, and any other hardcopy generated as part of the test.

13.4.6 **Variance Recording and Resolution**

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

a. Documentation deficiencies

b. Functional deficiencies

c. Performance deficiencies

d. Procedural deficiencies (as when deviations from contractually required QA procedures are observed)

e. Test deficiencies (as when the system cannot satisfactorily complete a test procedure due to a problem with the test).

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

13.4.7 **Variance Records**

The record of each variance shall include the following information:

a. The date of the initial discovery of the variance

b. A variance number – a sequential number assigned when the variance is entered into the tracking system

c. An identification of the person submitting the variance and the names of any other witnesses or knowledgeable Purchaser or Bidder staff

d. An identification of the SCADA/ADMS and Other Systems component, such as a hardware item or software function, against which the variance is being written

e. An identification of the test plan or procedure, if applicable. The stage or step of the plan or procedure shall be identified

f. An overview of the variance suitable for use in keyword searches

g. A detailed description of the variance

h. A variance category:

i. Open (recorded but not scheduled for further action)

ii. Assigned (scheduled for further action)

iii. Pending (the variance has been resolved but not tested)

iv. Closed (Purchaser has accepted the resolution)

i. The date of assignment into each category

j. A variance priority:

Critical – To be used only if the SCADA/ADMS and Other Systems is in commercial use, this priority identifies a problem that prevents the use of an system features that is essential to Purchaser's operation of the power system

High – Denotes the failure of the SCADA/ADMS and Other Systems to perform a required feature in a manner that significantly reduces the utility of the systems or feature or which delays further testing of the systems or features

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

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

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

l. A record of all testing performed

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

13.4.8 **Schedule for Variance Correction**

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

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

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

c. Purchaser and the Bidder shall establish a mutually agreeable date for the correction of high priority variances, with the overall objective of:

i. If the SCADA/ADMS and Other Systems is in productive use, correcting the variances within one calendar week of their discovery

ii. Prior to the commencement of productive use, maintaining the overall project schedule

d. Purchaser and the Bidder shall establish a mutually agreeable date for the correction of normal priority variances, with the overall objective of:

i. If the SCADA/ADMS and Other Systems is in productive use, correcting the variances within one calendar month of their discovery

ii. Prior to the commencement of productive use, maintaining the overall project schedule

e. Low priority variances may be scheduled for correction at any time and shall not exceed 30 days after identification.

13.4.9 **Variance Resolution**

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

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

13.4.10 **Test Schedule**

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

13.4.11 **Test Initiation**

The following conditions must be satisfied before starting any test:

a. Purchaser has approved all plans and procedures for the test

b. Purchaser has reviewed or approved all relevant documentation

c. A copy of all relevant documentation including design and maintenance documents, user manuals, test plans, and test procedures has been placed on the test floor

d. A complete regeneration of the software under test has been performed immediately prior to the start of testing

e. All operating system parameters, files, and configuration information has been saved to archive media so that the SCADA/ADMS and Other Systems operating environment can be recreated

f. All database, display, and report definitions have been saved to archive media so that the System databases, displays, and reports can be recreated if necessary

g. All source code libraries have been saved to archive media so that SCADA/ADMS and Other Systems software can be regenerated if necessary

h. For the factory test, preliminary testing, as described in ***Item-13.4.15 Preliminary Factory Testing*** has been completed and the Bidder has submitted written certification that the preliminary testing has been successfully completed.

For the availability test, all critical, high, and normal variances have been corrected and verified to the satisfaction of Purchaser

13.4.12 **Test Completion**

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

a. All variances have been resolved to the satisfaction of Purchaser

b. All test records have been transmitted to Purchaser

c. Purchaser acknowledges, in writing, successful completion of the test.

13.4.13 **Test Suspension**

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

13.4.14 **Modifications to the SCADA/ADMS and Other Systems during Testing**

No changes shall be made to the SCADA/ADMS and Other Systems after factory testing has started without the express authorization of Purchaser. It will be Purchaser's intent to carefully control the test environment so that all changes can be readily identified and so that any changes installed for any purpose can be removed and the previous test

environment restored. Purchaser shall have the right to suspend testing, to revert to a previous version of any software or hardware, and to restart any testing previously performed if, in its opinion, changes have been made to the system under test without authorization.

13.4.15 **Preliminary Factory Testing**

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

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

13.4.16 **Factory Acceptance Test (FAT)**

Factory tests shall include:

a. Equipment test

b. Functional test

c. Performance test

d. Stability test

e. Unstructured test

a. **Equipment Test**

The equipment test shall verify that the SCADA/ADMS and Other Systems includes all required equipment, that the equipment is properly configured, and that the equipment can successfully execute the diagnostic programs provided.

The equipment tests shall include a visual inspection for proper workmanship, including cables, connectors, and labeling. The assembly drawings and configuration drawings shall also be verified at this time. These tests shall also verify that the required SCADA/ADMS and

Other Systems capacity performance and expansion requirements as specified in this specification have been satisfied.

b. **Functional Test**

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

a. Verification of all required functionality of the system, such as SCADA/ADMS and Other Systems, applications, data exchange, and information storage and retrieval. Verification shall include all standard and custom functions as well as purchased options.

b. Verification that all software has been correctly sized and meets Purchaser's capacity requirements

c. Verification of proper acquisition, processing, and storage of data from appropriate sources, and verification of protocol and data exchanges with all external systems that will interface with the system. Where necessary, the Bidder shall provide appropriate simulations of the external systems; such simulations must themselves be verified before being used.

d. Verification of all user interface functions

e. Verification of the proper operation of local and wide area network devices, including bridges, routers, gateways, firewalls, Cyber Security measures, access control and the network as a whole by monitoring network traffic using diagnostic procedures and reconfiguration tests

f. Verification of the application program and system development capabilities including, software configuration management, source code development, documentation management, user interface development, real-time data set development, RDBMS development, database generation and maintenance, report generation and modification, alarm and event message definition, test environments, and other utility functions

g. Verification of communications maintenance capabilities including diagnostics, communications maintenance (Gateway / RTU, data links, interfaces etc.), and local input/output maintenance.

h. Verification of all hardware maintenance capabilities.

i. Verification of the proper response of the system to at least the following abnormal situations:

i. Loss and restoration of processors and servers, including auxiliary memory

ii. Loss and restoration of user interface equipment

iii. Loss and restoration of archive storage devices

iv. Loss and restoration of external subsystems

v. Loss and restoration of input power (UPS failure)

vi. Loss and restoration of communication network processors

vii. Loss and restoration of any other peripheral devices

viii. Loss and restoration of local and wide area network elements

ix. Detection of and recovery from communication errors (simulated by Bidder).

j. Demonstration of the security of the system from unauthorized access

k. Verification of the redundancy and failure recovery schemes of the system

l. Verification that changes of system time will not prevent the system from operating properly and that the system can correctly handle the beginning of a new day, month and year; leap years and the change in century and decade.

m. Documentation verification that will verify that all documentation to be delivered with the system is present and meets requirements.

c. **Performance Test**

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

d. **Stability Test**

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

Major hardware failure is defined for the purpose of this test as the loss of hardware such as a processor, disk, user console, etc. Non-repetitive mechanical failures of printers, loggers, pushbuttons, etc., are not considered major failures.

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

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

e. **Unstructured Test**

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

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

13.4.17 **Site Acceptance Test (SAT)**

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

13.4.18 **Installation Test**

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

a. A repetition of the equipment test

b. Loading of the SCADA/ADMS and Other Systems software and starting the system. At the option of Purchaser, all software shall be recompiled from the source or distribution media

c. In cooperation with Purchaser, attachment of the SCADA/ADMS and Other Systems to communications facilities for all data sources and other systems that interface with the Systems

d. Initialization and preliminary tuning of application software as needed.

13.4.19 **Functional and Performance Tests**

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

13.4.20 **Availability Test**

SCADA/ADMS and Other Systems and device availability in accordance with the criteria specified in the specification, System Availability shall be demonstrated by the availability test.

13.4.21 **Test Activity**

The test activity shall consist of normal SCADA/ADMS and Other Systems operations with the system in commercial use. Purchaser will modify the databases, displays, reports, and application software during the availability test. Such modifications will be described to the Bidder at least 48 hours in advance of implementation to allow assessment of impact on the availability test, except where such changes are necessary to maintain control of the power system.

13.4.22 **Test Definitions**

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

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

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

Scheduled shutdown – During scheduled shutdowns or if an equipment failure occurs while its backup device is scheduled out-of-service, the resulting system outage shall be hold time, provided that service can be restored according to the Bidder-specified procedures within 30 minutes.

Power Interruption & environmental excursion – Loss of power or manual shutdown of the SCADA/ADMS and Other Systems in the event of power excursion or the loss of environmental control shall be considered hold time. If the systems are operated during periods of power or environmental conditions beyond

those specified, any resultant downtime shall be considered hold time.

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

Failure of Purchaser software – Time during which the SCADA/ADMS and Other Systems is down due to failure of software written or provided by Purchaser shall be considered hold time. (Programs developed by Purchaser under Bidder supervision are specifically excluded from this provision.) If a failure in such software cannot be overcome by Bidder- defined procedures, execution of the failed program shall be suspended.

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

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

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

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

Test time – The time elapsed from the start of the availability test until the end of the availability test, excluding hold time. That is,

Test_time = Total Time – Hold_time

13.4.23 **Duration and Criteria for Passing**

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

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

System_Availability = [(Test_time – Down Time) / Test_time] X 100%

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

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

14.0 System Capacity, Performance and Demonstration

Proposed System shall meet performance standards required to maintain real-time monitoring and control of the network. Performance shall be evaluated according to the amount of time and computer resources required for accomplishing a variety of tasks. The tasks are grouped into the following major function areas:

a. Data Acquisition and processing

b. Historical data processing

c. Man-Machine Interface interaction

d. Support functions

14.1 System Capacity

The system functions and associated databases shall be capable of accommodating at least a 100% increase in the delivered capacity without requiring regeneration, recompilation, or any other processing other than definition of the database by Purchaser.

a. The system functions and their associated databases shall be dimensioned as per the functional requirement of the Purchaser, specified in this document. E.g. Non-telemetered data, IS&R data, Purchaser's present and estimated future network expansion, standard applications and user specific applications.

b. The main memory of each processor and console shall be expandable to twice the delivered capacity within the delivered enclosures by Purchaser.

c. Fifty percent of the auxiliary memory capacity of each processor, console, or storage unit shall be completely available for future use by Purchaser. The auxiliary memory of each processor, console, and storage unit shall be expandable to twice the delivered capacity within the delivered enclosures by Purchaser.

14.2 System Scenarios

The System performance shall be tested under the following system scenarios:

a. Base Conditions

b. Steady-State Conditions

c. High Activity Scenario Conditions

14.2.1 **Base Conditions**

The following conditions shall apply:

a. The System shall be configured with all hardware and functions required by this Specification including hardware and functions specified. .

b. All System function execution parameters shall be as mentioned in this document.

c. System functions shall execute at the periodicities and execution times specified in this document

d. The System software and databases shall be configured in accordance with the required System Capacity.

e. The contents of the System databases and the display and report definitions shall be as determined by Purchaser.

f. The hour change shall occur such that all data acquisition and processing associated with the hourly System functions, including report production, are executed.

g. Operation view shall be customizable to operator for view of any operational menu based on user display.

14.2.2 **Steady State Conditions**

The Steady State Conditions shall consist of the Base Conditions and the following activities over a sixty- minute period:

a. Twenty-five percent of all the analog points shall change sufficiently each time they are acquired. Sixty alarms per minute (Thirty status alarms and Thirty analog alarms) shall be generated and processed. Each of these alarms may be acknowledged within sixty seconds at Purchaser's discretion.

b. One new display shall be called into one of the viewports at each console every sixty seconds.

c. One supervisory control sequence consisting of the opening or closing of one device shall be executed at each operations console everyone minutes.

d. Power Flow application shall run for at least 50% of the network every 15 minutes.

e. Five adhoc queries of ISR data and five report requests of ISR data from one operations console shall be made during the scenario. Each query or report shall, on average, include 500 items.

f. Failure and restoration of 1 RTU per 5 minutes

g. Fail and restore 1 ICCP server connection every 30 minutes

h. Web servers to be accessed by 100 nos. of concurrent users

i. Transfer and store 1 save case for each application

j. Transfer and store 2 files of selected 10 minutes duration of continuous real-time data for playback and trending

14.2.3 **High Activity Scenario Conditions**

The high activity scenario shall consist of the base conditions and the following activities over a fifteen- minute period:

a. Fifty percent of all the analog points shall change sufficiently each time they are acquired so as to require complete processing by the System.

b. A burst of 10000 alarms (5000 status alarms and 5000 analog alarms) shall be generated and processed within the first sixty seconds of the scenario. Hundred alarms per minute (Fifty status alarms and fifty analog alarms) shall be generated and processed for the remainder of the scenario. Each of these alarms may be acknowledged within sixty seconds at Purchaser's discretion.

c. Five new displays shall be called up in one of the viewports at each console once every sixty seconds.

d. Five supervisory control sequences consisting of the opening or closing of devices shall be executed at each operating console every one minute.

e. Power Flow application shall run for at least 20% of the network every 5 minutes.

f. Five ad hoc queries of IS&R data and five report requests of IS&R data from one operations console shall be made during the scenario. Each query or report shall, on average, include 500 items.

g. Failure and restoration of 3 RTU per 1 minute

h. Failure and restoration of 1 ICCP server connection every 10 minutes

i. Web servers to be accessed by 200 people simultaneously

j. Transfer and store 1 save case for each application

k. Transfer and store 2 files of selected 10 minutes duration of continuous real-time data for playback and trending

14.3 **System Response**

Satisfaction of the performance requirements will be verified during factory test and the site test for each of the system and applications and the other functional requirement mentioned in the specification. It is Purchaser's intent that the System exhibits consistent performance even when operating in a degraded configuration. The System shall satisfy the performance and capacity requirement of this specification under the following configurations:

a. The "Normal" configuration with all System components operating

b. A degraded configuration where system is running on above 50% of each server processing and memory capacity.

Bidder shall provide performance metrics on the recommended hardware.

The system shall meet the following response and resource utilization requirements:

a. All low-resolution digital inputs shall be acquired every 5 mSec and high-resolution inputs are time stamped by RTU with a resolution of 1 mSec.

b. All hardware counters accumulating pulse inputs shall be scanned every 1 Sec.

c. The system shall report correct time stamping when all process inputs scanning, and processing is in progress and all the data is transmitted over a main data bus every sec.

d. For SCADA, Power System Applications and other User specific functional/application, the worst loading condition shall include the following tasks:

i. All processor inputs scanning, and processing is in progress and all the data is transmitted over the main data bus every 1 sec.

ii. All open loop controls in operation.

iii. All output devices are in operation with rated performance / speed.

iv. Control / information request is initiated on all CRTs.

v. In burst mode operation 100 digital alarms are generated per second for a period of 10 seconds.

vi. The system shall report correct time stamping in burst mode operation when 100 digital alarms are generated per second for a period of 10 sec.

The following sections specify the performance required for the user interface during average and peak loading conditions. Averaged or other statistically processed response and update times will not be accepted as a measure of contractual compliance.

The technical proposal shall include a performance analysis for each proposed computer system to indicate compliance with the requirements herein. In addition, on completion of the detailed system design during project implementation, the Bidder shall submit an updated performance analysis to reconfirm the ability of each system to meet Purchaser's performance requirements.

Failure to meet the performance criteria shall require the Bidder to provide all necessary hardware and software modifications and additions until the performance criteria are satisfied.

14.3.1 **Display Requirements**

The following requirements shall be met for all displays provided on each of the computer systems.

a. **Display Response Time**

When any real time display and application display (except displays which involve extensive RDBMS access) is requested at a workstation console, the display complete with data values shall appear on the screen within 1 seconds for 84% of the time, 2 seconds for 95% of the time, and 2.5 seconds for 100% of the time.

Requests for displays shall be acknowledged within 1 seconds at any console with an indication that the request is being processed. At no time shall the system delay the acceptance of a display request or "lock out" console operations due to the processing of application functions.

When data entry is performed on a display, the data entry operation shall be completed and the newly-entered values displayed within 2 seconds.

b. **Display Update Rate**

Once a display containing data that changes appears on the workstation screen, the display shall be periodically updated (unless defined as non-updatable by the system maintenance engineer) every 2 seconds. This update ability shall apply to all such displays appearing on the screen together. The update shall be completed within 0.5 seconds. The data update rate for each display shall be adjustable by the system maintenance engineer or be defined as not updating

c. **Pan and Zoom response time**

A world display on a workstation screen shall be capable of being panned in a continuous manner from one screen border to the opposite screen border within 2 seconds. A user request to jump to a different window of the world display shall cause the display to be presented within specified time.

Zooming between the maximum and minimum scale factors shall be accomplished in a continuous manner in steps defined by the system maintenance engineer. The system maintenance engineer shall be able to specify the change in magnification associated with the movement among steps.

d. **Supervisory Control Action Complete**

Once supervisory control is executed on a workstation display, the supervisory control operation shall be completed, and the result displayed at workstation consoles within 1 seconds plus scan-in progress, communication, and field device operation delays.

e. **Display Trending Update Rate**

Once a trend display containing data values appears on the workstation screen, the display shall be periodically updated every 2 seconds. The trend update rate for each display trend shall be adjustable by the user. From the start of visible update activity, an update shall be completed within 0.5 seconds.

f. **Tabular Trend Update Rate**

Once a data value has been assigned to a tabular trend on the workstation screen, the trend shall be updated every 2 seconds. The data update rate for each tabular trend shall be adjustable by the user. From the start of visible update activity, an update shall be completed within 0.5 seconds.

14.3.2 **Alarm & Event Response Time**

All alarm and event messages shall be displayed at workstation consoles within 1 second or better under average load condition and within 2 seconds or better under peak load condition, measured from the time the alarm or event is detected by the computer system. The alarm and event actions shall include message production, highlighting of alarm conditions, and audible annunciation. Alarm acknowledgement shall be completed within 0.5 seconds after the user initiates the acknowledgement.

14.3.3 **Projection System Update Rate**

The values displayed on the projection system shall be updated every 2 seconds.

14.3.4 **Display Hardcopy Response Time**

A request for display hardcopies shall be acknowledged within 2 seconds at any console with an indication the request is being processed. Each copy shall take no more than 1 minute from the time the queued copy request is processed until the copied image is complete on the printer.

14.3.5 **Report Response Time**

Requests for reports shall be acknowledged within 2 seconds at any console with an indication the report is being processed. Reports shall be in the print queue within 1 minute of their scheduled time, regardless of the level of system activity. The report response times exclude reports which involve extensive RDBMS access.

14.3.6 **Response Time of data through Secured ICCP**

The Status data shall be reported by exception & displayed at the operator consoles within 1 seconds of receipt at the Secured ICCP servers. A complete scan of all status data shall also be made every 10 minutes and any discrepancies between the received value shall be reported by an alarm message.

Analog data shall be periodically exchanged as reports from respective computer systems at a periodicity of 5 seconds. This periodicity shall be set by the Secured ICCP clients as per the Secured ICCP protocol. All scans from the proposed systems shall be monitored and any failure to shall be alarmed. The user shall also be able to assign different scan rates for different transfer sets/associations.

14.3.7 **Resource Monitoring**

Resource utilization shall be measured, calculated and displayed for the System processors, devices, and networks. The minimum set of parameters to be presented include:

a. Time utilization (percent processor utilization) of each function per processor

b. Time utilization (percent disk utilization) of each function per disk

c. Disk data transfers per disk

d. Performance of LANs, bridges, routers, switches, firewalls and other network devices.

e. Single click retrieval of Communication/system performance logs between master and gateway, master and client from any operator workstation

Statistical sampling and accumulation techniques shall be used to collect these parameters over a user- selected time period. The user shall be able to specify the study period over which samples are collected and the sampling frequency. Typical study periods shall be ten seconds to sixty minutes, and typical sampling frequencies shall be once per two milliseconds to once per fifty milliseconds.

14.3.8 **IS&R Data**

Data Type	Periodicity	Data Storage
Real-time, Manual and Calculated data	Upon Change	60 months
Alarms and Events	On Occurrence	24 months
Sequence of Events	On Occurrence	24 months
Data Retrieval from IS&R (1000 Tags)	-	1 Sec
Simultaneous System Users	-	10
Simultaneous non-System users	-	50
Maximum user accounts	-	20
Development users	-	5

14.3.9 **System Utilization**

Name	Utilization	Comments
Main Memory	10% 30%	Normal Peak
Processor Utilization Application processor	<30%	Normal

Name	Utilization	Comments
Communication processor	<40% <30% <50%	Peak Normal Peak
Workstation (average utilization of the processing capacity)	<30% <40%	Normal Peak
Local Area Networks Uncontrolled Access (e.g. Ethernet) Controlled Access	 15% 20% 20% 30%	 Normal Peak Normal Peak
Auxiliary Memory Allocated capacity Access and transfer capacity	 50% 30% 50%	 Normal Peak
Hardcopy Print time	 60 seconds	
Transfer capacity of each storage system	<30% <40%	Normal Peak

14.3.10 Power System Applications

Function	Max Execution Time	Comments
Connectivity Check	<30 Sec	On-demand
Network Topology (Per feeder average)	1 Sec	Variable
Unbalance load allocation (Per feeder average)	1 Sec	Variable
Unbalanced Load Flow (Per feeder average)	1 Sec 2 Sec	Normal Peak
Unbalanced state Estimator (Per feeder average)	1 Sec 2 Sec	Normal Peak
Fault Location (Per fault average)	120 Sec 180 Sec	Normal Peak
Fault Current Value (Per fault location)	1 Sec 1 Sec	Normal Peak
Fault Detection, Isolation and Restoration (Per fault average)	15 Sec 20 Sec	Normal Peak
Optimization functions (Per feeder average)	1 Sec	Normal

Function	Max Execution Time	Comments
	2 Sec	Peak
Switching creation, analysis and execution	10 Sec 15 Sec	Normal Peak
Integrated Volt/Var Control	120 Sec 180 Sec	Normal Peak

14.3.11 **System Administrative Function**

Failure / Failover	Performance	Comments
Detection of server or device failure and initiation of failover process	<10 Sec	
Recovery from communication failure	<10 Sec <10 Sec	Server/WS RTU
Complete system startup from power failure	600 sec	
Main to backup failover	<10 sec	Bumpless
Complete SCADA database generation	2-3 Hours	From source
On-line database update	<30 Sec	New point or device
Complete server build	<6 hours	Including operating system, applications and databases
Installation of new display	<60 Sec	including distribution to all W/S

The bidder shall factor in system sizing the loading of the individual system due to routine/emergency Antivirus updates, Antivirus Scans and Cyber Security Management updates/scans.

15.0 Warranty, Maintenance, Upgrades, Patch Management & Database Modification Requirements

This Section specifies the requirements for Warranty, hardware and software maintenance for the System, Post Warranty maintenance and support, system upgrades, patch management etc. Section covers the responsibility for the maintenance of the System hardware and software over the term of this Contract.

15.1 **Definitions**

The responsibility for maintenance of hardware and software will vary depending on the time during the Contract. So that the times for changes in responsibility can be determined, the following definitions shall be used:

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

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

15.2 **Deliverable Hardware and Software Version**

The delivered hardware shall be the latest version being delivered by the manufacturer of the hardware six months prior to its delivery to Purchaser's facility. Similarly, the delivered software shall be the latest version being delivered by the Bidder six months prior to its delivery to Purchaser's facility.

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

15.3 **Warranty and Post Warranty support**

a. Bidder shall provide warranty for all supplied Hardware and software including sub-vendor/ third party products for the period of 7 years. This period starts from the date of system handover after successful Site Acceptance Test (SAT) of integrated SACDA, DMS & OMS system, resolution of all punch point of SAT and trouble-free operation of the entire system for a period of one month.

b. Bidder shall provide maintenance service support for Software Upgrades, Patch Management and any software subscription of all software supplied under this project including sub-vendor products during warranty period.

15.4 **Hardware Maintenance**

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

15.4.1 **Pre-Delivery Maintenance**

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

15.4.2 **Maintenance During Commissioning**

The Bidder shall have the responsibility for maintenance of all hardware after delivery and prior to commencement of the Warranty. This maintenance may be performed by a maintenance contract with OEMs or other parties or by Bidder staff using spare parts from the Bidder's stores or other sources.

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

15.4.3 **Maintenance Under Warranty**

Maintenance during the warranty shall be in conformance with the terms of the warranty sections of this RFP ***(Item 15.3)*****.**

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

a. Provision of trained staff, responsible for call-out when problems occur

b. Providing local assistance to the Purchaser during problem resolutions

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

a. Providing maintenance of all equipment, including spare parts

b. Providing materials and instruction for appropriate engineering changes for equipment

c. Provision of technical guidance towards the resolution of all hardware problems for equipment.

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

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

The Bidder's technical support staff shall work with Purchaser's technical staff to establish a strategy to efficiently resolve each identified problem. If at any time, Purchaser believes that the Bidder's technical support is not effectively resolving a problem, Purchaser may request that the Bidder's system expert or staff from the equipment's manufacturer be dispatched to Purchaser's facility. The Bidder's technical team shall be at Purchaser's facility within 24 hours of that request to provide hands-on support towards the problem resolution. Purchaser will not be responsible for any expenses connected to the technical support, including travel expenses.

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

Category	Definition	Maximum Resolution Time
Severity 1 Urgent	Complete system failure, severe system instability, loss or failure of any major subsystem or system component such as to cause a significant adverse impact to system availability, performance, or operational capability	0-2 hrs
Severity 2 Serious	Degradation of services or critical functions such as to negatively impact system operation. Failure of any redundant system component such that the normal redundancy is lost Non-availability of Man-power at control center during working hours	0-4 hrs

Severity 3 Minor	Any other system defect, failure, or unexpected operation Request for information, technical configuration assistance, "how to" guidance, and enhancement requests.	0-24 hrs

Failure by the Bidder to comply with the above-mentioned timelines, shall attract a penalty @ Rs. 1000 per hour. Penalty amounts shall be recovered from the amounts due to Bidder or by invoking the Contract Performance Bank Guarantee submitted by Bidder against this Contract.

15.4.4 **Post Warranty Maintenance Support**

The following post-warranty maintenance services shall be provided as options for all hardware:

Contract maintenance, eight hours per day, seven days per week, two-hour response. The Bidder's technical support staff shall work with Purchaser's technical staff to establish a strategy to efficiently resolve each identified problem. If at any time, Purchaser believes that the Bidder's technical support is not effectively resolving a problem, Purchaser may request that the Bidder's system expert or staff from the equipment's manufacturer be dispatched to Purchaser's facility. The Bidder's technical team shall be at Purchaser's facility within 24 hours of that request to provide hands-on support towards the problem resolution. Purchaser will not be responsible for any expenses connected to the technical support, including travel expenses.

The maintenance contracts shall cover preventative and remedial maintenance, spare parts, and installation of all engineering, equipment, and field change and upgrades. Purchaser agrees to notify the Bidder of their intent to install any changes or upgrades so that their compatibility with the other elements of the System may be determined.

The SLAs for support including response time, resolution time, applicable penalties for non-compliance etc. shall remain same as per the terms and conditions prevailing during the warranty period.

15.4.5 **Hardware Minimum Support Period**

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

15.5 **Software Maintenance**

The term "software" shall include all firmware and software delivered under this Contract, as well as the associated configuration files, installation kits, release media, documentation, and support media such as on-line help facilities and maintenance tools.

15.5.1 **Software Categories**

Software shall be divided into two categories:

a. Category 1 – All software, whether supplied by the Bidder or a Subcontractor, exclusive of that software defined as Category 2.

b. Category 2 – General-purpose software to be executed on Linux or Microsoft Windows. This software specifically includes:

i. Operating systems from vendors such as Microsoft Corporation's Windows operating system and derivatives of LINUX

ii. Productivity software from Microsoft Corporation, such as versions of the Office productivity suite

iii. World Wide Web browsers from Microsoft Corporation (Internet Explorer) and Netscape

iv. Communications Corporation (Communicator)

v. Web enabled browser for remote client

15.5.2 **Right to Change Software**

Purchaser must have the right to alter, modify, edit, and add to all software provided with the System. This right shall begin with the delivery of the Development system and the Bidder's baseline software. This requirement is necessary to facilitate development of Purchaser-supplied software and the interfaces to the other Purchaser's computer systems.

15.5.3 **Pre-Delivery Maintenance**

The Bidder shall have the responsibility for maintenance for all software prior to delivery. This maintenance may be affected by a maintenance contract with OEMs or other parties or by Bidder staff.

15.5.4 **Maintenance During Commissioning**

The Bidder shall have the responsibility for maintenance of all (Category 1 and 2) software after delivery and prior to commencement of the availability test. This maintenance may be performed by a maintenance contract with OEMs or other parties or by Bidder staff.

15.5.5 **Maintenance during the Availability Test**

The Bidder shall have the responsibility for maintenance of all (Category 1 and 2) software after delivery and prior to commencement of the Warranty. This maintenance may be performed by a maintenance contract with OEMs or other parties or by Bidder staff.

15.5.6 **Maintenance Under Warranty**

Maintenance during the warranty shall be in conformance with the terms of the warranty sections of this Contract ***(Item 15.3).*** The Bidder shall have the responsibility for maintenance for all Category 1 & 2 software during the warranty period. This maintenance shall be performed by a resident engineer or by Bidder system expert. The Bidder is responsible to provide maintenance support for the system supplied by its sub- contractor. Bidder must have maintenance support contract with their sub-contractors.

The System software will likely be composed of Bidder's standard system elements, customized or specially developed elements, and several third-party products. In order to facilitate the efficient maintenance of the System software, the Bidder shall follow the general principle that software that is specific to Purchaser shall be implemented in specific libraries that are properly identified. This principle shall ensure that changes and upgrades to the Bidder's standard system software, applications, or third-party products can be implemented without affecting or interfering with the software specific to Purchaser.

During the Warranty period, Purchaser may make changes to databases, displays, and reports as necessary to meet Purchaser's operational needs. Purchaser shall be under no obligation to inform the Bidder of such changes.

The Bidder’s software maintenance responsibilities shall include - Provision of technical support towards the resolution of all software problems for equipment. When needed, the Bidder shall respond to requests for technical support within Two Hours, 24 hours a day, seven days a week. The Bidder's technical support staff shall work with Purchaser's technical staff to establish a strategy to efficiently resolve each identified problem. If at any time, Purchaser believes that the Bidder's technical support is not effectively resolving a problem,

Purchaser may request that the Bidder's system matter expert or staff from the equipment/software's manufacturer be dispatched to Purchaser's facility. The Bidder's technical team shall be at Purchaser's facility within 24 hours of that request to provide hands-on support towards the problem resolution. Purchaser will not be responsible for any expenses connected to the technical support, including travel expenses.

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

Category	Definition	Maximum Resolution
Severity 1 Urgent	Complete system failure, severe system instability, loss or failure of any major subsystem or system component such as to cause a significant adverse impact to system availability, performance, or operational capability	0-2 hrs
Severity 2 Serious	Degradation of services or critical functions such as to negatively impact system operation. Failure of any redundant system component such that the normal redundancy is lost Non-availability of Man-power at Control Centre during working hours	0-4 hrs
Severity 3 Minor	Any other system defect, failure, or unexpected operation. Request for information, technical configuration assistance, "how to" guidance, and enhancement requests.	0-24 hrs

Failure by the Bidder to comply with the above-mentioned timelines, shall attract a penalty @ Rs. 1000 per hour. Penalty amounts shall be recovered from the amounts due to Bidder or by invoking the Contract Performance Bank Guarantee submitted by Bidder against this Contract.

15.5.7 **End-of-Warranty Upgrade (Option)**

An option to upgrade the System software to the latest release at the end of the warranty period shall be quoted. This option shall remain open throughout the project, up to six months into the warranty period. That is, Purchaser shall be able to elect the option at any time up to six months into the warranty period at the cost originally quoted.

If this option is purchased, the Bidder shall upgrade the software to the latest release prior to the end of the warranty period. Purchaser staff will be available to work with the Bidder to affect this upgrade. However, the Bidder shall remain responsible for the successful completion of the upgrade.

15.5.8 **Post Warranty Maintenance Support**

The following post-warranty maintenance services shall be provided as options for all software:

A subscription to change notification services of the software Bidders. The service shall include transmission of service bulletins and notices of the availability of corrections, modifications, upgrades, revisions, patch and new releases. The service for each software Bidder shall be quoted separately. These bulletins and notices shall describe:

a. The release or version of the previous software to which the upgrade may be applied

b. Prerequisites for the upgrades, including a complete list of the minimum release or version of all other software necessary to support the new software

c. Problems with the previous releases corrected by the upgrade

d. New features available with the upgrade.

As part of this service, the Bidder shall maintain and periodically publish a list of the current release of their standard products and the compatible releases of all software supplied by Sub-vendors.

Subscriptions to the software upgrade services of the software Bidders. The service shall include the change notification service as described above, as well as a copy of the new software, appropriate licenses for the new software, installation instructions, and a reasonable amount of support for the installation of the upgrade. The service for each software Bidder shall be quoted separately.

A contract for upgrades to be performed by the software Bidder. This contract shall include the software upgrade service described above, plus on-site installation service to be provided by the software Bidder.

The SLAs for support including response time, resolution time, applicable penalties for non-compliance etc. shall remain same as per the terms and conditions prevailing during the warranty period.

15.5.9 **Software Minimum Support Period**

The Bidder shall guarantee the availability of upgrades, technical support for all System software, and announcements of software and hardware releases applicable to the system for a period of ten years after the expiry of the warranty. Subsequent to this minimum

support period, the Bidder and the System Software Bidders shall provide to Purchaser a minimum of two year's advance notice of their intent to terminate such support and mitigation plan.

15.6 **Resident Engineer Support**

a. The services of a resident engineer shall be considered for a period of 7 year

b. Bidder shall quote for annual charges for a Resident engineer to be posted at site.

c. Bidder shall also arrange for Sub-Bidder's (third party) engineer during the periodic visits to attend the critical components.

15.7 **Upgrades, Patch Management & Modifications**

a. Bidder shall continuously keep the Purchaser informed of all Software and Hardware upgrades as & when these are released.

b. Bidder shall supply upgrades and patches of all installed software (both own and third party) for a period of eight years from the date of system acceptance without commercial implication.

c. Bidder shall rectify all design defects and software bugs at no extra cost for a period of 10 years from the date of system acceptance.

d. Bidder shall support the system totally for ten (10) years, even if no upgrades are implemented.

e. Bidder shall provide lifetime support (10 years) for the system. To meet this requirement, Bidder shall refer with OEMs on the product's life cycle management and obsolescence. Bidder shall attaché the product life cycle matrix for hardware and software offered under this RFP.

f. The system referred to above includes Bidder's own as well as third party components.

15.8 **Database modification during Warranty and Post Warranty Period**

All database updation major or minor (including new bay, new station inclusion and new equipment/device) is in the scope of the bidder, after the system handover and during the warranty period. The Scope covers database updation for population of and changes in all the relevant system.

1. Monitoring of System Performance
2. Breakdown and Preventive maintenance support on Hardware and Software
3. Emergency Maintenance and system restoration
4. Data base updation for Configuration changes in SCADA/DMS Software for new elements addition (e.g. new RTUs/bays/derived points/any new reports/new mimic diagram etc.)
5. Checking healthiness of the system by daily fault rectification support/monitoring support on the hardware & software.
6. Preparation of monthly report as per check list format finalized.
7. Taking quarterly backups of both MCC & BCC system in Storage media provided by supplier.
8. Rectification of hardware faults shall be through the hardware spares available with TPCL. In case of non-availability of spares with TPCL , Supplier shall arrange the required spares/replace the complete hardware at the additional cost after receipt of Purchase order from TPCL.
9. Attending the reported problems and check the system for proper operation as per the checklist finalized with TPCL. In case if the problem does not get resolved by local resident engineer then expert support shall be arranged at site for critical situation like non-restoration of system shutdown by resident engineer etc.
10. Strictly follow all safety tagging/work permit systems, prevalent at site.
11. Provide an alternate engineer in case the Resident Engineer is not available or on leave.
12. Patches support on supplied software.
13. Diagnostic of Hardware issues of any servers, firewalls and switches.

15.9. Resident Engineer Qualification:

1. Residential engineer must be Graduate engineer (Electrical/Instrumentation/Electronics) background

2. He should be on payroll of supplier

3. He should have at least 3 to 4 years of experience on supplied system

4. Tata Power have rights to conduct interview of residential engineer and based on interview TPCL may select or reject the candidate.

16.0 Training

The Bidder shall prepare and deliver a comprehensive training program on the operation and maintenance of the SCADA, ADMS Applications, NMS, Cyber Security Management System, Next Generation HA Firewall and other Sub-vendors system supplied under this project. Software training shall teach Purchaser the skills required for the maintenance and expansion and for the preparation and integration of new functions. Hardware training shall qualify Purchaser to perform routine preventive maintenance, diagnostic testing on the processors, peripheral equipment, LANs, Display & communications equipment.

16.1 Scope of Training

The training curriculum shall comprehensively train Purchaser's staff on all hardware and software to be provided with the SCADA & ADMS, NMS, Cyber Security Management System, Next Generation HA Firewall with the following exceptions:

a. General-purpose office applications such as Microsoft Office

b. Internet browsers such as Internet Explorer

c. Personal computer operating systems such as Microsoft Windows

The Bidder shall provide training on all Sub-bidder software products used in the SCADA & ADMS using personnel of the software Bidder. This training shall cover their theory of design and operation, use, maintenance, and installation of upgrades or new releases. The Bidder shall provide extensions to all Sub-bidder-provided training that covers how these products are used in the applications, the specific features of these products implemented within the SCADA & ADMS, and features that cannot be used.

16.2 **Recording of Courses**

Purchaser shall be permitted to make video and audio recordings of all training classes. Purchaser will use these recordings solely for internal instruction purposes and will not release the recordings to third parties.

16.3 **Training Documents**

The Bidder shall prepare a training plan in cooperation with Purchaser. The Bidder shall also be responsible for the preparation and production of all course material. Training documents shall be subject to the review and approval process of the Purchaser.

16.3.1 **Training Plan**

The training plan shall support the SCADA & ADMS implementation schedule. A logical sequence of courses shall be arranged, so that training on base system elements (such as the hardware platform, operating system, languages, database, and displays) is given before the training for specific SCADA & ADMS elements (such as applications). The training program shall take into account the knowledge required by members of Purchaser's project team in order to participate in the project.

The training plan shall list each course to be taken, the dates for the course, and the expected number of students to attend. The plan shall reference the course description documents described below.

Training shall be scheduled to minimize the loss of knowledge through lack of use. Training shall be scheduled so that there will not be long periods of time between training and the use of the training.

It is Purchaser's preference that all training, with the exception of Operator Training, be completed prior to the start of factory testing.

16.3.2 **Course Descriptions**

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

a. The course name (and number if applicable)

b. A brief description of the course

c. A description of the intended audience for the course

d. A description of the relation of the course to others in the training plan

e. The duration of the course

f. A breakdown of the course schedule, identifying classroom, laboratory, and hands-on periods

g. A list of the training materials to be supplied

h. A list of reference material to be used in the course

i. A list of any prerequisite training or experience expected of the students.

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

16.3.3 **Course Material**

The Bidder shall provide all necessary training materials, including course manuals and reference materials. Each trainee shall receive individual copies of the training materials and one additional set shall be provided for Purchaser's archives. Class materials, including documents sent before the training classes and class handouts, shall become the property of Purchaser.

Purchaser prefers that all course material be transmitted to the students at least two weeks prior to the course.

16.4 **Instructor Qualifications**

Course instructors shall have demonstrated technical competence in the subject and previous instructing experience. Purchaser prefers instructors who specialize in courser presentation, as opposed to hardware or software developers who only occasionally present courses. However, for SCADA & ADMS NMS, Cyber Security Management System, Next Generation HA Firewall elements produced specifically for this Contract, the Bidder may use the developer as the instructor. The developer shall use appropriate training staff as resources when developing the training course and materials.

Where practical, Sub-bidders Bidders shall deliver training on their products directly. However, the Bidder shall remain responsible for selecting these courses, coordinating their delivery, and ensuring that all training objectives are met.

16.5 **Training Curriculum**

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

16.5.1 **System Overview**

The System overview course shall be the first course in the training sequence. The course shall constitute an introductory class for Purchaser's personnel who are designated to attend additional training later. It shall also provide each trainee with a general understanding of the SCADA & ADMS including those aspects of the SCADA & ADMS for which the trainee will not receive additional training.

This class shall be scheduled for duration of two days and shall provide ample opportunity for free interchange between the Bidder and Purchaser personnel. This class shall begin with a management seminar lasting half a day and providing a high-level overview; this shall be followed by a more technical seminar covering hardware and software components and their inter-relationships.

16.5.2 **Database and Display Building**

The database and display building courses shall be scheduled to coincide with the delivery of the PDS. The courses shall teach students how to prepare the input data to define the SCADA & ADMS operating environment, to build the SCADA & ADMS database and displays and, to prepare the database administrator to maintain and modify the database and its structures. Specifically:

a. How to set up an SCADA & ADMS database and display building environment

b. How to identify database fields, entries, records, tables and contexts

c. How to structure data source table definitions

d. How to build tables and arrays

e. How to build application models, such as network analysis and load shedding models

f. How to build displays

g. How to Import / Export data from/to other Purchaser systems

h. How to perform database maintenance

i. How to generate the database from source materials

j. How to maintain symbol libraries and other display constructs.

k. Various displays on NMS GUI

l. Various displays on Cyber Security Management GUI

At the end of this course, participants shall be able to:

a. Understand the Bidder's terminology

b. Perform data entry and data validation

c. Produce database reports

d. Identify the types of data needed to model Purchaser’s power system

e. Describe the functional capabilities of the Bidder's graphical display editors

f. Create simple images with basic figure types

g. Create new symbols

h. Describe the use of icons

i. Define the visual attributes of symbols on one lines to show changing data values

j. Describe the use of color on one-lines

k. Construct the static parts of a one-line display

l. Design displays that use multiple view capabilities to change the amount of detail presented

m. Design displays to emphasize important information

n. Describe the application of full graphic technology to the user interface

o. Create a new data source and install it in the System, including:

  i. Describe the data requirements of the data source

  ii. Describe the data addresses

  iii. Build the linkage between the data source and these addresses

  iv. Create, for the data source, a complete set of displays

v. Build the linkage between the data addresses and multiple displays using symbols, colors, etc.

vi. Create poke points for display selection.

16.5.3 **Data Engineering**

Data engineering course shall include the following:

a. The most effective and expeditious way to input the data from the existing system to the new SCADA & ADMS, NMS, Cyber Security Management System, Next Generation HA Firewall System

b. Mapping between data in the existing system to the new system

c. The identification of data that is not in the existing system that needs to be collected for input to the new system

d. Procedures to transmit data between the development and the production system

e. Display building design issues

f. Discussion of application-specific modeling techniques

g. Discussions of the different approaches to storing and retrieving historical data

h. Development of a program for data and display development activities.

i. SCADA database generation and conversion

j. Power System Applications, and other applications database development

k. Information Management database development

l. Display generation

m. Import and Export of GIS data (Spatial data, connectivity data and attribute data)

n. Operator Training Simulator database/scenario generation.

o. Cyber Security Management System database generation

p. Communication Network Management System data base generation

16.5.4 **Information Management**

The Information Management courses shall be designed to train Purchaser personnel in the use of the Information Management capabilities of the SCADA & ADMS, including selections

of items to be archived, calculations associated with historical data, and report building features. These courses shall be especially oriented for those Purchaser personnel who develop and maintain displays, reports, and calculations relating to Information Management data and for those Purchaser personnel who maintain the SCADA & ADMS as an enterprise-wide resource.

At the end of these courses, students shall be able to:

a. Create and maintain the Information Management database

b. Understand SQL / ORACLE features and functions

c. Construct SQL / ORACLE queries to retrieve, sort, summarize, and change data

d. Develop strategies for writing efficient applications

e. Define and develop interfaces to external systems such as the corporate data store.

16.5.5 **Operating System Administration**

The Operating System (OS) administration course shall be designed to train the Purchaser personnel in managing and maintaining the SCADA & ADMS at the operating system level. At the end of these courses, participants shall be able to:

a. Manage and maintain the system administration database and files

b. Manage and administer networks

c. Shutdown and restart the SCADA & ADMS from different media, such as disk, tape, CD-ROM, and over the network

d. Backup and restore all programs and data

e. Add processors and peripherals to the SCADA & ADMS

f. Add users to the SCADA & ADMS

g. Update the operating system software

Access Bidder and Sub-bidder system level programming interfaces to facilitate the development of software by Purchaser personnel.

16.5.6 **System Programming Languages**

Courses shall be provided for each of the programming languages that are used in the System. Bidder should assume that the students have minimum proficiency in the languages.

At the end of each course, the participant shall be able to:

a. Describe the language's program structure

b. Use data, expressions, and assignment statements

c. Use control statements, including Boolean and case statements

d. Use procedures and functions

e. Use arrays, structured elements, sets, and strings

f. Do simple file I/O and describe the language's I/O capabilities

g. Describe the pointer and dynamic storage allocation capability

h. Write a program

i. Write programs that can handle command-line arguments

j. Write programs that can use pointers and structures

k. Time a program's execution

l. Perform static analysis and dynamic analysis of programs

m. Maintain and control successive versions of source code

n. Compile and link modules using compile and link options

o. Debug programs.

16.5.7 **Programming in the System Environment**

This course shall instruct the Purchaser personnel on the skills needed to program in the SCADA & ADMS software environment and shall be designed for the software engineers responsible for maintaining, expanding, or adding new functions. At the end of this course, the participant shall be able to:

a. Plan the implementation of a new software function

b. Describe the directory structure and locate applications and all supporting functions and software structures

c. Design and implement program data structures

d. Add new attributes to existing data structures

e. Write and test programs

f. Use Bidder- and Sub-bidder-provided programming interfaces

g. Configure the failover and restart functions for Bidder- and Purchaser -provided software

h. Generate error messages

i. Use the trace and debug utilities

j. Extract code and check code using the source code utility

k. Describe the inter-program communication process.

16.5.8 **Communication Software**

The Bidder shall provide training on the communications among data sources, communications network software used for the SCADA & ADMS local and wide area networks, and on the interfaces or communications links with the external subsystems and networks. Training shall be provided for both Bidder- and Sub-bidder supplied software and communications products.

At the end of this course, participants shall be able to:

a. Understand the basic communications theory

b. Understand the communications design and implementation of the SCADA & ADMS

c. Database generation of the Communication Network Management System

d. Database generation of the Cyber Security Management System

e. Understanding of the logs / reports generated by Communication Network and Cyber Security Management System

f. Understand the protocol implementation

g. Be able to install, startup, and test the initial configuration

h. Be able to expand the communications

i. Be able to perform diagnostics and maintenance procedures

j. Be able to install communication upgrades.

16.5.9 **System Administration**

The system administration course shall familiarize participants with the procedures necessary to operate the system as an integrated entity, to recognize and respond to malfunctions, and to perform maintenance functions. The only prerequisite for this course shall be familiarity with the overall functionality and architecture of the SCADA & ADMS.

At the end of this course, participants shall be able to:

a. Start up the SCADA & ADMS and its components

b. Shut down the SCADA & ADMS and its components

c. Switch functions to backup equipment

d. Take equipment out of service

e. Restore equipment to service

f. Interpret and react to messages generated by error-monitoring functions

g. Test field device and communication links

h. Implement procedures for installing new or modified applications for operations use

i. Use procedures for altering and replacing the operations database

j. Identify procedures for using diagnostics

k. Describe the backup functions required for normal maintenance

l. Use the system's procedures to generate the SCADA & ADMS from source code or distribution media.

16.5.10 **Application Software**

The Bidder shall provide training on application software. These shall cover all applications other than those already covered in the database, display, and Information Management courses. Each application course shall be organized to be responsive to Purchaser’s specific requirements and shall be regarded as an extension to the standard courses that are provided. Each course shall cover the following topics:

a. Functional design of the specific application program (using the approved functional specifications and displays as text)

b. Algorithms and models used by the application program

c. Programming techniques for the algorithms

d. Software implementation aspects, including each module's calling parameters and its interfaces with other modules as determined by these parameters and the data flags described

e. Database implementation aspects, including those portions of the database used by an application relative to content, structure, meaning, origin, and usage

f. Application program command language structure and common techniques

g. Application program procedures, including a review of standard procedures used to modify source code and compile, load, and install programs.

The design specifications and the user manuals prepared for the SCADA & ADMS shall be used as course text where applicable.

16.5.11 **Simulator Trainer**

This course shall cover the operation of the Simulator, scenario building, and maintenance. At the conclusion of this course, students shall be able to:

a. Prepare training scenarios using the scenario building tools provided

b. Guide operator trainees through prepared scenarios

c. Pause, resume, and bookmark the training scenario

d. Generate ad-hoc events during a scenario.

16.5.12 **System Hardware Training**

The course shall teach participants the essential knowledge and skills required to successfully progress through the hardware maintenance curriculum and shall stress lab exercises. Emphasis shall be on the practical application of tools and commands that relate to SCADA, ADMS, Communication Network Management, Cyber Security Management System, On-line Backup, History and Report System maintenance activities. The course shall include entry-level training in the use of operating system skills, an introduction to the critical directories and files that drive the operating system, and a discussion of diagnostic tools, system boot process, networking concepts, and terminology for computer hardware.

The course shall be designed for the hardware maintenance engineer, who has computer maintenance experience, along with knowledge of the SCADA & ADMS hardware.

At the end of this course, participants shall be able to understand the general features, characteristics, and the trouble shooting issues for all hardware supplied with this procurement.

16.5.13 **Hardware Maintenance Training**

This training shall qualify the Maintenance engineer to maintain and troubleshoot to the level of field replaceable modules for all equipment. The level of training shall be commensurate with the maintenance responsibilities for each equipment item as described in Hardware Maintenance. It shall include practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments. The training shall be provided on all equipment or on similarly configured systems.

These courses shall teach participants to install, configure, diagnose, and verify the proper operation of processors, desktop workstations, communication interfaces, and all peripheral equipment. Participants shall troubleshoot malfunctions introduced into the system using all available diagnostic tools. The majority of time shall be spent in labs to maximize hands-on exposure to all offered hardware. These courses shall enable participants to perform fault isolation and repair of any equipment.

16.6 **Training In-Residence (Mandatory)**

It is Purchaser's intent, to supplement formal training and to assist the Bidder in developing customized application software, Purchaser proposes to locate its staff at the Bidder's works. Purchaser is planning to depute team of five members at bidder's works. This resident staff will attend training courses scheduled to promote early involvement in the implementation work. These individuals will spend at least 75% of their time at the Bidder's works during system implementation and shall participate in the design, coding, testing, and integration of SCADA & ADMS programs as their primary responsibility. The resident staff will also be involved in system integration and testing. The resident staff shall be trained to utilize the Bidder's standard software development, documentation, and quality assurance practices.

The Bidder shall utilize the resident staff as working members of the project team. The resident staff will begin assignments at a time recommended by the Bidder and approved by Purchaser. Work assignments by the Bidder shall be subject to Purchaser approval. The Bidder shall schedule the resident staff work assignments to no more than 75% of each individual's time on site, during normal working hours, to be used to perform the Bidder-

assigned tasks. The Bidder shall retain responsibility for all work assigned to or completed by Purchaser's resident technical staff.

The Bidder shall allocate a specified amount in the contract budget for this purpose including travel, lodging, boarding and local conveyance expenses.

16.7 **Operator Training**

The objective of this course is to train Purchaser staff in preparation for development of Operator training courses by Purchaser. The operations training course shall include:

a. A system overview that presents the System configuration, application, capability, and performance concepts

b. General operating procedures that cover basic user interface features, display and report capabilities, log-on steps, areas of jurisdiction, user access restrictions, error messages, etc.

c. Use of real-time and study applications under a full range of typical operating conditions, including purpose, theory of operation, and the user interface features that support each application

d. Equipment handling such as minor system maintenance activities that do not require a technician

e. Verification that the information in the user's manual is valid.

17.0 Tools Tackles for Erection & Commissioning

Bidder to consider and supply special tools and tackles (Hardware and Software) required for erection, commissioning and maintenance of the offered system. After commissioning of the system all tools and tackles shall be handed over to Purchaser's Project/Maintenance team.

All tools (both hardware and software), test instruments, simulation jigs, documents, programming equipment etc. required for Installation, Testing & Commissioning are in the scope of the bidder.

All configuration cables and other specialized testing passive devices to be provided with the supply of material.

18.0 Spares

a. Bidder needs to include competitive price for Mandatory Spare parts against the below specified list and schedules.

b. Bidder shall include list of spares with quantities as recommended by him required for Seven years trouble free operation of equipment.

c. The spares supplied shall be strictly interchangeable with parts for which they are intended for replacement.

d. The spares shall be treated and packed for long storage (minimum 7 years) under the climatic conditions prevailing at the site.

e. The start-up spares shall be delivered at the site well in time before the start-up and commissioning of the plant.

18.1 **Start-Up Spares:**

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

18.2 **Mandatory Spares**

Essential spares are those considered necessary by the owner for first Seven (7) years of normal SCADA System operations. A list of such spares has been listed in the below mentioned table and the same shall be included in bidder's scope. When a particular item of spares is indicated as `percentage', it shall be considered as percentage of total number of that item of spares in the single equipment/system, unless specified otherwise and the fraction shall be rounded-off to the next higher whole number. Whenever the item of spares has been indicated as `set' the same shall mean the supply for a single equipment/system. One set of spares for the particular equipment shall mean the total quantities of that

particular spares for a single equipment e.g., `set' of Server, set of Workstations, shall include HMI, keyboard, mouse etc. The `set' shall however include all components required to replace that item of spares. The Owner reserves the right to buy any of the essential spare parts as considered necessary.

In case during start-up and commissioning certain essential spares are used up, the same shall be replaced within one (1) month without any commercial implications.

Bidder shall furnish details for all essential spares as per the approved vendor document list.

Bidder to consider Mandatory spares Max 5% of total number of unique item of spares in the single equipment/system. Minimum following mandatory spares needs to be maintained at site.

SL. No.	System	UoM	Qty
1	Server with OS (Each Type of similar Hardware configuration)	Lot	1
2	Work-Station with 2 Monitors, Keyboard, Mouse, Speakers	Nos.	2
3	Server hard disks	Nos.	8
4	Work station hard disk	Nos.	4
5	SAN storage hard disk	Nos.	4
6	Portable ruggedized harddisk for backup (min 8 TB)	Nos.	2
7	Tapes for DAT (Pack of 10)	Lot	1
8	Layer 2 LAN Switch (Each Type of similar Hardware configuration)	Nos.	1
9	HA Firewall – Control Centre	Nos.	1
10	KVM Switch	Nos.	1
11	Cooling Fan modules of each type of Servers	Nos.	20
12	Power Supply modules of each type of Servers	Nos.	4

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

18.3 **Recommended Spares**

In addition to the spares mentioned above, the Bidder shall also furnish in his bid a list of recommended spares with unit prices. The Purchaser reserves the right to buy any of the recommended spare parts as considered necessary by him. The prices of recommended spares shall be consistent with those of start-up/essential spares. Purchase of these spare parts will be covered under this order / by a separate order / an amendment to the contract.

The Bidder shall provide a list of recommended spares for a period of five years from the date of handover of the project to Purchaser. The shelf-life of these spares is such as to last for at least 7 years from the date of handover of the project.

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

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

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

End of Section-A

Document Title: ADMS System for Tata Power Mumbai Distribution

Document No: TS/ADMS-SPEC/01/2024

SECTION – B

DETAILED TECHNICAL SPECIFICATIONS

Rev	Date	Description	Approvals		
			Prepared By	Checked By	Approved By
R0	2 March 2024	Issued for Comments	Balaji	SAW & RMP	GTJ

Section – B

Detailed Technical Specification

CONTENTS:

Chapter # 1

Hardware Specification

1.0 Hardware Specification

1.1 System Hardware Requirements

This section articulates the hardware requirements for the SCADA & ADMS system. The conceptual hardware configuration diagram of Main Control Centre (MCC) & Backup Control Center (BCC) is indicated in ***Section- E Annexures 1, 2***. 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 of the system. However certain applications are to be hosted on independent hardware. All hardware shall be manufactured, fabricated, assembled, finished, and documented with workmanship of the highest production quality and shall conform to all applicable quality control standards of the original manufacturer and the Bidder. All hardware components shall be new and suitable for the purposes specified.

Bidder shall assess the adequacy of hardware specified in the Indicative BOQ (***Section- E Annexures 4)*** and if any additional hardware is required to meet all the requirements of the technical specifications, the same shall be included in the offer. The Bidder shall offer the minimum hardware configuration as specified herein for various equipment, however if required, higher end hardware configurations shall be offered to meet all the requirements of the technical specification. The redundant hardware such as servers shall work in hot standby manner. It is necessary to ensure that the functional requirements, availability & performance aspects are met as per SCADA & ADMS system specification **(*Refer Section-A Item 14.0, System Capacity, Performance and Demonstration)***.

The bidder shall ensure that functionally equivalent hardware is available which is compatible with software delivered with the system. If purchaser chooses to purchase said functionally equivalent hardware proposed by the bidder, any software modifications necessary to maintain complete functional compatibility with all software delivered by bidder shall be made at no cost to purchaser. In the event the modified software is not found compatible with functional equivalent hardware, the bidder shall make suitable corrections to this modified software and install this corrected software at no cost to Purchaser.

1.1.1 **Hardware Characteristics**

This section describes the hardware characteristics for MCC, BCC to be supplied for Purchaser. Conceptual configuration drawings for the systems that comprise the SCADA, ADMS & other Systems are to be consider by the bidder. In addition, specific hardware quantities and associated characteristics for each individual system are described in this document.

The Bidder's proposal shall clearly show how the proposed hardware characteristics compare with the characteristics specified by the Purchaser. In this regard, the Bidder may propose alternative hardware better suited to the characteristics of the Bidder's standard products/solution if it represents a superior performance and cost optimization. Purchase of alternative hardware by Purchaser, however, shall not release the Bidder from the contractual obligation to satisfy the functional, availability, capacity, expandability, performance, and other requirements of the Specification.

1.1.2 **General Requirements for Hardware**

Functions, hardware requirement in this section is applicable for MCC and BCC. Bidder shall propose the hardware architecture accordingly.

The hardware shall include all engineering changes and updates announced by the equipment manufacturer since it was produced. The hardware shall be audited for change orders immediately prior to the Factory Acceptance Test and unimplemented change orders shall be installed at this time. As part of the field performance test, the Bidder shall have all hardware inspected and certified by the equipment manufacturers as acceptable for service under a manufacturer's maintenance contract.

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. All hardware components shall be new and suitable for the purposes specified. All hardware shall confirm to EMI and EMC requirements for immunity as per IEC-870-2-1 Level 1, emission as per IEC 870-2-1 Class B and Cyber Security compliance of IEC62443 & IEC62351.

All servers and workstations shall include self-diagnostic features. On interruption of power they shall resume operation when power is restored without corruption of any applications. The hardware shall be CE/FCC or equivalent international standard compliance. The specification contains minimum hardware requirement. However, the Bidder shall provide hardware with configuration equal or above to meet the technical functional & performance

requirement. Any hardware / software that is required to meet functional, performance & availability requirement shall be provided by Bidder & the same shall be mentioned in the BOQ at the time of bid submission. If not mentioned at the time of bid, bidder shall provide the same without any additional cost to the Purchaser.

The proposed system shall be designed for an open & scalable configuration, to ensure the inter-compatibility with other systems of the Purchaser, the future smooth expansion as well as the easy maintainability. The proposed hardware configuration should be extended by adding CPU processors / memory boards / disks etc. in delivered units or additional units for capacity extension. The configuration of the SCADA & ADMS system shall comprise a centralized computing environment with open systems architecture. The system architecture shall be open internally and externally to hardware or application software additions, whether supplied by the original supplier of the SCADA or obtained from third party Bidders, both for capacity expansion and for upgrading functionality, without affecting existing SCADA & ADMS components or operation. To be recognized as a true open computer system, all internal communications among the SCADA & ADMS Servers and all external communications between the SCADA, ADMS 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 bidder should ensure that at the time of final approval of hardware configuration/BOQ, all the above hardware are current industry standard models and that the equipment manufacturer has not established a date for termination of its production for said products. Any hardware changes proposed after contract agreement shall be subject to the following: -

i. Such changes/updates shall be proposed, and approval obtained from Purchaser along with the approval of Drawings/documents.

ii. The proposed equipment shall be equivalent or with better features than the equipment offered in the Contract.

iii. Complete justification along with a comparative statement showing the original and the proposed hardware features/parameters including technical brochures shall be submitted to the Purchaser for review and approval.

iv. Changes/updates proposed will be at no additional cost to the Purchaser.

All hardware features described in the Technical Proposal and in the supporting reference material that accompanies the Technical Proposal shall be fully supported for MCC, BCC & Sub-Station (if any) computer systems.

1.1.3 **Hardware configuration**

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

All hardware shall have MIB compliant with secure SNMP (SNMP V3) for monitoring of resource usage. For Servers/Processors the minimum shall include at least RAM utilization, CPU utilization, Disk I/O utilization. For Network equipment it shall include at least the Ethernet port utilization and Bandwidth utilization. The utilization of the resources shall be as per the Section A **(*Refer Section-A Item 14.0, System Capacity, Performance and Demonstration).***

1.1.4 **SCADA / Application / Communication Processors**

1.1.4.1 **Processors**

In this Specification, the term "processor" is defined as any general-purpose computing facility used to perform a SCADA, ADMS and other application computer system's functions. Any functions shall be assignable to any of the control center processors. Processors are divided into the following types:

a) **Application Processors**

Application processors (referred as hosts or servers) execute a variety of SCADA/ADMS functions, as defined in the specification. They typically serve as the centralized source of database, display, and report definitions, and most program and database development will be performed on an application processor. They may also serve as database and file servers for shared software, shared on-line data, database definitions, and historical information.

b) **Communication Processors**

Communication processors (also referred to as front-end processors, data concentrator and OPC, Secured ICCP servers etc.) retrieve, transmit, and process data to and from remote sources, particularly DCUs/RTUs/FPIs and other computer systems. Communication processors typically operate on data definitions and other parameters downloaded from remote application processors (Servers, Workstations, DCUs, FRTUs/FPIs). Data retrieved and processed from remote sources may be stored in a communication processor, which then distributes the data to other processors periodically or on demand. It is envisaged to have redundant communication link with all remote application processors from DCUs /RTUs, FRTUs, FPIs/ Other Systems).

All processors and workstations shall include facilities to detect the loss of input power, execute an orderly shutdown upon loss of input power, and automatically resume operation when power is restored. All processors and workstations shall be equipped with ports as per function requirements specified in the specification.

All servers/processor shall be high performance current model processors with modular architecture, suitable for real time process applications of Power System Network Management. The processors / servers shall be replaceable or upgradeable with future processor to obtain system expansion with no required system or application software changes.

The number of tags, general purpose registers, hardware instructions repertoire, memory capacity and cycle time, internal and external interrupt system and the architecture shall be designed to provide enhanced process-oriented real time capabilities. High inherent reliability, self-checking, error recovery and trouble isolating features are vital aspects of the system and shall be proved for.

Additional features that processor shall include as a minimum are:

i. All servers shall have expansion capability to 100% with regards to offered system. The server shall have multiple processors and shall have the capability to add processors in future in the same enclosure.

ii. The system shall have the provision of 100% additional capacity at all level such as, tags, processing capacity, memory etc. as spare for the future expansion.

iii. The hardware interrupt structure (CPU) shall support multi-programming and suitable memory protection (hardware) shall be provided for the system security.

iv. Power failure fail-safe mode shall be provided for the CPU. This feature shall permit orderly shutdown and resumption of CPU operation, after required time delay, on resumption of power supply.

v. Procedure for loading complete software from auxiliary storage shall be easy and can be done by control Centre engineer. (i.e. no need to have the special training by the operator). Loading shall be supervised by CPU and system re-initialization done automatically.

vi. The CPU shall have integrity features such as memory protection, memory error correction code scheme, arithmetic exception, privilege violation trap and non-present memory detection.

vii. The CPU shall have high-speed floating-point hardware for speed and accuracy of computation of single precision and double precision real operands.

viii. The CPU shall have instruction look-ahead feature for fast instruction execution.

ix. The CPU shall have capability to handle data sizes of bit, byte, half word, word and double word.

x. The CPU shall be capable of modular hardware enhancements with other hardware units that result in increased system level throughput.

xi. The system shall provide on-line backup facility. The procedure for taking backup shall be single click operation ***(Refer Chapter # 11 for details).***

xii. A real-time clock, the CPU shall have real time clock capability to accept a time synchronization pulse and on SNTP (using both network protocol (SNTP), hardware pulse from the clock) and adjust its internal clock with the pulse. And shall be capable of synchronizing the other subsystems.

xiii. An internal interrupt (trap) system for hardware and/or software errors associated with processor operation

xiv. A memory error correcting module that detects all double-bit errors and corrects all single- bit errors; parity checking on data, addresses, and commands (an indication and count of these errors shall be maintained)

xv. The ability to perform I/O operations without Central Processing Unit (CPU) intervention.

xvi. An I/O capability that services all units in the auxiliary memory and display subsystems at their maximum transfer rates.

xvii. Hardware bootstrap features that will support rapid system reload from disk or other storage devices.

xviii. Adequate Coprocessors shall be considered to meet all functional requirement as per the required functionality described in the RFP.

c) **Processor Utilization**

The Unified Computer systems shall support all functions described in this Specification utilizing no more than 30% of the processing capability of each processor under the normal loading conditions along with all reports as required by the purchaser (from Database Server). The corresponding factor for peak loading conditions shall be 40% for Application Processors and 40% for Communication Processors. Processor time waiting for I/O transfers (including auxiliary memory transfers) may be included as idle time, except that only one- half of the processor time waiting for I/O transfers may be included as idle time up to a maximum of 10%.

d) **Processor and Device States**

Processor and device states identify the operating condition of each processor and peripheral device of the SCADA/ADMS system and shall be used to determine the system's reaction when restart and failover operations take place. The definition of states will depend on the Bidder's system design. However, the following states, or their equivalent, shall be supported:

Primary – A primary processor or device performs any or all the SCADA & ADMS functions.

Backup – A backup processor or device replaces a primary processor or device in the event of primary failure or upon user command

Down – A down processor or device is not communicating with other elements of the system and is not capable of participating in any system activity.

1.1.4.2 **Main Memory**

The main memory of each processor shall be available for data storage, program execution, and all input/output operations without restriction. The main memory of each processor and workstation shall be delivered such that 60% of the delivered memory is spare. The total delivered memory shall be expandable by a factor of two in the field solely by card or circuit

module additions. To meet this requirement, the addition of enclosures, cables, chassis, or power supplies or the substitution of higher density memory modules for delivered memory modules shall not be necessary. Delivered memory shall include all memory supplied with the processor or workstation, whether or not this memory is needed to meet the requirements of this Specification.

i. The main memory shall be made of state-of-the-art technology with minimum cycle time and access time and the minimum word size shall be 64 bits wide with extra error correction code bits.

ii. The main memory of each processor shall be modular and expandable to twice the delivered capacity solely by card or circuit module additions within the delivered enclosures.

iii. The memory assembly shall have high performance memory system including memory bus controllers, refresh controllers and error corrections circuits.

iv. Interleaving and overlapping of memory operation shall be possible by memory bus controller for enhanced throughput.

v. The memory management system shall provide memory write protect facility.

1.1.4.3 **Auxiliary Memory**

The auxiliary memory supplied with each processor, processor group and workstation, shall have sufficient storage capacity to satisfy the requirements of each SCADA/ADMS computer system's functions under the normal and peak loading conditions, to take care of all the requirements up to completion of project. Fifty percent (50%) of each delivered auxiliary memory shall be spare capacity completely free and available for Purchaser's use. Each auxiliary memory shall also be expandable in the field within the delivered enclosures to at least two times the delivered capacity, where the delivered capacity includes the 50% spare capacity provided in accordance with this Specification and spare capacity in excess of specified requirements.

Where the data stored on the auxiliary memory is distributed among multiple storage units, the spare capacity and expansion requirements shall apply separately to each auxiliary memory unit or set of units allocated to one data type.

Auxiliary memory access and transfer times must be sufficiently low to serve the specified present and future needs of each system. No more than 30% of the available access and transfer capacity shall be utilized under the normal loading conditions. No more than 50% of the available access and transfer capacity shall be utilized under the peak loading conditions.

Storage devices shall be provided to meet the total storage requirements and performance requirements of the SCADA/ADMS system. The minimum capabilities shall be as follows:

i. Read/write capability.

ii. Ability to format blank disks in the background.

iii. Standard, non-proprietary, data transfer methodology in alignment with ISO 9660.

iv. Data transfer rate capable of meeting performance requirements.

v. Multiple disks shall be loaded without requiring user handling of optical media (i.e. multiple units shall be provided if necessary, to meet the on-line storage requirements).

vi. Messages shall be output to announce when a disk is filled to a configurable percentage of capacity.

vii. No restrictions shall be placed on the allocation of processor main or auxiliary (disk) memory to be used to any specific purpose.

1.1.4.4 **Archive Storage at MCC & BCC**

The SCADA/ADMS computer systems shall include Write Many, Read Many (WMRM) optical disk units and cartridge magnetic tape drives (SCSI/USB DAT Drive).

1.1.4.4.1 **Optical Disk Memory**

The optical disk units to be provided shall use cartridge media units as per the proposed database size. The bidder to propose the cartridge capacity based on user, system database size and expected data storage (for at least 5 years data).

1.1.4.4.2 **Cartridge Magnetic Tape Units**

A common cartridge tape unit shall be considered per rack with adequate capacity. A Cartridge tape unit configured for desk-top mounting shall also be supplied. Each server and workstation shall include an appropriate port (SCSI/USB) for interfacing with a desk-top DAT unit. Cartridge tape units will be used to reload the auxiliary memory of processors and workstations.

1.2 **Servers**

Each server shall have dual AC power supply. The servers shall be fully operational even with single source of power supply is available. The servers shall have the provision for expansion of the processor, auxiliary memory and main memory by 100% of the delivered capacity. The expandability shall be possible at site with addition of plug in modules. Initially, USB ports of

all servers shall be disabled. The server shall be supplied such that they are interchangeable and hence reduce the requirement of spares and maintenance.

Servers shall be rack mounted in the panel and a management console should be provided for centrally for accessing all the servers. However, the grouping of servers in a rack shall be such that the primary and backup servers for a system function are located in different racks. Proposed servers should allow hardware assisted virtualization and processor multithreading.

All Servers make, model and configuration shall be identical except memory storage.

Minimum configuration of the server is mentioned below:

Sl. No.	Technical Particulars	Tata Power Requirement
Independent Servers: Critical function servers SCADA, FEP, DMS, OMS should have independent hardware. PDS, QAS, DTS, Web Server, ICCP, IS&R Server, Interface Server, On-Line Backup server system can be operate independently in virtualised environment. Bidder to ensure that there shall not be any degradation in functional performance and cyber security of offered solution due to hardware optimisation.		
1	Make	HP/DELL/IBM
2	Model	
3	Operating System	Preferably, RED HAT LINUX, with latest version
4	Processor	Multi core (min Octa) Intel Xeon processor, 3.0 GHz or later, 64 bit
5	Memory	Min 64 GB or better RDIMM RAM
6	SAS / RAID Controller	RAID Controller with 1.2 GB or better Cache, Integrated hardware
7	Hard Disk	Min 4 x 600 GB in RAID 10 configuration SAS 10K rpm or better
8	Optical Drive	DVD-R/W drive
9	Ethernet Ports	4 nos Embedded Gigabit Ethernet ports
10	USB ports	Yes
11	Additional Ethernet SFP port	Server should support 2 Number of 10G Fiber Ethernet Ports with SFP
12	KVM Interface	Common mouse, monitor and keyboard for all server
13	Tape Drive (DAT)	Interface required
14	Redundant Power Supply	Redundant power supply (230 V AC) with 80 Plus Platinum Certification
15	Hot Swappable	Power supply Cards, Hot swappable disks, Hot pluggable/replaceable PCI Controllers, Cooling fans etc.
16	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
17	Management Console	The server should support integrated management with remote presence, Server should be supplied with OEM Server Management software/hardware and required ports

18	Condition Monitoring	Hardware shall be MIB compliant with secure SNMP Ver3.0. The system shall able to display /provide Sync Status- Main/Backup , Heartbeat of the Processor, LPMT, SPMT etc.
19	Size and Chassis	19", 2U Rack Chassis w/sliding Rapid/Versa Rails and Cable management Arm
20	Heat Load (in watts)	<< 500 w
21	Environment & Temperature	Ambient temperature range of 10 - 35 Degree C, Relative Humidity 95% non condensing
22	Specint & Specfp	As per the base runtime requirements of SPEC CPU 2017 Benchmarking Standards.

The above configuration is only indicative, Bidder shall consider the configuration higher than this for the proposed solution. The above-mentioned disk size is only for servers other than Time-series historian. Bidder shall size the disk as per the data storage mentioned in the specification for history.

1.3 Operator workstations

The operator workstation shall have dual monitors, single keyboard and a mouse. The same configuration workstation shall be used for MCC & BCC Operations, PDS & QAS, DTS and other systems. All workstation shall support full graphics displays. The minimum hardware configuration shall be:

Sl. No.	Technical Particulars	Tata Power Requirement
1	Make	HP/DELL/IBM
2	Model	
3	Operating System	Windows (Latest Version), 64 bit
4	Processor	Multi core (min Quad) Intel Xeon processor, 4.0 GHz or later, 64 Bit
5	Memory	32 GB Main Memory
6	Hard Disk	500GB SDD Enterprise grade
7	Optical Drive	DVD-RW drive
8	Ethernet Ports	1000 Mbps Dual Ethernet ports
9	Additional port	Dual Ethernet ports for interfacing LVS independently
10	USB ports	Yes
11	Redundant Power Supply	Redundant power supply (230 V AC) with 80 Plus Platinum certification
12	Size	Desktop/Rack mounted
13	Monitor Size & Type	24", LED
14	Aspect Ratio	16:9
15	Number of Monitor	Two
16	Peripherals	Keyboard & Optical Mouse
17	Graphic card	8 GB NVIDIA Quadro, DVI+VGA

13	Video Interface	4 (2 – Dual headed Monitor, 2 – Large Video Wall) Video interface for connecting Large Video Wall (SCADA & LVS independently)
18	Other I/O interface	Sound Card and Speakers for audible alarms, Stereo line-in, Microphone-in, front headphone/speaker out
19	Condition Monitoring	Hardware shall be MIB compliant with secure SNMP Ver3.0. The system shall able to display /provide Sync Status-Main/Backup , Heartbeat of the Processor, LPMT, SPMT etc.
20	Heat Load (in watts)	<< 500 w
21	Environment & Temperature	Ambient temperature range of 0 - 65 Degree C, Relative Humidity 95% non condensing
22	Specint & Specfp	As per the base runtime requirements of SPEC CPU 2017 Benchmarking Standards.

The above configuration is only indicative, Bidder shall consider the configuration higher than this for the proposed solution.

1.4 External Tape Drive

External DAT Cartridge 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.

1.5 Centralized Time Synchronization System

1.5.1 Centralized Time System

This facility is required to synchronize the MCC and BCC system and all Sub-Station Automation Systems. Bidder shall consider appropriate Central application to achieve the same with real-time response.

Time server Display to be developed with a facility of displaying connected IPs and synchronization status/alarm for abnormal condition.

1.5.2 GPS System

This facility shall provide IST (Indian Standard Time) for all the system elements and prints and displays. GPS based time and frequency facility to determine IST and date, system time, time deviation, power system frequency and power system frequency deviation shall be provided for MCC & BCC. The time receiver shall include propagation delay compensation to provide an overall accuracy of 1 msec and shall also

include an offset to permit correction to local time. The GPS system shall have dual 100/1000 Mbps LAN interface.

The time receiver shall detect the loss of signal from the source. A loss-of-signal contact shall be wired to the SCADA/ADMS and other computer systems and used as a telemetry failure indication. Upon loss of signal, the time and frequency facility shall revert to an internal time base. The internal time base shall have a stability of 1 msec per hour or better. Within five minutes of reacquisition of signal, the time shall return to within 1 msec of IST.

The time and frequency facility shall include digital displays for:

a. IST time and date in the format DD:HH:MM:SS:msec (the hour display shall be in 00 to 23 hour format)

b. Time deviation in the format xxx.xx seconds

c. Power system frequency in the format xx.xxx Hz

d. Frequency deviation in the format x.xxx Hz.

The time-deviation value shall be changeable via the SCADA/ADMS and other computer system's time and calendar function. The interface between the time and frequency facility and the processors shall be digital; analog interfaces are not acceptable.

Using digital interfaces, the time and frequency facility shall also be used to drive Bidder-supplied time and frequency indicators suitable for wall mounting. The display for time shall be in the 24-hour, HH:MM:SS:msec format. The display for frequency shall be in the xx. Xx Hz format. The indicators shall be connected to the time and frequency facility using plug-detachable cables.

a) The time Synchronization equipment shall receive the co-coordinated Universal time (UTC) transmitted through Geo Positioning Satellite (GPS) system and synchronize the servers, workstations and respective Control Centre and Sub-Station Automation system and other equipment.

b) GPS clock shall give real time corresponding to IST, taking into consideration all factors like voltage, temperature variations, propagation and processing delays etc.

c) Time Synchronization equipment shall include all accessories such as Antenna, special cables, processing equipment and all necessary software.

d) Equipment shall have real time digital display indicating HH:MM: SS: msec and frequency.

e) Equipment shall have an additional remote display unit with display of 100 mm height which can be mounted in the Control Centre indicating HH:MM:SS:msec and frequency in the format XX.XX Hz.

f) Clock shall have separate configuration port.

g) The equipment shall meet the requirement of IEC 60255 for storage and operation.

h) Tropical protection shall conform to BS: CP 1014 entitled "Protection of Electrical Power Equipment against climatic condition."

i) The antenna shall be an active antenna to provide the timing signals even under week signal conditions. In addition, antenna shall be waterproof to operate satisfactorily in an open environment under all weather conditions.

j) 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.

k) The GPS clock shall synchronize the computers using SNTP. In addition, it shall also have RS232, PPM and PPH signals.

1.6 **Server Panel / Console**

In case the equipment is mounted in panel type of enclosures, then such enclosures shall meet the following requirements:

a. Panel shall be free-standing; floor mounted and single panel dimension shall not exceed 2200(h) X 800(w) X 1000(d) mm.

b. Panel shall be front fixed and rear double door with front & rear access to the hardware with proper locking arrangement on the both sides. The Panel shall have levelling leg.

c. Cable entry shall be through the bottom/top with suitable cable trough for routing the internal & external field cables. No cables shall be visible, all cables shall be properly clamped, and all entries shall be properly sealed to prevent access by rodents. Bidder to note that the Bottom/Top entry will be finalized during detailed engineering.

d. The safety ground shall be isolated from the signal ground and shall be connected to the ground network Each ground shall be a copper bus bar. The grounding of the panels to the Purchaser's grounding network shall be done by the bidder.

e. All enclosures shall have suitable Power distribution units (PDUs) with indication of the socket healthiness with proper electrical rating, number of sockets (with 20% spares) and other accessories which are required to connect the equipment. The PDUs shall be designed

with proper rated voltage, load current and power based on the proposed solution by the bidder.

f. Bidder shall also provide additional 230 VAC 15/5A duplex type power socket & switch for maintenance purpose.

g. All panels shall be provided with an internal maintenance lamp and thermostat, space heaters with proper isolations, gaskets.

h. All panels shall be indoor, dust-proof with rodent protection, and meet IP41 class of protection.

i. There shall be no sharp corners or edges. All edges shall be rounded to prevent injury.

j. Document Holder shall be provided inside the cabinet to keep test report, drawing, maintenance register etc.

k. Cooling air shall be drawn from the available air within the Centre. Panel shall be designed with suitable inlet & exhaust FAN with Louvers at both the sides (top & bottom) shall be provided in ventilation. Ducted or directed cooling air to the enclosures will not be supplied by Purchaser.

l. 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.

m. All equipment shall have individual AC/DC power supply isolation through MCB for each source. The terminal blocks for AC/DC source shall be droppable type links (CBT4U or equivalent).

n. Suitable sized terminal blocks shall be provided for all external cablings.

o. All wiring shall use copper conductors. Conductors in multi core cables shall be individually color coded.

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

q. Enclosure Grounding-

A safety ground in accordance with the National Electrical code shall be provided within each enclosure and shall connect to the ground (green) wire of the ac power input. Enclosure grounding shall be subject to Purchaser approval.

Sl. No.	Technical Particulars	Tata Power Requirement
1	Make	Rittal
2	Size	19” / 42U
3	Dimension (H X W X D mm)	2300 X 800 X 1000 mm
4	Colour	Powder Coated Black
5	Captive front panel hardware, Pkt of 20, Castors with Brake	
6	Provision for mounting free floor standing with 100 mm plinth	
7	Panels with ingress protection degree IP41	
8	Internal Lighting Lamp - Yes with door interlock	
9	Front fixed, and Rear double door with proper locking arrangement on both sides	
10	Consist high quality extruded Aluminium vertical profiles, Top and bottom steel end frames with bottom panel having gland plate (4 parts) for cable entry, Top cover with FHU provision, side panels with latches and venting slot at bottom and top. 19” mounting angles,	
11	Front CRCA steel single door with hexagonal venting pattern	
12	Rear CRCA steel single door with hexagonal venting pattern	
13	Component shelf, Universal, 19” W / 575 mm D, Load cc 50 Kg	
14	Top mounting, Fan Housing unit with adequate fans with 230V	
15	Thinned copper earth bar	
16	Cable Entry – Bottom (Power Supply) /Top (Network Cable), with adequate number of trays	
17	PDUs: Adequate provision of 5A and 15A power sockets Provision of redundant Input supply with MCB	
18	All the material used in the panel shall be fire retardant	
19	Louvers with suitable wire mesh	
20	Color – RAL 9005 Black	

1.6.1 **Server Console**

The server console consists of a LED Sliding monitor connected to the different servers using LAN based KVM switch. There will be separate consoles for each of the redundant set of servers. The monitor and Keyboard shall be rack mounted.

1.0 Operating and Construction Requirements

1.0.1 Power Distribution and Protection

Purchaser will provide redundant single-phase 230 V AC power for all SCADA & associated equipment. Input voltage will vary ±10% and frequency will vary ±0.5% from nominal. Power will normally be supplied from an uninterruptible, conditioned source but may at times be supplied directly from the utility lines.

Each circuit shall include a circuit breaker typed and sized in accordance with the requirement in the server panel/console. Further the Bidder shall distribute power within the system enclosures, consoles, peripherals, and other components of the system. The Bidder shall supply all fusing, circuit breakers, switches, and surge protection necessary to protect the hardware, excluding only the power input circuit breakers to be provided by Purchaser.

1.0.2 Environment Conditions

Equipment located in the MCC & BCC building shall operate over an ambient temperature range of 16°C to 40°C, with a maximum rate of change of 5°C per hour. Relative humidity will be around 95% non-condensing.

Equipment located outside of the computer Centre shall operate over an ambient temperature range 0 to 50 °C, with a maximum rate of change of 10 °C per hour. Relative humidity will range from 30 to 95% non-condensing.

1.0.3 Acoustic Noise Level

The noise generated by the equipment in any enclosure, including desktop equipment, located in the computer Centre shall not exceed 60 dBA 1 meter (3 feet) from the enclosure. The noise generated by the equipment in any enclosure, including desktop equipment, located outside the computer Centre shall not exceed 50 dbA 1 meter (3 feet) from the enclosure. Sound-deadening enclosures shall be provided where necessary to meet these requirements.

1.0.4 Assembly and Component Identification

Each assembly in the system, to the level of printed circuit cards, shall be clearly marked with the manufacturer's part number, serial number, and the revision level. Changes to assemblies shall be indicated by an unambiguous change to the marked revision level. All printed circuit card cages and all slots within the cages shall be clearly labelled. Printed circuit cards shall be keyed for proper insertion orientation.

1.0.5 **Interconnections**

All signal cabling between component units of the computer systems shall be supplied by the Bidder. Plug-type connectors shall be used for all signal interconnections. The connectors shall be polarized to prevent improper assembly. Each end of each interconnection cable shall be marked with the cable number and the identifying number and location of each of the cable's terminations. Each cable shall be continuous between components; no intermediate splices or connectors shall be used. Terminations shall be entirely within the enclosures.

1.0.6 **Seismic Standards**

All equipment must conform to the latest uniform building code earthquake design standard. The design shall be for the current zone rating or zone four (4) as a minimum. No testing is required.

1.0.7 **Consumables**

The Bidder shall supply, at its own expense, all consumables required for use during all phases of the project through completion of the system availability test. The consumable items shall include as minimum:

a. Magnetic cartridges (DAT)/ MO-disks

b. Printer paper

c. Printer Accessories

d. Special cleaning materials

e. CDs/DVDs

f. Cable and Networking Accessories

1.0.8 **Other Peripheral Devices**

The Bidder shall supply any other peripheral devices or equipment normally provided for operation, software support, and maintenance for the proposed system as per the specification.

Chapter # 2

Software Requirements

2.0 General Requirements

2.1 System Software requirements

This section describes the software functions which need to be performed by the SCADA, ADMS and other systems to be procured under this project for Purchaser's Distribution network. These functions are directly concerned with efficient monitoring, Control and management of the entire power system operations.

Functions, software requirement in this section is applicable for all (SCADA & ADMS System applications). Bidder shall propose the software suit accordingly for required functionality.

This section describes the characteristics of system software such as Operating system, RDBMS, application suits and support software (programming language compilers, database development and maintenance, display development, network services, report generation, diagnostics and backup utilities) to be provided by Bidder and the original software manufacturer as necessary to support the SCADA & ADMS applications. The Bidder shall ensure that all necessary integration of SCADA & ADMS shall be based on Common Information Model (CIM) standards. The Bidder shall make use of common applications such as security, networking etc., in-line with Cybersecurity Standards/Guidelines ***(Refer Chapter # 13 of this section, Cyber Security Management System for further details)***. 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 be included in the offer.

System software shall be compatible and seamlessly integrate with Purchaser's 3rd Party system on standard interface / sockets / middleware etc. used in power utility.

2.2 Software Standardization

All software provided by the Bidder and third-party software, 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 (Software Engineering standards collection - latest edition), in order to facilitate maintenance and enhancement of the systems being supplied. The software shall comply with those widely accepted de-facto standards put forth by industry consortiums. The Bidder shall commit to meet the "open systems" objective promoted by industry standards groups by using non-proprietary software products.

All delivered software shall represent the latest available software versions. In addition, during project implementation, all software shall be kept current with the latest releases of

the specific standards that the Bidder has agreed to satisfy. Specific published standards available at the time of specification are set forth in the Specification where they apply.

All proposed software shall be completely maintainable by Purchaser using the software and documentation provided with the systems. Stringent design and coding standards shall be enforced for Bidder-produced software and software produced by sub Bidders for this project. Purchaser reserves the right to reject any software that does not conform to these standards.

The design and coding standards shall include the software documentation practices and shall be coordinated with the quality control procedures. The standards shall also address the following specific requirements:

a. **Scalability:** All software shall be dimensioned to accommodate the anticipated growth plan, as defined in this Specification. The dimensions and configuration of the software shall be established by parameters contained in files such that reassembly or recompilation shall not be necessary to accommodate the specified expansion.

The proposed system shall be designed for ease of expansion and alteration in a cost effective and efficient manner. Expansion includes adding and removing monitored and displayed quantities, adding and removing system functions and altering computer memory and input/output hardware. The system shall permit the compiling, debugging and integration of new software on-line with no interruption of normal system operations. One- line and tabular displays shall be generated, altered and maintained on-line.

b. **Modularity:** Software shall be modular to minimize the time and complexity involved in making a change to a program. The modularity required shall be as follows:

i. Logic and data shall be organized as distinct modules.

ii. Communication among programs for data or program control shall be symbolic rather than absolute so that all programs are essentially independent units.

iii. Each program, subroutine, or function module shall be designed with one entrance, one normal exit, and one error exit, consistent with structured programming practice.

iv. The structure of each program, routine, or function module shall be carefully controlled to ensure clarity of purpose to those who review the program documentation and code, and to ensure that each routine or module shall be limited to a single specific function.

v. Files shall be organized in the filing system such that all module files for a single program shall reside in one area.

c. **User-Directed Termination:** Functions taking long execution times shall recognize and process user requests to abort the processing.

d. **Programming languages:** The software shall be written using ISO or ANSI or ECMA standard programming languages like FORTRAN, C, C++, and RDBMS.

e. **Portability & Interoperability:** The software shall be designed for hardware independence and operation in a network environment that includes dissimilar hardware platforms. The use of system services software shall be built on Open standards.

f. **SOA architecture:** A service-oriented architecture is required for a collection of services required for achieving the functionality specified under this specification. The communication can involve either simple data passing, or it could involve two or more services coordinating some activity. Bidder shall ensure that connecting services for each the application / suite of applications are provided.

g. **Enterprise Service Bus (ESB):** ESB based architecture is essential to enable interaction of applications from different product manufacturer, platforms etc.

h. **Validation of Database Changes/Modification**

i. The System / Software linkages of every modifications in database / displays shall be highlighted in the PDS & QAS prior to roll out the changes into the production system.

ii. Facility to get a trail of each modification done in the system database.

i. **Software Management Tools and Services**

i. All SCADA & ADMS software management tools and engineering services, necessary to administer the SCADA & ADMS software system shall be provided such that no additional software or IT hardware should be required to configure or run each and every feature of the SCADA & ADMS system.

ii. To control operator access to unauthorized software or to the operating system, access to Windows "hot" keys such as Ctrl Esc, Ctrl Alt Del etc. will be limited by specific customization of users by the windows system administrator only.

iii. Inbuilt license management system with auto common repository and renewal alerts.

iv. Maintenance with condition-based report, supporting the periodic findings generated by the system with guidelines and WI to address the issues.

v. All the system application software/operating system shall support auto cleaning of unwanted and temporary files generated in the system with advanced warnings as a part of upkeep of the system and shall generate logs / reports for the same.

vi. During database configuration the system shall check automatically the standardization of text, duplication, repetition, and generate guidance for correction of the same.

j. **Speech Recognition Services**

The proposed Applications and System software shall support speech recognition services for data extraction and restoration.

k. **Switch over between MCC and BCC**

i. MCC and BCC system shall always be synchronized, the database shall always be concurrent in all respect.

ii. In case, where is a live changeover the system shall switchover with no loss of data/interruption to operator/no manual intervention

iii. The System/Software shall take care the racing between MCC and BCC to avoid floating of both the systems. In such a case the system shall detect hanging of the System / Software proactively and shut down the main system so as Backup Control Center become active.

2.3 **Operating System**

The Bidder shall use latest RED-HAT Linux or Windows Server operating system at server level, whereas all Workstations shall use Windows latest version (Windows 10 and above). The OS shall be tested, Proven with the offered Software & applications.

2.4 **CIM compliance**

The offered Software shall be CIM compliance for seamless data exchange between SCADA, & ADMS system, Purchaser's Specific applications, Purchaser's existing Geographic information system, Enterprise Historian system, Asset Management, Customer Information Systems, Network Planning System, SAP and other enterprise systems, bidder shall use Common Information Model (CIM, IEC61970 and IEC61968) to facilitate the exchange of power system network data between applications. The IEC 61970 and 61968 standards shall be used for defining in XML format for network model exchanges using RDF. Common semantic model and object-oriented modeling shall be used to construct the messages and network model that are used for communication between the applications. The network

integration shall address in detail to Node/Element level, not till Bus/Branch. Bidder shall submit their test reports on CIM, their product's compliance to CIM. The reports shall clearly show the profiles passed during the test. The bidder shall ensure that the integration shall be completely customizable for the purchaser's requirement rather being Bidder specific. Profiles and Equipment IDs shall be designed based on purchaser's requirement. The Bidder shall supply such a software suite/ Applications which are compliance to CIM and is also free to suggest the best method of integration using CIM for highest integrated operability performance of the system.

2.5 I/O Programs

I/O programs shall transfer data between main memory and the I/O devices. These I/O programs shall be designed to facilitate adding devices and shall provide the facility for dynamic device assignments, modifications, and deletions. The I/O software shall take advantage of the rated speed, error checking, and all other features of all I/O devices.

2.6 Time and Calendar Maintenance

The SCADA, ADMS and other system shall maintain Time and date for use by various software applications. The GPS based time receiver shall be used for synchronizing the SCADA & ADMS system time. All Servers and Operator workstation clocks shall be synchronized within the accuracy of +/-10 milliseconds. The SCADA & ADMS system shall not be dependent on a particular server for time /calendar maintenance. The SCADA & ADMS shall include two redundant time and frequency standards. Failure of the online unit shall result in automatic switching to the redundant unit. The SCADA & ADMS shall periodically check if the backup unit is operational and failure of either unit shall be alarmed. Bidder to ensure that all the SCADA and ADMS application uses IST standards for data modelling, logic building including data exchange with any third-party system using open protocols.

The frequency reading shall be accessible by SCADA & ADMS 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.

2.7 **Protocol Analyzer**

Capabilities shall be provided to monitor traffic between Front End Processor and RTUs/Gateway's/FRTUS in real-time; to search and filter the captured messages by RTUs/Gateway's/FRTUS and Scan Type; to view the raw and interpreted content of the messages; and to define filters to ignore messages until a specified Scan Type is received. Such real-time access to protocol information allows you to react quickly to changing conditions and to identify trends that can serve as indicators of future events.

Protocol Analyzer to be a built-in feature of SCADA/ADMS platform. Analyzer to be an essential tool for parsing and debugging protocol communications between the master station and field devices such as RTUs and IEDs (Intelligent Electrical Devices). As an accessible online tool on the SCADA/ADMS system, analyzer to eliminate trips into the field to gather information by providing detailed communications messaging information on familiar online screens within the Graphical User Interface.

2.8 **Common Network Topology:**

The Network Topology for data modelling shall be common for both SCADA & ADMS system. Modification in the data model shall reflect all the interface/linking data objects in both SCADA database and ADMS system at both MCC & BCC.

2.9 **Cyber Security:**

The offered software including 3rd party system shall be compliance to Cyber security standards (IEC62351, IEC62443 & ISO27001). ***(Refer Chapter # 13 of this section, Cyber Security Management System for further details)***.

The offered software including 3rd party system shall be comply to Cyber security compliance from CERT.IN empanelled agencies and any other notified MoP/Nodal agency /CEA from time to time Further, the equipment indicated in the MoP order no 12/34/2020-T&R dtd 08.06.21 & CEA/PLG/R&D/MII/2024 dtd 11.6.21 and any amendment from time to time shall be adhered to.

Chapter # 3

Functional Requirements

3.0 Functional Requirements

3.1 General Requirements

This section describes the functions to be performed by the SCADA & ADMS applications for Purchaser electrical network. Bidders are encouraged to supply standard, proven & tested products that meet or exceed the Specification requirements. Unless specified as optional functions / features; all functions / features mandatory for the required functionality.

Functional requirement mentioned in this section is applicable to both MCC & BCC. Bidder shall propose the software suit accordingly. Bidder shall go through the entire RFP to understand Purchaser's requirement.

Purchaser proposes Centralized Computing environment that assures adequate flexibility for the evolution of the SCADA and ADMS system for Distribution network. The SCADA/ADMS may run on an operating system compliant with the latest version of Red HAT Linux standards and derivatives or latest Microsoft Windows Server. Purchaser prefers to limit the use of latest Windows OS which includes Servers/Workstation OS for User Interface consoles and prefers Linux operating systems for all servers. Each operating system shall be a standard product and shall not be modified by the Bidder. Bidder shall refer both indicative BOM & GTP for more details.

The MCC and BCC computing environment shall be able to use both local area networks and wide area networks transparently taken care of all Cybersecurity measures and follow the Standards, such that there will be no restrictions on the geographic dispersal of applications and data among the servers of the SCADA & ADMS.

3.2 Design Requirements

The software shall be modular in nature. The software shall be platform independent and able to work on minimum 64-bit platform architecture. All the variable parameters of SCADA & ADMS, which require adjustment from time-to-time, shall be defined in the database and shall be user configurable. 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.

3.2.1 **Access to various functional applications**

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.

3.2.2 **Critical & Non-Critical Functions**

The functions defined in this specification shall be classified as Critical or 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 & ADMS Applications

b. Purchaser's Specific Applications

c. Information Storage and Retrieval (IS & R)

d. Data Integration & exchange between proposed SCADA & ADMS with 3rd Party Systems

e. Web server applications, Security applications

f. Cyber Security Management System

g. Integrated Communication Network Management system

The following are Non-Critical functions

a. Dispatcher Training Simulator (DTS)

b. Data exchange with Remote VDUs, if any.

3.3 **SCADA Functions**

The following minimum SCADA functions are envisaged under this specification.

a. Data Acquisition from Gateways, RTUs, FRTUs, FPIs from all Purchaser's Sub-Station Automation and field equipment/systems.

b. Time synchronization of Gateways, RTUs, FRTUs, FPIs (if time synch is supported in FPI) and field devices such as Numerical relays, Bay Control Units (BCU), Bay Control & Protection Units (BCPU), IEDs and other Condition Monitoring Systems.

c. Data Exchange among the bidder's supplied SCADA & ADMS system to/from other enterprise systems of Purchaser (in specified format (OPC (DA & UA) / CIM-XML / Secured ICCP / ODBC / JASON / RestAPI Format) Model & Data Exchange over Enterprise SOA Based BUS), other utilities Control Centre.

d. Data Processing

e. Continuous real-time data storage and playback

f. Sequence of event processing

g. Supervisory Control

h. Failsafe capability

i. Remote database downloading, diagnostics & configuration

j. CIM compliance IEC61968, IEC61970

k. Information Storage & Retrieval (IS&R)

l. Data recovery (DR)

m. GIS adaptor (GIS Land base data, network model using GIS engines/adaptors supporting Native Adapters, CIM/XML Model for Distribution System, using Model Exchange & Data Exchange over IEC 61968/70 over Enterprise SOA Based BUS)

n. The system shall detect loss of time synchronization of IEDs by comparing the time stamped SOE data of IEDs with the SCADA master time. Any deviation shall be alarmed.

o. Adaptors for OMS, WFM, SAP, AMI and other enterprise systems of Purchaser

The SCADA & Power System Application Design Parameters as per the required functions, the power system sizing, Performance requirements for complete SCADA & ADMS

Applications shall be considered as specified in this specification with future expansion. The SCADA & ADMS system shall have capability to accept data from the following sources:

i. Telemetered data received from Gateways, RTUs, FRTUs, NRs, BCPUs, IEDs & FPIs

ii. Data received from other existing / proposed / future enterprise systems / applications

iii. Data exchange

iv. Calculated data

v. Pseudo-data (Manually entered and Calculated data)

vi. GIS land base data, network model using GIS engines/adaptors

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 and used in other applications. 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.

3.4 **Data Acquisition**

a. Gateways/RTUs/FRTUs/FPIs located at substations and in Tata Power Mumbai distribution network. These Gateways/RTUs/FRTUs/FPIs communicates using the IEC 60870-5-104 profile. The SCADA & ADMS system shall support with this equipment over IP (Purchaser MPLS/VPN communication network & third-party wireless network).

b. Bidder shall also consider data acquisition from other devices on open protocols such as IEC61850, MODBUS, IEC 60870-5 profile 101, 103 & 104 protocol etc.

c. The Gateway/RTU at Substation level will have redundant Communication Processor which works on Hot-Hot / Hot-Standby Mode and will have different IEC104 Slave IP to communicate to SCADA. The proposed SCADA system shall support the same.

d. Computer systems connected to a computer network linking the SCADA & ADMS with the neighboring utilities, Load Control Centre, Enterprise Historian server, SAP, AMI etc. These systems communicate using the service-oriented architecture.

The SCADA & ADMS application shall support all features of all specified protocols (Server and Client) unless specifically stated otherwise. Bidder shall consider the appropriate integration tools to meet all the functional requirements of the specification.

A data source may collect data from more than one location (adjacent switchyard with a single RTU or a feeder, for example) or a location may have more than one data source (multiple RTUs in a substation). The SCADA shall associate telemetered data with the location rather than the data source. The identity of all data presented to the users of the SCADA shall include the location name including the source name, and, wherever applicable, data presentation shall be organized by location name rather than by source name alone. Purchaser shall determine the mapping of the location name and source name to the data source.

The Bidder shall identify any additional data that is required to accomplish the specified functions and to size the databases accordingly.

For SCADA & real-time data shall be collected from Data Concentrators, Remote Terminal Units (RTUs) / FRTUS / FPIs / other systems located at the various Sub-stations and field equipment of Purchaser. The data from field devices includes Status, Alarms, Control, Analog, disturbance record, condition monitoring data and SOE inputs.

All alarm and event messages generated by the SCADA & ADMS from field devices shall provide the name of the station from which the data is originated.

In addition to the real-time data collected from Gateways/RTUs/IEDs, the SCADA & ADMS computer system databases shall include provisions for the following types of data:

a. Calculated analog or status data generated by programs that periodically and non-periodically calculate database values based on other database values. The calculated data may be generated by programs that are part of the data acquisition function or any other power system applications.

b. Manually entered (Non-telemetered) Analog and Digital data by the user.

All quality flags applicable to real time data (e.g. monitoring against limits, detecting changes in state, enabling and inhibiting alarms, and displaying quality codes) shall apply equally to calculated and non-telemetered data.

3.4.1 **Alternate Data Sources**

The Data Processing specifies that analog and non-analog points shall have (the ability to have) multiple redundant sources (known as alternate sources), specified by priority. If the primary source of a point is not available, one of the alternate sources will be used. The resultant point shall allow up to min 8 sources to be defined with in different severity ranging.

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.

An option shall be provided to negate the value of a source within this configuration and no extra calculation or creation of points will be acceptable. One for the sources can be the State Estimated output of the point, a configurable drop-down shall be given to select SE value as an input to this resultant output point.

The Selection Mode (choosing the best source available) shall have two operating modes for each output point defined:

a. Automatic – In which the process shall chose the best available source based on Severity and Quality Ranking.

b. Manual – Ability to choose a source manually by the operator.

Operators shall have the ability to change the Priorities and Enabled States. Under these criteria, the operator shall be able to change the priority of the output point(s) on the fly as well as taking a source out of alternate data source processing. An event shall be generated when the operator choses to override the priority. The resultant value shall be able to store in historical database and shall be able to be used in reports and historical trending.

There shall be a separate display consisting minimum of the following:

a. Output ID

b. Output Point Name

c. Source1-8 Name

d. Source 1-8 Value

e. Source 1-8 Quality

3.4.2 **Periodic Scans**

Data shall be collected from the field devices by specifying the scan group address in the device poll message.

Status data shall be reported by exception and shall be updated and displayed within 1 second at SCADA & ADMS in worst case. Any discrepancies between field status and database shall be reported by an alarm message. Analog data shall be collected from Gateway /RTUs/IEDs at a scan rate of maximum 1 to 5 seconds depending upon number and type of

analogs data. Further the data collected from the Gateway/RTU/IEDs shall be updated on the SCADA & ADMS system within 1 sec in all circumstances.

Assumptions considered for Data Update are as follows:

a. The scan cycle shall be definable on Gateway/RTU/IED basis i.e., different scan rates can be assigned to different Gateway/RTU/IEDs

b. Status integrity check shall be performed as required

c. All scan cycles shall be on a rigid time basis with any failure to complete a scan within the designated time period resulting in data being marked with a quality code. Continuous failures of scans shall generate an alarm.

d. Provision for time synchronization shall be made at the specified interval. Time synchronization periodicity shall be user configurable (typically 15/30 minutes)

e. Provision for retransmission of data frame

f. SOE data transmission

g. Control Operation

The above assumptions are based on the protocol implementation at Master level. The frame transmission is as per protocol implemented at all levels of the SCADA network. All scan rates shall be monitored and any failure to complete a scan on time shall be alarmed.

The implementation of protocol shall be demonstrated during pre-offer demonstration (if any) and as well as during FAT & SAT. During site acceptance test bidder to demonstrate system performance and acquisition of data from Gateway/RTU/IEDs/Systems on all the protocols required under this specification.

3.4.3 **Demand Scans**

Each SCADA & ADMS computer system shall be able to collect any and all analog and status values (individually, as scan groups or collectively) from any of its Gateways, RTUs, FRTUs, FPIs on a non-periodic (demand) basis. Demand scans shall be initiated automatically and manually for DCU/RTU/IEDs whenever the following situations arise:

a. A change of status of Gateway/RTU/IEDs is detected

b. Gateways/RTUs/FRTUs/FPIs completion of a successful supervisory control action

c. On demand by a system function

d. Upon request by the user

3.4.4 **Telemetry Failure and Delete from Scan**

A failure to receive valid data from a data source in response to a scan request command shall cause a software commanded retransmission of data from that source. The number of re-scans to be attempted shall be user adjustable for each scan rate.

Manual replacement by Operator action shall be permitted for any telemetered or calculated point value, with database retaining the replacement value until data acquisition and processing of the point is resumed. Operator removal of any point or an entire data source from scan processing shall be permitted with retention of the last data received prior to scan processing suspension, until either scan processing is resumed, or a replacement value is entered by the Operator.

A quality code which shall be user configurable symbol or character shall be maintained in the database for each telemetered or calculated data value. The quality code shall indicate whether the point is being scanned and the data is valid, the point is experiencing telemetry failure, or the point has been removed from scan by the Operator. Calculated values shall have attached the most severe quality code associated with the data used in the calculation.

If valid data is not received from Gateways/RTUs/FRTUs/FPIs in response to a scan command, another scan request for data from that RTU/IEDs shall be issued. If valid data is not received from Gateways/RTUs/FRTUs/FPIs after a pre-defined number of retries, each point affected shall be marked with a telemetry failure quality code and an alarm shall be generated. If an entire Gateways/RTUs/FRTUs/FPIs or its communication channel fails, only a single alarm shall be generated. In the event of telemetry failure, all analog value and status shall be indicated with the bad quality flag for each affected point. The user shall be able to substitute a value in the database for any point that is experiencing telemetry failure. When telemetry returns to normal, the associated SCADA & ADMS computer system shall automatically resume updating the database with the scanned data.

If Actual status of Breakers / GOD's / Isolators are not updating on MIMIC (Due to any reason), user can create/simulate the actual condition.

The user shall be prohibited from entering a value for a point while the telemetry from that point is in scan and judged to be valid. On the other hand, the user shall be able to delete any point (or entire Gateways/RTUs/FRTUs) from scan processing and substitute a value (or values) for the data. Such points shall be marked with a delete-from-scan quality code and, as may be necessary, a manual entry quality code. When the user restores a point or Gateways/RTUs/FRTUs to scan processing, the SCADA & ADMS computer system shall

automatically resume updating the database with the scanned data. Delete from scan shall also apply to master station calculated points, in which case the term scan processing shall encompass the calculation of these values. Separate List shall be provided for delete-from-scan Alarms/Events with both time occurrence and return to normal, username, and workstation address.

3.4.5 **Data Acquisition via polling**

In data acquisition via polling, the SCADA/ADMS initiates the data collection by transmitting a scan request periodically to each scan group. Purchaser shall assign a scan periodicity and a start time to each scan group. The scan periodicity shall be set between 1 second and 3600 seconds to a resolution of one second. The scan start-time shall establish the time after the start of an hour that the first scan of the scan group is to occur. Start time shall be specified to a resolution of one second. The SCADA shall support parallel (concurrent) scanning of sources on multiple communications channels and over networks where the protocol supports concurrent exchanges (over TCP/IP networks).

3.4.6 **Spontaneous Reporting**

Unsolicited data acquisition is spontaneously initiated by data sources, typically when changes in input data (to the source) are detected or when processes within the data source determine that data should be reported (for example, periodically). The SCADA shall accept data transmitted from the spontaneously reporting data sources at any time and shall acknowledge the receipt of the data as required by the protocol.

3.4.7 **Demand, Programmable and integrity Scan**

In addition to periodic and spontaneous data acquisition, the SCADA shall acquire data from sources under the following conditions:

a. When requested by a user. (It shall be possible to define on any display, a cursor target that will initiate this “demand” scan.)

b. When initiated by an application.

c. Periodically for all scan groups where the data is acquired by report by exception. The periodicity of the integrity scan shall be user-defined for each scan group.

Each initiation of a demand, programmable, or integrity scan shall include parameters to specify the data source and scan group to be scanned.

3.4.8 **Enabling and Suspending Data Acquisition**

Users shall be able to suspend acquisition of ("remove from scan") any individual point, scan group, or entire data source. Suspended points scan groups, and data sources reporting spontaneously shall not be processed nor stored in the database. Suspended points acquired by polling may continue to be polled from the data source but shall not be processed nor stored in the database. Suspended data sources acquired by polling shall not be polled. It is preferred that suspended polled scan groups shall not be polled. When the user enables ("restores") the point, scan group, or data source, the SCADA shall resume polling the data and updating the database with the data.

3.4.9 **Telemetry Failure & Manual Substitution**

"Telemetry failure" is defined as any of the following conditions:

a. The inability of the SCADA to complete a scan group data collection within a timeout period defined for the scan group. The timeout period for each scan group shall be set between 1 and 60 seconds to a resolution of 1 second.

b. The inability of the SCADA to complete a scan group data collection prior to the next scan request addressed to the same scan group.

c. The inability of the SCADA to complete a scan group data collection due to errors in the communications with the data source.

Failed, polled scan groups with a scan periodicity longer than a threshold (initially 10 seconds) shall be immediately retried (without waiting for the next periodic scan time) and a "retry count" for the scan group shall be incremented. Failed, polled scan groups with scan periodicities less than the threshold shall not be retried, but the retry count shall be incremented. (The scan will be effectively "retried" at the next periodic scan time.) The SCADA shall generate an alarm when a telemetry failure occurs. The alarm shall describe the data source or scan group failing; the individual points of the scan group or data source shall not be listed.

The last good value of a point in telemetry failure (that value stored in the database immediately prior to the detection of the telemetry failure) shall be retained in the database.

The system shall enable Control Centre Engineer to apply temporary changes of the network structure without changes in the Database and re-initialization of the system. Temporary changes shall follow actual situation on the network (interruption of the line, providing

temporary supply line, grounding of the faulted part, temporary generators etc.) and be removed after problem is resolved.

3.4.10 **Backup Communication Channel Processing**

Purchaser's has redundant communication channel between master stations and the Gateways/RTUs/FRTUs/FPIs. If valid data cannot be acquired from one of these Gateways/RTUs/FRTUs/FPIs, the master station shall determine the likely cause of the failure. If it is determined that the source of failure may be the communications channel or associated communications channel interface, scanning of the Gateways/RTUs/FRTUs/FPIs shall automatically failover to the backup channel. A communications failure shall not cause a system failure.

The backup communications channel shall be tested periodically, without manual intervention, to determine its readiness to take over upon failure of the primary channel. An alarm shall be generated for any backup channel that is not ready to take over. A display shall be provided that shows whether each Gateway/RTU/IEDs is being scanned on the primary or backup communications channel. The user, via this display, shall be able to:

a. Force scanning to a specific channel (primary or backup)

b. Manually fail a channel

c. Inhibit automatic failover of communications

3.4.11 **Maintenance and Test**

The user of a SCADA & ADMS computer system shall be able to declare that any associated Gateways/RTUs/FRTUs/FPIs is in the maintenance mode. Placing an RTU/IED in maintenance mode shall generate an appropriate event message. When an Gateway/RTU/IED is in the maintenance mode, the real-time database shall retain the last value from all points collected via the Gateways/RTUs/FRTUs/FPIs before it was placed in the maintenance mode. The points shall be marked in the database with a quality code indicating that their source Gateways/RTUs/FRTUs/FPIs is in the maintenance mode. All system displays, programs, data links, and other devices shall use this value with the quality flag. Any control of equipment shall not be permitted when the Gateway/RTU/IED is in the maintenance mode.

When an Gateways/RTUs/FRTUs/FPIs is removed from the maintenance mode, a message shall be generated, the maintenance mode quality code shall be removed from all points assigned to the Gateways/RTUs/FRTUs/FPIs, the database values shall resume updating on each scan, and any controls for the Gateways/RTUs/FRTUs/FPIs shall be enabled. There shall not be any

restriction for putting any number of Gateways/RTUs/FRTUs/FPIs simultaneously in maintenance mode.

3.5 Data Reasonability

All input data and parameters, whether collected automatically or entered by a user / system maintenance engineer, 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 or used in any of the application. 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.

3.6 Data Processing

The SCADA & ADMS computer systems shall retrieve all data which is required for use by the power system operations functions. The requirements apply to all data collected from all specified sources.

3.6.1 Analog Data Processing

Analog data processing shall be performed according to the specified response time. Analog points that are transmitted to the master station shall be converted to the native engineering unit format of the master station before being stored in the database.

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

a. All / 33 / 11 KV loadings (Voltage, Current, Active Power, Reactive Power, Apparent Power, PF, Frequency, Energy Values (MW, MVAr Import & Export)

b. All TRF, DTs and STs loadings

c. All / 33 / 11kV KV Bus PT Voltages

d. All Sub-station loads (summated/individual) and Auxiliary Systems

3.6.1.1 Reasonability Limits

All Analog values shall be compared against high and low reasonability limits. The comparisons shall be performed at the scan rates of the Analog values. The reasonability limits shall represent the extremes of valid measurements for the point's value. 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. Reasonability limits shall be adjustable by the system maintenance engineer.

3.6.1.2 **Limit Monitoring**

All telemetered and calculated analog points shall be compared against limits that define various operating ranges for the variable.

Whenever a monitored point crosses a limit in the undesirable direction (i.e. away from the point's normal range of values), a limit alarm message shall be generated. The alarm message shall include:

a. Time of detection

b. Station name

c. Point name

d. Point value

e. Name of limit crossed

f. Value of limit crossed

Whenever a monitored point crosses a limit in the desirable direction (i.e., towards the point's normal range of values), a normal alarm message shall be generated. If multiple limits have been crossed since the last check, each limit crossed shall be reported.

Repeat fail block feature shall be provided in order to restrict the reappearance of alarms in the alarm list.

The telemetered and calculated analog data shall be compared against high and low operating limits each time the value is scanned or calculated. For directional quantities (positive or negative) there shall be a set of minimum two limits for each direction. Limit comparison shall be carried out only with respect to the specified limits.

The control Centre engineer shall be able to temporarily override an in-use limit by entering a new value. When the user overrides a limit, it shall be marked with an 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; a limit override summary shall be provided the lists with all overridden limits. Any change in alarm states resulting from a change in limit value shall be reported.

The system shall normally utilize default values of the operating limits entered by the user, which shall be stored in the database. It shall however, be convenient for the Operator to override any limit via an Operator display. A provision shall be provided to override a point's limit temporarily; this override shall be marked with a quality code with a user configurable symbol or alphabet. During normal operation, this limit override shall be propagated to the secondary site.

The limit monitoring software shall prevent annunciation of multiple alarms resulting from a point value oscillation about an alarm limit ('alarm chatter').

3.6.1.3 **Sign Conventions**

The following sign conventions for the display, data entry, and reporting of real and reactive power flow shall be used universally by all SCADA functions:

a. **Load** : Real and reactive powers flowing out of a bus towards the load are positive.

b. **Distribution Feeder (Incomer)** : Real and reactive powers flowing from one end to the other end of the line are positive.

c. **Network Transformer** : Real and reactive powers flowing from the higher voltage bus to the lower voltage bus are positive.

d. **Shunt Capacitor** : Reactive power flowing from the capacitor into a bus is positive.

e. **Shunt Reactor** : Reactive power flowing from the reactor into a bus is negative.

Feature of negation by Control Centre / Maintenance Engineer shall be provided at SCADA end.

3.6.2 **Digital Data Processing**

It shall be possible to associate each state of a digital input point with the state of an actual device. All the data shall be configured along with the quality flags. The following digital input data types shall be accommodated as a minimum:

(a) Single-state points: All protection, equipment (1-bit) alarms and Auxiliary system status e.g.

i. Transformer L/O Rly

ii. Incomer Feeder Protection Relay operation

iii. Outgoing Feeder Protection Relay operation

iv. 33 /11KV Bus Fault Rly (If available)

v. Under frequency L/O

vi. Under/Over Voltage Relay

vii. Earth Fault Protection Relay operation

viii. Auxiliary Systems – ACDB, DCDB, Battery Charger, UPS etc.

(b) Two-state points: All status points (2-bit). e.g.

i. All 33/ KV Line / Bus-Section / Transfer and Transformer Bkr and Disconnect status

ii. All Transformer LT Bkr and Disconnect status

iii. All 11 kV Feeder and Bus-Section Bkr and Disconnect status

iv. All RMU / FPI / Autorecloser & Sectionalizer Status

Unsolicited changes in state of telemetered and calculated digital input points shall be alarmed. The alarm message shall include:

i. Time of detection

ii. Station name

iii. Point name

iv. Description of field action (e.g., alarm messages for all intermediate operations associated)

v. Current state name

Control status changes, initiated by supervisory control shall not be alarmed, but shall generate event message. The event message shall include the same information as an unsolicited change-of-state alarm message, except that the event shall indicate that the state change resulted from supervisory control.

3.6.3 **Pulse Accumulator Data Processing**

Hourly accumulator data shall be retrieved every hour from each telemetered accumulator defined in the system. Completion of the retrieval process of all accumulator data shall be accomplished during an adjustable time window set by user entry. Initially, the time window shall be set from the top of the hour to one minute after the hour following the freeze request.

Hourly accumulator data shall be converted to engineering units using following algorithm:

Value = A * (Current Hour Scanned Value - Previous Hour Scanned Value)

Where 'A' is a user entered constant, unique to each defined accumulator point and 'scanned value' is the telemetered hourly raw value.

If any accumulator cannot be frozen, or if the accumulator cannot be scanned, the system shall substitute, if available, the appropriate integrated value from a periodic calculated point and tag the value to identify it as a non-telemetered reading.

The Master Station shall also be capable of retrieving and processing sub-hourly accumulator data. The collection of sub-hourly accumulator data shall be at user defined rates from 1 minute to 60-minute intervals.

3.6.4 **Calculated Data Processing**

Each SCADA & ADMS computer system shall be capable of performing calculations. The results shall be incorporated into the database as calculated data available for display. The database variables to be used for arguments and the mathematical functions to be used as operations shall be definable interactively at a console as well as by the system maintenance engineer using database creation and maintenance procedures.

The software shall be capable of inverting the state of a contact input point upon receipt of the telemetered data and before processing in the database. The software shall also be capable of associating either state of a contact input point (open or closed) with either state of the actual device (for example, open or closed breaker). The user shall specify point definitions individually. The system shall also accommodate non-telemetered points for use by Application programs, Displays, or reports.

3.6.4.1 **Generalized Calculations**

The user shall be able to define calculated analog values using database points as the arguments and mathematical functions as the operations. Functions such as addition, subtraction, multiplication, division, maximum value, minimum value, average, count, square root extraction, exponentiation, logical, trigonometric functions, logarithms, integration and other statistical functions shall be provided.

The user shall be able to define calculated status values using database points as arguments and combinational logic functions that include the logical operators AND, inclusive OR, exclusive OR, and NOT.

Suitable rules or operators (such as multi-level parentheses) shall be provided to indicate the sequence of operations in the calculation.

Standard Calc Function: Instead of writing separate calcs and running them separately, provision for creating calculated tags directly from the SCADA display to be provided.

Standard Calc Function: Instead of writing separate calcs and running them separately, provision for creating calculated tags directly from the SCADA display to be provided. Standard functions like add, sub, multiply, divide, comparison, if and else etc. should be available directly on calculated tags and to be available to users from the SCADA screen

Standard functions like add, sub, multiply, divide, comparison, if and else etc. should be available directly on calculated tags and to be available to users from the SCADA screen

3.6.4.2 **MVA and Power Factor Calculations**

The system shall provide built-in power system calculation functions for such quantities as MVA, KVA, Power Factor, Amps, etc. that are computed from telemetered MW, MVAR, and KV values

MVA and power factor values shall be calculated from MVA = SQRT (MW2 + MVAR2) and MW/MVA, respectively. The calculation shall be performed at the fastest scan rate of the component data.

3.6.4.3 **Megawatt and MegaVAR Integration**

Selected megawatt and MegaVAR values in the SCADA & ADMS computer system database shall be individually integrated at their scan rates over each quarter of an hour for each hour of the day. The quarter-hourly energy values shall be summed for each hour to compute hourly energy quantities. If any quarter-hourly data is substituted manually, the hourly value shall be assigned a corresponding quality code.

3.6.4.4 **Data Validity Tests**

Data validity tests shall be performed and shall generate an alarm when data changes from valid to invalid. A return-to-normal message shall be generated when the data again becomes valid. When invalid data is detected it shall be marked in the database with a quality code to denote the data is questionable.

3.6.4.5 **System Load and Interchange Monitor**

The megawatt load and net interchange (both import and export) for each constituent power system shall be calculated, at prevailing scan rates. System megawatt load, bus wise load, voltage wise load and interchange (both import and export) maximum and minimum values shall be retained by the SCADA & ADMS computer systems for 15

minutes, Half-hourly, Hourly, daily, weekly, monthly and yearly. Data shall be stored for minimum of 5 years.

3.6.4.6 **Feeder & Transformer Loss Calculations**

Feeder and transformer real and reactive power losses shall be computed for all Feeders and transformers where adequate telemetry is available to permit such computation. Examples of adequate telemetry are:

i. Real power flow measurement at both ends, for real power losses only

ii. Real and reactive power flow and voltage measurements at one end.

Necessary data required for the above computation will be provided by the user during detailed engineering.

3.6.4.7 **Mean Value Calculations**

The ability to calculate and display the mean and standard deviation values of user-selected telemetered and calculated analog points shall be provided. This shall include the ability of the user to enter the point names, sampling frequencies, and time periods of interest. The results shall be used to calculate, for example, the percentage of times the quarter-hour values of frequency are below 48 Hz for the month or yearly.

3.6.4.8 **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

3.6.5 **Meter Error**

The Bidder shall provide a calculation function or facility for meter error monitoring for, which Purchaser can utilize to compare selected MWH and MVARH telemetered pulse accumulator measurements with the periodic calculated MWH and MVARH integrated values. The function shall calculate the absolute magnitude of the difference between the integrated IN and OUT MWH values and associated telemetered IN and OUT MWH values. An alarm shall be generated if the difference between any integrated and associated telemetered IN and OUT MWH value exceeds a user entered value. The user entered value shall be configurable for each monitored point as an engineering unit or percentage, as defined by the user. The meter error alarm shall be inhibited if an insufficient number of samples have been received for the integration calculation.

The Bidder shall provide database entry procedures for adding or deleting points from the meter error monitoring function.

3.6.6 **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.

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 entry quality code from one of its component values.

The following are the examples of the data quality codes Test Mode, Telemetry Failure, delete from Scan, Reasonability Limit Exceeded, Limit Override, Questionable Data, Bad Data, Manual Entry, Alarm Inhibit etc. Provision for 10 additional user-definable quality codes shall also be provided.

3.7 **Time Synchronization**

The SCADA & ADMS system at MCC and BCC will be synchronized from the Central Time Synchronization system GPS based Time and frequency system. The SCADA system shall synchronize the time of all connected Gateways/RTUs/FRTUs/FPIs every 15 minutes (user configurable from 5 minutes to 24 hrs.) using time synchronization message in the IEC 870-5-104 protocol / NTP / SNTP. Further all Field devices such as IEDs/BCPUs/BCUs etc. shall synchronized through Gateways/RTUs/FRTUs.

Control Centre equipment shall synchronize the Sub-station end equipment i.e. RTUs/Gateways/BCUs/BCPUs/IEDs. These equipment/devices will be synchronized primarily from the MCC GPS system directly as a first priority and BCC Time synchronization as Second Priority.

All servers / Workstations at MCC, BCC, Sub-stations shall be synchronized using NTP / SNTP. The system shall generate alarm if any discrepancy is observed between the timing of the integrated system.

a. All system supplied shall use IST.

b. Redundant global positioning satellite receiver, including antenna, shall be furnished with the system for MCC and BCC. The SCADA & ADMS system shall receive the time reference from the GPS receiver and shall synchronize the time on all nodes on the SCADA/ADMS control network.

c. In case of failure of the GPS receiver, Backup receiver at Nodal Control Center shall act as the reference until the own GPS receiver signal is restored and vice versa.

d. The system shall use the Network Time Protocol (NTP) for time synchronization between the systems. Each node on the network shall run the NTP process that synchronizes the node's system clock to that of the other nodes on the network.

e. Time synchronization with RTUs/Gateways/BCUs/BCPUs/IEDs shall be done at startup and periodically.

f. The system shall detect loss of time synchronization of IEDs by comparing the time stamped SOE data of IEDs with the SCADA master time. Any deviation shall be alarmed.

g. The maximum time error at any time between Gateway, RTU, MMI and other IEDs shall be less than 2 milliseconds.

3.8 **Data Presentation**

The SCADA & ADMS computer systems shall provide the ability to display data via workstations, printers, and on Large video screen and to store data in appropriate logs. The computer systems shall provide the ability to display and log any data value in the system via any of the system devices and to transmit data to other computer systems regardless of the source of data, the frequency of its collection, or the means used to store it in the database. This requirement includes the following types of data:

a. All workstation shall have all static information such as static display, report template etc. Only they shall fetch the dynamic data from the servers. This includes workstation located at Remote location.

b. Telemetered data received from Gateways, RTUs and other computer systems

c. Calculated data

d. Manually entered data

e. Data in main and auxiliary memories, including purchaser's database management system, applications developed in-house by the purchaser and operating parameters

f. Data generated by system functions

g. Text data such as alarm messages, event messages, Control Centre Engineer notes, and data exchange messages.

3.8.1 **Dynamic Data Representation**

Device status or data values shall be displayable anywhere on the screen, excluding dedicated screen areas such as the display heading. There shall be no limitation on the number of data items presented on any display, up to the physical limitations of the window or screen. Similarly, screen locations for cursor targets shall be unrestricted.

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

a. Numerical text that presents analog values; the format definition of the text shall include the number of characters, number of decimal places, and the use of sign or flow direction arrows.

b. Display of analog values in amperes; the user shall have the capability to request replacement of MW and MVAR values with calculated amperes and direction on the transmission/distribution system and substation graphic diagrams. The calculated quality code shall be displayed with the value.

c. Symbols, including alphanumeric text strings for a single item, based upon state changes.

d. Symbols, including alphanumeric text strings for multi-state items, based on flag fields where each flag represents a condition or a state and where multiple states may be true at any time, e.g., data quality flag fields for both telemetry failure and alarm inhibit may be simultaneously set for an item.

e. X-Y and X-t point relationships with vectors connecting the points, e.g., trending and other plots.

f. Filled polygons (X or Y-axis inside the polygon showing the percent of full scale of the variable), e.g., bar charts etc.

g. Filled arcs (circular arcs of 90, 180, 270, and 360 degrees times the percentage of full scale of the variables), e.g., pie charts or simulations of meter movements.

h. Colors, textures, and blink conditions based upon state or value changes or a change of data quality, e.g. alarm limits.

i. Combinations of the actions listed above, e.g. change a bar chart color when the data value exceeds the limit.

j. Only standard X Window system fonts shall be provided with the SCADA/ADMS. All fonts supplied shall be supported on the user interface devices and all printers supplied with the system.

k. Time date and Frequency shall be displayed on a screen-basis, not on a display basis, and shall be always visible.

Additional features like Declutter levels; Display Navigation; Panning; Zooming; Element Highlighting must be possible.

3.9 **Function and Data Access Security**

After a user has successfully logged on, access to the SCADA/ADMS functions, displays, reports, and database elements shall be restricted by pre-assigned operating jurisdictions. These operating area assignments shall be made when the function, display, report, or database element is defined. Area of Responsibility (AOR), User permissions and workstation console restriction access control facilities shall be established during login.

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

a. Calling a display

b. Entering or changing display data

c. Tagging

d. Alarm acknowledgement

e. Supervisory control

f. Console Changeover

g. View-only, editing, or printing a report

h. Web browsers from each operator console & remote VDUs

i. Switch Over between System/ Control Center

j. Web clients /Dashboards

Each user login and logout attempt-success or failure shall be logged in an activity log maintained on the servers and also recorded as a system event and posted to the event log. An alarm shall be defined after a configurable number of unsuccessful attempt to login. Each user action shall be recorded in event log and identified by username. A feature shall be available to automatically log off the user or lock the workstation after a predefined period of inactivity to safeguard against users who may leave workstation unattended.

During the Log-off process, if the user is not a view only user, the system shall, by default verify that at least one other user still logged in to SCADA/EMS system has responsibility for each of the areas within the exiting user's AOR. If the user attempts to leave the system without another user having responsibility for each of the exiting user's AOR area, the user shall be prompted with a warning dialog before actually performing the log off sequence. If the user chooses to continue the log off process, an alarm shall be generated for each area that is left uncovered. An option to assign all of the uncovered AORs to a default user shall be provided.

3.9.1 **Area of Responsibility (AOR)**

Area of Responsibility shall be responsibility groups that are defined on a system wide basis. An AOR shall be comprised of one or more logical areas or functions grouped together to form a responsibility matrix for the operation of the electrical network. A user shall be assigned to a specific AOR and the AOR assigned to a user shall determine the responsibilities of the user within the SCADA/ADMS system. The AOR assigned to a user will establish the access capabilities of the user.

The system shall be flexible to define the AOR in all aspects such as View-only, edit/modify, limited/full display view, limited /full data access, etc. The system should not have any limitation and flexibility in terms of Number of Users, Grouping of AOR, bridging of AOR, Customized dashboards, Limited data view temporary assignment of AOR.

3.10 **Data Exchange**

The SCADA & ADMS computer systems shall be able to exchange various types of data within the specified response times, using the assigned priorities. The data shall include telemetered data and all other information that is required to meet the functional requirements of the Specification.

Data exchange shall utilize the communications system provided by the user and shall require the SCADA & ADMS computer systems to support:

a. Integration of SCADA & ADMS computer system to other Purchaser's systems as specified in this specification (e.g. GIS, Enterprise Historian & AMR, CYMEDist etc.).

b. Data exchange with other utilities and systems

c. Data exchange between SCADA & ADMS and Enterprise systems such as SAP etc.,

d. Data exchange with Purchaser's intranet

e. Data Exchange with Renewable Portfolio

f. Data Exchange with IMD and equivalent agency Weather monitoring system

Data exchange shall support the collection of real-time power system data (including calculated and manually entered data) automatically at Gateway/RTU scan rates as well as on user demand. The bidder shall determine and shall subsequently utilize data transmission rates that satisfy specified performance requirements.

Data exchange shall allow other information to be transferred periodically or on demand between SCADA & ADMS computer systems to any other system in the Purchaser network. This shall include but shall not be limited to the transfer of user-defined text messages, reports, power system information, substation graphic displays, tabular displays, and operational data.

The data exchange function with other utilities shall use the Secured ICCP protocol as specified in other section of this specification. This is to ensure that standard methods can be used to establish priorities between different types of data exchanges, so that critical real time data transfer will not be delayed by large file transfers of other type of non-critical data. Minimum requirements for the application layer shall include:

i. Secured FTP

ii. RDBMS for database access

3.11 **Continuous Real-Time Data Storage and Playback**

All real-time data shall be continuously stored in auxiliary memory for at least 30 days.

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 System shall be able to Playback the alarm/event pages along with SLD and network diagram during playback time.

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

The display shall show playback Event & Time during playback of the SOE. Playback time stamp widget should show SCADA time along with historical time during playback.

3.12 **Sequence of Event Processing**

Sequence-of-events (SOE) data shall be collected by the SCADA & ADMS computer systems for subsequent review by relevant user personnel. The SOE data shall be time-oriented listings of status change events collected from Gateway /RTU. The time difference between events shall be resolved within one millisecond.

The system shall collect the SOE data during channel idle time to minimize normal scanning activity. The collected SOE event data from the RTUs shall be stored in an ODBC accessible format for later analysis and report generation.

The SOE capability is not to be a substitute for normal status point scanning. The system shall report status changes for SOE points in the same manner as non-SOE points.

SOE data collection shall not interfere with periodic data acquisition or supervisory control actions. If, during normal scanning, the Gateway/RTU/IED indicates that its SOE buffer is approaching the design capacity by a pre-determined margin, the SCADA & ADMS computer system shall transmit a priority scan to the Gateway/RTU/IED in order to retrieve the SOE data. An acknowledgement of receipt by the SCADA & ADMS computer system shall be made prior to the loss of any SOE data in the Gateway/RTU. An additional indication shall provide the status of the Gateway/RTU/IEDs SOE data buffer overflow.

The description of each event shall include the database description name, device state, the date, and the time (to the nearest millisecond) of each event.

Events shall be displayed and logged in chronological order. The user shall be able to select the display of events by Gateway/RTU/IEDs, station, or the entire power system covered by the master station's Gateway/RTU/IEDs. The user shall also be able to deactivate and reactivate the storage and reporting of events for individual Gateway/RTU/IEDs and individual points within an Gateway/RTU/IED.

Extraction of SOE shall also be possible from Time Series Historian.

The facility to transfer SOE data from one system to another system shall be possible.

3.13 **Supervisory Control**

The Control Centre engineer 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 Sequence. The system shall be user configurable for auto popup messages before executing operations on critical equipment.

After selection of the equipment, Control pop up window shall appear, and the cursor on the pop window by default be placed on the intended state (Close/Open) of the breaker/eqpt control.

The system shall provide the real-time situational awareness, after selection of the equipment, for making decision of operation/alternate step. This situation shall be processed after capturing the real-time scenario of that instant.

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 Control Centre Engineer confirms that the correct point and control action have been selected.

Provision to view equipment technical details like capacity/length/Protection details by double click on that equipment i.e. Breaker/GOD

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

It shall be possible to issue control commands as a group control from SCADA where switching devices pertaining to different RTUs/FRTU/IED or a RTU/FRTU/IED may be controlled as a group. The SCADA system shall send the control commands sequentially (without Control Centre Engineer intervention or with a single click), if the commands pertain to switching devices in the same Gateway /RTU/FRTU/IED, using the Selection Check before operate (SCBO) of prior–to-execution. The control commands pertaining to different Gateway /RTUs /FRTUs/IED may be executed in parallel.

Group Command Issue - Each group command should be executed only after confirmation by operators for elements configured in that command. Provision of creating multiple group command (Save Case) and one symbol in Display for each Bay. Symbol should execute respective group command either open or close before that status of device should appear.

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 Gateway/ RTU /FRTU/IED 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 & ADMS 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 Gateway / RTU / FRTU / IED / FPI data acquisition function.

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

a. The requested control operation is inhibited by a tag placed on the device

b. The device or S/S in local manual control mode

c. An Uninitialized, Telemetry failure, delete from scan, manual replaced, Test / maintenance, or Manually Entered data quality indicator is shown for the device

d. The Operating Mode / user permission of the workstation / console attempting control does not permit supervisory control

e. The device is already selected for control request or control execution is from another workstation / user / window / console or control request is progressing

f. Time out after selection

g. 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 Control Centre Engineer.

3.13.1 **Single-bit Control (Relay Reset)**

A digital control output results in the activation of an output relay in an RTU/DCU through IED/Relay such as LOCKOUT RESET (86A, 86B, 96) Commands of Various Master Trip Relays. 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. Control requests shall be cancelled, 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. It shall not be possible to select a command into the second state for these devices.

3.13.2 **Double-bit Control (Switching Devices)**

The user shall be able to select and operate the two-state controllable switching device i.e. Circuit breakers, Motorized Isolators, Motorized Earth Switches and Local Remote Switches etc. Three-state points may also be commanded only into one of two states. It shall not be possible to select a command to a third or fourth state for three-state points.

3.13.3 **Raise/Lower Control (Incremental Control)**

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 system to generate an alarm.

The tap position control shall be initiated using the confirmation-of-selection, prior-to-execution procedure specified for switching devices. However, it shall be possible to command repeat raise or lower actions without re-selecting the device on the Operator display.

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/IED 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 system after a programmer-adjustable time period elapses after the last raise/lower command. This multi-step procedure is described below

a. The RAISE and LOWER pushbuttons shall be displayed.

b. 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.

c. The RAISE/LOWER pushbuttons shall remain available until either (a) the Control Centre Engineer clicks the CANCEL button or (b) the control times out due to inaction by the Control Centre Engineer.

d. 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.

3.13.4 **Time Delayed Control (Two and Three State Control)**

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. The interval shall be determined by Purchaser and specified individually for every device subject to delayed close. A message shall appear if an

attempt is made to operate the device prior to expiration of that time period & Control Centre Engineer is required to give command after expiration of inhibited time period.

3.13.5 **Set Point Control**

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

3.13.6 **Automatic Supervisory Control**

The Automatic Supervisory Control (ASC) function shall permit multiple supervisory control commands to be programmed for automatic execution in a predefined sequence.

Commands to be supported shall include:

a. All supervisory control commands

b. Pause execution for a given time delay

c. Stop execution until a user commanded restart or continue

d. Conditional check before execution

e. Jump (pass control to another ASC sequence)

f. Manual Entry

After executing a supervisory control action, the SCADA/ADMS 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/ADMS shall terminate the execution of the ASC 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/ADMS shall not introduce any artificial delays in the execution of an ASC command sequence.

No limit shall be placed on the number of ASC command sequences, which may execute in parallel. The following manipulation of ASC lists shall be possible:

a. Display a catalog of the lists

b. Display, build, copy, edit, and delete a list

c. Name the list and enter a description

d. Store the list

e. Select the list for execution

f. Execute the list

At any time during the execution of a list, the user shall be able to stop further execution via an ASC cancel feature.

In addition, telemetry and control permissive checks shall be incorporated in the sequence with user override capability. Upon failure of the telemetry and control permissive checks, the ASC sequence shall pause and require user interaction. Resumption of the ASC sequence at any point shall be provided.

Initiation of any ASC list shall be recorded as events, and events shall also be recorded noting the time of any “stop”, “continue”, or “cancel” command. All control malfunctions and control commands successfully completed shall also be recorded as events.

If the user is using a list to perform a repetitive function, such as issuing setpoints, the user shall be allowed to inhibit event messages for the sequence.

3.13.7 **Control Permissive**

The Supervisory control function shall perform a permissive check immediately after the user has selected the device and control action. The presence of any, all, or none of the following conditions for the selected point shall be deemed as a failure of the check:

a) The feedback point for the control point is in the state to be realized by the control command

b) A status value from the SCADA/ADMS database, designated for each controllable point, evaluates as true

c) A tag with a supervisory control inhibits property is set.

If the permissive check fails, the user shall be informed of the failure by a message that clearly indicates the permissive failure and that differentiates among the check types. The user shall be presented with the options of canceling the control action and of overriding the permissive. If the user elects to override the permissive check, the message presented for the execute step and all records of the control action shall clearly indicate that the user has overridden the permissive check.

If the permissive check passes, the control sequence shall proceed to the execute step.

Where a supervisory control action is initiated by a Bidder- or Purchaser supplied application (via the programming interface, Open Systems Interfaces, the interface shall include features

to report the presence of a control inhibit tag and to accept override commands from the application.

3.13.8 **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 Control Centre Engineer shall be able to execute this sequence. Commands to be supported shall include:

a. Time delayed

b. Pause & until a user commanded restart or step execution

c. Jump to other sequence on certain conditional logic

d. Manual Entry

e. Equipment (Breaker) engaged in group command sequence should not be available to any other operator during execution of control sequence. Completion message shall pop-up after completion of the sequence

After executing a supervisory control action, the SCADA & ADMS 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 & ADMS 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 & ADMS 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.

3.13.9 **Control Inhibit**

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. Tags shall be preferably identified by colors. However, distinct symbols /shapes after approval from Purchaser may also be used.

b. Tag priority

Further the user shall be able to place at least 6 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.

c. Safety Tag Implementation

i. Purchaser specific Tag system need to be implemented

ii. Tagging system shall be built on Parent/Child logics as per the network modelling

iii. Feature of Sticky Notes to be Replicated in Tagging System

iv. Symbol of tag should be clearly visible. If three tags are placed, all should be visible and there should be provision for entering related description which should be displayed after double clicking on respective tags.

v. Number of tags placed on the equipment shall be clearly visible on the screen.

vi. Shiftwise/Adhoc Report for Tags Existing in System

vii. Taking Mouse over equipment in all mimics should display all tags placed on that equipment

viii. AOR for Safety Tagging (Control Centre Engineer) thereby ensuring addition/deletion by Control Centre Engineer only. Colour and text of safety tags should be configured as per Purchaser safety tags.

ix. Breaker's Tag symbol should change colour if any tag is applied in breaker.

x. This tag should be equipment linked and to be reflected in all mimics where that equipment is displayed.

xi. Dynamic Network Colouring for: Dead Bus, Line one end open and Line both ends open, HT Open, LT Open, Both Open, Grounded

xii. All alarms generated for equipment with release/operating permit tags should not appear in operational viewpoint, it should be automatically transferred to event list. After removal of tags all active alarms must appear in online alarm viewpoint

3.13.10 **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, ADMS applications etc., the successful completion of all device control actions shall be reported via a single message. If the operation is unsuccessful, the user shall be informed of those devices in the group that failed to operate.

3.14 **Failsafe 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%.

The SCADA & ADMS computer systems shall be designed to ensure that the critical functions are always operational under all system loading conditions. However, in case of system loading in excess of the peak loading conditions, the performance of these critical functions shall not be degraded. Non-critical functions are those that support the maintenance and development of database, application software and the training of users.

During excessive loading conditions system shall optimize the use of system resources to ensure adequate resources for data scanning, data processing and alarm handling between scan times.

3.15 **Intelligent Alarm Processing**

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

a. Telemetered or calculated value limit violations

b. Values returning to normal from a limit violation state

c. Uncommand changes device status

d. Certain application program results

e. Data source communication errors resulting in loss of data

f. SCADA system hardware or software failures.

Each alarm shall be subjected to a series of alarm processing functions. A device or value's alarm conditions shall be assigned to an alarm category. All alarms shall be assigned to an alarm type. Alarms shall also be subjected to advanced alarm processing. The results of the alarm processing shall determine the console(s) that will receive and be authorized to respond to the alarm and the alarm actions associated with the alarm. Details of these functions are specified below:

Intelligent Alarm Processing - (Single Alarm for multiple events) and option to navigate from main alarm to their cause. Intelligence required rather than only filtering

Separate bins shall be provided as per the alarm categories. Reserved space shall be provided on the console at least for 10 latest high priority alarms.

If the front view is used as a World Map (SCADA & ADMS), Station name shall start blinking along with the audio to draw the attention of the Control Centre engineer. Control Centre engineer shall be able to access the alarm list by clicking the station name. Logical functions shall be supported for generation of alarms. Proposed alarm utility shall use the artificial intelligence to present the alarms in any emergency condition. During emergency condition only, the main alarm leading to failure/non-availability of power to consumer/ shutdown/ bus fault etc. conditions shall generate a relevant alarm on the operator workstation. However detailed alarms list shall be available for further analysis and corrective action by

the Control Centre Engineer. Bidder to provide the details of the proposed Alarm application along with the offer.

3.15.1 **Alarm Categories**

An alarm category provides the logical interface that connects an alarm condition to a specific Area of Responsibility (AOR) and priorities as defined and accordingly alarm shall be reported to user. Every alarm shall be assignable to a category. Each category shall, in turn, be assignable to one or more consoles/users. The following alarm category features shall be provided:

a. Each alarm condition in the database, including calculated values, non-telemetered data or devices, and data associated with applications functions, shall be assignable by a system maintenance engineer to an alarm category. Assignment of alarms to multiple categories shall be allowed.

b. Any or all categories may be assigned to any or all consoles.

c. Console failure shall result in automatic reassignment of categories to other consoles in a predefined manner and the generation of an alarm.

d. Alarm interactions shall only be permitted at consoles to which the alarm category has been assigned.

e. It shall be possible to assign one alarm condition of an item to one category and another alarm condition of the same item to another category. For example, an item's limit violation could be assigned to an operations category while the same items out of scan alarm could be assigned to a maintenance category. As another example, the warning level of an item's limit violation could be assigned to a minor operations category and the emergency limit assigned to a major operations category.

f. At least 20 categories shall be definable.

3.15.2 **Alarm Types**

Each alarm shall be assigned to an alarm type or priority level. The alarm type assignment shall determine how the alarm will be presented, acknowledged, deleted, and recorded. Up to 24 alarm types shall be supported. For each alarm type it shall be possible for the system maintenance engineer to independently select any of the following actions:

a. Audible annunciation

b. Display annunciation

c. Visual annunciation on the video projection system

d. Alarm message routed to alarm window

e. Alarm message displayed on an alarm summary with count

f. Alarm message deleted when acknowledged

g. Alarm message deleted when return-to-normal alarm occurs

h. Alarm message deleted when return-to-normal alarm is acknowledged

i. Alarm message deleted by user action.

As an example, the system maintenance engineer shall be able to create major and minor alarm types. A major alarm type could be provided for alarms displayed in a specific manner and requiring immediate attention. A minor alarm type could be defined with the same display definition as the major alarm type except that minor alarms would be deleted when acknowledged.

3.15.3 **Intelligent Alarm Management**

Nuisance alarms often clutter and obscure an Control Centre Engineer's view of critical information, with potentially severe consequences, the Intelligent Alarm Management System (IAMS) shall suppress nuisance alarms and provides valuable advisory information to help the Control Centre Engineer focus quickly on important alarm information and take correct, quick actions.

IAMS shall produce automatically a diagnosis when a fault event occurs in the network. Typically, a fault event creates an alarm peak and the Control Centre Engineer would have to look at up to hundreds of alarm messages. The IAMS should make an immediate, online analysis within a few seconds after a case of network trouble, so as to provide the Control Centre Engineer with sufficient information concerning the nature and the consequences of the trouble (System Alarm Analysis). The diagnosis shall include the faulted equipment and the behavior of the protection system. The system should be fully integrated into a large supervisory control and data acquisition system for power distribution networks and has to work in a real-time environment, as it will be used as an on-line tool. The diagnosis should be based on:

a. Actual network topology

b. Changes of breaker status (changes of topology)

c. Models of the installed protection system

d. Alarms of the protection system

e. Temporal behavior of the protection system

In case that more faults occur within a short time period, the system shall be able to manage this kind of scenario and to come up with an appropriate diagnosis for all faults, which have occurred.

The diagnostic reports have to be created by the system using an appropriate strategy to come up with all faulted equipment, the behavior of the protection system (operation of protection systems, unsuccessful operation) and the time the fault occurred. It should support the Control Centre Engineer to decide what operating actions should be taken, if any, either to correct the problem or to avoid getting into an even worse situation.

Desirable features of the alarm management function:

a. Alarm system shall be built on Parent/Child logics as per the network modelling

b. Minimization of nuisance alarm messages (e.g., repetitive alarms for the same alarm condition)

c. Combining of related alarm messages

d. System shall provide repeat-fail-block for continuous alarm toggling from field

e. Prioritization of alarm messages

f. Highlighting of the most urgent messages

g. Provision to segregate alarms where common point is used for multiple alarms.

h. Intelligent Alarm Search like search engine with option of selecting different stations through checkboxes

i. SOE/Alarms on occurrence shall be transferred to a common bin automatically for analyses at later time

j. Suppression of alarms based on related alarm conditions

k. Evaluation of related alarm conditions to determine the true alarm condition.

l. Appending comments to any alarm message and storage in IS&R.

m. All alarms and event messages are presented in alarm and event summaries shall use their class (priority) color. The same color shall be used for both active and historical alarms of the same class.

n. In the list of Active alarms, the critical alarms only shall pop-up at least every hour with same time & date of first origin, so that the critical alarms will be attended on urgent basis.

o. The user shall be able to export the alarms to Microsoft Excel and PDF any of the following options:

i. Export All Rows available in the online alarm database.

ii. Export Only Visible Rows within the view

iii. Export Only Selected Alarms.

Regardless of the alarm management technique used, all alarm messages shall be recorded on auxiliary memory for replay, review and printing upon demand by the user.

The Bidder's proposal shall describe intelligent alarm management features.

3.15.4 **Alarm Interactions**

The user shall be able to perform the alarm interactions as described. These actions shall be permitted only for those users that are assigned the alarm's category. The user shall be able to perform these actions for telemetered, calculated, and program-generated alarms.

3.15.5 **Alarm Inhibit / Enable**

The system shall provide capabilities for the Operator to inhibit and enable alarm processing for any point or Station without effecting the processing of the data. If an alarm condition is detected for a point for, which alarm processing has been inhibited, there shall occur no audible or visual annunciation, message printing or alarm indication on any Operator display. Normal alarm processing shall resume when the point alarm function is again enabled. An alarm inhibit tag/quality code shall be attached to all points for which alarm processing has been inhibited. All points for which alarm processing has been inhibited shall be displayed on an alarm inhibit summary display. There shall be provision in the system globally to have Alarm Inhibit action such as Ignorance which shall not generate any log messages.

Inhibiting alarms for a value or device, including a complete Gateway /RTU/IED or other data source, shall cause all alarm processing of that value or device to be suspended. Scanning of the value or device shall continue, however, and the database shall be updated.

Alarm inhibiting shall cause the SCADA system to:

a. Cease all further alarm annunciations for the value or device including symbol blinking or highlighting. The value or device status shall continue to be updated on all displays.

b. Present an alarm inhibit quality code next to the value or device on every display containing the item that is alarm-inhibited

c. Add a message to the alarm inhibit summary

d. Record the time alarming was inhibited. Alarm messages generated prior to the alarm inhibit shall remain and shall require user acknowledgement and deletion.

Alarm enabling shall cause the system to:

i. Resume normal alarm processing and annunciation

ii. Remove the inhibit message from the alarm inhibit summary

iii. Remove the alarm inhibit quality code from the value or device

iv. Record the time alarming was enabled.

3.15.6 **Alarm Acknowledgement**

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

a. Any display showing the item in alarm

b. Any display showing the alarm message.

It shall be possible to acknowledge alarms individually, by display page, or by user-specified block.

When an alarm is acknowledged, blinking of the alarm condition on displays and console visual indicators shall stop and the audible alarm shall be turned off. The console alarm priorities links shall be turned off when all alarms in the categories assigned to that console have been acknowledged.

When a return-to-normal alarm is acknowledged, the return-to-normal alarm message and its associated alarm message in the alarm summary display shall be removed. The remaining messages in the display shall be realigned to present a continuous listing of alarms.

3.15.7 **Audible Alarm Silencing**

Upon user command, the audible alarm annunciation shall be suppressed. Alarm audible suppression and enable operations shall be reported as events. The default suppression technique shall suppress the audible alarm only for existing alarms. New alarms shall again sound the audible alarm.

The system shall support multiple Wav files for managing different severity alarms and shall support sound customization.

A separate user action shall result in the audible alarm being suppressed for existing and new alarms. This condition shall affect only the workstation at which the action was initiated, and an indication of the suppression shall be presented on all displays at that workstation so that the user is clearly informed of the condition. The suppression shall be removed by a user action.

3.15.8 **Alarm Message Deletion**

Once an alarm has been acknowledged, the user shall be able to remove the alarm message from the alarm summary display and the alarm field with the proper authority (System administrator). Deleting an alarm message shall not cause the alarm condition highlighting of the value or device on associated displays to be deleted. The alarm condition highlight shall be shown until the value or device returns to a normal condition. Following deletion of an alarm message, the remaining messages on the alarm summary display shall be realigned to present a continuous listing of alarms. It shall be possible to delete alarms individually, by display page, or by user-specified block.

3.15.9 **Change Alarm Limits**

The control Centre engineer shall be able to change the alarm limits with proper authority. Alarm shall be generated as soon as the limits are changed by the Control Centre Engineer / Maintenance Engineer. When the user selects an item to change its alarm limits, a menu showing the alarm limits currently in use and a data entry field for the revised limits shall appear. All changes to alarm limits shall be subjected to data entry error checking and recorded as events. The event message shall include the old and new limits. System shall store the old and new setting changed by the Control Centre Engineer as an audit trail.

3.15.10 **Alarm Presentation**

Alarm presentation shall be determined by the alarm's category and type. The alarm class assignment shall determine how the alarm will be presented, acknowledged, deleted, and recorded. The alarm class shall determine how the following alarm presentation and management characteristics are to be employed:

(a) **Audible annunciation** – Enable/Disable, single stroke or repeating, which tone (if multiple tones are available)

(b) **Display annunciation** - For schematic diagrams – symbol change, color change, inversion, or no change, and flash/no flash for both unacknowledged and acknowledged alarms

For message displays (such as an alarm summary) – message color and flash/no flash.

(c) Presentation on the alarm window.

(d) Inclusion on the alarm summary (note that all alarms and events shall be included on the event summary

(e) User interaction

i. Alarm message is deleted when acknowledged and symbol or value reverts to normal.

ii. Alarm message is deleted when return-to-normal alarm occurs, and symbol or value reverts to normal.

iii. Alarm message is deleted when return-to-normal alarm is acknowledged, and symbol or value reverts to normal.

iv. Alarm message is deleted by other user action and symbol or value reverts to normal.

The alarm condition shall appear on all displays containing the device or value at all consoles regardless of the alarm's jurisdiction.

3.15.11 **Alarm Condition Highlighting**

Displays shall highlight every alarm condition using a combination of color, intensity, inverse video, and blinking. The alarm condition highlighting shall show whether the alarm has been acknowledged. The highlighted alarm condition shall appear on all displays containing the device or value at all consoles regardless of the alarm's category. The alarm condition shall be represented on black and white display hardcopy by means of printed characters adjacent to the item in alarm with all attributes.

3.15.12 **Alarm Messages**

Alarm messages shall be a single line of text describing the alarm that has occurred and the time of occurrence. Alarms from previous days shall be uniquely identified. The value at the time of the alarm and the limit violation shall be included. The alarm message shall be unabbreviated English text and shall not require the use of a reference document for interpretation.

For viewing and printing, control Centre engineer shall be able to hide the columns of the alarm/event message default format.

The system maintenance engineer shall be able to modify alarm message formats and add new formats.

3.15.13 **Alarm Window**

Each screen shall include a scalable window containing names for substations, generating stations, computer system facilities, and others. These names shall blink when an alarm condition is detected for a device or value associated with the station name. Blinking shall cease, and the name shall be highlighted when all alarms associated with the name are acknowledged. The name shall return to its normal presentation when the last alarm associated with the name is deleted. Cursor selection of the name in alarm shall result in the presentation of a display associated with the name.

A special alarm window shall be provided, in which the most recent alarm messages shall be displayed. This window shall allow for at least 10 alarm lines.

3.15.14 **Alarm Message Recording**

Alarm messages shall be stored on auxiliary memory and archived in chronological order. It shall be possible to sort, display, and print archived alarm messages from any console.

3.15.15 **Console Annunciation**

Audible alarm enunciators shall be installed with each console. The audible alarms shall sound when major and minor alarm types occur. The audible tones for major and minor alarms shall be different and shall be distinguishable on a console basis. The audible alarm shall cease when the last active alarm of multiple alarms is acknowledged. A user shall have the capability to silence audible alarms until the next new alarm occurs. A total inhibit feature shall also be provided to silence the audible alarm under any circumstance. Alarm silencing shall be cancellable by a specific user request. A special indication shall be provided when audible alarms are totally inhibited, or the volume is set to off.

3.15.16 **Projection System Annunciation**

Annunciation of alarms on a video projection system shall be the same as for console screens.

3.15.17 **Annotating Alarm & Event Message**

The Control Centre engineer shall be able to annotate or add comments to any alarm/event message. Separate list shall be provided to view these messages by any control Centre engineer. Any control Centre engineer shall be able to add their comments to the appended message. Deletion of the messages shall be by the authorized person.

3.15.18 **Alarm Suppression**

The system shall have the capability of defining a relationship between certain devices that can be used to suppress alarms from related devices or measurements. The relationship shall be defined in such a way as to establish a dependency between one device and others. An example of this relationship would be if a circuit breaker opens, without operator intervention, under voltage alarms associated with that breaker trip would be suppressed for a user defined period.

3.15.19 **Alarms & Events Filtering and Sorting**

Alarm filtering and sorting facility shall be provided, filtering and sorting criteria as a minimum can be AOR, substations, equipment wise, voltage wise, priorities wise, alarm status, time & date.

The requirement also includes Severity wise filtering, Number of days filtering as Abnormal summary

3.15.20 **Alarms/Events Locate**

The location of an alarm shall be quickly determined by selecting the locate pushbutton in the active alarm and event bins. Selecting this button shall automatically call up the graphical display with the device or location that is the subject of the alarm concerned in the display.

3.15.21 **Historical Playback of Alarms**

The SCADA shall include an historical playback of alarms feature. The Control Centre Engineer shall be able to select a start date and time from a disturbance file or the historical alarm and event file and have the alarms shown visually on a graphical representation of the system. The Control Centre Engineer shall be able to move forward and backward through the disturbance file or historical alarm and event file and the corresponding alarms shall be shown on the display as they occurred in time.

3.16 **Events**

Events are conditions or actions that shall be recorded by the SCADA system but do not require user action. Events shall include:

a. User actions and others associated with the application functions.

b. Conditions detected by application functions that do not require immediate user notification but should be recorded.

3.16.1 **Event Messages**

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

3.16.2 **Event message Recording**

Event messages shall be stored on auxiliary memory and archived in chronological order. It shall be possible to sort, display, and print archived event messages from any console. Each database item may be associated with several alarms. For example, a telemetered analog point will include operating limit alarms, reasonability limit alarms, and telemetry failure alarms.

3.17 **User Interface**

3.17.1 **Design Standards**

All displays provided by the Bidder shall have a consistent layout and consistent rules of operation (also known as a consistent “look and feel”). This requirement shall apply to displays provided from the Bidder’s standard offering and displays developed specifically for the Purchaser as part of this contract. Each display shall be consistent in its use of graphics, commands, menus, colors, poke procedures, and data entry such that data similar in appearance shall have a consistent meaning throughout the SCADA.

The User Interface Design Standards document shall include information about how the Bidder provided displays will be constructed, presented, and operated. The User Interface Design Standards document shall also have sufficient information so that the Purchaser provided displays can be built to conform to the same standards as the Bidder provided displays.

3.17.2 **User Interaction General Features**

All applications user interfaces running on full-graphics workstations shall be implemented in X-Windows using the /OSFMotif widget set. These widgets shall provide standard user interface objects such as pushbuttons, lists, menus, etc. OSF/Motif controls the display handling of these widgets, thus ensuring a consistent look and feel. Motif shall also provide standard window manipulation functions, such as window re-sizing, text scrolling, window movement using the window title bar, and window iconizing and de-iconizing.

The following features shall be included in the SCADA user interface. Alternatives may be offered but must be functionally equivalent or better to the features specified.

3.17.3 **Common Display Features**

Each display shall have the following common features:

a. Each display shall include a heading at the top of the display consisting of a title showing the unabbreviated name of the display, User name, date & time (DD:MM:YYYY HH:MM:SS:msec) and, on multi-page displays, a page number in the form Page X of Y, and shall always be visible.

b. Each console shall include the alarm window as described in alarm management function.

c. When a display that is larger than the screen or window is presented, a navigation aid shall appear with the display. The navigation aid shall be a condensed map of the full display. It shall be located in the lower right hand corner of the screen and pertain to the display in the active window. Highlighting within the condensed display shall indicate the portion of the display that is currently presented. The user shall be able to move and resize the navigation aid.

d. A means for the user to enter and edit free-format text notes related to any display shall be provided. The notes or an indication of the presence of notes for each display shall be presented each time the display is called. If an indication is present, the notes shall be called via a single user action.

e. A means for presenting software-generated user guidance and help messages on a console shall be provided. User guidance and help messages shall be unabbreviated English text.

3.17.4 **Display Selection**

Rapid, convenient, and reliable selection of displays shall be provided using the following methods:

a. Selection from a menu display

b. Cursor target selection on any menu, graphic, or tabular display

c. Selection of an alarm on an alarm summary or the alarm window followed by a display request command

d. Entry of a display name in a display select field

e. Forward and reverse paging through a series of displays. Paging forward from a display's last page of a series shall present the display's first page. Paging backward from a display's first page of a series shall present the display's last page.

f. Selecting a display recall command. This shall cause the display that was on view immediately prior to the current display to be recalled.

g. Selecting function keys or cursor targets dedicated to displays.

h. Zooming from an overview display to an area of interest within the display and vice versa.

i. Panning a display to an area of interest.

j. Automatically displaying the boundaries of an area of interest on an overview or navigation window when the cursor is moved into the area of interest and panning and zooming to the area of interest when the cursor positioning device is operated.

k. Toggle button shall be provided to toggle between the two displays.

l. The user shall be provided window selection techniques to independently direct a display to any window on any screen at the console.

3.17.5 **Display Navigation**

Display navigation methods shall provide a consistent approach to moving between and within displays.

The following methods shall be provided to navigate between displays:

i. Pull down menu selections

ii. Pushbuttons/poke points

iii. Display name/code entries.

iv. The following methods shall be provided to navigate within a display:

v. Panning with cursor positioning device or scroll bars

vi. Zooming with cursor positioning device

vii. Navigation window for rapid movement between portions of a world display

viii. Rubber band zooming

3.17.6 **Display Note Pad**

A means for the user to enter and edit messages related to any display shall be provided. The messages or an indication of appended messages shall be displayed each time the display is called. The note pad shall be callable using a cursor target.

3.18 **Display Types**

The following list describes the types of displays that are to be included in the SCADA system. The bidder's user interface shall support the capabilities of all displays as specified. In addition, the bidder shall assume full responsibility for all displays.

3.18.1 **Power System Overview One-Line**

The power system overview will present a schematic overview of the Purchaser's power system. As a minimum, the elements of the power system shall include generators, substations, transformers, reactors, capacitors, lines, line regulators, reclosers, and circuit breakers.

Telemetered and calculated data shall be presented on the overview one-line displays. Flows such as amperes, watts, and vars shall be displayed as values with direction arrows. In addition, the symbols used to represent the elements of the power system shall reflect the presence of alarms and other abnormal operating conditions. This shall include the use of highlighting to distinguish elements that have exceeded loading limits and different colors to distinguish elements that have been de-energized. The user shall be able to navigate to substation displays by selecting poke points on the overview displays.

These displays will be produced and linked to the real-time database by the Bidder. The Bidder shall be responsible for linking these displays to the other data sets and layers (e.g., power flow data, training simulator).

3.18.2 **Substation One-Line**

These displays show the interconnected elements of individual substations. The elements shall include buses, incoming and outgoing lines, transformer banks, circuit breakers, capacitor banks, and disconnects. The displays shall present telemetered and calculated data, including all alarm conditions. Highlighting and colors shall be used to distinguish the

operating states of the different substation elements shall be consistent with all other one-line displays. The user shall be able to interact with the substation one-line displays to perform any associated user interactions such as data entry and supervisory control.

The user shall be able to navigate to other substation displays from poke points on transmission line segments on the one-line. The user shall also be able to call-up the associated substation tabular display from a poke point on the one-line.

These displays will be produced and linked to the real-time database by the Bidder. The Bidder shall be responsible for linking these displays to the other data sets and layers (e.g., state estimator results, power flow data, and training simulator).

3.18.3 **Other One-Line Displays**

Other one-line displays may be provided to show the power system to the Control Centre Engineer. For example, one-line displays may be provided of major transmission and distribution circuits. The characteristics of these displays shall be the same as the Power System Overview One-Line displays and the Substation One-Line displays.

These displays shall be produced and linked to the real-time database by the Bidder. The Bidder shall be responsible for linking these displays to other data sets and layers (e.g., power flow data, training simulator).

3.18.4 **Menu Directory Display**

A display shall be provided the list of all menu displays. The menu displays shall be listed in alphabetical order with suitable separation in the list to enhance readability. Each entry in the list shall have a cursor target for menu selection.

3.18.5 **SCADA System Directory Display**

A display shall be provided the list of all SCADA system displays. The displays shall be listed in alphabetical order with suitable separation in the list to enhance readability. Each entry in the list shall have a cursor target for display selection.

3.18.6 **Power System Overview Display**

A graphic overview display of the transmission and distribution system with substations, power stations, and transmission lines color coded by voltage shall be provided. This display shall present the transmission system in a graphic format provided by Purchaser. Telemetered and calculated data shall be presented on this display. Real and reactive power flows shall be displayed as a value with a direction arrow. Lines that have exceeded their loading limits shall be highlighted. Substations and power stations shall be depicted by

symbols that reflect the presence of alarms at the substation. Cursor selection of a substation, or transmission line symbol shall result in the associated display for that facility being displayed.

The user shall be able to pan and zoom this display to present different representations of portions of the relevant service territory such as only the 33kV, 11kV systems etc. Decluttering of symbols, devices, data values, and text shall occur at selected scale factors.

3.18.7 **Interchange Display**

The interchange display shall be provided as a schematic diagram showing power transfers between all Constituent power systems in the Purchaser network.

The diagram shall show each power system as a block with actual and scheduled values of load inside the block and with actual and scheduled net interchange values outside the block. Symbolic arrows shall indicate power flow directions. The diagram shall also show schedule deviations.

In addition to the block diagram, three sub-displays shall be provided as follows:

a. **Transaction Schedule:** This display shall provide the ability to enter and display Constituent hourly interchange transaction schedules for today and tomorrow. Only one entry shall be required for all Constituents affected by the transaction.

b. **System Frequency:** This display shall show the frequency values collected from all substations. The substation buses with telemetered frequency values shall be clearly indicated. The display shall take the form of a schematic diagram showing the geographical location of the substations.

3.18.8 **Substation Graphic Displays Menu**

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

3.18.9 **Substation Graphic Displays**

Graphic displays shall be provided for each substation, including those for which telemetry may not be available. Each display shall present telemetered, manually entered, and calculated power system data on a one-line diagram that shows substation layout in terms

of its buses, switches, lines, and transformers. The user shall be able to perform any user interaction defined by the specification on these displays.

3.18.10 **Substation Tabular Displays**

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

3.18.11 **Transmission/Distribution Feeder Graphic Displays Menu**

A display shall be provided that lists all transmission/distribution feeders that can be viewed via a graphic display. The transmission lines shall be listed by voltage class and in ascending numerical order with suitable separation to enhance readability. The transmission line number shall be accompanied by the names of associated substations. Each entry in the list shall have cursor targets for selection of the substation graphic display as well as the transmission line graphic display.

3.18.12 **Transmission/Distribution Feeder Graphic Displays**

Graphic displays shall be provided for each transmission line, including those for which telemetry may not be available. Each display shall present telemetered, manually entered, and calculated power system data on a one-line diagram that shows the entire line and all of its connections. At each end of the line, the diagram shall show the line breakers and the bus or line to which the breakers are connected. The user shall be able to perform any user interaction defined by the Specification on these displays.

3.18.13 **Alarm Summary Displays**

Displays that list or summarize all unacknowledged and acknowledged alarms shall be provided. Alarm messages shall be organized by category for those categories assigned to a given user, as one summary display for all categories assigned to a user, or by all conditions system-wide without reference to the categories assigned to a user, as selected by the user. The user shall be able to select between viewing alarms in chronological and reverse chronological order. The default shall be chronological order. The summary shall separate acknowledged and unacknowledged alarms. To facilitate reading unacknowledged messages the time field shall blink or entire row shall blink.

The system shall be configurable to alert/Remind the Control Centre Engineer for the persisting active alarms, which are acknowledged by the Control Centre Engineer, this

feature shall be inbuilt of intelligent alarm management function and configuration shall be available with pop-up display on Operator's workstation based on date, time, station and priority of persisting alarms.

Alarm page shall display alarms in chronological order provided by the Purchaser e.g. In the event of fault, the alarm page shall display in sequence of all equipment change of state, followed by protection actions and specific bay related alarms of the specific fault.

When the messages will not fit on a single page, multiple pages shall be provided, and a message shall appear on each page of the display, indicating there are more alarm messages on other pages. Capacity shall be provided for at least 1000 alarm messages for each alarm summary type. If an alarm summary display becomes full, the oldest messages shall be automatically deleted, and the newest messages shall be added. It shall be possible to perform any alarm interaction from this display.

In addition to the general alarm list and summaries above, the following specific alarm summary displays with count of the alarms shall be provided and made accessible via a convenient and efficient means of user selection:

a. **Major Alarm Summary:** This display shall list all alarms defined by Purchaser to be major. These alarms shall be grouped by different priorities.

b. **Minor Alarm Summary:** This display shall list all alarms defined by Purchaser to be minor. These alarms shall be grouped by different priorities.

c. **Change of State Alarm Summary:** This display shall summarize the unauthorized status changes.

d. **Limit Violation Alarm Summary:** This display shall summarize the limit violation alarms.

e. **Islanding Alarm Summary:** This display shall present a list of islanded power system networks detected by the Purchaser electrical network.

f. **Communication Alarm Summaries:** These displays shall summarize all communication alarms collected from RTU/IEDs and other data sources as well as communication alarms determined by the SCADA & ADMS computer

system independently, e.g., loss of RTU/IED or data link channel.

3.18.14 **Event Summary Displays**

Event summary displays shall list the most recent events and shall be organized by category for those categories assigned to a given console, as one summary display for all categories assigned to a console, or by all conditions system-wide without reference to the categories assigned to a console, as selected by the user. The user shall be able to select between viewing events in chronological and reverse chronological order. The default shall be reverse chronological order. (i.e. latest events shall appear at the top of the list) When the messages will not fit on a single page, multiple pages shall be provided, and a message shall appear on each page of the display, indicating there are more event messages on other pages. If an event summary display becomes full, the oldest messages shall be deleted automatically, and the newest messages shall be added. No user interaction with the event summary displays is required. The user shall be provided, however, with a convenient and efficient means of selecting an event summary display.

3.18.15 **SCADA System Alarm/Event Summary Displays**

The alarm function shall maintain summary information that includes a list of all acknowledged and/or unacknowledged Alarm messages and events of the SCADA system.

3.18.16 **Operating Information Summaries**

The operating information summaries defined below shall be provided. Summary items will be listed in reverse chronological order with the most recent item shown on the first page. The user shall have the ability to sort summary items by substation except for the Tag Summary in which items shall be organized alphabetically by control center, substation, then device, and then reverse chronological order. In all cases, when summary items will not fit on a summary page, multiple pages will be provided, and a message shall appear on each appropriate page of the display, indicating there are more summary items on other pages. All summary displays, except for Tag Summary shall be information-only displays; no user interaction, other than display call-up, shall be associated with them. The Tag Summary shall be interactive, i.e., the user shall be able to place or remove tags on this summary.

3.18.17 **Manual Override Summary**

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

3.18.18 **Off-Normal Summary**

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

3.18.19 **Out-of-Scan Summary**

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

3.18.20 **Alarm Inhibit Summary**

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

3.18.21 **Tag Summary**

This display shall list and describe all active device tags.

3.18.22 **Display Trending Control and Summary Displays**

The trend display shall enable the user to select parameters related to items to be trended on displays. The associated summary display shall list all items being trended. The list shall include the item name, trace number or color, trend orientation, and trend range.

3.18.23 **Tabular Trending Control and Summary Displays**

The trend display shall enable the user to select parameters related to tabular trends. The associated summary display shall list all items being recorded for tabular trends. The list shall include the item name and the file name.

3.18.24 **Notes Display**

This display shall include a minimum of 10 pages on which a user at any console may enter and edit messages. The contents of these pages shall be accessible by any console. The user shall have the ability to clear any page of this display and to type over previous messages.

3.18.25 **Report Scheduling Display**

A report scheduling display shall be provided so that the user can schedule periodic reports, direct a report to a display, print a report, record a report on auxiliary memory, and archive a report on archival storage media or print.

3.18.26 **Report Review and Editing Displays**

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

3.18.27 **System Configuration Monitoring and Control Displays**

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

a. Review and revise the configuration of the SCADA & ADMS computer system

b. Monitor the system's resource utilization statistics

c. Select alternative data sources.

The displays shall include menus or cursor targets for performing the actions.

3.18.28 **Communication Equipment Information Display**

This display shall allow the user to review information collected from RTU/IEDs and other data sources concerning remote communications equipment and associated power supplies. The communications equipment may include RTU/IEDs as well as communication interface hardware.

3.18.29 **Communication Network Monitoring Display**

This display shall show information on the status of the system's communication interface devices (including communication channels), the accessibility of each RTU/IED, and the status of the data acquisition computer. The ability to access communication channel utilization statistics shall also be provided.

3.18.30 **Data Exchange System Display**

This display shall allow the user to interact with the data exchange function that supports site-to-site communication services. The associated features include the ability to transfer user-defined text messages, reports, power system modelling information, operational data, and software code, and the ability to place a data link in test mode.

3.18.31 **Application Program Displays**

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

Apart from the standard application program displays provided with the system, the following displays shall also be provided.

3.18.32 **Load Shed Display**

The load shed display shall allow the user to monitor and enter load shed and restore requirements for the power system under the user's jurisdiction. In addition, the load shed display shall allow the user to send command and to receive acknowledgement that specific amounts of load have actually been shed or restored. Other features shall include the ability to monitor and track past load shed / restore activities. Bidder shall develop the load shedding displays as per the requirement of the Purchaser.

3.18.33 **Help Displays**

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

The Purchaser system maintenance engineer shall be allowed to modify and create help displays.

System shall allow linking (poke point near the object e.g. Breaker / transformer details etc.) any information available with the purchaser developed with Microsoft office package.

3.18.33.1 **User Guidance**

The SCADA & ADMS computer systems shall respond to all user input actions indicating whether the action was accepted, was not accepted, or is pending. For multi-step procedures, the systems shall provide feedback at each step. Indications such as text messages, color changes, and blinking shall provide this feedback.

A means shall be provided for displaying user guidance messages. User guidance messages shall be unabbreviated English text and shall not require the use of a reference document for interpretation. The use of mnemonics is prohibited, unless the mnemonics are industry-accepted or approved by Purchaser.

3.18.33.2 **User Help**

General and specific context-sensitive on-line help shall be available to the SCADA user. Access to user help shall be available by:

a. A Help command on the window menu bar

b. A Help button in a dialog box

c. Topics from a Help menu

The Help menu shall present a list of topics available for reference. The topics shall refer to the SCADA user documents. The ability to scroll through the topic's explanatory text shall be supported.

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

As a minimum, context-sensitive help facilities shall be provided for each application software package and the database fields. The capability to easily edit or add additional help facilities in the future shall be provided.

3.19 **Scaling and Translation**

The user shall be able to scale (zoom) the image of a world coordinate space or other display in a smooth fashion to any scale factor in a minimum of 64 steps. The scale factors shall allow the presentation of an entire world coordinate space or other display on the full screen or a window. Static and dynamic data shall be displayed and updated during a scaling operation, and display text shall be scalable to be consistent with the scaled image. At defined scale factors, levels of declutter shall be invoked.

The user shall be able to select an area of a world coordinate display by cursor manipulation ("rubber-banding") and cause the display to be redrawn with the selected area centered in the display and with the selected area magnified to best fit the full window. The window dimensions shall not be changed by such an action.

The user shall be able to translate (pan) the display image in steps no larger than 16 pixels to permit the observation of other portions of a display within a selected window. Static and dynamic data shall be displayed and updated during a translation operation.

3.20 **Manual Data Entry**

User entry of data shall be facilitated by simple procedures to select the point or points to be entered, enter the value or values, validate the changed, and to confirm or cancel the entry. Data entry may use full screen or single point techniques as appropriate.

The full screen entry mode shall be initiated by a single user action and shall simultaneously affect all points on the display for which data entry is possible. The SCADA shall respond by suspending the updating of and highlighting all points on the display that may be entered. The user shall then enter the new values and request entry of the values. The SCADA shall perform any validity checks appropriate to the affected points ***(Refer Section 6.3, Data Processing for telemetered, calculated, and non-telemetered data entry validity checks*)**. If there are no invalid entries, the new values shall be written to the database. If there are invalid entries, the invalid entries shall be highlighted, and the user presented with the option of correcting the entries or accepting only the valid entries.

Single-point data entry shall be initiated by selecting the point to be entered and commanding the data entry mode. Only the selected point shall be placed in the data entry mode. The remainder of the entry procedure shall be as for full-screen entry.

3.21 **Interlocks**

Although the same display may appear concurrently in multiple windows at multiple consoles, data entry for that display shall be restricted so that multiple users will not produce conflicting actions on a given value. If a display is in the full-screen data entry mode in one window, an attempt to initiate the data entry function for that display in another window shall result in rejection of the second attempt to enter the data entry mode and the second user shall be informed of the conflict.

Similarly, control of a power system device or management of a single point (such as manual entry of the value or removing a point from scan) shall only be allowed from one window at one console at a time. Concurrent user action on different areas of a world coordinate map or other display and concurrent supervisory control or data management of different points on the same display shall be allowed.

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

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

b. **Supervisory Control**: Although the same power system device, such as a circuit breaker, may appear concurrently in multiple windows at multiple consoles, control of the power system device shall be restricted to one window at one console at a time. An attempt to initiate control of the power system device from another window shall result in a user guidance message.

c. **Interlock Display:** All Interlock logic diagram shall be displayed with actual Status of the associated equipment and conditions

3.22 **Inactivity Timeout**

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

3.23 **Screen Saver**

The SCADA shall provide a screen saver, which shall blank the monitor whenever there is no activity on the monitor for a configurable period of time. The screen saver may be turned on or off by the user. If the monitor has been blanked by the screen saver function, the display selected for that monitor shall immediately reappear if any keyboard entry or pointer movement occurs. The screen saver shall not be activated during data entry procedures.

3.24 **Trending**

The SCADA shall include facilities to generate graphic trend curves for all real-time, historical and calculated data. Any numeric or Boolean data from any application database may be

selected for trending. Up to eight (8) trends on a same and separate axis shall be allowed on a single display.

At a minimum, the Data Trending function shall provide the user with the following capabilities:

a. Continuously capture samples of selected data values

b. Selection of any data value in the System real-time or applications data for trending

c. The pen shall be added in trend window through drag and drop and add through pen selection feature.

d. Data collection shall run continuously until deactivated by the user

e. Display of multiple trend variables on a trend display

f. Trend axis shall be automatically scaled in time and engineering units based on the data point under trend

g. Selection of trend color for each data variable

h. Scrolling forward and backward through all the collected trend samples

i. Panning and zooming through all the collected trend samples

j. Print of trend displays on laser printers (color and black & white)

k. Multiple trend windows with multiple pens in each window

l. It shall be possible to illustrate all types of process data (historical and real time) as trends – input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a minimum of 50 trends in trend boards. Adjustable time span and scaling ranges must be provided.

m. Trend shall have the ability to superimpose minimum two different time frames in a single window for comparison.

n. It shall be possible to trend selected alarms.

o. It shall be possible to execute basic mathematical operations directly on the trend without writing any separate calculation in the system.

p. Trend window shall have inbuilt time ranges available for selection from a list such as last hour, current hour, current day, last week etc. for a selected pen.

q. Tabular trending feature shall be available.

Selecting a point and designating a trend curve shall result in the display of a dialog box where the user can enter information on how the selected point is to be displayed:

a. Value name

b. Trend direction

c. Scaling factor

d. Offset

e. Trend number and color (for multiple trends on one display)

f. Time base values of all trends being displayed using a hairline cursor

g. Trend rate

h. Trend start time (historical data)

i. Trend period (historical data)

j. Initiate trending on a database point by adding the point to the currently displayed trend.

The color of the trend shall represent the highest priority data quality code. Quality code colors shall be consistent with those used for data display and they shall be protected, that is, they shall not be selectable for normal trending. The trend color shall change as the quality code changes.

Trend control displays shall enable the user to select and control any defined analog (Real-time, Calculated, historical) and Boolean data for trending. The user shall be able to select real-time or historical data for trending on graphical and for tabular output. For real-time data, the user shall be able to select a trend rate different than the scan rate. A print option shall be available in order to print currently displayed trends on any printer.

3.24.1 **Display Trending**

The user shall be able to select and control trending on displays. The display trend control displays shall enable entry of the following parameters, with default values provided for all items except (a):

a. Data value name

b. Trend header

c. Trend direction (horizontal or vertical)

d. Scale (unidirectional and bi-directional), Zero offset

e. Trace number or color

f. Trend rate

g. Trend starts time and date (historical data only)

h. Trend period (historical data only)

i. Reference lines or shading axes (with default to most restrictive alarm limits)

j. Online History Retrieval for All Analog Parameters from Respective SCADA Mimics: At Least For 1 Day

Both horizontal and vertical trending shall be provided. There shall be automatic movement of data down or across the screen as new values are generated. When the number of real-time trend samples reaches the limit that can be displayed, the oldest value shall automatically be removed as the display is updated.

The current value of all the trended quantities shall be displayed when the cursor is placed at any relevant point of the trend.

When historical data is selected for trending, the user shall be able to page forward and backward, or scroll by the use of a scroll bar, through a non-updating snapshot of the data within the constraints of the data stored in the historical files. Shading between each trend value and user-definable axes shall be provided. Trend attributes shall be changeable based on a comparison of the trend value against associated alarm limits.

The time of activation and deactivation of a trend, together with the data value name, range, and trace assignment shall be logged. A summary display shall provide the user with an overview of the current values being trended along with their assigned trace.

Trend facilities shall include a trend library feature. The trend library shall consist of a circular buffer in which as many as 10 user-specified trend files, each with up to 5,000 data points, can be saved for subsequent retrieval.

3.24.2 **Tabular Trending**

Tabular trending, which produces a printed listing of the time-sequential values of a trend item, shall be initiated and controlled using techniques similar to those employed for display trending. The output shall be directed to a file on any archival storage device. The user shall be able to display the tabular trend or print the trend on a user-selected printer without interfering with the continuing trending process. Operation engineer shall be able to transfer the data to Microsoft office (Excel) file, with date and time information and the engineering

unit value of the selected point for each collection interval. There shall be no limit on the number of samples collected for any tabular trend.

3.24.3 **Other features required for Trend function**

a. Trending must be display on same graph by superimposing with today and previous day (24 Hrs) / 7 days.

b. The data source can be either a process object or another log.

c. Minimum following sampling and logging interval shall be supported by the system

Seconds	Minutes	Hours	Weeks
1S	1M	1H	1W
2S	2M	2H	
3S	3M	3H	
4S	4M	4H	
5S	5M	5H	
6S	6M	6H	
10S	10M	12H	
12S	12M	24H	
15S	15M		
20S	20M		
30S	30M		

d. Configuration of variable Attribute such as Mean, momentary, maximum, minimum, sum, sum of squares and standard deviation shall be possible.

e. Ruler shall be provided to get the value of the variable of any given time available on the trace diagram.

f. Search facility shall be available to search for names / descriptions of the variable for configuration in trace table.

g. Single trace table can have variable of different sampling interval.

h. Y-axis of the trace display shall be drawn as per the variable.

i. User shall be able to configure the trace in a different form. E.g. forms – Linear, Rectangular, Histogram, Point etc.

j. Extrapolate to current setting shall be available to see the logs that are out of scope such as horizontal, tangential etc.

k. A trend display shall contain a trace diagram with traces and a trace table with information about the data sources displayed in the trace diagram.

l. Normally the trend display shall show the time scope with the current time to the right.

m. When user starts to change (pan or zoom) the viewed time scope, the trend display frame around the drawing area shall change in different colors, indicating non-updated mode. When the current time is selected again the selected time scope shall be preserved.

n. Trace table shall contain at least the following data

i. Toggle button (On/Off) to hide or show the trace in the trace diagram.

ii. Object name, description

iii. Access indication – this field is for indication showing that trace data is requested from a controller or from the other system.

iv. Attribute – shall show the used object attribute e.g. Measured Value (MV).

v. Treatment – this field shall show the log function selected for the log. E.g. Mom, Max, Min etc.

vi. Ruler time and value shall be displayed on a movable crosshair for reading the data values on a graph.

vii. Average – the average column shall contain the computed average of the data displayed in the trace diagram for each trace.

viii. Current value – This field shall display the last value received for a log.

ix. Unit – Shall contain the unit type of the displayed value.

x. Form – This field shall display the selected form. Clicking this field shall also bring up a menu allowing the user to select the desired form.

xi. Direct Access Buttons –

- The scope buttons for panning the trace diagram 20%, 80% on either direction.
- Current time button to update the trace diagram after panning.
- Ruler buttons – To move the ruler in the desired direction.
- Save trend button – Save button to save the changes made in the trend display.
- Hide / Show table toggle button – The trace table can be hidden by activating this button.

o. The trend display shall be provided with the trend dialog menu, which shall have the following sub-menus:

i. Direct buttons to change the time scope e.g. direct time scope – 10 sec, 30 minute, 1 hour, 4 Hours, 8 Hours, 1 Day, 2 Days (user configurable time scope) etc.

ii. Set time input field to enter the desired time directly by the user.

iii. Filter input field to reduce the noise on the traces.

iv. Time offset field to add a time offset for the trace.

v. Input field for setting the Max and Min value for the Y-axis of each trace.

vi. Zoom In/Out field to reduce or expand the time scope. Ability to zoom in one area of a particular trend.

p. The trend export program shall allow the user to view trend archive files in CSV format for analysis or insertion of data into reports. Efficient compression techniques shall be used to save data to disks, and data shall be organized into monthly files, which can be separately archived on CD/DVD media for future use.

q. Ability to have unlimited number of windows on a monitor (limited only by performance).

r. Ability to superimpose two different time frames in a single window for comparison purposes.

s. Trending must be user configurable with upper and lower space with filled colour effect. Comparison of two diff tags in graphical display in trend (Filled Graph with diff colour)

3.25 **REPORT FORMATS**

This SCADA section contains the format requirements for several typical reports. Reports shall not include blank entries to accommodate future growth. Instead, the report generation software shall provide the capability to add future points as it becomes necessary. Each delivered system shall include total storage for 10 times the space required for the reports defined in this section.

The fields used in the reports are defined as follows:

a. **Total Data Values/Report:** The number of variables contained in the report including telemetered, entered, and calculated quantities. Quality codes shall be included where applicable.

b. **Calculated Values/Report:** The number of values that are the result of calculations performed on other report quantities especially for that report. All calculations are simple arithmetic functions, unless otherwise noted.

c. **Periodicity:** This field indicates how frequently the report is printed. Additionally, all reports shall be capable of being printed on-demand.

d. **Edit Capability:** This field indicates whether or not the user should have the capability to edit the data contained in the report via workstations.

e. **On-Line Retention Period:** The period of time that the report and the data used to create the report are required to remain on-line for display, review, and editing purposes.

f. **Manual Entry of Report Data:** A 'Yes' in this field indicates that this report contains data values or text that may be manually entered on the report's review displays, i.e., the data would not otherwise reside in the SCADA database unless entered on the report.

g. Data Retrieval in Excel/User defined formats in value formats

h. Report Generation Utility should have provision to retrieve historical data for user defined criteria of station/elements/period/category/other filters

3.25.1 **Report Display**

a. The SCADA system shall provide storage of shift report, daily report, and monthly report as below

i. Daily report – At least for 2 months

ii. Monthly Report – At least for 1 year

iii. Yearly Report- At least for 5 years

b. Automatic periodic storage of these reports shall be available in addition to manual storage.

c. Automatic printing of these reports shall be possible on time basis or on any trigger. Manual printing of these reports shall be possible at any given time.

d. System shall allow transfer of archived and as well as current reports to any third-party system (possible to send in EXCEL form).

e. System shall allow control Centre engineer to enter the un-telemetered data in these reports. Entry of data shall only be possible, when the data is not available from the measuring IEDs. These entries shall be password protected.

f. Integration of energy import / export shall be possible at 15-minutes interval (user configurable).

g. The system shall generate the following reports in the required formats and shall be approved by the purchaser.

3.25.2 **Periodic Logs**

a. The system shall store values of specified parameters at hourly or half-hourly, 15-minute intervals in different groups (exact groups will be identified later). Logs shall be automatically printed out periodically.

b. Pre-trip and Post-trip logs of major analog values 10 seconds before and after at power faults. These values shall be stored in the separate files for future use / replay.

c. 15-minute energy integration report

3.25.3 **Shift Report**

The system shall generate and print shift report at the end of each shift:

a. Summary of persisting alarms, including bad inputs.

b. Status changes (Breaker / Isolator)

c. Alarm Limit changes by the Control Centre Engineer.

d. 15-minute energy integration report for the shift

e. Handing Over: ShiftWise/Adhoc report for all operations carried out along with Provision of Manual Entering Special Conditions.

3.25.4 **Daily Report**

The system shall generate and printout following daily reports at the end of each day:

a) Daily maximum and minimum values with time for frequency, voltage, Energy (Import, Export), current, MW, MVAR.

b) Daily report of specified points based on status changes with time.

c) Summary of predefined important alarms. A printout of persisting alarms related to SCADA system and process separately shall be printed in reverse chronological order, which will be used for necessary action.

d) Energy Auditing per bus basis / for each voltage level / for each consumer

e) 15-minute energy integration report for the day

3.25.5 **Monthly Report**

The day wise monthly report shall be prepared for the following parameters: –

a. Daily maximum and minimum values with date and time.

- Voltages / Frequency
- Line flows
- System generation
- Bus wise Energy Audit
- Calculated losses
- Status change of equipment

b. System demand - 15-minute energy integration report for the month on daily basis

3.25.6 **Yearly Report**

The month wise yearly report shall be prepared for the following parameters: –

a. Monthly maximum and minimum values with date and time of:

- System demand
- Voltages / Frequency
- Line flows
- System generation
- Bus wise Energy Audit

b. Calculated losses Number of normal operations and fault operations per circuit breaker.

c. In service and out of service log per circuit breaker with date and time.

d. Export / Import Energy report for all feeders

e. Status change of equipment

3.25.7 **Web based Operator Log Book**

The Bidder shall provide features of web-based logbook with graphical user interface and features a modern, web-oriented interface that can be restricted by specific users' credentials. The highly configurable logbooks to contain user-defined log note entry types and fields that can be fashioned to represent various types of logs such as:

a. Operator logs

b. Administrative logs

c. Substation logs

d. Compliance logs

e. General auditing

The logbook main menu shall list out the number of eateries in each logbook. Each entry shall have the capability to attach a file (Excel, PDF). If an entry has any attachment, the user shall be notified with a symbol. The ability to filter, sort grouping and ungrouping with the book shall be provided.

An option to export all entries to Microsoft Excel shall be provided

3.25.8 **Report Templates**

During detailed engineering Purchaser will provide required templates to the bidder.

3.25.8.1 **Circuit Breaker Status Report**

The IS&R function shall maintain a table in RDBMS database where real-time status of all Circuit breakers, in case of RMU isolators also along with the associated quality codes shall be stored. The change of status of any breaker shall be updated in this table as soon as the change is detected by the SCADA system. This table shall contain additional information such as date & time of tripping, cause of tripping, Expected duration of outage etc. Some of the causes of tripping could be Supervisory control by user, Protection tripping, Tripping / closing by ADMS applications. Information on expected duration of outage shall be taken from schedules for ADMS application such as Load shed application etc. For expected duration of outages due to protection tripping, the same shall be user enterable field. Such daily tables for two months duration shall be stored on auxiliary memory. Tables for the previous day shall be backed up to Magnetic tape automatically. The IS&R function shall transfer the information available in the "Circuit breaker status table" as defined above, to the PI / SAP system using SOA/Enterprise Service Bus, over CIM/XML Models, or CIM/XML

OPC/Secured ICCP Adapters / Interfaces. The complete Circuit Breaker Information shall be transferred to Customer Information System on demand & by exception along with the associated quality codes and additional information associated with the CB.

3.25.8.2 **Real-Time Database Snapshot Report**

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

i. 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.

ii. 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. Tables for the previous day shall be automatically backed up for future use. The IS&R function shall prompt the user through a pop-up window to inform the user for taking the backup. The pop-up window shall persist till user acknowledges the same. In addition to that data can be stored on offline storage device. The user shall also be able to initialize the study-mode power system analysis functions from stored snapshot data.

3.25.8.3 **Hourly Data**

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

i. Selected analog values along with their associated quality codes

ii. Selected status values along with their associated quality codes

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

iv. 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 IS&R 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. Hourly data table for the previous month shall be

backed up to on-line backup server at frequency decided by the Purchaser's. The IS&R function shall prompt the user through a pop-up window to remind the user for taking the backup. The pop-up window shall persist till user acknowledges the same.

3.25.8.4 **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.

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

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

iii. 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.

3.25.8.5 **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:

i. Addition, subtraction, multiplication, and division

ii. 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.

iii. Maximum and minimum of a value over a programmer-definable time period, and the time the maximum or minimum occurred

iv. Average of a value over a programmer-definable time period

3.25.8.6 **Daily Energy Data Report**

The daily energy data table shall be generated for storage of daily energy values for 15- minute blocks / one hour blocks of a day & shall be stored for each feeder on daily basis along with quality codes. This daily energy data shall be exchanged with the Billing system on daily basis and on demand. This table shall be created on daily basis. Such daily tables for

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

3.25.8.7 **Load Priority Report**

IS&R system shall maintain a Load priority table containing information such as breaker name, number of consumers connected to each Breaker and Load priority of each Breaker. Control Centre Engineer can also assign priorities in load priority table & the priorities assigned by the Billing system may be accepted/ rejected by him. There shall be suitable alarm/event message including user ID for such activity. The table information shall be used by various ADMS applications.

3.25.8.8 **SOE Data Report**

IS&R 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. All CBs, protection and alarm contacts shall be considered as SOE. Tables for the previous day shall also be backed up on auxiliary memory.

3.25.8.9 **Gateway, RTU, FRTUs and FPI communication channels monitoring Report**

This display/report shall show information on the status of the system's communication interface devices (including communication channels), the accessibility of each RTU/FRTU/IED/FPI in a tabular and graphical form. The user shall be able to Enable/Disable any communication channel from this display/report.

3.25.9 **Display Hardcopy**

A means shall be provided to produce printed copies of any display on any printer. The output shall be directed to any printer of the user’s choice. Color displays shall be translated for black and white printers using a mapping table (or similar) that can be changed by the user. The background (if any) shall be disabled before automatically printing (i.e. with the print command).

3.25.10 **Windows Environment**

The system displays shall operate within a window environment. A window is a rectangular area that covers all or part of the screen used to view displays. Windows shall be selectable by the user. Most windows may be moved and re-sized to suit the user's changing needs. A

screen may include multiple windows. In particular, the SCADA & ADMS computer systems shall be configured so that up to 8 windows may be open on the screen at the same time.

The windows shall be displayable in either cascaded (overlapping) or tiled fashion, depending on the window definition of the user. The user shall be able to adjust the active window size from an icon to the full dimensions of the screen. User placement of a window into any screen position shall be supported.

3.25.10.1 **Window Frame and Window Decorations**

Each window shall have a border or window frame around its outer perimeter. An OSF/Motif compliant window manager that supports the following window frame components shall be provided:

a. **Title area or display name:** Used to identify the display within the window.

b. **Maximize button:** Used to increase the size of the window to cover the entire screen.

c. **Minimize button:** Used to decrease the size of the window to an icon, a graphic image representation of the window with an identification label, in which the same text as the window's title area appears. Icons shall be capable of re-location on the screen by the user.

d. **Resize border:** Method to change the initial size of the window. (Some windows, such as dialog boxes, may not support this feature.)

e. **Window Menu button:** Used to display a list of control actions supported by the window. (Some windows, such as dialog boxes, may not support this feature.)

3.25.10.2 **Active Window**

One window at each console shall be the active window, which is used for user interaction with the system. Any other windows shall continue to be displayed and updated. A different window may be activated by selecting it with the click of the mouse anywhere inside the desired window's border. The window border surrounding the window shall change color to indicate that the window is active, and the active window shall be displayed on top of any other overlapping windows.

3.25.10.3 **Work Area**

The work area shall be the portion of a window dedicated to the application program information (e.g., reports) or specific display information.

3.25.10.4 **Centres**

Centres shall be saved window configurations. Centres shall allow each user to configure and save a preferred layout, size, and location of windows and displays. This shall include the ability to select border styles, foreground and background colors (including the color of the active window's border), and the format and color of a window's contents (including title area attributes).

3.25.10.5 **Graphics User Interface Features**

The System shall be having Unified Graphical User Interface (GUI) for SCADA/ADMS, Purchaser Specific Application and other 3rd Party system integration

This section describes the Graphics User Interface (GUI) features that shall be provided for each display.

3.25.10.6 **Menu Bar**

A Menu Bar is a horizontal bar at the top edge of a display window, just below the title. A Menu Bar shall contain buttons with Pull down menus attached to it.

3.25.10.7 **Pull down Menus**

Pull down menus shall be available by selecting buttons on the Menu Bar. They shall be used as a means of initiating functions, accessing displays, and manipulating information on the screen.

3.25.10.8 **Control Menus**

Control menus shall be implemented via Popup windows or tool bars. A Popup window/ tool bar control menu shall be attached to controllable display elements, such as circuit breaker symbols. The Popup window/tool bar control menu shall contain a set of control buttons.

3.25.10.9 **Push Buttons**

A Push Button is a button symbol with a text or graphic label to indicate the operation that is performed when the button is selected (pressed and/or released).

3.25.10.10 **World Display Features**

The Bidder shall provide two-dimensional full-graphic world displays that a user shall be capable of panning and zooming. World displays may represent a large overview of the power system network or any segment of the power system network such as a single substation. A "named" window feature shall allow one or more portions of a world display to be called up by an associated identifier, such as a name and/or number. The following world display features shall also be supported.

3.25.10.11 **Layers**

A layer is a set of logically related static and dynamic display elements that are displayed as a group on a world display. A layer covers a complete two-dimensional area and is visible within certain minimum and maximum zoom values.

3.25.10.12 **Declutter Levels**

A declutter level identifies a group of layers that are all visible for a given zoom value. A minimum of 16 declutter levels shall be provided for each world display.

3.25.10.13 **Overlays**

An overlay is a feature that allows individual layers to be assigned to layer groups so that the layers as a group may be turned on or off. When an overlay is turned off, the elements in the layers assigned to the group are hidden and do not show on the display. When an overlay is turned on, the elements are allowed to show provided the current zoom level falls within their minimum and maximum zoom levels.

3.25.11 **Browser-based User Interface**

The SCADA shall provide the capability to authorized users to view a pre-defined list of displays via a browser-based user interface. The Bidder’s proposal shall describe how authorized users may be verified. The Bidder’s proposal shall also describe how the predefined list of displays can be managed by the Purchaser.

Additionally, the Bidder shall describe how the proposed SCADA meets the following design guidelines for such a browser-based user interface:

a. Pages shall load quickly

b. Displays shall have a consistent look and style. Use of colors and fonts shall be applied consistently. Control buttons, navigation aids, message windows, etc. shall have consistent appearance and location.

c. Navigation aids shall be provided to enable users to easily determine which display is being viewed and to facilitate movement around the current display and to other displays

d. Users shall be provided with positive, visual feedback when they make a selection, which remains visible until the request is completed or until they make a new selection

e. Dynamic information on the displays shall refresh at a rate configurable by the user, from 1 second to 1 minute.

The PURCHASER would prefer an implementation that is not dependent on use of a specific browser.

3.25.12 **Geographic Maps and drawings**

The proposed SCADA shall be able to import and store spatial data, connectivity information as well as attribute information from the Geographic Information System (GIS) required for SCADA operations. The GIS contains the information about the feeder topology, and all devices associated with the electrical network including their features, attributes and connectivity. The SCADA/ADMS system shall provide adequate disk storage capacity capable of importing the data for entire Purchaser service territory in bulk initially and incremental updates on a periodic basis. The Bidder shall explain in detail how this is accomplished, including the data validation process. The frequency of incremental update and network part for incremental update shall be a user definable parameter. Geographic maps shall display real time status of devices and measured values for all the points where such data is available in the SCADA/ADMS system. The maps shall reflect current connectivity of the network (e.g. energized, de-energized, grounded segments etc. in distinct colors) based on the status (open, close etc., derived from the real time system or manually entered) of the devices.

3.25.13 **AutoCAD Interface**

The SCADA shall be able to use AutoCAD drawings output in .DXF format as input to the Bidder's display editor in order to add dynamic data to the display. In addition, the capability to import AutoCAD drawings in .DXF format and directly view static drawings in a viewport on the user’s console shall be provided.

3.25.14 **Video Images**

The SCADA shall be able to display security camera real time input, VCR input, and any static video image associated with a point on the console monitors’ viewports.

3.26 User Interface Development

3.26.1 Graphics Standards

Consoles in the computing network shall adhere to the latest recognized standards such as the X Window system for windowing and OSF/Motif for presentation, Microsoft® Windows 2000 Professional (or later) graphic standards, or HTML (hypertext mark-up language). The graphics system supplied with the SCADA shall execute on all consoles provided by the Bidder, using commercially available GUI software products. The Purchaser shall define a display only once, after which it shall operate on any workstation. The Purchaser shall not have to develop multiple versions of displays for each workstation.

3.26.2 Display Generation and Editing

An interactive tool shall be provided for creating the operational displays and interfaces associated with each application. With this tool, the user shall draw (rather than code) the contents of application windows, define dynamic linkages to any SCADA data, and sensitize graphical elements to respond to user input actions. (Such sensitized elements are typically referred to as cursor targets.) The ability to link to any SCADA data, not only real-time data, shall allow interactive graphic displays to be constructed for all applications in the SCADA via the display building tool.

A scripting tool is also required to allow displays to be easily modified to incorporate Purchaser changes on top of any Bidder product upgrades. The scripting tool can also be used to port existing Purchaser displays and third-party products into the Bidder’s system.

A display editor shall be used to construct new displays and modify existing displays. The display editor shall be fully compatible with the database generation and editing function. The display editor shall be fully interactive and shall provide "What You See Is What You Get" (WYSIWYG) capabilities. The display editor shall maintain a complete audit trail of edit activity as part of software configuration management.

New displays shall be constructed beginning from a blank display, from an existing display definition, or from display templates within a library. The editor shall support the creation of libraries of standard and custom symbols or components to be created, modified, and used to facilitate the editing process. The editor shall be designed such that any future display requirements may be readily added to its functional display definition capabilities.

The display editor shall support the listing, dumping, reloading, and validating of display definitions. The list function shall provide for partial and full summaries (directories) of displays cross-referenced to their use in applications. The list function shall also produce

detailed documentation of the contents of any display showing all elements. The list function shall also provide tools to find on which displays a given piece of data is referenced. Dumping and reloading of displays shall be provided for individual displays, display libraries, individual applications, or an entire application system.

The display editor shall support a variety of construction options that simplify the building and modification of displays:

a. Editing features to copy, move, delete and modify selected groups of information and to undo/redo the previous actions.

b. Building a display at any zoom level.

c. Visible and invisible snap-grids at specifiable increments with snap-to-placement of objects on the grid.

d. Various font sizes, line types, and line thickness.

e. Linking of any defined graphics symbol to any database point.

f. Pop-up menus for selection of points for linkages by default. The points shall be those in a user-defined substation for which the display is being built. The user, however, shall be able to request a menu list of all available points.

g. Ability to establish different symbol or display conventions for the same database point on the same or on different displays.

h. Definition of dynamic display linkages to any SCADA database variable on any SCADA display.

i. Building and modification of display icons and store them in an easily accessible library.

j. Protection of any data field on any display against user entry based on log-on identifiers.

k. Activation of displays within any application system or across all application systems by a simple procedure that causes no noticeable interruption of on-line SCADA activity.

If a display definition is stored in multiple locations (for example, a copy in each console), a validation function shall be provided to ensure that all definitions over all consoles in both systems are consistent and up-to-date. With entry of the proper authorization code, it shall be possible to edit any display at any console. Similarly, a validation function shall be provided to ensure that displays used by more than one system are propagated to the other systems.

3.26.3 **Display Elements**

Displays shall be composed of display elements, primitives, symbols, and macros. Macros form an arbitrarily complex hierarchy of display elements, primitives, symbols, and other macros. Graphical macros, such as gauges (for example, thermometers and circular meters), bar charts, and X-Y plots, shall be provided to display selected data elements graphically. As a minimum, displays shall consist of the following:

a. Fixed text

b. Drawing primitives (polylines, arcs, and circles)

c. Bit-mapped images

d. Data references

e. Formats

f. Formatted data items

g. Sensitized regions

h. Conditionality

i. Graphic attribute definitions

j. Custom polygons

k. Macros

Drawing primitives, text, and formats shall refer to common graphic attribute definitions for color, line width, fill pattern, et al. Text shall also refer to fonts.

3.26.4 **Data Presentation**

The user, during the interactive display definition process, shall logically identify individual dynamic data fields and data arrays in defined displays. All linkages to the database necessary for ensuring the proper retrieval and output of the dynamic data or data arrays during actual use of the display shall be automatically established according to this identification. The linkages between the displays and the database shall be by logical identification (for example, point name or point identifier) and shall be designed such that any database modifications (even those resulting in insertions into tables/files and changes in table/file sizes) do not require redefinition of existing displays.

Data fields shall reference all supported formats. These formats shall include programming language-equivalent data-to-ASCII conversions, plus all general OSF/Motif style elements

(for example, radio boxes, menus, and sliders) and a special set of formats appropriate to the SCADA context. Formats shall be conveniently definable and modifiable.

Data items shall be defined as locally resident (that is, only for use as parameters in commands), or as RDBMS or real-time data set resident. In the latter two cases, multiple fields in a record shall be grouped as a record reference, so that the record identity need only be entered once. Data items shall be specified as being enterable. Data verification routines shall be specifiable to execute on data entry, before data is actually transacted to its source database.

It shall be possible to present any item in the database on any display. Database items shall be displayable anywhere on the screen, excluding dedicated screen areas such as the display heading. There shall be no limitation on the number of data items presented on any display, up to the physical limitations of the viewport or screen. Similarly, screen locations for cursor targets shall be unrestricted.

Database items shall be presented in the following formats as appropriate:

a. Numerical text that presents analog and accumulator values; the format definition of the text shall include the number of characters, number of decimal places, and the use of sign or flow direction arrows.

b. Symbols, including alphanumeric text strings for a single item, based upon the item's state for all defined states.

c. Symbols, including alphanumeric text strings for multi-state items, based on flag fields where each flag represents a condition or a state and where multiple states may be true at any time; for example, data quality flag fields for both telemetry failure and alarm inhibit may be simultaneously set for an item.

d. X-Y and X-t point relationships with vectors connecting the points; for example trending and Kiviat plots.

e. Filled polygons (x or y axis inside the polygon showing the percent of full scale of the variable); for example, bar charts.

f. Filled arcs; for example, pie charts or simulations of meter movements.

g. Colors, textures, and blink conditions based upon state or value changes or a change of data quality; for example, alarm limits.

h. Combinations of the actions listed above; for example, change a bar chart color when the data value exceeds the limit.

3.26.5 **Quality Code and Tag Presentation**

The quality code reflects the condition of the data on the display. When more than one condition applies to the data, the highest priority condition, as determined by a Purchaser defined priority sequence shall be displayed. The Purchaser shall determine the presentation of each quality code. Color, appended symbols, and other display features may be used. It shall be possible to construct multiple representations for a data item and its quality codes such that the presentation of data may be optimized for a particular display.

A separate indicator shall be used to reflect the tag status of a database point. Tags are defined in Tagging. When more than one tag applies to a point, the highest priority tag, as determined by a Purchaser defined priority sequence, shall be displayed. The Purchaser shall determine the presentation of each tag. Color, appended symbols, and other display features may be used. It shall be possible to construct multiple representations for a data item and its tags such that the presentation of data may be optimized for a particular display.

3.26.6 **User Interaction**

Cursor targets shall send a message to an application or issue a command when events (such as a user action) occur. Such messages and commands shall convey both fixed and contextual data. As a minimum, supported contextual information shall include:

a. Record identities linked to the cursor target.

b. Cursor position on the screen and within the display.

c. Database, application, and application system associated with the display.

d. List position (for lists).

e. Console identification and any associated parameters, such as permissions.

Conditional attribute values shall be attached to any display element, primitive, symbol, macro, or macro sub-element. Conditional attributes shall be able to make a particular display item valid or invalid depending on whether the referenced data or display context is in a specified state. Multiple cases shall be supported so that, for example, a data item may appear in one color if it is in range, another color if it is below range, and a third color if it is above range. Other examples of some of the attributes of power system entities that can be

color-coded are states (in service/out of service/manually overridden, etc.) and values (real time, state estimated, unavailable, good, bad, manually overridden, etc.).

3.26.7 **Display Layers**

World coordinate displays shall be constructed in layers. Each layer shall be a self-contained world co-ordinate space onto which display elements, including data, shall be placed. Layers shall be displayed in a defined order, with higher-order layers overlaying lower-order layers. Where displayable elements of a multiple layers occupy the same space, the higher-order layer elements shall be displayed. Otherwise, the elements of the lower-order layers shall be visible.

The selective presentation of layers – "decluttering" – shall be controlled by the scale (zoom or magnification) level and by user selection. Each layer shall be visible over a range of scale level set defined as the display is built. As the user scales the display, layers shall be presented or removed from presentation. It shall also be possible for the user to override the automatic selection of layers and to select those layers presented at any time.

3.26.8 **Menus**

The SCADA shall support the employment of "pop-up" and "pull-down" menus for user interaction. Those menus supplied with the SCADA shall be extensible by the Purchaser to incorporate new features and applications developed by the Purchaser. It shall be possible to add additional items to existing menus, to define entirely new menus, and to link the call- up of new menus to specific user actions. The menu items, when selected, shall pass messages to applications including fixed and contextual data as described, user interface.

3.26.9 **Display Macros**

The user shall be able to create display macros to aid in the display construction process. Display macros shall be created with an editor designed for this purpose. It shall be convenient to switch back and forth between macro editing and display editing. The editor shall support an arbitrary number of sharable macro libraries. Changes made to macros shall automatically be reflected in all displays that use the macro once the macro is installed in a system. A display macro may be defined to reserve a region of display for a connection with custom application code.

Display macros shall be placed individually. The user shall be prompted for necessary additional information as required by the macro. For instance, if the macro references a particular field of a particular record type, the macro placement shall prompt the user to identify which record is being referenced.

For all record references, it shall be possible to supply the required reference by selecting it with the cursor from any list or from another macro placement showing the record in any window at the console. A generalized copy/paste facility for data references is preferred.

3.26.10 **Function Access**

Access to the power system operations functions shall be limited by access control. Users that do not have access to a function may view displays associated with the function unless they are denied access to the display for other reasons. Users with access to the displays but not the function may not interact with the associated displays to change data or initiate actions.

Functions shall be designated as single-user or multi-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.

3.26.11 **Object Selection**

3.26.12 Selection is the process of picking objects on a display to start an operation or perform an action. The selection process shall be the primary means for a user to initiate system actions from displays. The selection method for each display shall be chosen so that user interaction is efficient.

Basic objects that may be selected include windows, Pushbuttons, and list elements. Other objects that may be selected include symbols for controllable devices, a poke point (designated target area) for an enterable field or a controllable device, or other poke points for other graphic objects or text. For some operations, more than one object may be selected. For some operations, objects previously selected may be deselected.

Moving the cursor to the object or target area and clicking the selection key on the cursor control device shall perform selection. The cursor may be controlled by the cursor- positioning device or by cursor control keys on the console keyboard. The selected action will be determined by the function that is being performed.

3.26.13 **Panning and Zooming**

The user shall be able to zoom (scale) the image of a display in a smooth fashion to any zoom factor. The zoom factors shall allow the presentation of a display window on the full screen or within a small window on a portion of the screen. At defined zoom factors, levels of declutter shall be invoked. Also, the highest and lowest limit of the zoom level shall be readily apparent to the user.

The user shall be able to pan (translate) the display image to permit the observation of other portions of a display within the selected window.

3.26.14 **Element Highlighting**

Highlighting techniques shall direct the user to critical data on displays. The display attributes of color, color intensity, blinking, character inversion, line texture, and appended symbols shall be provided to highlight alarms, power system device and measurement status, data quality, data entry locations, and error conditions. (e.g. Blinking effect with colour change when any line open in Geographical/Mapboard display).

3.26.15 **Quality Code and Tag Indication**

All displays and reports containing telemetered analog values, device status, or calculated values shall have a data quality indicator associated with each data field. The quality indicator shall reflect the condition of the data on the display or report. When more than one condition applies to the data, the symbol for the highest priority condition shall be displayed. A separate indicator shall identify the devices that have supervisory control inhibit tags.

3.26.16 **Cursor Position Selection**

Multiple methods of rapid and convenient cursor positioning shall be provided, including forward and backward tab keys, a cursor positioning device (i.e., mouse), and cursor control keys. Cursor positioning techniques shall be consistent for all displays. Un-displayed tab stops shall be placed at the first character of enterable data fields, at controllable devices, and at all other cursor targets. Cursor targets on displays shall be sufficiently large to permit rapid selection of the target without excessive movement of the cursor positioning device. The size of each target shall be adjustable by the system maintenance engineer. An action that triggers the appearance of a pop-up or pull-down menu shall move the cursor within that menu field if the next user step requires cursor selection from that menu.

The system shall provide a means for moving the cursor from screen to screen on multiple screen consoles. Acceptable methods for moving the cursor to another screen include movement of the cursor-positioning device, selection of a cursor target, and screen selection function keys. The keyboard shall be assigned automatically to the screen containing the cursor.

3.26.17 **Function Key Usage**

There will be no special function keyboard. Special functions shall be assigned to the 12 function keys on a standard keyboard. With extensions (e.g., Shift, Alt, Esc) this shall result in a minimum of 48 function key actions. The meaning of the function keys shall be, as a minimum, system maintenance engineer configurable on a system-wide basis. It is preferred that the function keys be Control Centre Engineer-assignable with the configuration saved and initiated with the Control Centre Engineer logon. There may be a subset of function keys whose meaning is defined by the named window currently being displayed and another subset whose meaning is associated with specific LOGON IDs. The number of these subsets of function keys will depend on the Bidder's UI design and shall be finalized after contract award. A hot-key approach shall be used to call up (and leave on the screen, if desired) a menu showing the system wide, context sensitive, and current user defined function key meanings. The Bidder shall clearly describe the function key definition features proposed.

The functionality of each function key shall also be implemented using poke point targets on displays or dialog menus, allowing full functionality on consoles without the use of function keys.

3.26.18 **User Interaction Techniques**

The user's communication with the SCADA system for power system operations shall primarily be accomplished using a menu item selection technique. The first step in the interaction will be selection of the item to be operated upon. This will be accomplished by positioning the cursor on the item as shown on a graphic, tabular, or summary display and initiating a select command.

The user shall then be provided a menu of operations applicable to the selected item. The required operation alternatives include:

a. Data entry

b. Device status entry

c. Scan inhibit/enable

d. Tag placement/removal

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

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

The user shall be able to end the interaction sequence at any time by selecting a cancel command. A system maintenance engineer-adjustable time-out cancel shall also be provided.

3.26.19 **Point Entry**

Enterable data fields shall be defined when a display is generated. All enterable data fields shall be highlighted during the data entry process only. The user shall be able to enter the desired value anywhere within the data entry field. This shall include the ability of the user to select formats that are left justified, right justified, or cantered as well as based on number of digits, sign, and decimal point location. If only a portion of a data value needs to be changed, only that portion of the value shall need to be entered. In addition, the user shall be supported by automatic cursor movements to the next data entry field required and by data repeat and copy facilities applied to user-selected single and multiple (including full or partial row and column) values.

Data entry shall be initiated by the user selecting the value to be entered on a display. The value shall be highlighted, and the value's identification shall be displayed. An authorization feature shall determine if proper authorization exists for the user to perform data entry. The system shall also verify user entries. For example, a device's high limit shall not exceed its reasonability limit and must be greater than its low limit. Invalid entries shall be detected and reported to the user via user guidance messages. The data entry function shall provide a means to view the acceptable limits of data entry.

The sequence of actions for manual entry of telemetered data values shall depend on the state of the telemetered data. If the telemetered data does not have a telemetry failure quality indicator, the system shall require the user to remove the item from scan before manual data entry is allowed. If the item does have a telemetry failure quality indicator, it need not be removed from scan by the user. The system shall remove the item from scan automatically during the manual data entry process. Following either sequence, the data value shall be marked as manually entered on displays and reports containing the value.

Full page data entry shall be provided to allow the user to make multiple data entries before requesting, via poke point or key selection, that the data be entered into the database. All

valid entries shall be accepted unless the associated system function requires all entries to be correct. In the latter case, the user shall not be required to re-enter valid entries. When the user successfully completes a data entry, the previous value and the new value shall be reported in an event message.

All data entry shall be subject to a time limit. If data entry is not completed within the specified time from the last keystroke performed in a window, the system shall revert to the previous database value, generate an event message, and display a user guidance message. The timer shall be adjustable by the system maintenance engineer for each user action.

The user shall be able to select another window without cancellation of an active data entry process. The user shall be able to end data entry at any time, however, by selecting a cancel command or requesting a different display in that window. These actions shall cause the process to be terminated and the data value shall remain unchanged.

3.26.20 **Device Status Entry:**

Displays shall show the state of power system devices whose status is not telemetered or that have been removed from scan. To change the status indication of these devices, the user will follow the procedure for supervisory control, except an execute step shall not be required.

The system database shall retain the manually entered status of these devices. Devices that are not telemetered or have been removed from scan shall be indicated by special symbols or unique Colors.

3.26.21 **Scan Inhibit and Enable:**

When an item is selected to be deleted from or returned to scan, the requested action shall occur without further interaction from the user. The changing of an item's scan status shall be recorded as an event, the out-of-scan summary shall be updated, and an out-of-scan quality code added to or removed from the displayed item.

Scan Inhibit for a value or device, including a complete DCU/RTU/IED or other data source, shall cause scanning of that value or device to be suspended.

3.26.22 **Tag Placement and Removal:**

Up to 6 tag types shall be provided. The user shall be able to define the following for each tag type:

a. Tag symbol to be displayed

b. Tag priority

c. Type of controls that shall be inhibited by the tag, i.e. open only, close only, open and close, or information only (no control inhibit).

The user shall be able to place up to 6 tags on a device, but 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 the user selects a device for tag placement or removal, a menu of the tag types shall appear. When placing a tag, after the tag type is selected, the system shall prompt the user to enter comments in a free form comment field and activate the tag. The comment field shall be a minimum of 200 characters in length.

A tag summary of all active tags on devices shall be conveniently accessible to the user. The tag summary shall indicate for each device the date and time each tag was placed on the device, console identifier, tag type, tag number, and the user-entered comment for each active tag.

Tag placement or removal shall be permitted on the tag summary and on any display that includes the device. An event message shall be generated each time a tag is placed or removed.

3.26.23 **Report Control**

The user shall be able to schedule periodic reports, direct report to a display, print a report, and archive a report using a report scheduling display. The report scheduling display shall enable entry of the following parameters, with default values provided where appropriate:

i. Report name

ii. Report destination (printer or archiving device)

iii. Time the system should produce the report.

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

3.26.24 **System Configuration Monitoring and Control**

The user shall be provided with the capability to review the SCADA & ADMS computer system configuration and to control the state of the configuration equipment using displays. The following operations shall be possible:

i. Failover, switching, and monitoring of each processor and device, including workstations, RTU/IEDs, LANs, data links, and remote consoles. Monitoring shall include status and accumulated downtime.

ii. Control of the resource usage monitoring function and display of processor resource utilization.

iii. Selection of alternative data sources.

3.26.24.1 **Logging, Monitoring**

The system shall log all actions/events executed by user in the workstations/servers etc. for necessary analysis and post operation review.

3.26.25 **Applications Program Control**

The user shall be provided with the capability to interact with all SCADA functions using displays. Appropriate data entry fields and cursor targets shall be provided on these displays to augment the user's efficiency and effectiveness in interacting with the application.

3.26.26 **Data Set Selection**

Transmission system overviews and substation graphic diagrams will be used for multiple purposes. For example, these displays will be used to monitor the power system as well as to prepare the inputs for and review the outputs of power system applications. The user shall be able to change the data set presented on these displays by selecting a cursor target or menu item. The name of the data set in use, including the real-time data set, shall be displayed. Another means, such as background texture or Color or window border Color, shall be provided to distinguish between real-time and other data set usage on these displays.

3.26.27 **Dynamic Data Presentation**

Device status or data values shall be displayable anywhere on the screen, excluding dedicated screen areas such as the display heading. There shall be no limitation on the number of data items presented on any display, up to the physical limitations of the window or screen. Similarly, screen locations for cursor targets shall be unrestricted.

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

a. Numerical text that presents analog values; the format definition of the text shall include the number of characters, number of decimal places, and the use of sign or flow direction arrows.

b. Display of analog values in amperes; the user shall have the capability to request replacement of MW and MVar values with calculated amperes and direction on the transmission system and substation graphic diagrams. The calculated quality code shall be displayed with the value.

c. Symbols, including alphanumeric text strings for a single item, based upon state changes.

d. Symbols, including alphanumeric text strings for multi-state items, based on flag fields where each flag represents a condition or a state and where multiple states may be true at any time, e.g., data quality flag fields for both telemetry failure and alarm inhibit may be simultaneously set for an item.

e. X-Y and X-t point relationships with vectors connecting the points, e.g., trending and other plots.

f. Filled polygons (X or Y axis inside the polygon showing the percent of full scale of the variable), e.g., bar charts.

g. Filled arcs (circular arcs of 90, 180, 270, and 360 degrees times the percentage of full scale of the variables), e.g., pie charts or simulations of meter movements.

h. Colors, textures, and blink conditions based upon state or value changes or a change of data quality, e.g., alarm limits.

i. Combinations of the actions listed above, e.g., change a bar chart color when the data value exceeds the limit.

j. Only standard X Window system fonts shall be provided with the SCADA. All fonts supplied shall be supported on the user interface devices and all printers supplied with the system. The types of fonts to be used in a particular display shall be selected at display definition time. It shall be possible to define additional fonts and download them into display list memory. The additional fonts shall be scalable as to point size, compression / expansion, light to bold, slant, and other standard features.

It shall be possible to present any item in the database on any display. All supervisory control and data control capabilities shall be supported from any window of a world display.

Time date and Frequency shall be displayed on a screen-basis, not on a display basis, and shall be always visible.

3.27 **Dynamic Network Coloring**

The network components shall be automatically Colored using the Dynamic Network Coloring (DNC) function:

i. To reflect real-time events and status changes as they happen.

ii. To distinguish network components with a common property (voltage, type etc.)

iii. To provide the Control Centre Engineer with the facility to analyze the conditions of any part of the network database.

iv. Dynamic Network Colouring Based TPCL Distribution Circle/Division/Station Maps (Power Flows and Topology Based Logics)

The following two modes of operation shall be provided:

i. Global Dynamic Network Coloring provided to all Control Centre Engineers

ii. Local Tracing Function provided to individual Control Centre Engineers on request (tracing)

Both global and local DNC modes shall be updated when a processing event (real-time or manual) affects the connectivity of the network.

3.27.1 **Global Coloring Functions**

The Dynamic Network Coloring (DNC) function shall combine topological information with the electrical status information and determines the network connectivity and electrical status of the power system. The result shall be presented in world map overview pictures and in station diagrams.

DNC shall have the following features:

a. Change in colour of line when line overloaded and/or reaches reasonability limit. It must be user configurable and Change in colour of “Text” for “Feeder/Line name” when its MW becomes zero.

b. Flexible network area coloring permit individual division of each system in order to optimize legibility by colors.

c. Flexible color selection shall give each system a possibility to individually choose colors for presentation.

d. Easy interpretation of network connectivity and electrical status as connected areas are colored in a uniform way and the same color is used in different pictures.

e. Feeder identification as the colors can identify from where an area or a load is fed.

f. Very efficient re-coloring response after process events due to incremental processing and efficient search algorithms.

g. Comfort area re-coloring shall provide a possibility for the Control Centre Engineer to increase legibility between different neighboring connected areas.

DNC shall provide an easy and flexible possibility for each system to be individually divided into different color areas in order to increase the legibility between different network areas, voltage levels or other chosen network area divisions. Each system shall also use a number of individually selected colors for the presentation.

The following ways of coloring the network dynamically shall be available.

a. **Electrical Status** - Energized, De-energized, Earthed (Grounded), Inconsistent (e.g. earthed and energized at the same time), Undetermined

b. **Voltage Levels** - In cases where more than one voltage level is represented on an operating diagram all equipment at the same voltage level can be designated with the same color. Transformers between the voltage levels provide the logical separating point. Equipment that is not energized is colored by its status color (e.g. de-energized, earthed).

c. **Tags** - Tagged equipment and all connected equipment can be colored as notification of a probable restriction. Priority rules shall be employed to cover multiple tags in the same connected island.

d. **Multiple Sources** - There are cases when one load point is supplied from more than one source, particularly in meshed networks. The DNC function shall have a set of rules to appropriately identify, which sources supply a particular load point.

3.27.1.1 **Color Reference Points (CRP)**

Color reference points are fictitious objects consisting of a color and a priority. The color reference points shall be used to control the coloring in the DNC and give the Control Centre Engineer a possibility to identify from where the connected areas or load areas are fed.

The DNC shall use several colors when coloring energized connected areas and components. When a connected area or a component is de-energized or grounded, reserved colors shall be used. The final color presentation shall be based on the quality of the data collected by the data acquisition. If data is reliable and consistent, the color presents a well-defined connectivity and electrical status (energized, de-energized or grounded) to the Control Centre Engineer.

DNC shall also provide a possibility for the Control Centre Engineer to temporarily change the presented color in order to increase the legibility between different neighboring connected areas.

3.27.2 **Local Coloring Functions (Tracing)**

The tracing services shall answer specific questions about the actual network conditions (connectivity) and the flow conditions for parts of the network. The functionality is primarily intended for use in distribution systems where the network is radial.

a. **Connected Source Tracing:** Connected Source Tracing shall trace all sources (feeding points) connected to an Control Centre Engineer-selected element and colors all the valid paths found. A path is declared as not valid if an open switch, an open-ended line or a non-source element is found at the end of the path. Sources such as generators and elements shall be marked as power injection elements (for instance, loads, lines).

b. **Interconnection Tracing:** Interconnection tracing, shall trace all possible elements connecting two Control Centre Engineers given elements and colors all the valid paths found. The end criterion for the searching is reached if a possible path to the target has been traced.

c. **Load Tracing:** Load tracing, shall trace all loads connected to an Control Centre Engineer selected element and colors all the valid paths leading from the selected element to the consumers. The end criterion for the searching is reached if a possible path is traced for a load.

d. **Main Source Tracing:** Main source tracing, shall trace all sources connected to an Control Centre Engineer selected element and colors the path to the source feeding the highest power flow to that element. A first end criterion is reached if all possible paths are traced for a source. As a second criterion, only the path to the found sources is

declared as valid which feeds the highest power flow. Sources such as generators and elements marked as power injection elements (for instance, loads, lines).

e. **Profile Tracing:** Profile Tracing is a combination of connectivity and flow tracing. It shall give the Control Centre Engineer a possibility to display process values corresponding to points along a selected path in the power system, on an XY plot. The selected path can be specified (via a dialog) by two end-points on a network and the desired process value type. The profile tracing function determines the power system elements and the corresponding process values between both end points. The results shall be displayed on an XY plot in the presentation window.

3.27.3 **Electronic Mail (E-Mail) & SMS Notification system:**

The system shall have the facility to send messages and files between SCADA consoles and to and from workstations exclusively on the SCADA LAN.

The offered system shall also facility to exchange of emails & messages of customized dashboards/notifications etc., through Purchaser's existing email servers and other mail servers supporting SMTP.

The Message notification shall be through Purchaser/Third Party SMS Gateway. The dashboard /notification / Alarms / Analog Data for email & message shall be customizable and shall be categorized level of users such as Operator, Supervisor, Head/Chief and Management Leaders etc.

Chapter # 4

Advance Distribution Management System Applications

4.0 General Requirements

This Section describes the ADMS applications that are required for Sub-Transmission & Distribution network. These applications shall utilize the data acquired by the SCADA & its application. The Software shall include the following applications. Purchaser shall select /all or certain applications as per the requirements

Graphical & Tabular Display

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

All ADMS result tabular displays shall have capability for sorting by name and calculated parameters.

The solution prescribed by ADMS application shall consider & identify & sort the following as minimum

a) Remote controllable circuit breaker with capability to interrupt fault currents

b) Non-remote controllable circuit breaker with capability to interrupt fault currents

c) Remote controllable circuit breaker with no capability to interrupt fault currents

d) Non-remote controllable circuit breaker with no capability to interrupt fault currents

e) Remote controllable disconnector

f) Non remote controllable disconnector

g) Fuse

h) Ground/ Earth switch

i) Sectionalizer

j) On-load Tap Changers

k) Switchable Capacitors / Reactors etc.

4.1 **System Requirements**

Power System Applications require a highly interactive user interface that shall provide extensive user support. For these functions to be useful, the user interface shall be logical, convenient, and simple to use.

The user interface of all real-time and study network analysis functions shall confirm to the user interface requirements, and the general user interface requirements summarized below:

a) It shall be possible to display real-time data and network analysis functions data simultaneously on the same display; however, they should be distinguished from each other through color or appended symbols with full set of displays to support all the specified network analysis functions.

b) We shall review rights for the network analysis functions user interface, including all displays, logs, printed output, messages, and alarms.

c) Displays shall be available to support all functional capabilities in a convenient manner.

d) There shall be a high degree of consistency among the network analysis functions user interfaces with respect to display naming convention, layout, appearance, look and feel, presentation, and user dialogue. Execution control procedures shall be simple.

e) Disconnected and open-ended equipment shall be identified on all displays and print output.

f) Multiple islands, when they exist, shall be easily identified on one-line diagrams and tabular displays by different attributes of the related elements (busbars, generators, branches, etc.)

g) All displays, error messages, alarms, logs, and reports shall be useful and understandable to the Operator.

h) It shall be possible to present network analysis functions input and results on one-line diagrams. It shall be possible to provide this capability by using the static and dynamic definitions of the one-line diagrams.

i) All input and output shall be in engineering units.

j) Displays provided should permit Operators to easily modify any data, whether metered, calculated, or obtained from a save case, prior to the execution of any of the network analysis functions.

k) Set-up and execution of all network analysis functions shall be made as simple as possible through the utilization of interactive, menu-driven execution control displays. It shall be possible to execute individual study network analysis functions in an interactive mode with a minimum amount of user input required. It shall also be possible to execute a series of study network analysis functions with a single command.

l) The SCADA/ADMS shall provide the capability to execute study functions without switching the console to a dedicated study mode. The console shall have the ability to operate in both the real time and study mode simultaneously. Only one mode will be active at any given time. Switching between the two modes through windowing is acceptable.

m) All execution control and output display of the real-time network analysis functions sequence shall show when the real-time data was collected.

n) All programs shall provide an indication that execution is in progress, notification of program completion, and an indication of significant error conditions.

o) Each program shall provide messages of error conditions, inconsistent data, or significant events occurring during execution that may be of interest to Operators. These messages shall be routed to the program displays according to the network application modes. For messages related to real-time mode, the messages shall be sent to those consoles with the appropriate assigned area of responsibility. For messages generated from applications running in study mode, the messages shall be sent to the console from which the program operation was requested. The messages shall be understandable by the Operator and shall be “actionable” meaning that they shall indicate clearly what action needs to be taken, given the circumstance being encountered. The Operator shall not be exposed to messages that are to be used by programmers or support personnel.

p) All displays available for the real-time mode of the network analysis programs shall also be available in the study mode, where relevant.

q) Data entry capability shall be provided via both tabular displays and one-line diagrams. Operators shall be able to enter typical power flow inputs, such as individual loads, generation, device statuses, transformer tap positions, and desired voltages on one-line diagrams for use by the network analysis functions. The Operator shall also be able to change limits in study mode. All modified data shall be saved with the save case.

r) All displays shall clearly differentiate between metered data and data calculated by the network analysis or other application functions.

s) Where identical one-line diagrams and tabular displays are used in different functions (e.g., power flow, state estimator), it shall only be necessary to build these displays and specify linkage names once.

t) Displays shall clearly differentiate between study mode and real-time program results, through color, display heading, and dynamic field indicators. For study mode displays, the indicators shall clearly identify the individual study case that is being displayed.

u) Bus numbers internal to the network analysis programs shall not be shown on any Operator-oriented displays. All equipment shall be displayed via a consistent alphanumeric naming convention used throughout the SCADA/ADMS. Leading numbers and blanks in the names shall be allowed.

v) Operator-oriented messages related to equipment shall refer to the equipment by station and equipment name.

w) Maintenance displays shall be available to provide control of convergence tolerances, step sizes, and other program control parameters.

x) All solution results must be limit checked and violations highlighted by providing separate tabular displays for each type of violation using standard conventions described in Section 4, User Interface.

y) The control and monitoring of the network analysis functions shall occur at consoles with appropriate authorization (determined by the console operational responsibility assignments).

z) A convergence summary display shall be provided for all iterative functions (e.g., state estimator, contingency analysis, power flow, as a minimum). This display shall identify, for each iteration, the buses with the largest MW and Mvar mismatches or voltage angle and magnitude changes. In the case of a divergent solution, the display shall also provide information regarding the network area (or buses) where the calculation process is encountering divergence (or difficulty in solving) in order to assist the user in the correction of the problem.

aa) Detailed solution debug information shall be provided showing for example: matrix values, bus voltages, and generation outputs at each iteration. This information shall be available to the user, in a readable format, for the purpose of investigating divergent cases and other

solution problems. Debug information shall only be generated when specifically requested by the user.

bb) The displays associated with the network analysis functions, be they one-line diagrams or tabular displays shall provide context-sensitive help. This feature shall permit access not only to help with running the network analysis tools but shall also permit on-line access to the procedures relative to specific equipment or operational procedures.

4.2 **Execution and Solution**

All functions shall be designed and integrated for fast and reliable execution. Data checking and verification shall be available beyond the rudimentary reasonability and format checks provided by the user interface software.

All network analysis functions shall provide solutions (voltage and vars) at the open ends of open-ended branches.

For real-time functions the same limits shall be used as are currently used for limit monitoring of real- time metered data. Real time limits shall be the default limits for study mode. The Operator shall have the ability to change the limits in study mode on-line. The Operator shall have the option to reset the study mode limits to the real time limits. Solutions shall be obtained for bus voltages as low as 0.5 pu or as high as 1.5 pu. The solution constraints shall be user definable.

4.3 **Advance Distribution Management System Applications**

a) Network Model

b) Network Connectivity Analysis

c) Dynamic Network Coloring

d) Real-Time Network Analysis

i. Real-Time Network Analysis Function Execution

ii. Real-Time Network Model Builder

iii. Parameter Adaptation

iv. State Estimator

v. Power Flow Studies

vi. Contingency Analysis

vii. Security Constrained Dispatch

viii. Voltage Var Control

e) Load Shedding

f) Switch Order Management

g) Fault Location, Isolation & Restoration

h) Optimal Feeder Reconfiguration

i) Distribution Power Flow (DPF)

j) Outage Management, Trouble Call Management

k) Crew Management, Field Scheduling and Dispatch

l) Outage Analysis & Prediction

m) Web Portal for Outage Management

n) Mobile Crew Management Client

o) Quality of Service Indices

p) Interactive Voice Response

4.3.1 **Network Model**

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

a. Power Injection points

b. Transformers

c. Feeders

d. Load (balanced as well as unbalanced)

e. Circuit Breakers

f. Sectionalizers

g. Isolators

h. Fuses

i. Capacitor banks

j. Reactors

k. Generators

l. Bus bars

m. Temporary Jumper, Cut and Ground

n. Meshed & radial network configuration

o. Line segments, which can be single-phase, two-phase or three-phase

p. Conductors

q. Grounding devices

r. Fault detectors

s. IEDs

t. Operational limits for components such as lines, transformers, and switching devices

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

Population and maintenance of the Sub-transmission & distribution network model should be possible by using the database maintenance tools to build the database from scratch. In case the required data already exists within the Purchaser's Geographic Information System (GIS) or otherwise, the ADMS database functions should leverage this effort by providing an interface/adaptor to extract GIS data using the CIM international standard IEC 61970/61968 and automatically generate the complete Network Operations Model. The data extracted should include network device information, connectivity, topology, nominal status and non-electrical data such as cable, land base data etc. Further Land base data can be sourced from GIS in Shape files or DXF.

The extraction process should comply with the international standard CIM data descriptions. The extraction process should be independent of the real-time network management system. Any GIS model should be extractable to build the network model regardless of the Bidder or internal schema.

The extraction should also allow incremental updates & global transfer with no need to bring the system down or even fail over. The model should support extraction on a per-station basis and must be fully scalable from a single zone substation to the largest distribution networks. SCADA & ADMS should be able to present geospatial data even when the link to the source GIS at the Data Center/DR is not available.

The user interface supporting the database will provide updated data directly to display geographic and/or schematic views of the network.

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

An interface with the already existing Geographical Information Systems shall be developed using interoperability features between the ADMS and the installed GIS, covering all the integration features.

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

The interface shall be developed in order to obtain a maximum benefit of the two systems use. It shall be implemented while maintaining the SCADA & ADMS and GIS integrity as individual systems. It is of the utmost importance that the two systems remain able to operate separately.

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

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

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

4.3.2 **Network Connectivity Analysis**

The network connectivity analysis function shall provide the connectivity between various network elements. The prevailing network topology shall be determined from the status of

all the switching devices such as circuit breaker, isolators etc. that affect the topology of the network modeled.

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

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

The topology shall be based on

a. Tele-metered switching device statuses

b. Manually entered switching device statuses.

c. Modeled element statuses from ADMS applications.

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

e. Bus connectivity (Live/ dead status)

f. Feeder connectivity

g. Network connectivity representing S/S bus as node

h. Energized /de-energized state of network equipment

i. Representation of Loops (Possible alternate routes)

j. Representation of parallels

k. Abnormal/off-normal state of CB/Isolators

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

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

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

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

4.3.2.1 **Tracing**

NCA function shall also have the capabilities of network tracing when requested by the Control Centre Engineer. Dedicated Colors shall be used for feeder and circuit tracing and also when information available is not complete or inconsistent. The trace shall persist through subsequent display call-ups, until the Control Centre Engineer 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 Control Centre Engineer to identify the path from a source to all connected components by same color.

b) **Circuit Tracing** - This feature shall enable Control Centre Engineer to select any device and identify the source and path by which it is connected through the same Color.

c) **Between Tracing** - This feature shall enable the Control Centre Engineer 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.

e) Tracing by Voltage levels

f) Tracing by On/Off status of elements

g) Tracing by NW groups/divisions/area of responsibility

h) Locating and tracing of all sources and flow directions that supply a point

i) Locating and tracing of all network loops.

4.3.2.2 **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.

4.3.2.3 **Cuts**

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

a. The cut must be given a name or id number for identification, which is displayed as a label on the geographic network view.

b. It should be possible to select the position of the label relative to the cut symbol.

c. 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 Control Centre Engineer in the same way as a standard disconnect switch. Cuts can also be tagged.

4.3.2.4 **Jumpers**

Jumpers are a means of providing a temporary, switchable connection between two points on the network. The Control Centre Engineer 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 Control Centre Engineer 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.

4.3.2.5 **Temporary Grounds**

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

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

4.3.2.6 **Reports & Displays**

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

a. Abnormal switches in tabular display

b. De-energized components of network in tabular display

c. Presence of loops & parallels on network displays

d. Un-served/ disconnected loads (loads affected due to tripping of CBs) in tabular displays

e. List of temporary jumpers/cuts /grounds

4.3.3 **Dynamic Network Coloring**

The network components shall be automatically Colored using the Dynamic Network Coloring (DNC) function:

a. To reflect real-time events and status changes as they happen.

b. To distinguish network components with a common property (voltage, type etc.)

c. To provide the Control Centre Engineer with the facility to analyze the conditions of any part of the network database.

The following two modes of operation shall be provided:

a. Global Dynamic Network Coloring provided to all Control Centre Engineers

b. Local Tracing Function provided to individual Control Centre Engineers on request (tracing)

Both global and local DNC modes shall be updated when a processing event (real-time or manual) affects the connectivity of the network.

4.3.3.1 **Global Coloring Functions**

The Dynamic Network Coloring (DNC) function shall combine topological information with the electrical status information and determines the network connectivity and electrical status of the power system. The result shall be presented in world map overview pictures and in station diagrams.

DNC shall have the following features:

a. Flexible network area coloring permit individual division of each system in order to optimize legibility by colors.

b. Flexible color selection shall give each system a possibility to individually choose colors for presentation.

c. Easy interpretation of network connectivity and electrical status as connected areas are colored in a uniform way and the same color is used in different pictures.

d. Feeder identification as the colors can identify from where an area or a load is fed.

e. Very efficient re-coloring response after process events due to incremental processing and efficient search algorithms.

f. Comfort area re-coloring shall provide a possibility for the Control Centre Engineer to increase legibility between different neighboring connected areas.

DNC shall provide an easy and flexible possibility for each system to be individually divided into different color areas in order to increase the legibility between different network areas, voltage levels or other chosen network area divisions. Each system shall also use a number of individually selected colors for the presentation.

The following ways of coloring the network dynamically shall be available.

a. **Electrical Status** - Energized, De-energized, Earthed (Grounded), Inconsistent (e.g. earthed and energized at the same time), Undetermined

b. **Voltage Levels** - In cases where more than one voltage level are represented on an operating diagram all equipment at the same voltage level can be designated with the same color. Transformers between the voltage levels provide the logical separating point. Equipment that is not energized is colored by its status color (e.g. de-energized, earthed).

c. **Tags** - Tagged equipment and all connected equipment can be colored as notification of a probable restriction. Priority rules shall be employed to cover multiple tags in the same connected island.

d. **Multiple Sources** - There are cases when one load point is supplied from more than one source, particularly in meshed networks. The DNC function shall have a set of rules to appropriately identify, which sources supply a particular load point.

4.3.3.2 **Color Reference Points (CRP)**

Color reference points are fictitious objects consisting of a color and a priority. The color reference points shall be used to control the coloring in the DNC and give the Control Centre Engineer a possibility to identify from where the connected areas or load areas are fed.

The DNC shall use several colors when coloring energized connected areas and components. When a connected area or a component is de-energized or grounded, reserved colors shall be used. The final color presentation shall be based on the quality of the data collected by the data acquisition. If data is reliable and consistent, the color presents a well-defined connectivity and electrical status (energized, de-energized or grounded) to the Control Centre Engineer.

DNC shall also provide a possibility for the Control Centre Engineer to temporarily change the presented color in order to increase the legibility between different neighboring connected areas.

4.3.3.3 **Local Coloring Functions (Tracing)**

The tracing services shall answer specific questions about the actual network conditions (connectivity) and the flow conditions for parts of the network. The functionality is primarily intended for use in distribution systems where the network is radial.

a. **Connected Source Tracing:** Connected Source Tracing shall trace all sources (feeding points) connected to an Control Centre Engineer-selected element and colors all the valid paths found. A path is declared as not valid if an open switch, an open-ended line or a non-source element is found at the end of the path. Sources such as generators and elements shall be marked as power injection elements (for instance, loads, lines).

b. **Interconnection Tracing:** Interconnection tracing, shall trace all possible elements connecting two Control Centre Engineers given elements and colors all the valid paths found. The end criterion for the searching is reached if a possible path to the target has been traced.

c. **Load Tracing:** Load tracing, shall trace all loads connected to an Control Centre Engineer selected element and colors all the valid paths leading from the selected element to the consumers. The end criterion for the searching is reached if a possible path is traced for a load.

d. **Main Source Tracing:** Main source tracing, shall trace all sources connected to an Control Centre Engineer selected element and colors the path to the source feeding the highest power flow to that element. A first end criterion is reached if all possible paths are traced for a source. As a second criterion, only the path to the found sources is declared as valid which feeds the highest power flow. Sources such as generators and elements marked as power injection elements (for instance, loads, lines).

e. **Profile Tracing:** Profile Tracing is a combination of connectivity and flow tracing. It shall give the Control Centre Engineer a possibility to display process values corresponding to points along a selected path in the power system, on an XY plot. The selected path can be specified (via a dialog) by two end-points on a network and the desired process value type. The profile tracing function determines the power system elements and the corresponding process values between both end points. The results shall be displayed on an XY plot in the presentation window.

4.3.4 **Real-Time Network Analysis**

In the real-time mode, the network analysis functions shall monitor the current state of the power system and analyze the effect of contingencies. Real-time data will be the primary input to the functions in this mode.

Network analysis functions in the real-time mode shall be executed automatically on a periodic basis, when triggered by the occurrence of pre-specified events, or when initiated by a user. No manual inputs shall be required for the execution of the functions.

The following real-time network analysis functions shall be provided:

a) Real-Time Network Model Builder (RTNMB)

b) Parameter Adaptation (PA)

c) State Estimator (SE)

d) Optimal Power Flow (PF)

e) Contingency Analysis (CA)

f) Security Constrained Dispatch

g) Voltage Var Dispatch

The capability shall be provided to define a real-time network analysis functions sequence (real-time sequence) consisting of the above real-time network analysis functions. A data set shall be gathered at the start of the network analysis functions sequence so that all functions in the sequence are using a consistent set of input information (e.g., the CA must use the same network model that the SE used in the same sequence).

4.3.4.1 **Real-Time Network Analysis Function Execution**

Three initiation methods shall be provided to control the execution of the real-time sequence:

a) Time Triggers – The real-time sequence shall be scheduled for periodic initiation. Time triggers shall be monitored. Missed periodic triggers shall be recorded as events except when reset by event or demand triggers. If interrupted, the periodic trigger shall automatically reset to the next cycle.

b) Event Triggers – When a status change event is detected by the SCADA/ADMS, the real-time sequence shall be initiated after a short delay (typically 10-20 seconds, adjustable). This delay is intended to allow acquisition of status and analog data corresponding to the post- event power system conditions. It shall be possible to define event triggers as a logical function of one or more user-defined switching elements and analog points exceeding a pre- specified threshold. Event triggers shall be recorded as events.

c) Demand Triggers – A manual trigger shall cause any sequence in progress to stop and a new sequence to start. No other triggers shall be initiated if a real-time sequence initiated by a demand trigger is already active. Demand triggers shall be recorded as events.

It shall be possible for the user to change the periodicity of any real-time network analysis functions on-line using an Operator-oriented display.

Operators shall have the ability to initiate or cancel executions of the real-time sequence at any time. A real-time sequence execution control display shall be provided, which shall show program completion, occurrence of error conditions, and which programs are executing. If the real-time sequence is canceled, the execution shall stop as soon as possible and all network data that is displayed in tabular or single line displays shall remain at the values of the last valid solution. No database areas shall be corrupted with inconsistent data.

Alarm and event processing for state estimated data shall be like real-time data, however, alarms for state estimated data shall not be repeated. Alarms related to state estimated data shall be distinguished on alarm summaries with a different attribute. It shall be possible to inhibit alarming for state estimated data, both globally and on a per-point basis.

The capability to automatically collect data after every execution of a network analysis function for which collection is defined shall be provided. Results of the real-time network analysis functions shall be reconstructed using the telemetered data stored in the Information Storage & Retrieval database for a specific collection period. Databases for old network models shall be archived with the time in use and retrievable for result reconstruction.

4.3.4.2 **Real-Time Network Model Builder**

The real-time network model builder (RTNMB) shall build a bus model to support real-time network analysis calculations and for the display of connectivity on one-line diagrams, overview diagrams, and other displays. The RTNMB and all of its associated sub-functions shall be executed automatically as part of the real-time sequence.

The RTNMB shall analyze the connectivity of all substation equipment, including generators, synchronous condensers, transmission lines, transformers, loads, capacitors, and reactors. It shall analyze the connectivity of stations and transmission elements throughout the network to support all network analysis functions. A bus-oriented network model consisting of branch and shunt admittance, bus loads, and bus generations shall be constructed from the substation and transmission element connectivity.

The RTNMB shall also access the LTC transformer and phase shifter tap position data, analog measurements, and equipment limits from the real-time database and shall format this data for use by the real-time network analysis functions. It shall be possible to enter fixed tap positions manually into the database through the network analysis user interface.

4.3.4.2.1 **Study Network Analysis**

In the study mode, programs shall be executed on user demand to analyze current, past, and future power system conditions. The following study network analysis functions shall be provided:

a. Study Case Initialization

b. Study Network Model Builder (SNMB)

c. Power Flow Study (PFS)

d. Contingency Analysis (CA)

Study functions shall work together as an integrated set of functions. It shall be possible to execute a sequence of study functions with a single command. The exchange of data among functions in a study sequence shall be transparent to the user. General-purpose tools shall be available for sequencing and execution of the study functions.

Operators shall have the capability to easily initiate or cancel studies at any time. A study sequence execution control display shall be provided, which shall allow the Operator to control study setup, sequencing, and execution, and which shall show study completion as well as the occurrence of error conditions. If a study is canceled, the execution shall stop as soon as possible, and no database areas shall be corrupted with inconsistent data. A canceled study shall be re-executable with no adverse effect on the results.

All study network analysis functions that provide functionality similar to real-time network analysis functions (i.e., study network model builder, and contingency analysis) shall be based on the same algorithms, provide the same features, and use an identical user interface as the real-time versions, except where noted specifically. However, the control of each study function shall be totally independent of the real-time version, and each study function shall have execution and tuning parameters that can be adjusted independently. Study network analysis functions shall not generate any alarms due to detected violations or solution failures; these types of conditions shall be available on solution results and diagnostic displays.

4.3.4.2.2 **Study Base Case Initialization**

Study base case initialization shall be used to create a base case for the study network analysis functions. It shall be possible to initialize a study base case using information available from:

a. The most recent state estimator solution

b. Power flow study save cases

c. State estimator save cases

d. Real-time SCADA data

e. Historical SCADA data.

By specifying a date and time, the base case for a given date and time shall automatically be constructed using data from the equipment outage scheduling function and the parameter adaptation function.

Study case initialization shall be performed by either automatic or manual execution of one or more of the sub functions of the study network model builder, at the user's option.

Multiple users with multiple independent working areas shall be supported. Each user shall have an individual working area, which shall be used as a temporary location to gather information needed to run a study, modify the data as needed to represent the desired study conditions, and temporarily hold the study results. Each working area shall be able to support multiple temporary save cases. Modifications made by a user in the user's working area shall not affect the source of data or any other user's working area. Interaction between users shall only be through permanent save cases. It shall be possible for multiple users to simultaneously prepare input cases, execute programs, and examine the output data. Local temporary save cases shall be saved to or retrieved from permanent save cases.

Save cases shall contain all information needed to describe the power system at the time it is being studied. This includes not only data normally considered as dynamic, such as system load, switching device statuses, and generating unit limits, but also a full definition of the network model (node level connectivity and electrical characteristics). Save case information shall be enough to execute a study for a previous network model and generation schedule, even after a database change of any of this data.

Save cases shall be accessible by all users. A locking mechanism shall be provided to prevent users from inadvertently purging, overwriting, or modifying a specific save case.

4.3.4.2.3 **Study Network Model Builder**

The study network model builder (SNMB) shall build a bus model to support study network analysis functions. SNMB shall also be used for connectivity presentation on study network analysis function one-line and overview diagrams, and other displays.

The SNMB shall be executed as part of a power flow study execution. A mode of operation, in which the SNMB simply checks a retrieved study case to ensure that all network model processing needed to execute a study has been completed, shall be available.

SNMB connectivity processing requirements are the same as those for RTNMB.

4.3.4.2.4 **Study Data Initialization**

For studies that are initialized from current real-time conditions, initialized from the state estimator results and conducted for the current date and time, or initialized from a state estimator save case and conducted for the date and time of the state estimator execution; all data shall normally be left at their initial (save case) values.

4.3.4.2.5 **Study Configuration Scheduler**

The study configuration scheduler shall schedule the open/closed status of breakers and disconnects to allow the SNMB function to build the bus model of the electrical network.

4.3.4.2.6 **Study Load Scheduler**

It shall be possible for the study load scheduler to execute automatically prior to a study, calculating the loads automatically. However, manual execution shall also be provided in order to review and modify bus loads on one-line diagrams before input is provided to the study network analysis functions.

4.3.4.2.7 **Study Regulating Equipment Scheduler**

For studies that take place at a future or past time or for a different load level, the study regulating equipment scheduler shall initialize the regulated voltage setpoints, transformer tap positions, capacitor and reactor connectivity, and phase shifter settings based on parameter adaptation values.

4.3.4.3 **Parameter Adaptation**

The parameter adaptation (PA) function shall be used to maintain schedule information for database- defined day types, hour of day, and season of the year.

Together with scheduling information provided by other sources, parameter adaptation data shall be used by other network analysis functions to obtain time-dependent values for:

a. Breaker/disconnect positions

b. Loads

c. Scheduled voltage setpoints

d. Transformer voltage setpoints and phase shifter MW setpoints.

4.3.4.3.1 **Capabilities**

Parameter adaptation shall provide the following capabilities:

The number of day types shall be configurable. As a minimum, 30 day types per season shall be available (e.g., days of the week, holiday 1, holiday 2, etc.).

Ensure that the switch between standard time and daylight savings time is handled seamlessly and transparently wherever it is required, considering the specific time zone of the input data

Time of the day shall be determined by specifying time intervals over a 24-hour period. These time intervals shall be of varying length, to be defined via database input. Time intervals shall allow a granularity of one hour.

Where possible, schedule information shall be adaptively updated via a smoothing algorithm using state estimator results. Smoothing parameters shall be definable in the database. It shall be possible to manually suppress updating globally or for selected points. It shall also be possible for the user to specify that only points in the observable network will be adaptively updated.

Schedule information shall initially be defined in the database via database input. Tools shall be available to minimize the effort needed to enter and maintain the schedule information in the database. Adding or deleting equipment from the database shall not require any existing schedule information to be re-entered or to be modified.

Schedule information that has been adaptively updated shall not be lost upon any change in the database.

Error statistics shall be calculated and maintained for schedule information for which real-time data or real-time state estimated data is available. If the error for schedule information increases beyond a tunable threshold, updating shall be paused, and an alarm message shall be generated. Upon return to normal, updating shall resume automatically.

4.3.4.3.2 **Parameter Schedules**

The parameter adaptation function shall maintain the following schedules:

i. Conforming bus load schedules (MW and Mvar) – Parameter adaptation shall maintain load distribution factors that relate total power system conforming load to internal and external company loads, zone loads, station loads, and bus loads. Load distribution factors shall be used to schedule actual conforming loads on buses on a given day and time of the day. Load distribution factors shall accurately account for the effects of load shedding and load management.

ii. Non-conforming bus load schedules (MW and Mvar) – Parameter adaptation shall maintain MW and Mvar values for bus load components that do not conform to the overall power system load pattern.

iii. Breaker/disconnect schedules – For selected breakers and disconnects, parameter adaptation shall maintain the status (open or closed).

iv. Scheduled voltages at voltage-controlled buses.

v. Transformer voltage or phase shifter MW schedules.

Where applicable, all of the above schedules shall be adaptively updated by using state estimator results and metered data. For breaker/disconnect schedules, the scheduled switching times shall be adaptively updated by means of a smoothing algorithm using actual switching times as input.

4.3.4.3.3 Parameter Adaptation User Interface

Displays of all parameter adaptation data shall be available. The Operator shall have the ability to review and easily modify/override any parameter adaptation data. Summary displays showing individual data (for example, forecasted loads, transformer voltage schedules, scheduled bus voltages, individual bus load distribution factors, conforming loads, nonconforming loads, etc.) are required. These displays shall be organized by season, day type, and hour. System load forecasts from the Load Forecast function shall be used as input to calculate the individual bus loads for these summary displays.

4.3.4.4 State Estimator

The Bidder shall provide a state estimator (SE) function that shall provide a complete voltage solution for the power system model, which includes bus voltages and angles. This solution shall be used as a validated input for further analysis of the network by other SCADA/ADMS security functions. The solution shall be based on real-time and scheduled information.

The state estimator shall perform the following functions as a minimum:

a. Preprocess input data to perform consistency checking

b. Determine observable and unobservable portions of the network

c. Estimate bus voltages, phase angles, transformer tap settings, branch flows, and bus injections based on monitored data for the observable portions of the network

d. Estimate bus voltages, phase angles, branch flows, and bus injections based on scheduled data and available information in the unobservable portions of the network

e. Allocate estimated bus injections to individual generation and load components attached to the bus

f. Identify single and multiple anomalous measurements in the observable portions of the network

g. Estimate analog measurement bias

h. Maintain generator real and reactive power on unobservable buses within limits specified by the generator capability diagram

i. Maintain voltages on regulated unobservable buses within a voltage band

j. Provide a base case solution for other transmission system security functions

k. Issue alarms if overloads and/or voltage violations occur on non-monitored and monitored equipment. When the number of alarms for a particular SE solution exceeds a certain limit, then only a general alarm shall be issued.

l. Verify overloads and alarms on monitored equipment.

When inconsistencies are detected between alarmed monitored data and estimated data, an alarm shall be issued. The state estimator shall provide a complete estimate for all the observable and unobservable islands of the network. There shall be consistency between the solution of the observable and unobservable islands of the network; specifically, there shall be no mismatch at the boundaries of these islands.

4.3.4.4.1 **Measurements Used**

The state estimator shall be capable of handling the following types of measurements:

a) Line and transformer flows (real and reactive power) at both terminals

b) Circuit breaker flow measurements (real and reactive power) such as a Bus Sectionaliser circuit breaker

c) Loads (MW, Mvar)

d) Generation (MW, Mvar)

e) Zero Injections

f) Bus Voltages (magnitudes), including multiple voltage measurements at a bus

g) Tap positions of transformers and phase shifters

h) Circuit breaker and switch status.

Both paired and unpaired real and reactive power measurements shall be used by the SE. In addition, when one of the measurements of a pair becomes unavailable, then the other one shall be used as an individual measurement. Also, reporting of unavailable measurements shall be done on an individual basis.

Measurement data quality codes (e.g., telemetry failure) shall be checked for each measurement and “bad” data shall not be used in the state estimator solution.

The state estimator shall maintain a history of bad data such that an anomalous measurement returns to a good condition when the state estimator detects that it is good data.

4.3.4.4.2 **Measurement Weighting**

Measurement weighting factors (i.e., confidence values and anomaly threshold values) shall be individually definable for all monitored and pseudo measurements used by the SE. These weighting factors shall reflect the accuracy of the associated measurements. Default values shall be assigned by measurement class during database input. Two sets of measurement weighting factors shall be maintained. One set shall contain the default values for the measurement class, while the other set contains the user defined values. The user shall be able to specify which set will be used. As a minimum, the following measurement classes shall be available:

a. Voltage measurements

b. Active power measurements

c. Reactive power measurements

d. Pseudo load MW measurements

e. Pseudo load Mvar measurements

f. Pseudo generator MW measurements

g. Pseudo generator Mvar measurements

h. Pseudo voltage measurements.

The capability shall be provided to tune measurement weighting factors on an individual basis from a display that shall also show time-averaged measurement biases. The tuned values shall be retained after a database change.

4.3.4.4.3 **Capabilities**

SE shall estimate transformer taps by defining transformer tap positions as state variables. As part of the observability analysis, the state estimator shall verify whether an individual tap position can be estimated or not. The user shall be able to inhibit tap estimation on selected transformers.

The SE algorithm, including the bad datadetection technique, shall be robust and be capable of producing a converged and accurate solution under conditions such as, but not limited to:

a. Varying load levels in the power system

b. Gross measurement error conditions

c. Loss of measurements, including loss of all measurements from one or more sources, whether or not this affects observability. The SE must continue to function even with partial loss of data.

d. Modeling errors in the unobservable portions of the network.

Obtaining a robust solution for the observable portions of the network shall not require the use of pseudo bus load information on non-measured buses. On the other hand, the user shall be provided with the capability to identify that selected scheduled pseudo bus load measurements shall be generated from bus load parameters provided by the parameter adaptation function, to enhance the stability of the solution for some buses of the observable part of the network. Monitored measurements shall automatically be replaced with pseudo measurements when a monitored value is not available.

In order to determine the observable portions of the network, a robust observability algorithm shall be used.

4.3.4.4.4 **Unobservable Areas**

A solution shall be obtained for the unobservable portions of the network by using data such as:

a. Pseudo bus loads calculated from bus load distribution parameters provided by the parameter adaptation function

b. Pseudo voltage measurements for voltage-controlled buses

c. Any available measurements

d. Information such as total power system load.

The boundaries between the observable and unobservable portions of the network may change dynamically due to loss of individual measurements. Any unobservable area of the network model must be completely solved (i.e., it is not acceptable to create a reduced equivalent representation for any portions of the network modeled in the database).

The SE shall provide the following capabilities in solving the unobservable portion of the network:

a. Enable/disable automatic tap changing for transformers

4.3.4.4.5 **Information Consistency Checking**

As a pre-processor to formal state estimation, a measurement plausibility check and a topology validation shall be performed to verify reasonability of measurements and analyze whether monitored values including switch status indications and analog measurements are consistent with each other. This process shall be capable of detecting an inconsistency between the status and the metered flow of reactors connected to the tertiary winding of 3-winding transformers.

Measurement plausibility checking, and the topology validation shall be based on a consistency analysis of interrelated information. Interrelationships shall be derived from the topological properties of the network.

Inconsistencies in the unobservable portions of the network shall not influence the SE results for the observable portions of the network. The presence of any inconsistency shall be indicated on a data inconsistency display, and descriptive information about the inconsistency shall be provided. Where possible, this information shall include the data value that most likely is erroneous.

4.3.4.4.6 **Calculations and Features**

The SE shall calculate:

a) Voltage magnitudes and phase angles at the network model buses

b) Transformer tap settings

c) Bus real and reactive power injections

d) Shunt MW and Mvar flows

e) Branch flows in terms of amperes, MW, Mvar, and MVA

f) MW and Mvar flows through selected breakers (e.g., bus couplers)

g) Voltage magnitude and phase angles at the open end of open-ended branches

h) Measurement confidence values based on measurement covariances

i) Residuals (estimated minus telemetered)

j) Schedule errors (estimated minus scheduled) above a threshold value

k) External company sensitivity factors (i.e., penalty factors)

l) Average flow for each critical constrained internal path.

m) In addition to these specified calculations the SE shall have the following features:

i. The discrete nature of transformer tap positions shall be recognized by the SE. The SE shall provide the capability to estimate transformer tap positions, where rounding to the nearest tap position is an acceptable approach. A comparison between the telemetered and estimated tap positions shall be provided with indications for excessive differences between monitored and estimated values.

ii. The SE shall be capable of handling bus sectionalizing, as well as multiple measurements of the same electrical quantity, including multiple voltage measurement data inputs at buses that are capable of sectionalisation.

iii. The program shall detect and identify both single and multiple bad data using statistical techniques (e.g., chi-square test and normalized residual test). When a measurement is detected as bad, a quality flag (data attribute) shall be set for the given measurement in the database resulting in a unique presentation on one-line diagrams and alarm summaries and the user shall be notified by an alarm when the estimated and telemetered data again agree, the quality code shall be removed.

iv. It shall be possible to manually activate or deactivate measurements on an individual or substation basis.

v. It shall be possible to globally or individually activate or deactivate generator real and reactive power limits and voltage limits on unobservable buses.

vi. The SE post-processor shall calculate biases of analog measurements using exponential smoothing techniques applied to the measurement residuals (errors) over an extended number of executions.

vii. Real-power network transmission losses shall be calculated for predefined areas, including, but not limited to, the entire control area; specific voltage levels within PURCHASER's power system and user defined zones.

viii. When islanding occurs, due either to real electrical separation or observability islanding, the SE shall solve all islands.

ix. It shall be possible to obtain a solution for only the observable portions of the power system in the event of SE convergence problems in the unobservable areas.

4.3.4.4.7 **State Estimator User Interface**

State estimator results shall be displayed on one-line diagrams and other graphical displays, as well as in tabular form. The user interface shall provide a clear and visible indication that state-estimated data is being displayed.

a) Specifically, the following tabular displays shall be provided:

i. List of normalized residuals above a threshold value

ii. List of bus injections above a threshold value

iii. List of measurement biases (time-averaged residual) consistently above a threshold over a configurable period of time

iv. List of pseudo-measurements currently in use

v. List of points manually replaced by the operator

vi. Measurement confidence values calculated as a function of the measurement covariances

b) The following summary displays shall be provided:

i. State estimator solution summary

ii. Transformer tap estimation summary

iii. Bus summary (estimated versus telemetered or scheduled bus injections, estimated voltages, estimated versus telemetered connected line flows)

iv. Voltage regulation summary, including generator reactive power limiting; the user shall have the capability to edit regulated voltages

v. Voltage violation summary

vi. Anomaly summary

vii. Overloaded Equipment Summary

viii. Critical Measurements Summary.

c) Once a one-line diagram has been called up, it shall be possible through simple user actions to display all or any of the following:

i. Telemetered values

ii. State estimated values showing all estimated voltages, MW, and Mvar even where no telemetry is available

iii. Monitored values where information is available and state-estimated values where no information is available

iv. Measurement residuals.

d) Using color coding of data or flags next to the displayed value, it shall be possible to show attributes, such as:

i. State estimated values

ii. Monitored values

iii. Manually entered data

iv. Bad measurement identified by bad data analysis

v. Major differences between state estimated values and measured values

vi. Deactivated SE measurements

vii. Estimated values in the observable portion of the network

viii. Estimated values in the unobservable portion of the network

ix. Pseudo measurements.

A common approach shall be used for presentation of data attributes, whether these attributes are for monitored or state-estimated values.

The time-stamp corresponding to the time of snapshot of monitored data used for the SE solution shall be displayable on every display that shows state estimated data. This time-

stamp shall be attached to the SE results that are transferred to any other function or stored in a save case.

4.3.4.4.8 **Execution and Save Cases**

The capability to automatically trigger a state estimator execution based on pre-defined system events and conditions, such as detection of a new system or substation daily peak load and other system conditions, such as, but possibly different from System Disturbance conditions shall be provided. The SCADA/ADMS shall provide a facility for the Operator to easily construct the triggering conditions, and to easily enable/disable each defined condition or all automatic executions. The Operator shall also be able to demand a state estimator execution.

The output of these automatically triggered and Operator-demand state estimator executions shall be automatically saved for future use (i.e., they can be used to initialize study network applications base cases as well as DTS scenarios). The SCADA/ADMS shall provide facilities to store and manage the state estimator save cases (see Section 3, Capacity and Performance, Table 3-6: Application Capacity). Each case shall be labeled with the date/time and trigger condition of the occurrence, and up to 80 characters of user-enterable text. The cases shall be able to be saved to alternate storage media and restored for further analyses. The system shall generate alarms at configurable thresholds once 75% or more of these cases are filled, indicating the need to the Operator to delete or archive cases. If all of the cases are filled, the oldest case shall be replaced.

4.3.4.5 **Power Flow Studies**

The Bidder shall provide a power flow study (PFS) program. The PFS shall be used to perform power flow studies that include loss of power system equipment, changes in bus load, and any other changes in system or area quantities (load, generation, interchange, and voltages).

The PFS user interface shall be structured to require the minimum amount of user input for execution. Equipment outage, and loss-of-load studies shall simply require that the user change the status of the appropriate switching devices on a one-line display or by clicking only the appropriate equipment symbol (line etc.) on a one-line or tabular display.

It shall be possible to perform a full PFS for a selected contingency from the contingency analysis function starting from any save case. It shall be possible to accurately reproduce the results of contingency analysis for the selected contingency when starting from the same base case. Execution of PFS for a selected contingency shall be possible through a simple execution control procedure.

4.3.4.5.1 **Capabilities**

The PFS solution algorithm shall be efficient, accurate, and robust. Decoupled solution techniques are acceptable. However, the Bidder shall be required to provide more robust algorithms as well. These algorithms shall be used in the event the Fast-Decoupled algorithm experiences convergence problem. It shall be possible to manually select between the solution algorithms. However, it shall not be required to make the selection for every study run. The study shall default to one of the algorithms, according to a tuning parameter setting.

The following power flow controls shall be implemented in PFS, subject to appropriate limits:

a. Transformer tap voltage or Mvar flow control

b. Phase shifter MW control

c. Inter-area flow control

d. Generator voltage control

e. Shunt capacitor voltage control

f. Shunt reactor voltage control

Implementation of these controls shall not degrade the efficiency, accuracy or robustness of the basic power flow algorithm.

The user shall be able to select either the distributed generation slack or the distributed load slack option to adjust for changes in losses. In the distributed generation slack mode, selected unit outputs shall be adjusted. In the load slack mode, all load elements shall be adjusted.

4.3.4.5.2 **Calculations**

The PFS program shall calculate:

a. Load, and losses for the overall power system, areas

b. Bus voltages (magnitude and angle)

c. Line and transformer flows (MW, Mvar, MVA)

d. Flow of power in / out of shunt devices.

4.3.4.5.3 **Power Flow Study User Interface**

All PFS displays shall be specifically designed to provide an efficient and user-friendly interface for the PFS function.

The PFS user interface shall provide all the flexibility to set-up input cases while minimizing the amount of manual entry. To perform PFS studies with the minimal amount of manual entry the PFS user interface shall support the following:

a. Accessing information by specifying date and time

b. Making use of default values

c.

d. Making use of automatic execution of subtasks

e. Making use of default initialization sequences

f. Entering equipment status, limits, set points and target values from one-line diagrams and tabular displays.

4.3.4.5.4 **Display Features**

PFS display requirements include the following:

a. PFS execution control displays

b. Ability to choose slack bus

c. Initialization control

d. Output of scheduler sub-functions on tabular displays and one-line diagrams

e. Generation summary by station providing MW, Mvar, voltage, Mvar limit, etc.

f. Summary of bus loads by station and voltage level

g. Transformer summary by station and by voltage level providing tap position, controlled voltage,

h. MW, Mvar flow, etc.

i. Summary of bus voltage limit violations

j. Summary of line and transformer flow limit violations

k. Summary of company statistics, including totals of load, generation, losses, interchange, etc.

l. Summary of any network islanding, generation isolation that may occur

m. PFS execution summary (summary of program execution statistics and problem)

n. Displays to enable/disable power flow controls by type or for individual devices

o. Power solutions shall be displayed on single line diagrams.

4.3.4.5.5 **Execution Procedures**

For the majority of PFS studies, it shall be necessary to perform only the following procedural steps:

a. Enter the date and time for which the simulation is to be performed or request initialization from the most recent SE solution or from a SE saved case

b. Alter equipment status or limits, if desired, using one- line diagrams and tabulars

c. Request execution

For studies in which the user must modify selected bus loads, bus generations, voltages, or topology; displays shall be provided for the following functions, as a minimum:

a. Initialization

b. Configuration scheduling

c. Capacitor/reactor scheduling

d. Load scheduling

e. Interchange scheduling

f. Bus voltage scheduling

g. Transformer tap scheduling

h. Enable/disable control variables individually or globally.

4.3.4.5.6 **Power Flow Study Comparison**

The PFS comparison sub-function shall provide a summary of significant differences in input as well as output between two power flow cases. Whether the PFS is initialized from the most recent SE solution, from a save case, or from the current working area, the user shall be able to request that the PFS automatically execute and present a summary of differences between the base case and the new PFS solution. It shall also be possible to use the PFS comparison sub-function to analyze the differences between two selected SE and PFS save cases or between a save case and the working area. As a minimum, the following differences shall be reported, based on thresholds defined by the user:

a. Total power system load

b. Equipment out of service

c. Capacitor status

d. Branch status

e. Limit violations

f. Differences between flows, bus voltages, interchanges, transformer taps, and system losses

g. Differences between bus names, control area names, and a summary of any facilities not in one of the cases or topology changes.

The PFS program and its user interface shall be designed to anticipate all events and problems that could reasonably be expected to occur in the course of the PFS setup and execution and aid the user in avoiding or recovering from these problems.

For maintenance and debugging purposes, it shall be possible to provide display output for non- converged cases. This shall include output on one-line diagrams and tabular displays. In addition, tabular summaries shall be available that provide details about the nature of the convergence problem including a list of stations where the most severe convergence problem did occur and solution statistics such as number of iterations, number of control actions such as tap changes, Mvar limiting, area control interchange control, bus mismatches, etc.

4.3.4.6 **Contingency Analysis**

The Bidder shall provide a contingency analysis function that shall be used to analyze the real-time power system security under pre-defined contingency conditions. The contingency analysis function shall consist of:

a. Contingency definition

b. Contingency screening

c. Full contingency analysis.

Contingency analysis shall use the latest state estimator solution (for real-time investigation) or a saved power flow case solution (for studies) as a base case power flow solution. Contingencies shall be applied to this base case. Each contingency may consist of single or multiple outages of power system components. Power flow solutions shall be used to analyze the effects of these contingencies.

Contingency analysis shall provide the option to evaluate a contingency that involves loss of generation or loss of load either before or after generation reallocation. If the option is chosen to perform contingency analysis for the time instant prior to generation reallocation, the power unbalance shall be compensated from the external network. Generation

reallocation in the internal network to compensate for loss of generation or loss of load shall be made by using distribution factors to compensate for the change in generation and load.

Limits of generating units shall not be violated after the reallocation. Contingency analysis shall use the same unit limits as used by other functions.

4.3.4.6.1 **Contingency Definition**

The contingency definition function shall provide the capability to define, edit, validate, and maintain contingency cases for real-time and study contingency analyses. This function shall have two components: base contingency case definition and a dynamic contingency case re-definition.

4.3.4.6.1.1 **Base Contingency Case Definition**

It shall be possible to define contingencies as a combination of outages or placing in service of one or more power system elements and/or the opening or closing of one or more switching devices. Power system elements shall include transmission lines, transformers, DC lines, bus bars, load elements, SVCs, shunt capacitors and reactors, and series capacitors. Switching devices shall include circuit breakers, switches, and disconnects. The number of equipment outages per case that can be included in a contingency definition is provided in Section 3, Capacity and Performance, Table 3-6: Application Capacity. The Operator shall be able to modify contingencies via user interface displays.

Contingency definition shall also include the following capabilities:

a. Load Transfer – It shall be possible to define automatic load transfer in any specified percent load or MW amount to model the effect of the outage of a distribution transformer.

b. Contingency List Augmentation – It shall be possible to augment the active contingency list automatically with equipment that reaches a user-defined percentage of the limit in the base case. The Operators shall be able to disable this feature.

It shall be possible to organize the contingencies into groups. A contingency can be assigned to any number of groups and the assignments can be modified interactively. It shall be possible for the user to enable/disable any or all contingencies of a group.

It shall be possible for the user to perform contingency case list updates, as necessary, to reflect equipment additions, deletions or modifications to power system equipment.

Checks shall be performed to ensure a valid contingency definition.

4.3.4.6.1.2 **Dynamic Contingency Case Re-definition**

The dynamic contingency case re-definition function runs in real-time whenever the state of an element changes such that the connectivity of the power system is altered or the arming selections on special protection schemes is changed. (Examples of a contingency re- definition scenario include: arming of a Special Protection Scheme when flows on a given transmission path(s) exceed a predefined flow level or arming of a generator tripping scheme when a series capacitor is removed from service. There will be no more than 30 contingency re-definition scenarios.) The dynamic contingency case re-definition function shall then modify each base contingency definition affected by the element or arming pattern changes to ensure the post contingency configuration remains accurate (The identification of the re-definition scenario triggering events, contingencies, element changes, and companion outages shall be completed prior to execution of the contingency case re- definition function and shall not be edited when the function is active.).

4.3.4.6.2 **Contingency Screening**

A contingency screening capability shall be provided to screen a large number of predefined contingencies for critical cases. Critical contingencies shall be analyzed automatically by full AC contingency analysis. The goal of contingency screening shall be to identify the most critical contingencies, thereby reducing the number of contingencies that must be analyzed in more detail by full AC contingency analysis. The contingency screening function shall be capable of handling contingency cases of any complexity, including cases that cause bus splits. Any contingencies leading to bus splits, isolated equipment, or changes in network islands shall be reported as such on results displays.

Contingency screening shall scan the specified list of contingencies and shall rank the most severe contingencies. The most severe contingencies shall subsequently be analyzed in detail by the full AC contingency analysis. The ranking shall be tunable by using weighing factors. Based on the ranking results, a reduced contingency list shall be constructed for use by full AC contingency analysis.

It shall be possible to specify how many of the highest ranked contingencies shall be analyzed by full AC contingency analysis. As an alternative, it shall be possible to specify that all contingencies that resulted in violations in the screening process be analyzed by full AC contingency analysis, in which case ranking is not necessary.

The Operator shall have the ability to specify that particular contingencies or all contingencies be processed by full AC contingency analysis (regardless of contingency

screening's ranking), thereby ensuring that those particular contingencies will be accurately analyzed. In addition, contingencies that caused a violation in the previous execution of the real-time contingency analysis function shall be added to the full AC contingency list.

The Bidder shall tune contingency screening so that any contingency that may result in significant overloads or voltage violations will be captured by the screening process. This may be achieved by tuning weighting factors used for contingency ranking, placing contingencies on the reduced contingency list without screening, changing limits used for violation checking, or by changing the selection algorithm itself (e.g., adding an additional iteration). After tuning, performance requirements shall still be satisfied. Any tuning of the screening process shall not affect the results of full AC contingency analysis.

4.3.4.6.2.1 **Ranking**

Ranking of contingencies shall be performed to:

a. Select contingencies to be analyzed by full AC contingency analysis

b. Display contingencies in order of severity after full AC contingency analysis.

c. Ranking shall be based on the following categories of contingency violations or base case deviations:

d. Branch flow limit violations

e. Interface flow limit violations

f. Bus voltage limit violations

g. Reactive power generation limit violations

h. Bus voltage shifts from base case.

For ranking purposes, it shall be possible to define two severity indexes, one to be used for flow related violations and one for voltage related violations. Both rankings shall be based on a weighted sum of contingency violations and base case deviations, where different weights can be defined for each of the two severity indexes. It shall be possible to assign weights for a whole category (e.g., bus voltage limit violations), for individual violations, or base case deviations. Default values for the weights shall be available for each category. Weights of zero shall be allowed (to disable consideration of the associated violation type).

For tuning and validation purposes, it shall be possible to compare, for all contingencies, the ranking obtained from the contingency screening with the ranking obtained from full contingency analysis. It shall be possible to compare these rankings side by side such that

the accuracy of the contingency screening and its ranking criteria can be tuned. In addition, it shall be possible to produce a solution output based on the results obtained from the contingency screening for any specified contingency.

4.3.4.6.3 **Full AC Contingency Analysis**

Full AC contingency analysis shall be executed automatically after contingency screening. The objective of full AC contingency analysis shall be fast and accurate analysis of contingencies in the reduced contingency list for flow limit violations and bus voltage limit violations. A robust AC power flow solution shall be used. It shall not be acceptable that cases that can be solved by the power flow function do not converge in contingency analysis.

It shall be possible to enable or disable power flow controls, such as Mvar limiting for generators, generator voltage control, shunt reactor and capacitor voltage control, transformer LTC voltage control, and automatic phase shifter control on a system-wide basis, type basis, or on an individual device basis.

Contingency cases that fail to converge shall be reported. In order to further investigate non-convergence, it shall be possible to obtain iteration and convergence records for a contingency analysis execution, similar to the ones that can be obtained for a power flow execution.

4.3.4.7 **Limit Set**

The limit set used for monitoring by the contingency analysis function shall be capable of comprising any and all limits that are available to the SCADA/ADMS and shall be configurable to meet the specific requirements of Purchaser.

4.3.4.8 **Contingency Analysis User Interface**

User interface functions shall be provided to facilitate definition, editing and validation of contingency cases. The contingency definition and editing shall be made as simple as possible through interactive and menu-driven procedures.

It shall be possible to identify equipment to be included in a contingency by selecting equipment from a one-line diagram as well as from a tabular display. In addition, it shall be possible to enter or edit equipment names.

Through simple interactive procedures it shall be possible to assign or reassign contingencies to groups and specify which groups are included in either the real-time or study mode analysis.

The primary output of the contingency analysis function shall be provided by full AC contingency analysis. Displays shall be provided to show contingencies with their violations. The presentation of these contingencies shall be ordered according to the severity of their associated violations. Within a contingency, the presentation of individual violations shall be ordered according to their severity.

a) In addition, displays shall be provided to

i. Show violations and their associated contingencies. The presentation of these violations shall be ordered by their severity. Multiple presentations shall be used for violations that are associated with more than one contingency.

For each violation that is presented, pre- and post-contingency values, as well as the violated limits shall be displayed.

ii. The Operator shall be able to distinguish between new violations and violations that have already been detected in the previous execution of contingency analysis. In addition, summaries shall be provided for:

b) In addition, summaries shall be provided for:

i. Contingency cases that did not converge or that have non-converged islands

ii. Contingency cases that cause islanding or isolated equipment

iii. Contingency cases that caused bus splits.

c) In addition, displays shall be able provided to:

i. Enter weighting factors either by category or for individual violations or base case deviations

ii. Enable/disable power flow controls by type or by individual device

iii. Select which method shall be used for generator reallocation

iv. Enter tolerances of limit values for which warning violations will be reported. It shall be possible to enter these tolerances by category or voltage level.

v. Define contingencies and the grouping of contingencies.

4.3.5 **Security Constrained Dispatch (SC Dispatch)**

The Optimal Power Flow (PF) would be used for following Security Constrained Dispatch.

4.3.5.1 **SC MW Dispatch**

Determine MW schedules that minimize production cost so that branch flow limits are not violated.

4.3.5.2 **SC Mvar Dispatch**

Determine the optimal voltage/VAR/Tap settings for generators, transformers and capacitors/reactors.

Minimize MW losses and ensure that voltage, VAR & tap limits are not violated.

4.3.5.3 **SC Combined P/Q Dispatch**

Achieve both, i.e. minimize cost and ensure that voltage, VAR and branch flow limits are not violated.

4.3.5.4 The Application shall also achieve the following functions.

a. Controls:

i. Active power generation.

ii. Reactive power generation.

iii. Regulated bus voltage magnitudes.

iv. Transformer Taps.

v. Phase shifters.

vi. Shunt Capacitors.

vii. Shunt reactors.

b. Constraints:

i. Active power generation of the units.

ii. Phase shifter angles.

iii. Active power reserves in an area.

iv. Reactive power generation of the units.

v. OLTC Transformer taps.

vi. Line flows (amps).

vii. Transformer flows (MVA).

viii. Bus voltage magnitude.

ix. For Conflicting constraints user would specify following priorities.

c. Input state estimator results, contingency analysis for network state power flow output.

d. Output Upper/lower limits for unit MW, phase shifter, OLTC, Controlled voltages, shunt capacitors.

4.3.5.5 **Security Enhancement**

It should have two functions:

a. Provide control recommendations to enforce feasibility in both the existing network state and postulated system states.

b. Provide control recommendations to reduce cost of operation, if cost saving can be incurred without causing constraint violations.

SENH should Cover three scheduling mode of operation:

a. Constrained dispatch enforcing feasibility and/or reduce costs within existing network state by recommending controls to move in the existing network. These are known as pre-contingency control recommendations.

b. Contingency planning enforcing feasibility for a postulated system state by recommending controls in post contingency state.

c. Integrated preventive action contingency planning and/or reducing cost within existing network and all contingencies where contingency planning is not able to alleviate all violations caused by the contingency.

The solution method should decouple all real and reactive power / voltage problem to give recommendation to alleviate real power constraints and reactive power / voltage constraint violations.

Both controls and constraints should individually or in group be activated or deactivated.

Rescheduling can be controlled by user to emphasize moving most sensitive controls, moving most cost effective or weighted combination of both.

Cost curve may be assigned to controls as well as to objective function.

OPF and SENH should use the same input data for controls, cost curves and objective functions.

4.3.5.6 **Future Based Contingency Analysis (FBCA)**

The Future Based Contingency Analysis function shall execute automatically on a periodic (at least hourly) basis to assess the expected short-term trajectory of power system conditions and the Resulting susceptibility to the set of contingency cases that are defined for CA.

FBCA will automatically build an hourly base case for four hours in the immediate future, using the expected outage schedule, the expected system load and the expected generation dispatch for each period and then utilizing the PF function to calculate the resulting base case power flows, voltages and phase angles throughout the power system.

FBCA will then analyze the effect of the outage/s in each defined contingency case upon the expected base case power system state, without any direct user interaction, and apply the same method as CA to determine a ranking for each defined contingency case

The primary FBCA User Interface shall be focused on operational users and will provide for rapid identification of any emerging vulnerabilities of the power system. This should encompass:

a. Dashboard displays that identify that FBCA has detected specific cases of concern and highlights the cases of most concern (highest severity ranking), including cases that result in bus splits, loss of load or isolation of equipment, or creation of network islands.

b. Rapid “drill down capability to investigate the issues related to specific cases and understand the severity of the potential violations, directing focus to the most severe violations in the case.

4.3.6 **Voltage VAR Control (VVC)**

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

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

a. TAP Changer for voltage control

b. VAR control devices: switchable and fixed type capacitor banks.

The function shall propose the Control Centre Engineer solution up on change in the topology of the network switching. The function shall consider the planned & unplanned outages, equipment operating limits, tags placed in the SCADA system while recommending the switching operations. The functions shall be based on user configurable objectives i.e. minimal loss, optimal reactive flow, voltage limits, load balancing. These objectives shall be selectable on the basis of feeder, substation & group of substations or entire network. The Control Centre Engineer shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltage profiles, load restored, system losses, and number of affected customers. The solution shall identify/sort the different type of switches that are required for operation i.e. remote/manual etc.

4.3.6.1 **Objectives**

a. Minimizing real and reactive power loss.

b. Correcting low or high voltages.

c. Maintaining maximum MVAR or units & condensers and minimum control movement.

4.3.6.2 **To achieve**

a. Reduced voltage gradients.

b. Increase power transfer capability of network elements.

c. Improving power factor of gen. units improved.

d. Enhancement in system security by retaining reactive gen capability in reserve during emergency / fault.

4.3.6.3 **Control Types**

a. LTC Taps.

b. Switched capacitor and reactors.

c. Generator and synchronous condenser voltage regulator set point.

d. LTC Voltage regulator.

e. Switched capacitor and reactor voltage regulator set point.

4.3.6.4 **Constraints**

a. Bus voltage limits (min & max).

b. Capacitor & reactor nominal voltage MVAR limits (min & max).

c. Generator & synchronous condenser MVAR limits (min & max).

d. LTC transformer tap limits (min & max).

4.3.6.5 **Modes of Operation**

The VVC function shall have following modes of reconfiguration process:

a. Auto mode

b. Manual mode

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

4.3.6.5.1 **Auto mode**

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

4.3.6.5.2 **Manual mode**

In manual mode, the function shall determine switching plans automatically and perform switching operations in step-by-step manner. A filter for remote operable & manual switches shall be provided with switching plan.

4.3.6.5.3 **Reports & Displays**

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

a) Network & tabular display to VVC switching

b) Tabular display giving chronological sequence for VVC operation

4.3.7 **Load Shedding**

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

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

4.3.7.1 **Rules for Load shedding & Restoration**

The load shall be shed or restored based on following basic rules:

a. **By load priority** — The LSA shall have a priority mechanism that shall allow the user to assign higher priorities for essential or any other important load. The load assigned with the higher priorities shall be advised to be shed later and restore earlier than load with relatively lower priorities. Each load priority shall be user definable over the scale of at least 1-10.

b. **By 24 Hrs load shed /restore history** — The loads of equal priorities shall be advised for restoration in such a way that loads shed first shall be advised to be restored first. The application shall ensure that tripping operations is done in a cyclic manner to avoid the same consumers being affected repeatedly, however, priority loads shall be affected least.

c. **By number of consumers affected** — The consumer with equal priority and similar past load shed history shall be considered by the application in such a way that minimum number of consumers are affected during the proposed load shed. The data for number of consumers connected to a feeder /device shall be taken from GIS/other system via interface/adopter.

d. **Load shedding History** — The system shall check the history of load-shedding, where the feeders / consumers faced forced outage or repeated outage in the recent past.

4.3.7.2 **Modes of Operations**

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

a. Manual load shed

b. Manual load restoration

c. Auto load shed

d. Auto load restoration

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

4.3.7.2.1 **Manual Load Shed**

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

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

4.3.7.2.2 **Manual Load Restoration**

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

In case more than one options are possible, then the application shall identify all such options with the priority of consumers along with the number of consumers are likely to be restored for the particular load restore option if chosen by Control Centre Engineer. The Control Centre Engineer shall select & execute one of these options for effecting the load restoration.

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

4.3.7.2.3 **Auto Load Shed**

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

(a) **Frequency based Load Shed** - The function shall execute the tripping of breakers based on the system frequency automatically considering the basic rules for load shed & restoration. The software shall automatically execute the switching operations as soon as system frequency reaches at load shed start (LSS_str) frequency threshold and it shall continue to do so unless system frequency crosses the load shed stop (LSS-stp) frequency limit. The frequency limits shall be Control Centre Engineer assignable up to single decimal points. Once frequency crosses below LSS_stp limit, then load shed can only be started again when frequency attains LSS_str. Limit LSS_str shall be lower than LSS_stp & suitable protection to ensure that shall be provided in user interface such as discard, forbidden etc if user accidently enters LSS _str higher or equal to LSS_stp or LSS are entered higher than LSR.

(b) **Time of day based Load Shed** - The function shall operate to shed load at the predefined time of the day & load to be shed. The software shall automatically execute the switching operations considering the basic rules for load shed & restoration.

4.3.7.2.4 **Auto Load restoration**

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

(a) **Frequency based restoration** - The function shall execute the closing of breakers based on the system frequency automatically considering the basic rules for load shed & restoration. The software shall automatically execute the switching operations as soon as system frequency attains load restore start frequency limit (LSR_str) and it shall

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

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

4.3.7.3 **Alarms and Events**

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

4.3.7.4 **Summary Report**

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

a. Daily Load shed report indicating, substation name, feeder/device name, date/time, duration of load shed, and amount of load shed, Number of consumers affected based on consumer indexing information, mode of load shed including planned outages of feeders/network equipment.

b. Daily Alarm summary pertaining to LSA, substation wise.

c. Substation wise daily Served, un-served power & energy for every 5 minute time block

d. Served & un-served power for last seven days for every 5-minute time block to calculate Load forecast for the next day. The report shall contain a column to define weightage factor (multiplier) by Control Centre Engineer to calculate Load forecast for the next day. The weightage factor is required to consider the type of the day such as holiday, festivals, rainy day, etc. Separate report for total load forecast of complete project area shall also be generated from above two reports.

4.3.8 **Fault Location, Isolation & Restoration (FLISR)**

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

4.3.8.1 **Functional Requirement**

The FMSR function shall include the following characteristics:

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

b. FMSR shall be capable of allowing the substitution of an auxiliary circuit breaker or line recloser that may temporarily function in place of a circuit breaker or line recloser that is undergoing maintenance.

c. The Control Centre Engineer shall be able to suspend FMSR restoration capabilities by activating a single control point. Otherwise, FMSR shall continue to operate for fault detection and isolation purposes. The Control Centre Engineer shall be able to resume FMSR's normal operation by deactivating the same point.

d. FMSR shall be capable of isolating faulty sections of network by opening any available line Circuit Breaker that may be necessary, however operating limitations on device such as control inhibit flag shall be respected.

e. FMSR application shall utilize the results of LF for recommendations of switching steps for restoration where in it should guide the Control Centre Engineer for amount of overloading in lines, bus voltage violations and amount of load that can be restored for various options of restorations, the Control Centre Engineer shall have the privilege of selecting the best restoration option suggested by FMSR before it starts restoration. The Control Centre Engineer shall also be able to simulate the LF for the recommended switching actions, so that the necessary violations can be displayed on graphical display also. If an overload condition is expected as a result of the proposed switching, it shall be displayed to the Control Centre Engineer on a graphical display and proposed alternative switching sequence to avoid or minimize the overload.

f. FMSR shall be capable of using data derived from substation RTUs/FRTUs /IEDs/FPIs to recognize faults in substation transformer banks, any fault on the primary side of these banks that cause loss of outgoing feeder voltage and current or any fault occurred on 11KV network.

g. FMSR shall be capable to make Restoration plans with identification name and respective merit orders & its execution of Restoration plan using network Display and single line diagram of substation

h. FMSR shall be capable to find delay in the restoration of network beyond specified time (Control Centre Engineer configurable) and shall be able to report separately in the form of pending restoration actions.

4.3.8.2 **Detection of Fault**

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

Switching device tripping caused by SCADA & ADMS applications shall not be considered as a faulty condition. FMSR application shall not be initiated if the quality flags such as, manually replaced value and Out of scan are set for a switching device.

To avoid potential difficulties during severe storm conditions, the Control Centre Engineer shall be able to suspend FMSR switching sequence of restoration capabilities by activating a single control point. Otherwise, FMSR shall continue to operate for fault detection and isolation purposes. The Control Centre Engineer shall be able to resume FMSR's normal

operation by deactivating the storm-mode control point. When this occurs, FMSR shall be ready to restore power as well as detect and isolate faults following the next outage event. The same shall be recorded as an event.

4.3.8.3 **Localization of Fault**

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

a. Remote controllable circuit breaker with capability to interrupt fault currents

b. Non-remote controllable circuit breaker with capability to interrupt fault currents

c. Remote controllable circuit breaker with no capability to interrupt fault currents

d. Non-remote controllable circuit breaker with no capability to interrupt fault currents.

e. Remote controllable disconnector

f. Non remote controllable disconnector.

g. Fuse

h. Ground/ Earth switch etc.

4.3.8.4 **System Isolation & Restoration**

Once faulty section is identified, the FMSR function shall determine the switching plan to isolate healthy area from unhealthy area. FMSR function shall suggest switching plans for restoration of power to the de-energized healthy sections of the network. It may be done by closing NO switch to allow the power from alternate source. In case more than one feasible switching plan exist, the Control Centre Engineer shall be guided for most optimum plan

based on the merit order i.e. minimum switching operations, minimum loss path, system operation within the safe limits of various network elements. The Control Centre Engineer shall have the option to simulate switching operations and visualize the effect on the distribution network by comparisons based on line loadings, voltage profiles, load restored, system losses, number of affected customers. The FMSR function shall have feature to attain the pre-fault configuration on Control Centre Engineer's request after repair of faulty sections. The FMSR function shall have following modes of restoration process:

a. Auto mode of restoration

b. Manual mode of restoration

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

(a) **Auto mode of restoration:** in auto mode, the FMSR shall determine switching plans automatically upon experiencing fault & proper isolation of unhealthy network from healthy part of the network and perform restoration actions upon Control Centre Engineer validation automatically.

(b) **Manual mode of restoration:** in manual mode, the FMSR shall determine switching plans upon experiencing faulty state & proper isolation of unhealthy network from healthy part of the network. The switching plans shall be presented to Control Centre Engineer for step by step restoration. Control Centre Engineer shall be allowed to introduce new steps. A filter for remote operable & manual switches shall be provided with switching plan.

4.3.8.5 **Summary Report & Displays**

a. **Reports**

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

b. **Displays:**

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

i. Network & tabular display to identify faulty network

ii. Network & tabular display to identify remotely controllable devices

iii. Network Display to show plan for Isolation of faulty sections from the network using single line diagram of substation or network as selected by the Control Centre Engineer.

iv. Tabular display for Restoration plans with identification name and respective merit orders & execution of Restoration plan using network Display, and single line diagram of substation

v. Delay in the restoration of network beyond specified time (Control Centre Engineer configurable) shall be reported separately in the form of pending restoration actions in Tabular display.

vi. List of sections not restored with the reasons for non-restoration such as overloading and voltage limit violations etc.., shall be shown in tabular display.

4.3.9 **Optimal Feeder Reconfiguration (OFR)**

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

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

The user should select the desired following objective function:

a. Power losses calculated by summing up active power losses occurring in all line sections and transformers within the study boundary.

b. The degree of unbalance in an individual transformer loading is defined as the difference between the load on the supplying transformer and the average loading of all transformers

located within the study boundary. This objective shall give solution to balance load among supply transformers in study area.

c. Limiting Overloading of Different Element.

d. Limiting Voltage Violations and Var Flow constraints

e. Multi Objective: E.g. Combination of load balancing and loss minimization, where each objective is included in the total sum with user-specified or default weighting factors.

To run the OFR the user should be required to specify the area to be considered for feeder reconfiguration and the desired objective function. The results of the Feeder Reconfiguration function include switching actions, the values of the objective functions before and after the feeder reconfiguration.

4.3.9.1 **Modes of operation**

The function shall have following modes of reconfiguration process:

a. Auto mode

b. Manual mode

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

4.3.9.1.1 **Auto mode**

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

4.3.9.1.2 **Manual mode**

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

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

4.3.9.2 **Displays & Reports**

The summary report shall cover the followings:

a. Loadings of feeders and transformers before and after reconfiguration.

b. Voltage profile of the feeders before and after reconfiguration.

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

4.3.10 **Switch Order Management**

A switching order is a list of operations to be directed by the user when carrying out a procedure for switching elements of the power system. The SCADA/ADMS shall support the manual creation, automatic creation, execution, display, modification, maintenance, and printing of switching orders. This shall include the ability to define time delays and breakpoints as part of switching orders.

After a switching order has been created, the user shall be able to have it saved.

Once defined, switching orders shall be executable in real-time and in study mode. Study mode execution shall allow the user to check out the switching order's potential impact on the power system prior to actual execution.

4.3.10.1 **Manual Creation of Switching Orders**

The user shall be able to create a switching order by using a full screen editor to enter information for the header and the body of the switching order. Preparation of the switching order shall require as little user interaction as possible. The header of the switching order shall contain general information about the switching order, such as the following:

a. Switching order sequential number

b. Circuit name

c. Permit required (Yes/No)

d. Start date and time

e. Complete date and time

f. Crew ID: Service car number and crew names

g. Nature of work

h. Location of work

i. Prepared by whom and when

j. Checked by whom and when.

The main body of the switching order shall consist of multiple entries defining the actions to be taken. Each entry shall have an entry number automatically assigned by the

SCADA/ADMS. The user shall be able to enter the text of each entry directly or employ a macro capability in which the macro has already been defined as a complete or partial switching order.

When the user enters a switching order macro, the macro shall be automatically expanded to the full text. The user shall be able to edit the text of the macro expansion. In some cases, the user will have to fill in the blanks in the macro expansion to complete the entry.

The exact form and content of the switching order headers and macros will be determined by Purchaser during detailed engineering.

4.3.10.2 **Automatic Switching Order Creation and Execution**

The user shall be able to initiate the automatic creation of a switching order by using SCADA supervisory control procedures. After creating the header as described in the previous section, the user shall be able to select either “Manual Creation” or “Automatic Creation”.

In case of unplanned outage and scheduled switch order, the system shall intelligently recommend, by comparing the plan of scheduled outage vs real-time network condition. The system shall display the recommendation for decision by the control Centre engineer, which may involve the review of scheduled switch order/cancellation.

To initiate automatic creation and execution of a switching order, the user shall be able to identify (e.g., by a point-and-click operation) the transmission line, bus, feeder, or feeder sections to be reconfigured (i.e., disconnected or reconnected) and then request the SCADA/ADMS to automatically create and execute the appropriate switching operations. This shall include the rules used by fault isolation and system restoration function.

If desired, the user shall be able to review the switching operations created by the SCADA/ADMS, make any necessary changes, and then request their automatic execution of the same. Each switching operation shall be listed in the order in which the switching devices need to be controlled (tagged, opened, closed, etc.).

The ability to define these procedures via the distribution systems schematic and geographical displays shall be supported. No control commands shall be generated. Instead, SCADA system shall enter the identification of the controlled devices and the types of control in the proper sequence required to execute the switching order. Subsequently, the user shall be able to review and edit the text of the switching order. This shall include manual addition or deletion of entries.

4.3.10.3 **Automatic Generation of a Blackout Order**

Most switching orders are created to perform temporary work. When the work is completed, there is often a requirement to restore or backout the circuit to normal conditions. This is frequently the opposite procedure from the one used initially.

The SCADA/ADMS shall provide a mechanism to automatically generate a backout switching order. Starting from an initial switching order, when the user requests "Generate Backout Order", the SCADA/ADMS shall reverse the order of all entries in the body of the initial switching order and shall change each of the "reversible" entries to its opposite. For example, an entry CLOSE BREAKER shall be reversed to OPEN BREAKER, an entry PLACE TAG shall be reversed to REMOVE TAG. The ultimate list of "reversible" entries and their associated "opposites" will be developed in coordination with Purchaser during the course of the project. The user shall be able to edit the text of the various entries. Before the user is permitted to save the backout order, the SCADA/ADMS shall prompt the user to edit its header.

4.3.10.4 **Maintenance of Switching Orders**

After a switching order has been created, the user shall be able to have it saved. The SCADA/ADMS shall save the actual expanded text of the switching order, not the text of the macros or the supervisory control procedure used to create it.

The SCADA/ADMS shall maintain a directory of switching orders, organized by area of authority. The user shall be able to use the directory to review, copy, rename, print, and delete switching orders, and to call them up for review and modification.

The SCADA/ADMS shall also maintain a file of switching order macros, organized by area of authority, and sorted alphabetically. The user shall be able to add, delete, and modify the macros in this file according to the console's assigned areas of jurisdiction. While manually creating a switching order, the user shall be able to open a window, view the contents of the macro file, and select the macro to be expanded and placed in the switching order being created.

4.3.10.5 **Switching Order Execution and Checkout**

Once defined, switching orders (including backout orders) shall be executable in real-time and in study mode. Execution shall take place in proper sequence automatically or in manual step-by-step mode based on assigned breakpoints. All built-in time delays and breakpoints shall be recognized. Alternatively, the user may temporarily assign new time delays and breakpoints.

Study mode execution shall allow the user to check out the switching order's potential impact on the power system prior to actual execution. This capability shall also be available during the course of preparing the switching orders. In particular, it shall be possible to verify whether a planned switching order will result in power system overloads and voltage problems. The new circuit configuration, the energization of the circuit segments (as described in Section 10.2.5, Distribution Power Flow), and the ampere and voltage values expected from the planned switching order shall be shown on study versions of the power system world-map displays using dynamic coloring to highlight all possible limit violations.

4.3.11 **Quality of service Indices**

The purpose of the system will be obtained the quality indices (e.g. CAIDI, SAIDI, SAIFI, MAIFI etc.), referred to continuity of the service, outages (duration and frequency), the values to be compensated related to penalties, furthermore statistical information about the quality of the materials. Furthermore, the Quality of Service Indices must facilitate the necessary tools to realize in a homogenous and effective manner, all the calculations, indicators, and indices required by Purchaser.

The user will be able to view the quality of service indices and the variables used to calculate them via interactive displays that allow the user to:

a) Annual indicators, monthly indicators per feeder, lines and substation report, annual indices of incidents, damage types, damage causes, HV, MV and LV damaged elements, Incident time resolution

b) Create, verify, and edit quality-of-service formulas

c) Verify and edit individual values of the calculation variables

d) Enable and disable one or more index calculations

e) Enter schedules for index calculations.

4.3.11.1 **Supply Reliability and Quality Indices**

a) Supply Reliability Indices

i. System – Minutes Lost Index (SMLI)

SMLI = ∑ [MW Lost X Duration (minutes)] / System Peak Load (MW)

ii. System Average Interruption Frequency Index (SAIFI)

SAIFI = ∑ [Customer Interruptions] / Total System Customers

iii. System Average Interruption Duration Index (SAIDI)

SAIDI = ∑ [Customer Interruptions Minutes] / Total System Customers

iv. Customer Average Interruption Duration Index (CAIDI)

CAIDI = ∑ [Customer Interruptions Minutes]/ ∑ [Customer Interruptions]

v. Customer Average Interruption Frequency Index (CAIFI)

CAIFI = ∑ [Customer Interruptions]/ [No of Customers who had interruptions]

vi. Momentary Average Interruption Frequency Index

MAIFI = ∑ [Customer Interruptions] / Total System Customers (where only events of duration less than 5 minutes are counted.)

vii. Customer Total Average Interruption Duration Index (CTAIDI)

CTAIDI = ∑ (Customer Interruption Duration) / Total Number of Customers Interrupted

b) Supply Quality Indices

i. Voltage Dips Interruption Frequency Index (VDFI)

VDFI = ∑Voltage Dip Events Causing MW loss

ii. Voltage Dips Interruption Severity Index (VDSI)

VDSI = ∑ [MW Lost by voltage dips] / System peak load

c) Equipment Reliability Indices

i. Equipment Forced Outage Frequency Index (FOFI)

FOFI = ∑ [Forced Outage Events] X 100/ ∑System Units

Unit Class	∑ (Forced outage Events)	∑ (System units)
Lines: (Overhead & Cables)	Forced outage events of all lines	Circuit kilometers of all lines
Reactive equipment (Transformers, reactors, capacitors)	Forced outage events of all reactive equipment	Number of all reactive equipment

ii. Equipment Forced Outage Mean Duration Index (FOMDI)

FOMDI = ∑ [Forced Outage Events durations] / ∑Forced Outage Events

The above indices shall be calculated for up to different customer categories as defined by Purchaser.

4.3.12 **Energy Balance**

Electrical network in some parts of the Purchaser network has energy losses that are higher than expected. Different causes including commercial losses contribute to this. As a consequence, in order to increase the overall company efficiency, it is desired to monitor the energy flows of an electrical area in order to measure:

a. The flow of energy into/out of the area

b. The amount of energy losses calculated by the net sum of the flows of energy including sign.

The following definitions apply for this function:

Electrical Area: Any portion of the network that has measured energy in all of its boundaries with other electrical areas or for which accumulator substitution data, as explained below, are calculated.

Flow Sign: All energy flows into an electrical area are considered positive; flows out of the electrical area are in consequence negative.

Boundary: Is any electrical point that is common to two different electrical areas for which one or several accumulator data points are gathered or for which an accumulator substitution calculation can be performed.

An example of electrical area could be the entire 220KV, 110KV, 33KV and 22KV network belonging to Purchaser including step-down transformers up to the power delivery to consumer station. Electrical areas shall not be mutually exclusive. That is for instance one electrical area could be the entire Purchaser grid including several smaller electrical areas.

4.3.12.1 **Input Data**

The basic input data for energy balance calculations are all Energy meter data collected by the SCADA functionality and stored initially in the real time data base and consequently collected by the Storage and Retrieval function.

Prior to storage in the real time database, accumulator data shall be processed as follows:

a. Conversion to engineering units

b. Reasonability checking

c. Accumulator substitution

At some boundaries more than one energy meter can be installed. For instance, at interchange points with other utilities both SEND and RECEIVE energy meters will be available. All energy values stored shall be positive. However, the user shall be able to define the corresponding sign that any energy value shall be given in a particular calculation.

SCADA shall support the substitution of accumulator values. The substitution shall be triggered by any of the following conditions:

a. Telemetry failure of an accumulator point.

b. When the raw value of the point from the previous scan is not valid due to a telemetry failure. (The conversion algorithm cannot compute the difference between the previous and current raw values.)

c. The accumulator scan cycles shall be synchronized to the system time (for example, the hourly scan occurs at the top of the hour).

d. When the difference between the accumulator value and another analog or accumulator value (typically a calculated analog value) exceeds a predefined value. The User shall specify, for each accumulator value, the association between the accumulator value and the other value and the maximum difference value.

Note that the accumulator value may be the result of redundant data processing. To ensure that the redundant data processing completes prior to the accumulator substitution processing, accumulator substitution processing shall be delayed by 15 seconds from the completion of the accumulator value conversation and storage of the converted value in the database. An accumulator value that has been manually entered by a user shall be considered a valid value.

The value to be substituted shall be selected by the User for each point from any of the following:

a. A calculated or telemetered accumulator value

b. A calculated or telemetered analog value

c. A value of zero (0)

Only a single substitution value shall be selected. That value shall be substituted only if its quality codes indicate a current and valid value. (Values outside alarm limits shall be deemed valid.) If the substitution value is not current or valid, a zero value shall be substituted. This substitution processing in lieu of storage of the last good value as defined for telemetry

failure. Substituted values shall be marked with a suitable quality code, in addition to a telemetry failure code and distinguishable from the redundant data processing quality code.

4.3.12.2 **Energy Balance Calculations**

The energy balance function shall use all the Storage and Retrieval arithmetic calculation functions to calculate the following values:

a. Total energy inflow into the area

b. Total energy outflow from the area

c. Net energy losses: energy inflow minus energy outflow

d. Percentage of losses: 100 x Net energy losses/Total Energy Inflow

In some cases where energy wheeling is common practice the user may define the energy inflow as all energy inflow minus the wheeled energy in order to get a more accurate energy loss percentage value.

All data calculated by the Energy Balance function shall be stored again as part of the historical files. In consequence the calculated data should be input for higher periodicity calculations. For instance, energy balance calculated daily shall be used to calculate the monthly energy balance values. Annual values shall be calculated from monthly balances. It shall be possible to define a limit on any percentage loss figure to alarm the user indicating losses above a certain threshold.

All energy balance calculations shall be performed on data stored in the historical files by the Storage and Retrieval function rather than on real-time collected data in order to allow the Control Centre Engineer to consolidate the data collected and provide any manual inputs in case of missing information. No accumulator data shall be lost from the real-time database or from the Storage and Retrieval function in case of a single computer system failure. Accumulator data shall be collected at least every hour. Energy Balance will not perform faster than every hour on any group of input data. The user shall be able to define the periodicity of the energy balance calculations which by default shall be every hour.

4.3.12.3 **Output Data**

Using the provided Storage and Retrieval function calculation means it shall be possible to produce a report for one or several selected area or group of areas. It shall be possible to include in the report selected input data and the required calculations results for each area.

4.3.13 **Fault Level Analysis**

The Fault level analysis application shall simulate faults at designated locations in the network and shall calculate the resulting fault current. The Control Centre engineer shall specify phase-to-phase or phase-to-ground faults including optional fault impedance. The application shall calculate the three-phase fault currents as well as the post fault voltages.

Fault level analysis application shall also be available for real-time environment, in which case it shall automatically execute on all buses in the network that are configured for automatic fault level analysis.

4.3.13.1 **Displays & Reports**

The Control Centre engineer can select to view the result in the graphical single-line display, load flow application window, detailed device information window.

4.3.13.2 **Output Data**

The result provides the fault level of the devices and the switches; whose interrupting current capacity are less than their post-fault current.

4.3.14 **Network Automation**

Network Automation (NA) function shall be used for simulation of automation of MV distribution networks, as well as detailed analysis of effects of automation application from the aspect of reliability of consumer supply and total costs of the distribution utility in specified planning period. The main objective of this function will be the analysis of reduction of consumer's outage time, non-delivered energy and reduction of mentioned costs, regarding different types and positioning of automation equipment in the network.

The main goal of this function shall be to calculate the number and positions of automation equipment that will be necessary to improve network operation. This is in fact a cost/benefit analysis. Costs will be related to introducing automation equipment while benefits will be related to reduction of operation costs (lost revenue due to non-delivered energy, field crew costs). The function shall take into account failure rates in the network, consumer priority, and different methods for fault management depending on level of equipment in the network for fault location, fault isolation and supply restoration. Function shall be based on cost/benefit analysis in defined period of planning. Benefit is encountered through reduction of total expected annual costs due to undelivered energy, cut-off power, costs of maintenance and exploitation, etc. On the other hand, network automation implies investment costs, which include basic installation costs of existing equipment for automation

and remote-control system, taking into account balancing value of equipment remaining at the end of planned period. All costs shall be actualized at the beginning of planned period.

The function shall be used for analysis of network operation improvement from the reliability point of view. Cost/benefit analysis provides very clear insight in costs and expected effects of possible automation equipment implementation.

The main outputs of the function shall be:

i. Number and positions of automation equipment in the network

ii. Report to indicate reliability indices and cost-benefit indices for each and every generated scenario for power system network automation

4.3.15 **System Studies**

The Bidder shall provide application/Software to carry out for the following studies:

a. Switching Study

b. Load Transfer Study

c. Short Circuit Study

d. Outage Restoration Analysis Study

e. Capacitor Dispatch Study

The purpose of the studies is to assist the Control Centre Engineer in assessing how switching or other Control Centre Engineer actions would affect the system under different circumstances.

The Bidder shall provide a simple user interface that allows the Control Centre Engineer to operate the studies. The user interface shall contain a dialog that allows the user to select the desired study. Circuits and devices for study shall be selected by clicking on the desired items in the map-based display.

The results of a study shall be provided to the Control Centre Engineer in a report that can be printed or viewed using the normal user interface. Further details on the studies are provided below.

4.3.15.1 **Switching Study**

The purpose of the switching study is to allow the Control Centre Engineer to observe what would happen if a switch were opened or closed without actually doing it.

When the study results are ready, the user shall be able to view them in a resizable popup window. The study shall show the before and after results for the feeder, including the total loss or gain at the switch. The results shall include the total current for the feeder, the real/reactive load, real/reactive loss. A pushbutton shall allow the user to view the corresponding expected volt/loss profile along the feeder. The results shall be printable to any printer available to the SCADA /ADMS user interface. Once the user has viewed or printed the results, it shall be possible to select a new switch for study.

4.3.15.2 **Load Transfer Study**

The Load Transfer Study shall allow the Control Centre Engineer to assess a transfer of load from one feeder to another without actually performing the transfer.

After selecting the study, the user shall select the desired switches by simply clicking on them in the map. Selection of two switches that don't transfer load from one feeder to another shall be rejected by the study.

When the study results are ready, the user shall be able to view them in a resizable popup window. The study shall show the before and after results for the two feeders affected by the load transfer, including the total loss or gain for each feeder. The results shall include the total current for the feeder, the real/reactive load, real/reactive loss. Pushbuttons shall allow the user to view the corresponding expected volt/loss profiles along the two feeders.

The results shall be printable to any printer available to the SCADA user interface. Once the user has viewed or printed the results, it shall be possible to select a new load transfer for study.

4.3.15.3 **Short-Circuit Study**

Short Circuit Calculation (SCC) is used to calculate currents that are results of a short circuit due to a fault or an incorrect connection in an electric network. It basically solves symmetric or asymmetric faults in balanced or unbalanced distribution networks.

SCC shall be used to determine:

a. The maximum short-circuit current which determines the rating of electrical equipment (normally a circuit breaker for real-time SCC).

b. The minimum short-circuit current which can be a basis for the protection sensitivity checking or fuses selection.

c. Fault current calculation at selected location.

d. Earth fault current for ungrounded networks.

4.3.15.3.1 **SCC Calculation**

SCC shall check for violations of the breaking capability, violation of the protections sensitivity settings and violation of the earth fault currents. Short circuit calculation shall either be activated upon user request or automatically (after network changes or cyclically).

The function shall be able to simulate following fault types and each of them may contain fault impedance and/or grounding impedance, depending on user requirements

a. Three phase faults (L-L-L)

b. Three phase faults with ground connection (L-L-L-G)

c. Two phase faults (L-L)

d. Two phase faults with ground connection (L-L-G)

e. Single phase faults, with or without neutral point (L-G)

f. It shall be able to calculate minimum and maximum current for the complete distribution network.

Modes of operation:

a. Real time mode: SCC calculation shall be based on the current electrical network configuration

b. Study: SCC shall work with copies of the database. It shall be possible to simulate different scenarios and/or “What if" studies.

4.3.15.4 **Outage Restoration Study**

The Outage Restoration study shall generate a recommended set of switching actions to restore service both above and below a faulted line section.

After selecting the study, the user shall select the faulted circuit element by simply clicking on it in the map. When the study results are ready, the user shall be able to view them in a resizable popup window. The study shall generate a report of switching actions for both fault isolation and service restoration. The report shall show alternatives for the switching actions and shall contain the restored kW and number of customers for each alternative as well as the remaining kW to be restored and the number of un-serviced customers. The switching actions shall be presented in the following order:

Above the fault:

a. Switching actions that isolate the fault on the line side

b. Switching actions that restore service above the fault

Below the fault:

a. Switching actions that isolate the fault on the load side

b. Switching actions that restore service below the fault (via interties)

The recommended switch actions shall be based on margin and capacity. The results shall be printable to any printer available to the SCADA user interface. Once the user has viewed or printed the results, it shall be possible to select a new faulted circuit element for study. It shall be possible by means of a pushbutton to transfer the recommendations from the report to a switching order.

4.3.15.5 **Capacitor Dispatch Study**

The Capacitor Dispatch study shall allow the Control Centre Engineer to explore the effects of capacitor bank switching on a feeder before actually performing the switching.

After selecting the study, the user shall select the capacitor bank to switch by simply clicking on it in the map. When the study results are ready, the user shall be able to view them in a resizable popup window. The results of this study shall include the following pre and post study data regarding the switched capacitor:

a. Status of the capacitor banks

b. High and low voltages

c. Total line losses

d. Total real and reactive power injected into the feeder

The results shall be printable to any printer available to the SCADA user interface. Once the user has viewed or printed the results, it shall be possible to select a new capacitor for study.

4.4 Outage Management System Applications

4.4.1 OMS Specifications Overview

The OMS shall be flexible Outage Management System designed to maximize the performance of Purchaser dispatchers by working with a single SCADA/ADMS user interface to help operators and dispatchers better handle system outages. Purchaser likes to

automate the outage management capabilities (today manually done) with a commercially available OMS.

The OMS system shall have a graphical map display capability to include functionality for locating outages and crews on a geographic background of land containing the electric transmission & distribution system with user defined settings for display of various layers of graphical data (land, roads, poles, switches, all outages, predicted locations, etc.) at various scales. The graphics system shall be able to have different symbols for different types of crews and outages and the ability to suppress the display of lower priority calls and include normal pan, zoom, and locate functionality. Outages affecting sections of primary shall highlight the affected circuit(s). The graphics system shall allow manual placement of outages. A method of linking raster images, vector design files, jpeg, bitmap or gif files, and operating procedures or other documents to specific objects shall be included which will allow selection of the object to display the associated document, image or file. A second schematic view of the distribution system shall be automatically generated from the geographic view to assist in development of planned and un-planned switching procedures.

It is intended that the OMS will interface with the following systems:

a. The Purchaser's Customer Information System (CIS)

b. The proposed Power System Applications (ADMS)

c. The Purchaser's Interactive Voice Response System (IVR)

d. The proposed Work Force Management System (WFM)

e. The Purchaser's SAP system

f. The proposed mobile Field Force Management system (FFM)

It is intended that the network model be extracted from the Purchaser's GIS data model. It is proposed that the application software and database reside on the Purchaser communication network, but portions of the application are also accessible to selected locations (including a back-up control center) and to maintenance crew in the field.

Implementation of the integrated OMS is intended to provide Purchaser with the following functions:

a. A graphical display of the electric sub-transmission and distribution network with dynamic symbols indicating outages, crews and predicted failure points

b. A predictive engine to identify potential outage devices based on the number, type and location of customer outage calls

c. A management information capability to allow management and executives access to summaries and details of outage status and progress via the intranet

d. A database capable of calculating monthly, year-to-date, and annual industry standard outage statistics using the latest IEEE or other industry bench marks

e. A predictive engine to provide information on expected restoration time

f. Crew scheduling and tracking capability to manage crews and field personnel during outages

g. A switch management module that supports the initiation of Power outage requests, schedules Power outage requests, generates suggested switching plans for both a geographical view and an operating schematic view of the networks.

h. A set of vgeographical views of the facilities that provide both a geographical view and an automated operating schematic view generated of the networks

i. A set of field based tools that facilitates status reporting and outage completion collection.

Purchaser has identified two business processes wherein a fully deployed outage management system will provide benefits to Purchaser. In order to achieve these process benefits, certain functionality for an OMS solution must be present. The two processes are described below.

4.4.2 **Planned Outage Business Process**

Planned outage is the process to de-energize a portion or an entire electric circuit. Events that trigger this process include work identified (internal or external to Purchaser) that require a Network outage or section of the network outage, requests from the Project and Maintenance department or the Control Centre and certain customer requests to Purchaser. Results of the process are that the system is returned to normal state and that the identified work is completed.

A critical aspect of this process is that a high level of communications is required to convey system status to customers for planned outages as for them it is unplanned outage. The outage management system (OMS) must provide the capability for real-time status of the system as well as provide switch status and orders.

When planned outages take place, there are several aspects of planning, communications and performance of the work that involve best practices related to outage management viz.

a. Advance notifications

b. Management of Power outage requests

c. Work Permits

d. Generating switching plans to support the Power outage requests

e. Status updates

f. Work order completion

4.4.2.1 **Advance Notifications**

For planned outages, it is best practice to notify affected customers in advance so that they have adequate time to make appropriate decisions or alternate plans. This is very important for commercial and industrial customers, as well as residential customers. Purchaser will notify commercial and industrial customers by phone. Notifications are provided to the Customer Service Call Center who may receive calls from affected customers. The Purchaser Corporate Communications Department would also be notified at this time.

4.4.2.2 **Status Updates**

When field crews performing planned work encounter conditions that will extend the duration or extent of planned outages, it is desirable that they provide a timely update to the expected time of restoration. This information may be reported to their field supervisor or Control Centre, but the key element is that the Customer Service Call Center is also informed so that they have accurate and timely information to share with customers when they call. For larger or more critical customers, this updated information is generally passed on directly and proactively. At Purchaser, the Customer Care Department will address the notification of key industrial and commercial customers.

4.4.2.3 **Work Order Completion**

The practice related to the closure of work order completion is that the field crew promptly provides notification when their work is completed, submits preliminary information about changes made to the energized system, and promptly closes the associated work orders or tasks. These steps are necessary to inform the Customer Call Centre that subsequent outage calls are unplanned and should be handled as trouble calls, to provide Control Centre Engineers with immediate information about the distribution system so they can operate it safely while records are being updated, and to allow the records updating process to proceed in a timely manner.

4.4.3 **Unplanned Outage Business Process**

Unplanned outage is the business process to manage events surrounding unplanned outages, including communications to clients on outage status, and restoration of the electric circuit to energized condition. At Purchaser, a sustained outage is greater than two- minutes. Events that trigger this process include customer calls to the Customer Call Centre, IVR indications from customers, SCADA alarm, and calls from external public or essential services / private agencies such as the fire department, police or large customers. Results of this process are that the electric system is restored, and follow-on work is requested.

The outage management system technology will address this process and its activities. OMS will handle the management of trouble calls to generate trouble tickets, as well as provide the analysis of the outage calls to identify the most probable failed device or devices that is causing the outage. The OMS will provide the functionality to dispatch this information to the field and get current status information from field personnel on the extent and nature of the outage, estimated time to restore, and request for assistance. Status information, especially the estimated time to restore, is sent back to the Customer Service Call Centre through the CIS and IVR to keep customers updated. This information is also passed to internal departments such as Customer Care Department and Corporate Communications who in turn can respond to requests from the large customers and the media in a timely and accurate manner.

When unplanned outages occur, often the first indication a utility has is a call from a customer or outside agency. It has never been considered practical or economically feasible to monitor all customers to detect when service has been interrupted. For this reason, it is general practice to rely on customer calls for detecting unplanned outages, with the exception of a limited number of large customers, who may warrant direct monitoring. Best practice using an OMS with respect to unplanned outages, therefore, mainly relate to how Purchaser effectively handles trouble calls in the following areas:

a. Call taking

b. Overflow call handling

c. Outage status information

d. Callbacks

4.4.3.1 **Call Taking**

It is common practice that customer trouble calls are entered directly in the Customer Information System (CIS). Using the CIS user interface enhances the productivity of the Customer Service Representative, since a single user interface with which they are most familiar with is most efficient. Also, the CIS often provides more robust means of searching for a customer record and payment histories than an outage management system may have. All unplanned "No Current" call from the customers will be directed to the OMS from the Call Centre.

4.4.3.2 **Overflow Call Handling**

Purchaser will have means available to handle the overflow calls that cannot be taken immediately by the Customer Call Center. Purchaser typically addresses overflow call handling effectively using a combination of interactive voice response (IVR) units, outsource, and available internal staff trained in taking customer calls during storm conditions. During extreme storm situations, Purchaser may use an outsource service that have access to Purchaser's Customer Information System to augment the Purchaser Customer Service staff.

4.4.3.3 **Outage Status Information**

The most important and desired best practice in customer care is to provide outage status information readily to the utility's Customer Call Centre and interactive voice response units. The two most important pieces of information that a customer without power (No Current) desires to know are, first, that the electric company knows of my outage and is working on it, and secondly, how long will it take to restore power. Currently at Purchaser, operations Control Centre Engineers manually keep the Customer Call Centre informed about outages, the extent of the outage and the estimated time to restore. This provides the information that customer service representatives use to explain details of the outage to customers that call or to proactively call customers to inform them of outage status.

4.4.3.4 **Callbacks**

Often during a storm, a single customer's service will be interrupted concurrent with the outage of a larger portion of the feeder-circuit that serves the customer. When such a nested outage occurs, it is difficult to know whether the restoration of the larger circuit portion has restored all customers. Certain situations may require call back to some of the affected customers in an attempt to determine whether any single customers remain

without power. Again, a combination of using both Customer Service Representatives and the IVR system to perform callbacks and to generate new outage tickets if required.

4.4.4 **Outage Analysis**

The OMS will provide an analysis engine that processes the trouble call information received from the trouble call entry system, from the IVR system and device state change messages from the DMS/SCADA system. The outage prediction engine will generate the most likely device and an estimated restoration time for the probable outage event.

4.4.4.1 **Probable event prediction**

The outage prediction engine will generate a probable outage event based on the currently defined set of heuristic rules that typically takes into consideration: number of calls received, time between calls, trouble call codes, network topology, currently available crews, currently dispatched crews and type of probable outage device; the outage prediction engine will generate a probable outage event.

The system shall support incoming calls that have multiple call codes on a single call that indicate whether there may be an outage, there is an emergency situation, there is a need for maintenance or there is a request for service. The system shall support call types that indicate a service or premise level outage and it will not try to roll these types of events into events upstream, nor will the system try to group and close these events when upstream events are restored and completed.

The system shall support automatic notification of confirmed or real outages via an automated interface with a SCADA system and automatically group all future related calls to the outage event.

The system shall support a catalog of named configurations that can be loaded and put into production during special storm conditions.

The system shall support multiple voltage classes in its topology model used to predict outage events:

a. Sub-transmission Voltages

b. Distribution Voltages

The system shall use the transmission substation breaker as its source for sub-transmission category outages and trace to source functionality and distribution substation breakers as its source for the same in distribution category outages. Describe the system’s algorithm(s) for

breaking up outage prediction zones across sub-transmission and distribution voltages. Assume connectivity exists in the topology model through the distribution substation.

4.4.4.2 **Time estimation**

The analysis engine shall also provide estimates of restoration time for the Control Centre Engineers, the CIS interface, the IVR interface, and management summaries through the intranet. These estimates shall be based on configurable heuristic rules and shall vary depending on weather, time of day, day of week, number of other outages within the same area and/or feeder, number of crews dispatched, and the number of crews available for dispatch. The Control Centre Engineer shall also be able to over-ride the estimated restoration time for any given outage based on field conditions reported by the crews. This Override will be tracked in a summary table with the name of the Control Centre Engineer, Time of occurrence, override and current value. The system shall generate new estimated restored times for all events that have been extended beyond their original estimated restore time because of the lack of resources to dispatch to.

The system shall assign an estimated restoration time based on device type, number of active outage events, and number of active crews. The system shall assign a start time to the outage event based on the earliest of the first call associated with the event, or the automated interface message that raised the event.

4.4.5 **Power outage Requests and Switch Order Management**

The system shall automatically generate a suggested switching order to isolate the selected group of devices or sections of circuit based on load flow analysis, minimum number of switching steps and the current network configuration.

The switch order management module shall support both planned and unplanned switching. Before actually issuing a restoration switching order step, the user will be able to see if any voltage violations will result because of the new circuit configuration. The system needs to support the planning of future Power outage requests (switching orders) and in particular provide help in the coordination of future Power outage requests that cause the same facility to be operated. The system shall provide a graphical user interface (GUI) that allows the user to identify the area to be isolated and the system shall generate a recommended switching order based on the results of a load flow analysis and minimizing the number of switching steps.

Alternatively, the GUI interface shall allow the user to manually open and close devices and record the actions into a switching order. The user will be provided a planning or study mode

that allows the user to test and verify his switching orders without affecting the operational configuration as seen by the outage management users. The switch management module shall provide a catalogue of switching templates that may be created by facility. The user shall be able to query the catalogue of switching templates and instantiate his current Power outage request based on the selected template. This will ensure a uniform approach to isolating the same facility.

The system shall have the provisions to allow the user to do the following actions

a. The user shall be able to add safety and operational steps at the appropriate locations in the switching order. The user shall also have the capability to insert additional instructions, checks or otherwise edit the system generated step.

b. The user shall be able to group multiple work orders and manually entered Power outage requests and generate a single switching order for that set of work orders.

c. The user shall be able to create multiple switching orders for a single work order or Power outage request.

d. The user shall be able to generate a list of affected customers for each planned outage and use the list to generate door hangers, mailers and phone calls.

e. The user shall be able to generate additional switching orders based on switching orders that have been saved.

f. The user will be able to adjust the steps within a switching order after it has been started. To support this, the system shall support alphanumeric numbering of switching steps within a switching order.

The switching order management tool shall have the following functionalities as

a. The system shall pre-fill in the switching header from the details it receives from a work order.

b. The system shall support an import mechanism to load existing switching templates and historical switching orders from a RDBMS.

c. The system shall track all work orders supported by a switching order.

d. The system will provide assistance to the user once he has indicated the start of a planned switching order has been executed in the field. It will timestamp the switching steps as the Control Centre Engineer acknowledges them. It will keep the active step highlighted within the switching order for the Control Centre Engineer.

e. The system will provide assistance during the planning of Power outage requests by displaying a list of existing planned switching orders that affect overlapping facilities with the Power Out request's isolation area during an user definable window of time (within next 2 days, week, 2 weeks, etc.)

f. The system will provide signature review cycles for planned switching orders.

g. The system will notify the work management system when all necessary switching orders have been created for a work order/Power outage request.

h. The system shall have a module for users to manually enter Power outage requests as well as supporting the interface with a WMS to accept Power Out requests from an external system.

i. The system shall support GUI based management screens for users to display, sort, and group Power outage requests.

4.4.5.1 **Outage Management**

The system shall allow the user to perform the following functions

a. The user shall be able to sort his list of outage events associated with his area of control by any combination of the displayed sets of fields

b. The user shall be able to select any outage event and see the detailed customer called-in comments entered by the customer service representative associated with the predicted or confirmed event.

c. The user shall be able to manually enter in the start time for an outage event. The system shall save all outage events that had their start times manually overridden in a table, identifying the user, time of override, current and overridden values.

d. The user shall be able to create an event anywhere along a circuit segment or at advice for a hazardous/emergency call or add non-grouped calls to an event.

e. The user shall be able to create a temporary jumper to capture the current configuration of a circuit as reported by the crews.

f. The user shall be able to add one or more tags/notes to a device.

g. The user shall be able to raise and remove conditions on a device as they are created and removed in the field to indicate:

i. grounds exist

ii. a device in local mode

iii. a device in lightning mode

iv. the communication to device has failed

v. a device in loop scheme

vi. a device in auto reclosing mode

h. The user shall be able to generate a tabular list of all devices that are currently operating in their abnormal state.

i. The user shall be able to open and close a device by selecting it graphically and performing the operation. Please indicate if the proposed system supports select before operate approach.

j. The user shall be able to enter all outage event details required to complete the outage.

k. The user shall be able to enter appropriate information to generate a follow-up work order for the outage event.

l. The user shall be able to push any predicted outage event upstream to the next device.

m. The user shall be able to push any predicted outage event downstream. The system shall generate a new predicted outage for each of the devices (typically lateral fuses) that are immediately downstream from the currently predicted outage device.

n. The user shall be able to generate a tabular list of work orders that were created for an outage event and see their current status information or completion dates.

o. The user shall be able to enter completion details for partial restoration events.

The system shall also support the following functions:

a. The system shall be able to create a work order request based on the previously entered information in the work management system.

b. The system shall track all work orders that were created for an outage event.

c. The system shall keep track of all partial restoration events that were part of restoring all customers. Each partial step shall have its own ending time stamp for the set of customers it restored.

d. The system shall log every device open/close action and record the person who performed the action.

e. The system shall be able to generate a list of executives and managers to be used to page, email or phone with the related outage details when a set of critical customers are affected by either a probable or confirmed outage event.

f. The system shall automatically refresh all users' displays that contain an event that has just been created or restored.

g. The system shall automatically refresh all users' displays that contain a device whose status has changed or had an operating condition raised or removed.

h. The system shall accept schematic drawings as input and generate the connectivity to the topology model based on the devices that appear on both the geo-reference view that has already been loaded from the GIS and the new schematic that is being imported.

4.4.5.2 **Intranet Access**

The necessary modules to allow full outage analysis, dispatching, switching and geographical map display via a standard browser for use at different locations other than the system Control Centre shall be provided. Access to these functions shall be from the Purchaser corporate intranet.

4.4.5.3 **Intranet Management Summary Access**

The necessary module to provide management summary information for Purchaser executive and management through the corporate intranet shall be provided.

4.4.5.4 **GUI functional requirements**

The system shall provide the user with a seamless view of the company's complete set of maps. That is, the user will not have to manually load map sheets or map files for display, but that the system will keep the physical storage structure invisible to the user's navigation and display functions. The system shall support scale dependent visibility of features. The system shall automatically turn on and off specific features based on the current display scale. The system shall use line color or symbology to indicate the number of phases on a section of circuit. The system shall use line color to differentiate circuits. To support this, the system shall use its own color map to generate the color to be used for each circuit such that no circuits that could be tied or jumpered together have the same circuit color. The system shall automatically generate its single circuit view and 3-phase schematic backbone view from its topology model each time the topology model is reloaded from the GIS.

4.4.5.5 **Navigation (Office: Control Centre Engineers, Supervisors)**

The OMS shall have both tabular and geographical map display capability. The graphical display shall include functionality for locating outages and crews on a geographic background of land and the electric sub-transmission and distribution system with user- defined settings for display of various layers of graphical data (land, roads, poles, switches, crew locations, predicted outage location, etc) at various scales. The graphical display shall be able to have different symbols for different types of crews and outages and include normal pan, zoom, and locate functionality. Outages affecting sections of the sub transmission and/or primary distribution system shall dynamically highlight the affected line(s)/circuit(s) by changing the line/circuit segments to a de-energized color status. The system must provide automation that directly supports how Control Centre Engineers be able to find the outage geographically in case they need to dispatch instructions over a radio to the crew, they need to zoom out to its circuit level view to see if there are other related events, and in some cases they need to be able to zoom out to the three-phase backbone view to see if there are related events on other circuits.

The function shall include current predicted outages, emergency alarms, outages being worked by crews and recently completed outages, listing customers affected by an outage and reviewing the customer supplied notes associated with specific trouble calls.

Following functions shall also be considered:

4.4.5.5.1 **Pan and zoom facility for Navigation**

The system shall support navigational aids that will be based on the information Control Centre Engineers use to find locations. A sample subset of potential items is:

Facility Ids: switch number, breaker number, Pole number & street name

Customer info: name, phone, address

System shall zoom and center on the device the customer is attached to-Typically a transformer or primary meter. Street address, cross street, Circuit Name, Line Name, Substation Name, saved user view name, Outage Event ID, Crew Name, Switching Order.

For all such navigational aids supported, please describe the behavior of proposed system when the user's input results in a set of values being returned instead of a single location.

The system GUI shall also allow the following functionalities

a. The user shall be able to manually toggle on/off feature classes or sets of feature classes to be displayed.

b. The user shall be able to select a device on any graphics display and be able to toggle/cycle through all of the views that the device is graphically depicted on. This shall include the device's representation on its geo-reference view, on its single circuit view, on its 3-phase schematic backbone view, and for substation equipment, on its substation one-line view.

c. The user shall be able to select a device or line segment within a loop and go to its open point.

d. The user shall be able to select an outage event from its tabular/textual displays and go to it on a graphical view.

4.4.5.5.2 **Facility Information**

The graphical display shall provide the user with the ability to lookup related information about a selected facility. These include engineering/construction type of attribution typically managed in the GIS, generated operating attribution created by a load flow analysis program, and electrical network based connectivity information indicating customers serviced by the selected facility or other conditions downstream from the selected facility that the Control Centre Engineer would typically need to know about. The system shall maintain all device states, tags, notes, conditions, jumpers, crew locations and crew assignments after its topology model has been updated from the GIS.

a. The user shall be able to look at the selected facility 's attribution.

b. The user shall be able to view all associated load flow analysis results associated with the selected facility.

c. The user shall be able to view the count of customers served by the selected facility by phase.

d. The user shall be able to view the list of all the customers as well as the list of the critical customers served by the selected facility by phase.

e. The user shall be able to view the standard operating procedures associated with the selected facility.

f. The user shall be able to view all conditions that are downstream from the selected device.

g. The user shall be able to view all current and future scheduled work orders from both the work management system and the maintenance and inspection system that the selected

device is a member of. For current work in progress, the system shall display the status of the work orders.

h. The user shall be able to toggle on/off the selected facility class' annotation.

i. The user shall be able to view all current and future scheduled work orders from both the work management system and the maintenance and inspection system that the selected customer will be affected by. For current work in progress, the system shall display the status of the work orders

4.4.5.5.3 **Tracing (Outage Trouble Analysis Aids)**

The graphical display system shall provide the Control Centre Engineer with trouble shooting aids. These are mainly based on using the network topology as supplied by the GIS and further updated by the Control Centre Engineer to reflect the currently operating configuration of the sub-transmission and distribution systems.

The proposed system shall support the following functions:

a. The user shall be able to select a device or segment of circuit and generate a trace set from the selection downstream to its distribution transformers, open points and tie switches.

b. The user shall be able to select a device or segment of circuit and generate a trace set from the selection upstream to the previous protective or sectionalizing device.

c. The user shall be able to select a device or segment of circuit and generate a trace set from the selection upstream to its source.

d. The user shall be able to select a device or segment of circuit and generate a highlighted trace set from the selection to the next occurrence of a specific device type: fuse, switch, recloser, or sectionalizer in the user specified direction.

e. The system shall keep all trace sets highlighted while the user pans and zooms until the user deactivates the highlighted trace set.

f. The user shall be able to select a device or segment of circuit and generate a highlighted trace set from the selection to its set of sources.

4.4.5.5.4 **Reporting**

The reporting module shall provide all industry standard statistical indices by circuit, reporting area, and company summaries. These indices shall be further categorized as with and without major storms. These standard reports shall be produced monthly, quarterly, and annually. The reporting module shall provide daily operational reports. These operational

reports shall be produced at the end of each shift or on demand with ad-hoc previous date & time ranges.

The system shall provide a set of daily operational reports:

a. Outage Summary
b. Outage Detailed
c. Circuit Summary
d. Line Summary
e. Area Summary
f. Crew Summary
g. Crew Detailed
h. Daily Outage Completions
i. Outage Completion Forecasts
j. Crew Resource Forecasts
k. Abnormal Device Summary
l. Abnormal Device Detailed
m. Tomorrow's Switch Plans
n. This Week's Switch Plans
o. Today's Planned Outages
p. Tomorrow's Planned Outages
q. Next Week or Next Four Weeks
r. Flash Report

The indices shall be further categorized as with and without major storms. These standard reports shall be produced monthly, quarterly and annually. Current operations reports will be available by circuit, operating district and reporting geographical area.

The system shall provide an ad-hoc reporting environment that allows users to develop their own reports against the system's data mart and save the same in a catalogue of reports. It shall also provide reporting and read only access of graphical and tabular screens for customer service and management users.

The user shall be able to view any report definition and copy it to reuse its logic as a starting point for a new report. The user shall also be able to designate Microsoft Excel as his output format and the system will start up Excel and load the results of his report into Excel. The user shall be able to print the results of any reports that are executed.

4.5 Work Force Management (WFM)

Purchaser defines Work Force Management (WFM) as an information system that prioritizes, schedules, resources, and dispatches work to field personnel. Work types can include trouble orders to field trouble men during outage conditions, same day orders for customer services field crews, crews performing routine maintenance and business continuity inspection work, and crews performing construction work. WFM systems can support an OMS with functionality to dispatch trouble orders generated by the OMS to manage field personnel during outage conditions. WFM can also be used to dispatch daily work orders to personnel who perform routine field work.

Purchaser is actively seeking WFM functionality to support field personnel. The technology is seen as a critical component to support of the outage management system as well as address planned short-duration (same-day) work, such as customer service orders, collections, maintenance and inspections and trouble orders. The benefits of WFM is increased field personnel productivity through optimum order scheduling and routing, equitable distribution of workload to available resources, and the ability to meet customer date and time preferences by offering customers smaller appointment windows. Effective scheduling and resource management of field personnel eliminates multiple visits to the same premise, helps to minimize overtime and reduces vehicle expenses from reduced travel times.

The following are high-level functional requirements for WFM system technology to meet Purchaser's future state process definitions.

4.5.1 Scheduling

The necessary interface mechanism to send both pre-assigned trouble work, and unassigned trouble work to a scheduling module is part of this project.

The functions carried out by the scheduling module of the Work force management system can be broadly explained as

a. Ability to prioritize and book appointments in real time. The system shall generate a list of 10 alternative time slots if the requested appointment time slot is not available.

b. Assign work based on field worker availability, work areas, skills, equipment and service Contracts

c. Schedule work to meet customer time preferences

d. Schedule work to optimize network performance metrics

The system shall automatically generate a schedule to be used by either the auto dispatching module or a human Control Centre Engineer. It will be based on the trouble call codes, the location of the predicted device and the location and skill types of the crews that are active.

The system shall generate a resource loaded schedule of distinct work order tasks assigned to distinct crews for the next 6 calendar weeks. The user shall be able to generate a schedule for this week, this month, or the next two months and either print a hard copy or post it to all crews personal Calendars

The system shall accept multiple work order types to be scheduled:

a. Service (turn on, shut off, meter checks)

b. Maintenance & inspection

c. Trouble

d. Emergency

e. Construction work orders

f. Switching orders

g. Street light service requests

The system shall accept cancellation requests for all work order types even after the work order has been scheduled and dispatched to the field.

During major storm events, the system will take back all work orders from their scheduled crews, generate a new schedule based on the estimated restoration times for all of the known outages and generate a list of customer executives to be paged and/or a list of customers to be called or to receive a mailer to notify them that their work order has been rescheduled past its need date. The system shall accept as input the personal calendar for each crewmember.

The system shall treat emergency and outage types of tasks with higher priority and schedule the closest qualified crew to be dispatched.

The field crew will be given the option to keep their previously assigned work orders for the day when they receive a trouble event. Automatic rescheduling of all work order tasks sent back by field crew due to the new trouble work order tasks shall be done. The user shall be able to enter the company's workday calendar and shift definitions.

The system shall also have the functions required to deal with the inter work order dependencies of a work order to be auto scheduled and dispatched with its related work orders.

4.5.2 **Dispatching**

The dispatching module shall allow the following dispatching business models

a. Centralized dispatching

b. De-centralized dispatching

During normal business hours, off-hours and during moderate storm situations, dispatching typically will be done centrally. Some severe storm situations may require de-centralized dispatching. The dispatching module shall allow a seamless transition from centralized to de-centralized and back to centralized dispatching, with appropriate communications and status reporting functionality to ensure the Control Centre Engineers fully understand the situation in the field at the transition time, i.e., from centralized to decentralized and vice versa.

The dispatching module shall allow dispatching of multiple outages to a single crew and multiple crews to a single outage. The dispatching module shall also provide crew management functionality including tracking crew makeup, allowing creation of crews, allowing additional or removal of personnel from crew and changes in crew make-up, allowing combining of crews at a single outage, searching for individual crew members by name, tracking total time worked and continuous time worked by individual crew member, tracking when meals or rest periods are due, tracking equipment needed by or assigned to crews, etc. It shall also allow for the dispatching of bidder (non-Purchaser) crews.

The system shall support the following modes of operation for field dispatching:

a. Automatic mode

b. Manual mode

4.5.2.1 **Automatic mode**

The system shall auto dispatch to the field a complete days' worth of work before the crews sign on for their shift. The user shall be alarmed when the system attempted to auto

dispatch a trouble or emergency work order and the crew hasn't acknowledged it within a user defined period of time. There shall be a provision to dispatch all work orders previously dispatched to a crew who doesn't sign on within user specified time interval from his shift's scheduled start time.

4.5.2.2 **Manual mode**

The user shall be able to manually dispatch a crew to a work order by dragging the crew to the work order or the work order to the crew. The user shall be alarmed when a crew is in jeopardy of missing his current work order's estimated end time, so the Control Centre Engineer can proactively take over the rest of the crew's work orders and reassign them.

The system shall ensure two different crews with similar skill sets won't be assigned work orders on the same street and area in the service territory.

The system shall display the current location of the crew if the system supports AVL.

The system shall be able to track when a work order has been dispatched,

a. Acknowledged by a crew

b. Crew is in route

c. Crew has arrived at the location

d. Crew has restored service

e. Crew has completed work order.

The system shall automatically re-dispatch all work orders not marked to stay with the crew at the end of the shift.

The system shall be able to send to the field either with the original trouble work order header information or as requested by the field, a map of the probable outage device, a list of critical customers affected, a list of customers who have called in, a list of all customers affected including the actual text messages collected from customer service representative and the alternative views that contain the various customer lists plotted on the outage map as well.

4.6 **Crew Management**

The WFM shall provide management tools to help the Control Centre Engineer keep track of where his crews are during trouble events. The crews are made up of crew members, trucks

and special equipment. For each individual crew member, the system shall contain his contact information:

a. Cell number

b. Radio number

c. Truck id

d. Emergency contact number

The system will generate the forecasted resource skill requirements for all work orders with need dates within the next 6 months.

The system needs to support the true dynamics of a storm event and allow the Control Centre Engineer to quickly merge/split existing crews, create new crews based on bidder crews, assign additional outage events to crews to be worked that are in close proximity to the event they are currently working. For shift and holiday support, the system shall be integrated with the call out roster to automatically page and assign outage events to crews acknowledging their pages.

The system shall track hours on the job for each individual crewmember. The system shall generate an alarm that color codes the crew on both the graphical and tabular displays they are displayed on when any member of the crew has reached a user definable threshold of hours on the job. The user shall be able to generate a list of all such crew members.

The system needs to track and alarm the Control Centre Engineer when crew members need to go on break or when they are coming up to the end of their current availability. This system shall also alarm the Control Centre Engineer when a crew member is overdue for a meal or rest period.

The system shall be able to generate the number of additional crews required based on the current set of known and predicted outages and the number of active crews, their remaining availability and the user entered desired outage completion time.

The user shall be able to list for each crew, its members and the hours (and partial hours to the tenth of an hour) currently on the job for each crew member and all events that have either been dispatched or assigned to the crew, thus marking a crew as active or inactive.

The system shall allow the user to view the following information:

a. Available crews

b. Crews that have been dispatched to trouble events in the field.

c. Crews who have no trouble events dispatched or assigned to them.

The system shall generate and display for each crew the estimated time they have left on the trouble events that have been dispatched or assigned to them. Also, the system shall provide remote access (via a secure Web based application) for all of its crew management functionality.

4.7 **Order Management**

a. Ability to manage task assignments and dispatch of orders to field personnel

b. Manage precedence relationships between jobs

c. Monitor task status

d. Field entry of device status, outage status and outage completion

e. Collect and validate work results

4.8 **Field Device Requirements**

List mobile hardware platforms supported. Include Operating System supported, basic system requirements required, and which components/modules/products of your solution are required for the following hardware types:

a. Laptop Computer

b. PDA

c. Tablet PC

d. Hand Held Devices

e. Mobile Smart Phone

4.9 **Outage Web Portal**

The OMS shall provide a customer facing outage mapping portal (i.e. on corporate website) that geographically displays known outages and provides basic outage status information including the number of current outages, number of affected customers, and expected restoration times per outage. Ensure outage mapping portal dynamically updates based on new, dispatched or restored outages.

The OMS shall have an customer facing Outage Web Portal.

Verified outages shall be automatically pushed from the OMS to the Outage Web Portal without the need for operator intervention. Outage Web Portal application should have the ability to:

a. View locations and the extent of existing outage cases

b. View outage ticket information such as cause, estimated time of restoration and information messages from the system operators

c. Allow customers to submit outage reports

d. Allow customers to view a list of all planned outages

The Outage Portal shall use mapping technology such as Microsoft Bing Map, Google Map or Open Street Map as the underlying background mapping technology.

The outage pushpins on the map point to where the outage is located. Clicking on one navigates to and highlights the area associated with that outage and displays an outage ticket containing the outage details.

The Outage Web Portal application can be used from a desktop, a laptop or a tablet, however, the application is optimized for handheld mobile devices such as smartphones.

Operators shall have the ability to update the following information on the Outage Web Portal including:

a. Estimated time of restoration

b. Outage Cause

c. Pre-defined message from a dropped down list of pre-defined messages

d. Free form message

The outage portal shall be connected in real-time to the OMS system, however it should be isolated on its on DMZ and can only access the OMS via middleware server to ensure the security of the system.

4.10 **Notifications**

The OMS shall be able to integrate with IVR and corporate website to provide notification of planned and unplanned outages status via customer phone lines (work phone, cell phone and home phone, etc.), emails, or text messages to customers.

The OMS shall provide method(s) to contact a customer electronically with outage status updates using IVR, Email, and SMS text messaging.

4.11 **Tabular List**

All dynamic lists have sorting capability on any column, including the capability to have multiple nested sorts, in order to rank and sort outages in an order that is quick to locate information (i.e., medical alert customers). All dynamic lists have filtering capability, with the ability to filter on multiple fields. The sorts in the outage list can be sorted at a minimum with the following column information: customer hours and minutes interrupted priority customers, customer type, outage types and number of customers out. The OMS dynamic list of grouped calls supports a dynamic status indicating current status of event (acknowledge, crew on site, restored).

OMS have the functionality to generate estimated restoration times for each outage with the ability for manual override of the calculation. The OMS solution has the ability to provide an estimated number of customers out of power (versus actual), per outage prediction. The OMS dynamic list shall have the ability to filter on multiple fields and the ability to export in xml format or other reporting generators.

4.12 **Automatic Vehicle Locator (AVL) Integration**

The SCADA/ADMS shall have the ability to be integrated with an AVL system to receive as a minimum the following information:

a. Vehicle GPS Coordinates

b. Vehicle travel direction

User selectable symbols can be used to represent different types of vehicles. Vehicles can be positioned on the operator user interface to allow operators to quickly view vehicle locations. The distance of vehicles from an outage should be available to allow dispatchers to easily select the nearest crew to an outage.

4.13 **Mobile Crew Outage Client (MC)**

The MC should allow the extension of the SCADA/ADMS onto mobile devices such as laptops, tablets and smart phones. Once work items are added the assigned crews shall receive email and/or SMS notification to notify them of new work items available to them. Crews will have the ability to view work items assigned to them including the following minimum details:

a. Location of the work item

b. Description of the work item

c. Assigned crew

d. Scheduled start time

e. Scheduled stop time

f. Work order

g. Switch Order

h. Clearance

Crews shall have the ability to update the following information as a minimum:

a. Estimated Time of Restoration

b. Outage Cause

c. Work status

The MC client shall show the location of the outage on a map. The map should be optimized for viewing on laptops or tablets and based on industry standard mapping technology from Microsoft Bing, Google Maps or Open street Maps.

The MC shall have real time connectivity to the ADMS system via a secure middle-ware server to ensure that any real time changes on the ADMS are available to the MC Client.

4.14 **Non-Outage Call/Events Handling Application**

The SCADA/ADMS shall have the ability to handle tickets which may or may not be related to outages

The SCADA/ADMS shall have the ability to distinguish between Emergency Tickets and Service Tickets. Emergency Tickets are related to critical items from a network and public safety point of view. These must be addressed before an outage can be closed. Visual indicators must be available to flash in order highlight and bring operator attention to any outstanding emergency items.

Service Tickets are related to non-outage related items such as tree branch trimming, maintenance work, etc. These should be maintained on a separate list which is easily accessible to the operator.

4.15 **Social Media / Public Website Integration**

The OMS shall have the ability to share outage information through integration with social media platforms such as Twitter. The OMS shall be configurable to allow it to tweet outage

information automatically. The operator should have the optional ability to tweet information about an outage directly via the OMS GUI. Pre-defined messages can be defined to ensure any tweeted messages are within the corporate policy for the organization

The system shall have the ability to add information to the tweets such as ETOR, location of outage and a short link to the Outage Web Portal. The OMS shall have the ability for tweets to be sent to a corporate communications person to allow them to approve tweets before they are posted

4.16 **Distribution Power Flow**

The Distribution Power Flow (DPF) shall calculate the state of the distribution network based on:

a. Real- time measurements at substations and a limited number of locations along the feeders,

b. Manually/Interfaced-entered input,

c. Facilities data imported from the GIS,

d. Model of the operation of automatic devices such as LTCs, voltage regulators, and capacitor banks, and (e) a model of the loads along the feeder.

The DPF shall be designed explicitly for three-phase unbalanced distribution systems.

Distribution Load/power Flow shall be an event-triggered and interval based application that uses network topology information provided by the Connectivity Analyses application, as well as the current estimated load demands and trend, the network's state shall consist of:

a. Complex voltages & Currents,

b. Flows of Active and Reactive powers

c. Voltage drops,

d. Losses etc.

Generally, load (power) flow model of power systems. (Distribution networks included) represents a mathematical description of the active and reactive power balance in the system (the power supply equals to the load and losses), for selected voltage conditions. The Load Flow application shall provide estimated values for those electrical quantities at network locations where telemetered measurements are not available/not provided by user. Load Flow shall be the base for establishment of all other SCADA/ADMS functions.

The DPF shall take the following into consideration:

a. Real time data from SCADA

b. Manual entered data

c. Estimated data from last state estimator/LF raw.

d. Power source injections including DER generation, if applicable

e. Loops and parallels

f. Unbalanced & Balanced loads

g. Manually replaced values

h. Temporary jumpers/cut/ grounds

i. Electrical connectivity information from the real-time distribution network model

j. Transformer tap settings

k. Generator voltages, real and reactive generations l) Capacitor/reactor bank ON/OFF status value.

l. HVDS and Non HVDS Network

m. Data from MDMS for load allocation amongst transformers

n. Save case data

The SCADA/ADMS power flow includes functionality that calculates the impedances from the line lengths based upon the geographical coordinates of the conductors and conductor parameters for wire size, wire type and construction type.

The DPF function should ideally be able to conduct these studies based only on the network and consumer (numbers, categories) information which is available in GIS and the feeder source telemetered data. When smart meters are installed at one or more points in the feeder, the system should be able to take into account their input through meter management system (MDM).

The SCADA/ADMS power flow solves for power flow given feeder source injection and feeder load from a last trend load (i.e. 48 hrs.). The power flow has the ability to utilize any additional phase measurements of voltage and current from sensors downstream of the feeder source.

The power flow function has the ability to generate alarms when the voltage and current flow results are outside of predefined limits that are configurable. This includes fuse, switch, and line overload warnings. The SCADA/ADMS power flow function has the ability to generate transformer overload alarms when the voltage and current flow results are outside of predefined limits that are configurable. The power flow has the ability to perform feeder reconfiguration (load balancing and optimal switching).

The SCADA/ADMS power flow has the ability to perform cable capacity calculation. The power flow has the ability to run against the current electrical model and loads; and then reduce demand by reducing voltage for Conservation Voltage Control (CVR).

The DPF shall run periodically at the frequency (a user definable parameter) Capacity and Performance, Function Periodicity and Execution Time, as well as when triggered by an event (whenever a change in the topology of the power system network or pre-defined change in status or analog data is detected

The Operator must be able to execute DPF on demand for an Operator-specified feeder or all feeders associated with a substation via the graphical User Interface and see the results on the same display.

4.16.1 **Study mode**

DPF shall also run in study mode in conjunction with other application programs, such as the Var Control, Voltage Control, and FDIR functions. The DPF shall also allow the user to execute power flow studies in study mode on selected areas within the distribution power network to determine, for example, the effects of feeder configuration and/or voltage adjustments on feeder load balancing, voltage drops, and losses. Study mode will be used to run “What If” scenarios. The application must provide the capability for storage and retrieval of the number of “Save Cases” The operator will have the capability to modify the parameters such as connectivity, device parameters and other operational parameters before running a “What If” scenario. Study mode operation shall be distinguished by a unique background color for the window or such other means so that it is not confused with real time window

4.16.2 **The DPF application shall be capable of**

The discrete transformer tap positions of LTCs and line voltage regulators shall be adjusted to maintain specified voltages while complying with prescribed ranges on voltages and tap positions. The switching dead band shall also be modeled

Line charging effects shall be modeled, including the insulation losses of underground cables where applicable Provision shall be made to accommodate capacitor banks that are switched on and off based on locally measured parameters

Automatic transfer switch positions shall be modified according to associated line energization status values

It shall be possible to model each load as proportional to a pre-specified normalized load profile. The real and reactive components of each load profile will be specified independently as functions of time, day-type, and season. The DPF shall accommodate a minimum of twenty distinct load profiles (for example, residential, small commercial, large commercial, school, etc.). Each load profile shall be defined as a set of 48 hourly values of real and reactive load for a minimum of five day-types and three seasons.

The DPF shall also allow for individual telemetered loads whose values are acquired through direct telemetry or through an interface with a future AMR (automatic meter reading) system. The modeled load shall be scaled by multiplying the load from the load profile by a scale factor which may be defined to be proportional to the capacity of the distribution transformer, be proportional to the customer's monthly kWh usage, or be another scale factor specified by Purchaser

The network topology, connectivity, symbology, attribute data and location of the loads shall be derived from input from the GIS or another source. If the information is not available in the GIS database regarding the distribution of the loads along a feeder, the DPF shall be built as the sum of individual, user-specified loads plus a uniform distribution of loads along the feeder.

The variation of load with voltage shall be modeled using separate expressions for real and reactive power. Loads shall be adjusted to account for the changes in voltage that occur during the iterative power flow solution process.

Transformers shall be modeled by explicitly considering their copper losses, core losses, and voltage dependence. Voltage drops on LV lines may be calculated with a simplified model that assumes that the LV voltage drop is proportional to the transformer loading of the distribution transformer and that the maximum designed LV voltage drop (a parameter initially set to 10%) occurs when the transformer load is the nominal loading.

4.16.3 **User Input**

The Power Flow function shall be designed to run in periodic or event trigger mode without user intervention and to require a minimum amount of user input when run on demand. This input shall largely be limited to identifying the base case for the study and then making all desired changes prior to execution. Line-out, re- sectionalizing, or other configuration change studies shall simply require the user to change the status of the appropriate switching devices on the associated one-line diagram display. Other changes shall only require simple numerical entries and, where appropriate, the selection of any relevant solution option available.

The user shall be able to execute the Power Flow function for a particular circuit, a particular substation, or a particular "area" (that is, combination of substations) selected by the user, using current base case or postulated load conditions.

Multiple independent users shall be able to execute the Power Flow function simultaneously, starting from the last execution or a selected save case. In these “what if” studies, alarms generated by Power Flow shall not be treated as real-time alarms but shall be retained for display at the console on which the function was run. In modifying the base case prior to execution, the user shall be able to scale loads, specify loads individually, modify bus voltages, and change device status values.

4.16.4 **Output of DPF should minimum calculate following parameters**

a. Real power, reactive power, and current for all circuit elements

b. Voltage on each phase at all buses, including secondaries of distribution transformers

c. Total real and reactive losses, line losses (load and no load), and transformer losses (load and no load), both in kWh and kvarh, and in percent

d. Monthly accumulated losses, in kWh and kvarh, and in percent

e. Tap positions for substation transformers and line voltage regulators

f. Switch positions for capacitors and automatic transfer switches

g. Feeder voltage drops along MV and LV lines

h. Phase imbalance of 3-phase circuits (e.g., average phase current minus minimum phase current, divided by the average current)

i. Voltage imbalance of 3-phase buses (e.g., maximum voltage minus average voltage, divided by the average voltage).

4.16.5 **Results**

The Power Flow results shall be presented on the graphical displays used for real-time dispatching as well as in tabular form on dedicated displays. The results of the Power Flow calculation shall be subject to the same limit alarm processing as other calculated data, i.e., each calculated variable shall be tested against three pairs of alarm limits, and an alarm shall be generated when a limit violation is detected. Alarms and overloads determined by Power Flow shall be indicated to the user simply and clearly. All line sections that are overloaded and all buses that have voltage violations shall be highlighted in color. All loops and parallel- fed loads shall be highlighted in a distinct manner.

Chapter # 5

Purchaser's Specific Applications

5.0 Purchaser's Specific Applications

This Section describes the Purchaser's Specific applications that are required for Sub-Transmission & Distribution network. These applications shall utilize the data acquired by the SCADA & its application. The Bidder shall propose the advance application for enhancing reliability, availability and addressing the consumer transformation specific applications. Purchaser shall select /all or certain applications as per the requirements.

The current pace of change within the electric grid is challenging. At the same time, due to the continually evolving energy mix, Transmission & distribution operators are experiencing an ongoing increase in grid complexity coupled with rising uncertainty due to changing business and regulatory models. Some of the specific requirements are listed below, bidder shall propose appropriate suite of application accordingly:

a) Protect and increase current reliability levels

b) Decrease outage response times

c) Improve power quality

d) Integrate DG and DERs

e) Load Forecasting, Schedule Management

f) Provide resiliency to natural disasters and other threats

g) Multi-site Network Management

h) Advance Analytics

- Online analytics/ intelligence to diagnose and predict incipient faults / developing faults within the equipment & SCADA
- Capability of building artificial intelligence in the system so as to guide operation Engineers during emergencies interactively.
- Vendor shall give the details of applications available on Mobility platform
- Analytical system for intelligent filtering of alarm or real time analysis over analogue data
- The bidder shall provide solution for identifying non-reporting of analog/digital data of feeder/line/bus/station on SCADA system with an auto trigger to Maintenance team through SMS/Email notification/SAP-PM for resolution. Records of such failure

instances to be displayed in separate tab/mimic. This input should be utilized by SAP for autogenerating defect notification.

- Advance analytics through Power BI, enabling rich set of visualization and obtaining tiles from multiple datasets including historian

5.1 **Migration of Purchaser's existing Applications and Logic**

Bidder to migrate all existing application and logic / calculation package built over a period by the purchaser's personals on the proposed system.

Chapter # 6

Communication Network Requirements

6.0 General Requirements

6.1 Proposed System at MCC

Reliable, Secured and highly available communication infrastructure is the backbone for any real-time system used for remote monitoring and control, and connects geographically spread Sub-Stations with the Central Systems.

Following communication schemes are proposed at MCC ***(Refer Section-E, Annexure-1 & 2 Proposed SCADA and ADMS Application Landscape, integration with field devices)***

6.1.1 FEP LAN-A shall be a Dual LAN network, where each LAN will be established through Layer-3 Switches to ensure the N-1 redundancy, comprising of 24 ports on minimum 1000 Mbps bandwidth. The field RTUs, FRTUs, Controllers, Gateway from Sub-stations and Field shall communicate to this dual LAN network.

6.1.2 SERVER LAN-B shall be a Dual LAN network, where each LAN will be established through Stacked Layer-3 Switches to ensure the N-1 redundancy, comprising of 24/48 ports on minimum 1000 Mbps bandwidth. All real time production servers shall be part of this LAN network.

6.1.3 Bidder to establish separate LAN network for Operator workstations and their communication with purchasers Large Video Wall.

6.1.4 DTS LAN-C shall be a Dual LAN network established through Layer-3 Switches, comprising of 24 ports on minimum 1000 Mbps bandwidth. All DTS-workstations, printers, Large video Wall will be part of this network.

6.1.5 PDS & QAS LAN-D shall be a Dual LAN network established through Layer-3 Switches, comprising of 24 ports on minimum 1000 Mbps bandwidth. All PDS & QAS workstations and printers will be part of this network.

6.1.6 DMZ LAN shall be a Dual LAN network established through Layer-3 Switches, comprising of 24/48 ports on minimum 1000 Mbps bandwidth. All DMZ servers for applications such as Antivirus Server, Patch Management, GPS receiver, Interface Server, Jump Host server, Web Server, etc. will be part of this network.

6.1.7 High Availability Firewall will be placed between the DMZ LAN-F network and the SERVER LAN-C network. For firewall specifications please ***Refer Section-B Chapter 13.0, Cyber Security Management System.***

6.1.8 High Availability Firewall will be placed between the DMZ LAN-F network and the external Corporate / IT WAN network. For firewall specifications please ***Refer Section-B Chapter 13.0, Cyber Security Management System***

6.1.9 WAN Router shall be placed between DMZ LAN and the Corporate WAN

6.1.10 All the above Communication Network systems shall be installed in pre-wired network panels as per the site requirement

6.1.11 All the above Communication Network systems shall be compatible and communicate with the Centralized Network Management System. The Centralized NMS shall have necessary Software Interface / Sockets / APIs for integration with these systems.

6.1.12 Services required for commissioning and testing of offered system and integration of the same with existing communication and Automation system.

6.1.13 Operator workstations at substations (if any) shall communicate to the MCC and BCC through Firewall over the purchasers fiber optic based automation WAN/ MPLS network.

6.1.14 Existing communication at PSCC shall be extended to the New Server Centre location by establishing connectivity from existing Communication Network panel located at PSCC

6.1.15 Bidder to establish communication between MCC and BCC using high availability firewalls. It is proposed to use existing Tata Power Automation network.

6.1.16 The communications links provided by Purchaser for Data Exchange among control Centres shall be redundant. Communication links shall be configured as Main & Backup links. The communication links shall automatically switch-over to backup communication links on failure of main links. All the communication applications shall have detailed logging of all the activities on a communication link. The logs shall be organized in multiple levels such as operator controls, error messages, warning messages, event messages and low-level tracing.

6.1.17 High Availability Firewall shall be compatible and communicate with the Centralized Network Management System and Centralized Cyber Security Management System.

6.1.18 High Availability Firewall and other networking accessories shall be mounted in a separate network panel

6.1.19 RTUs, FRTUs, Gateways will communicate to the central MCC and BCC through mobile networks (4G / MPLS, etc. network) and purchasers own fiber optic network over IEC 60870-5-104. Bidder to ensure these connectivity's are established at the MCC and BCC end and any network accessories required at MCC / BCC end shall be considered by the bidder.

6.2 **Integration with Third Party Systems:**

6.2.1 The offered system shall be able to exchange various types of data within the specified response times, using the assigned priorities.

6.2.2 Data exchange shall utilize the communications system provided by the user and shall require the SCADA & ADMS computer systems to support:

a) Integration of the proposed system to Purchaser's systems as specified in section-A scope of work document (e.g. Secured ICCP, Corporate WAN, SMS Gateway, E-mail Server, GIS, VMS, etc.). Bidder to consider required communication Hardware to establish the communication between the purchaser's systems with proposed solution.

b) Data exchange between SCADA / ADMS and Purchasers Enterprise systems

c) Data exchange with Purchaser's intranet

6.3 **Other important considerations:**

6.3.1 The project scope also includes establishing / restructuring a robust Passive / Active Infrastructure with proper logical segregation planning / implementation of the complete back bone (VLANS and Proper Sub netting) in line with Purchasers current and future applications integration in place.

6.3.2 Planning / Deployment of Dynamic routing, Central Management, Radius / AAA, Proper Quality of service for Control System applications in integration with the passive and other Security solutions.

6.3.3 The design of the network and selection of the equipment has to be done in such a way that failure of a switch or its component, failure of one link, increased traffic due to problems at substation level L2 switches or rebooting of L3 devices should not affect the performance or availability of the rest of the network.

6.3.4 Seamless integration, testing, performance, validation with Purchasers existing systems including all applications presently running on the network.

6.3.5 Propose and implement a complete Logical Layer 2 and Layer 3 network topology for SCADA, ADMS and other systems as per the functional requirement of the RFP

6.3.6 Propose / integrate a complete IP addressing schema in line with the current and future requirements of Purchaser and ensure the existing infrastructure is seamlessly integrated with the new design to be adopted. The IP schema will be shared and approved by Purchaser.

6.3.7 All the uplinks from distribution/core switches should be routed interfaces for higher availability, resiliency of network and the design shall ensure total layer 3 based design up to the substation router / switching level and layer 2 below each substation Access network.

6.3.8 Bidders are advised to adopt dynamic routing like OSPF or equivalent across the network back bone.

6.3.9 The complete back bone solution offered / designed shall be based on a mix of both ring and star architecture interconnected in a high available cluster mode at each location on 1G back bone.

6.3.10 All the switches and data communication accessories are to be housed in appropriate communication racks in conformity with structured cabling & EIA/TIA standards (Switches and Racks Fixing).

6.3.11 Successful bidder should propose a complete migration plan on the IP addressing scheme, VLAN planning, security architecture, Central management to Purchaser and mutually agreed deployment plan should be adopted and further deployed.

6.3.12 Bidder is expected to adopt open standards to ensure seamless integration with the existing network / other IT equipment and also the new infrastructure should support all the new emerging technologies without any interoperability issues.

6.3.13 The Bidder is responsible for all unpacking, assemblies, wiring, installations, cabling between hardware units and connecting to power supplies. The Bidder will test all hardware operations and accomplish all adjustments necessary for successful and continuous operation of the hardware at all installation sites.

6.3.14 It is recommended that bidder shall visit the site for finalization of BOM of the respective station. The final BOM along with detailed architecture shall be submitted by the bidder before placement of the Order by Purchaser.

6.3.15 Integration of all health monitoring signals of L3 Switches, Convertors, power supply with Purchaser's SCADA system.

6.3.16 All necessary hardware, software, licenses or any other item required and not covered in the RFQ & BOM of the Communication Network requirements shall be included in the Bidders BOM as separate line items for Purchaser's technical evaluation and consideration

6.4 Codes and Standards

The design, manufacture and performance of the Communication System shall comply with all the requirements of the latest editions of international codes and standards applicable. Given below are the acceptable code and standards. The Bidder shall take Purchasers approval for use of other codes & standards

6.4.1 Layer-3 Network

Equipment / Module/Functionality		Standards
Layer3 Stack Switch	**Border Gateway Protocol (BGP)**	RFC 1772, RFC 1997, RFC 2385, RFC 2439, RFC 2545, RFC 2858, RFC 2918, RFC 3392, RFC 3882, RFC 4271, RFC 4360, RFC 4456, RFC 4724, RFC 4893, RFC 5065
	Cryptographic Algorithms	**Encryption (Block Ciphers):** AES (ECB, CBC, CFB and OFB Modes), 3DES (ECB, CBC, CFB and OFB Modes)
		Block Cipher Modes: CCM, CMAC, GCM, XTS
		Digital Signatures & Asymmetric Key Generation: DSA, ECDSA, RSA
		Secure Hashing: SHA-1, SHA-2, SHA-224, SHA-256, SHA-384, SHA-512
		Message Authentication: HMAC (SHA-1, SHA-2 (224, 256, 384, 512)
		Random Number Generation: DRBG (Hash, HMAC and Counter)
	Ethernet	IEEE 802.2, IEEE 802.3, IEEE 802.3ab, IEEE 802.3ae, IEEE 802.3af, IEEE 802.3an, IEEE 802.3az, IEEE 802.3ba, IEEE 802.3u, IEEE 802.3x, IEEE 802.3z, IEEE 1588v2
	IPv4 Features	RFC 768, RFC 791, RFC 792, RFC 793, RFC 826, RFC 894, RFC 919, RFC 922, RFC 932, RFC 950, RFC 951, RFC 1027, RFC 1035, RFC 1042, RFC 1071, RFC 1122, RFC 1191, RFC 1256, RFC 1518, RFC 1519, RFC 1542, RFC 159, RFC 1812, RFC 1918, RFC 2581
	IPv6 Features	RFC 1981, RFC 2460, RFC 2464, RFC 3484, RFC 3587,

Equipment / Module/Functionality		Standards
		RFC 3596, RFC 4007, RFC 4193, RFC 4213, RFC 4291, RFC 4443, RFC 4862, RFC 5014, RFC 5095, RFC 5175, RFC 6105
	Management	IEEE 802.1AB, RFC 1155, RFC 1157, RFC 1212, RFC 1213, RFC 1215, RFC 1227, RFC 1239, RFC 1724, RFC 2579, RFC 2580, RFC 2674, RFC 2741, RFC 2787, RFC 2819, RFC 2863, RFC 3176, RFC 3411, RFC 3412, RFC 3413, RFC 3415, RFC 3416, RFC 3417, RFC 3418, RFC 3621, RFC 3635, RFC 3636, RFC 4022, RFC 4113, RFC 4188, RFC 4292, RFC 4293, RFC 4318, RFC 4560, RFC 5424, RFC 6527
	Multicast Support	Bootstrap Router (BSR) mechanism for PIM-SM, IGMP query solicitation, IGMP snooping (IGMPv1, v2 and v3), IGMP snooping fast-leave, IGMP/MLD multicast forwarding (IGMP/MLD proxy), MLD snooping (MLDv1 and v2), PIM-SM and PIM-SSM for IPv6
		RFC 1112, RFC 2236, RFC 2710, RFC 2715, RFC 3306, RFC 3376, RFC 3810, RFC 3956, RFC 3973, RFC 4541, RFC 4601, RFC 4604, RFC 4607
	Open Shortest Path First (OSPF)	RFC 1245, RFC 1246, RFC 1370, RFC 1765, RFC 2328, RFC 2370, RFC 2740, RFC 3101, RFC 3509, RFC 3623, RFC 3630, RFC 4552, RFC 5329, RFC 5340
	Quality of Service (QoS)	RFC 2211, RFC 2474, RFC 2475, RFC 2597, RFC 2697, RFC 2698, RFC 3246
	Resiliency Features	ITU-T G.8023 / Y.1344, IEEE 802.1ag, IEEE 802.1AX, IEEE 802.1D, IEEE 802.1s, IEEE 802.1w, IEEE 802.3ad, RFC 5798
	Routing Information Protocol (RIP)	RFC 1058, RFC 2080, RFC 2081, RFC 2082, RFC 2453 RIPv2
	Security Features	SSH remote login, SSLv2 and SSLv3 TACACS+ Accounting, Authentication and Authorization (AAA), IEEE 802.1X authentication protocols, IEEE 802.1X multi-supplicant authentication, IEEE 802.1X port-based network access control, RFC 2560 X.509, RFC 2818 HTTP over TLS (“HTTPS”), RFC 2865, RFC 2866, RFC 2868, RFC 2986 PKCS #10, RFC 3546, RFC 3579, RFC 3580 IEEE 802.1x, RFC 3748, RFC 4251 Secure Shell (SSHv2), RFC 4252 Secure Shell (SSHv2) authentication, RFC 4253 Secure Shell (SSHv2) transport layer RFC 4254 Secure Shell (SSHv2)

Equipment / Module/Functionality		Standards
		connection, RFC 5246 Transport Layer Security (TLS) v1.2, RFC 5280 X.509, RFC 5425, RFC 5656, RFC 6125, RFC 6614, RFC 6668 SHA-2 data integrity
	Services	RFC 854, RFC 855, RFC 857, RFC 858, RFC 1091, RFC 1350, RFC 1985, RFC 2049, RFC 2131, RFC 2132, RFC 2616, RFC 2821, RFC 2822, RFC 3046, RFC 3315, RFC 3633, RFC 3646, RFC 3993, RFC 4330, RFC 5905
	VLAN Support	IEEE 802.1ad, IEEE 802.1Q, IEEE 802.1v, IEEE 802.3ac VLAN tagging
Electrical Approvals and Compliances	EMC	EN55022 class A, FCC class A, VCCI class A, ICES-003 class A
	Immunity	EN55024, EN61000-3-levels 2 (Harmonics), and 3 (Flicker) – AC models
	Restrictions on Hazardous Substances (RoHS) Compliance	EU RoHS compliant
Safety		UL60950-1, CAN/CSA-C22.2 No. 60950-1-03, EN60950-1, EN60825-1, AS/NZS 60950.1 Certification: UL, cUL

6.5 Layer 2 Stacked Network Switch: General Technical Particulars (GTP)

6.5.1 Generic Requirements

6.5.1.1 The Switch should have 24/48-port each port of 1 Gigabit

6.5.1.2 switch shall be Rack mountable with minimum 24-port 100/1000Mbps Base-T & minimum Nos.10G-FX ports.

Switch shall auto-negogiate between 1 & 10G Uplink ports.

6.5.1.3 The switch should have redundant power supplies (Hot swappable) for high availability. Combination of AC(230VAC).

6.5.1.4 Switch shall support virtual stacking/Hardstacking functionality for stacking of switches. Stacking of switches shall be supported up 8 switches(It is expected that stack switch should behave like single switch governed by single logical IP).It shall also support stacking of power supply

6.5.1.5 Switch shall support virtual stacking in Active-Active mode. The switch must support minimum stacking bandwidth of up to 160Gbps between Switches.

6.5.1.6 LAN switch shall be available with minimum 250 Gbps Switch.

6.5.1.7 LAN switch shall have minimum packet forwarding rate of 200 million packets per second at 64-byte packet length

6.5.1.8	It should support Active-Active Clustering, VSS or equivalent technology for high availability and quick resiliency.
6.5.1.9	LAN switch shall support minimum 64000 MAC address.
6.5.1.10	switch support multi-port mirroring & jumbo frame 9k.
6.5.1.11	Switch shall support up to 4K Vlans
6.5.1.12	The switch must support at least 2GB of DDR SDRAM & 256MB of Flash Memory.
6.5.1.13	L2 switch shall comply to following temperature performance parameters. Operating Temperature- min 0 to 50 degree C. Storage Temperature- min 0 to 70 degree C.
6.5.1.14	IPV4 & IPV6 multicast functionalities/features for switches are desirable and it is also desired that offered switch should support inbuilt passive sensor for OT applications
6.5.1.15	Switch shall support optical diagnostics monitoring for all SFP ports.Switch shall support third party SFP makes with diagnostic feature support
6.5.1.16	Switch shall support web-based GUI /CLI for management
6.5.1.17	Switch shall support strong event logging function & facility to integrate with syslog server. Switch shall support logging of all events related to STP, LACP & security events.
6.5.1.18	Switch shall have capability of advance debugging & diagnostic.
6.5.1.19	Switch shall support SNMPv1,v2 & v3 for management
6.5.1.20	Switch shall support advance monitoring functionality like Netflow & sFlow.
6.5.1.21	Switch shall support NTP protocol
6.5.1.22	Switch should have USB port & SD card for backup & restore functionality.
6.5.1.23	switch must support Ethernet interfaces based on IEEE 802.3, IEEE 802.3u, IEEE 802.3z, IEEE 802.3ab and IEEE 802.3ae
6.5.1.24	Switch shall support IPV6 in hardware based on RFC 2460
6.5.1.25	Switch shall support feature of auto recovery in case of failure

6.5.1.26 Switch shall should support IEEE link aggregation.

6.5.1.27 Switch shall support REST API for integration with U-NMS system.

6.5.1.28 Switch shall have capability to automate some functions using switch internal scripting

6.5.2 **LAYER 2 features**

6.5.2.1 The Switch must have VLAN support on all ports.

6.5.2.2 The Switch should support Rapid Spanning Tree Protocol & Multiple Spanning Tree Protocol.

6.5.2.3 The Switch must support Voice VLAN

6.5.2.4 Switch must support LLDP-MED based on ANSI/TIA-1057

6.5.2.5 Switch must support 13KB Jumbo Frames.

6.5.2.6 Switch must support IEEE 802. 1s Multiple instance spanning Tree

6.5.2.7 Switch must support IEEE 802.1w Rapid Spanning Tree for fast failover in the event of link failure

6.5.2.8 Switch shall support link aggregation (LACP) feature based on 802.3ad.

6.5.2.9 Switch shall support spanning-tree Port Fast and Port Fast guard for fast convergence.

6.5.2.10 Switch shall support 802.3ah for Detection of Unidirectional Links and to disable them to avoid problems such as spanning-tree loops and shall support UDLD or any other industry equivalent protocol for unidirectional link detection.

6.5.2.11 Switch shall support for switch port auto recovery (err disable) to automatically reenable a link that is disabled because of a network error.

6.5.2.12 Switch shall support NTP protocol.

6.5.2.13 Switch shall support port mirroring, multi-port mirroring & RSPAN feature for capture of network traffic without affecting switch functionality during production.

6.5.2.14 Switch should support per port broadcast, Multicast & unicast strom control.

6.5.2.15 The Switch shall have IEEE compliance for 802.1Q VLAN, 801.2p, 802.1d STP, 802.3ad (Port aggregation), 802.1w RSTP, 802.1s MSTP, 802.3ad LACP, IEEE 802.1ab Link Layer Discovery Protocol.

6.5.2.16 The switch should have support for Port mirroring

6.5.2.17 The Switch should be able to discover the neighboring device of the same Bidder giving the details about the platform, IP Address, Link connected through etc., thus helping in troubleshooting connectivity problems or equivalent

6.5.2.18 The Switch should support a mechanism to prevent edge devices not in the network administrator's control from becoming Spanning Tree Protocol root nodes

6.5.3 **Security Features**

6.5.3.1 The Switch must support RADIUS, PIM & TACACS

6.5.3.2 Switch must support standard & extended ACL

6.5.3.3 Switch must support minimum 3000 ACL entries.

6.5.3.4 Switch must support VLAN based & port based ACL

6.5.3.5 Switch should support MAC security

6.5.3.6 The LAN switch shall support IEEE 802.1x to allow dynamic, port-based security providing user authentication.

6.5.3.7 It shall have MAC-IP-Port binding up with support for ACL mode

6.5.3.8 Switch should provide different privilege for login in to switch for management & monitoring

6.5.3.9 Switch must support Network Access Control

6.5.3.10 Switch shall support 802.1AE encryption with MACsec.

6.5.4 **QOS Features**

6.5.4.1 Switch must support IEEE 802.1p class of service (COS) prioritization with 8 queues per port

6.5.4.2 Switch must support rate limiting based on source/destination, IP/MAC, TCP/UDP

6.5.4.3 Switch must have ability to complete traffic shaping to configurable levels based on source/destination IP/MAC & Layer 4(TCP/UDP) protocols

6.5.4.4 Switch must support a priority queuing mechanism to guarantee delivery of highest-priority packets ahead of all other traffic

6.5.4.5 Switch should support rate limiting function to guarantee bandwidth

6.5.5 **Quality of Service**

6.5.5.1 The Switch should support Per-port -per-VLAN policies, Distributed policing (up to 4 K polices), Egress/Ingress policing, Diff Serv QoS on all ports, minimum four queues per port in hardware.

6.5.5.2 The Switch should support Congestion Avoidance: WTD or WRED, multiple Queue Thresholds or equivalent technology.

6.5.5.3 The Switch should support Strict-Priority Queue (protects mission-critical, delay-sensitive traffic), Weighted Round Robin (WRR), Priority queuing, Weighted Random Early Detection (WRED), Tail-drop thresholds or equivalent technology.

6.5.5.4 The switch should support Traffic policing, Traffic shaping, Traffic marking and classification

6.5.5.5 The switch should support IEEE802.1p CoS and DSCP based traffic marking

6.5.5.6 The switch should support Cross stack QoS

6.5.5.7 The Switch should support Private VLANs

6.5.5.8 The Switch should support a mechanism to prevent a malicious user from spoofing or taking over another user's IP address by creating a binding table between client's IP and MAC address, port, and VLAN

6.5.6 **Management features**

a. The Switch should support SNMP v2c, V3

b. Switch must provide management using 10/100/1000-Mbps management or console ports.

c. Switch must have In-band switch management as well.

d. Switch must Support RS-232 serial console port.

e. Switch must have Configuration rollback feature.

f. Switch must support Secure Shell Version 2 (SSHv2), Telnet.

g. Switch must support sFlow / NetFlow - industry standard technology for monitoring high speed switched networks. It gives complete visibility into the use of networks enabling performance optimization, accounting/billing for usage, and defense against security threats

h. The switch must support built in Management Framework to provide the network with backup, recovery and firmware upgrade management without the need of any additional hardware modules or software.

i. The Network must support the ability to centrally manage switches over the WAN network for device backup, zero touch network node recovery and Centralized firmware upgrades with rolling reboots feature.

j. The Switch must support Event-based triggers and scripting.

k. The switch must support full environmental monitoring of PSUs, fans, temperature and internal voltages.

l. Switch shall support for zero touch provisioning & configuration of switch to reduce provisioning time

6.5.7 **Troubleshooting features**

6.5.7.1 Switch must support for basic administrative like Ping, tracert & extended Ping commands.

6.5.7.2 Switch must support built in TCP Dump or Wireshark troubleshooting tool.

6.5.7.3 Switch should be integrated with Security Information and Event Management (SIEM) server. Also should support multiple centralized syslog server, for monitoring and audit trail.

6.5.7.4 Switch must support advance debugging functions like packet capture & packet tracer.

6.5.7.5 Switch shall also support advance ping feature.

6.5.7.6 Switch shall have mechanism for internal storage of log events for minimum period of 3 months.

6.6 **Environmental**

The switches should have IEEE 802.3az Energy efficient Ethernet and ROHS compliance Switch should be capable of operating under normal Centre temperature without the requirement of Air conditioning

Chapter # 7

System Integration & Data Exchange Requirements

7.0 General Requirements

Bidder shall ensure that existing systems and the new solutions offered by them are tightly integrated and do not remain stand-alone and shall perform on real time basis as envisaged in specifications. All required external systems shall be integrated using an integration middleware layer. The scope of integration of external systems includes, Integration with SLDC system, existing RTU/FRTU, GIS, AMR/AMI, SAP, Weather Monitoring System and other enterprise systems. The integration is expected to be Industry Standards Based on IEC 61968-1 Bus (SOA Enabled on enterprise Bus) using CIM/XML, OPC, Secured ICCP etc., which is, on-line, real time or offline where appropriate and shall operate in an automated fashion without manual intervention. Bidder shall consider necessary interfaces, provisions/software linkages in the proposed solution so that the required enterprise systems may be integrated seamlessly.

The system shall utilize an IEC 61968 and IEC 61970 compliant interface. The system shall enable export of all data via a CIM-XML interface and shall utilize modelling from IEC 61968 as appropriate. The profiles supported should be CDPSM (Common Distribution Power System Model) and CPSM (Common Power System Model). Messaging interfaces shall be based on model neutral interfaces based on the IEC 61970-40X series for access to real-time and historical data and use the IEC 61968-3 and IEC 61968-9 standards for messaging interfaces.

Further the proposed Interfaces, socket, Adapters, software tools/applications shall be used for Integrating with Purchaser's enterprise Systems being deployed for real-time & historical data exchange to and from the SCADA & ADMS & Other Purchaser's Systems. The proposed Systems Interface & the SCADA & ADMS Systems Interface shall be using CIM/XML & IEC 61970/61968 standards so that any application can be integrated seamlessly by the user without having to know specific Database Tables / Information of the other system.

Any Change in the electrical network system which will be captured in GIS (ESRI) database of Purchaser shall be automatically added/modified to proposed SCADA & ADMS system. e.g.: A new asset addition, should be able to be exchanged through Model Information between the enterprise system, and SCADA & ADMS System without programming or configuration effort automatically & adjust and accept the Model and re-configure its databases, and shall provide updated results. SCADA & ADMS bidder shall provide CIM/XML Adapters for Secured ICCP, OPC or ODBC for their System and CIM/XML Model repository for data and model exchange with other enterprise Systems.

The Data exchange shall also allow other information to be transferred periodically or on demand between main & backup control Centre. This shall include but shall not be limited to the transfer of file; Operation related data and control, reports, selected Sequence of Events (SOE) etc. The proposed system shall have the capability to request the exchange of data by various methods, including periodic, periodic by exception, one shot and event. The most basic method of data transfer shall be to request data periodically. Using this, the data shall be sent at a pre-configured interval. When data is requested by exception, only data that has changed shall be transferred at the specified periodicity. Data that is requested by one-shot shall be returned as single time.

The communications links provided by Purchaser for data exchange among control Centres shall be redundant. Communication links shall be configured as Main & Backup links. The communication links shall automatically switch-over to backup communication links on failure of main links.

All the communication applications shall have detailed logging of all the activities on a communication link. The logs shall be organized in multiple levels such as operator controls, error messages, warning messages, event messages and low-level tracing.

7.1 **Protocol Support**

The proposed solution shall support following Protocol (Client/Server, Master/Slave) for data acquisition and for data exchange with other Purchaser's and third-party systems

a. IEC 60870-5-101, IEC 60870-5-104, IEC 61850, MODBUS (Serial & TCP/IP)

b. IEC 61970, IEC61968

c. IEEE C37.118.1a-2014 (IEEE 60255-118-1-2018)

d. Secured ICCP, OPC-UA & DA, ODBC, SQL, DDE & XML, CIM-XML

e. Open ADR, MQTT, NB-IoT, LORA

f. FTP/FTPS, HTTPS, XMPP, SOAP, REST JSON,SFTP

7.2 **Data Exchange on Secured ICCP**

The offered system shall provide Secured ICCP communication with Purchaser's existing systems, AMR/AMI System, and systems of other utilities with capability for future extension to interface to other Automation Systems of Purchaser. This connectivity may be for exchanging large amount of real-time/offline data, file transfer including spread sheet data, disturbance data, email with control functions. The scope includes integration of SCADA &

ADMS systems with State and Customer utilities SCADA system and other automation systems of Purchaser. Time synchronization of the Secured ICCP server with GPS clock. Time synchronization between server and client system. (E.g. Purchaser/Utility server – Purchaser / Utility Client), integration with other utilities. It shall be the responsibility of the Bidder to successfully establish the bi-directional connectivity of the offered Secured ICCP system with the existing systems of Purchaser and the other utilities. This includes interaction with their representatives and bidders.

Bidder shall ensure provisioning of association as per the operational requirement of Purchaser time to time. Bidder shall consider exchange of entire Data with the systems under consideration.

Data exchange shall allow information to be transferred report by exception but also configurable periodically, or on demand. It shall be possible to exchange at least the following data:

a. Real-time telemetered data of the interconnected network,

b. Non-telemetered data of the interconnected network,

c. Calculated data of the interconnected network

d. SOE data of the interconnected network

e. Historical data of the interconnected network

f. Scheduling data

g. Operator messages

h. Event /Alarm lists

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

The Secured ICCP data link shall provide the Block 1, 2, 4, 5 and 8 functions. ICCP software shall be operating system independent and shall have capability to support at-least Linux and Windows OS. Secure ICCP shall be provided with Linux OS for enhanced security. Online Editing of ICCP database shall be supported via user friendly interface. There shall be no need to go to any file on the server for any type of configuration related to ICCP connection or database build if the user wishes to do online Secured ICCP DB editing.

The data link shall provide interactive database editors to define the points to be exchanged with each remote site. The points that can be selected for transfer shall include any status, analog, accumulator SCADA data and applications data.

For each remote site, capability shall be provided to define the transfer rate for each group of points to be exchanged. At a minimum, each group of points shall be selectable for transfer at 1, 2, 5, 10, 15, 30, 60-second rates as well as at 5, 15, 30, 60-minute rates.

The data link shall process point quality codes, time stamp for both incoming and outgoing point data. When a communication failure is detected for an incoming data set the point quality codes shall be set to indicate telemetry failure. Server time of either system shall be displayed separately for comparison by Control Room Engineer.

The data link function shall provide for redundant operation allowing configuration of up to two communications paths with each remote site. One path shall be designated as a primary path and the second as a secondary path.

The Secured ICCP connectivity shall be established with systems at MCC, BCC of Utility Systems. Separate Communication link need to be established with MCC and BCC of utility. In addition, if the Systems are redundant at MCC & BCC, data shall be exchanged accordingly.

The data link shall perform communications error monitoring and inform the System Operator of communications link failures with remote sites by issuing appropriate alarms. The data link interface shall have capability for System Operator control of up/down status for a remote site and for manual/automatic communications path selection (primary/secondary) to a remote site. Capability for Secure ICCP connection will be supported.

A separate display shall be provided for points which are garbage and denoted by a user configurable symbol/alphabet denoting that the point has not been changed from the other control center from the last time the database was synced from QA.

A separate tabular display shall be provided to denote Secured ICCP point mismatch between control centers, i.e. a point defined in Purchaser for import point but not available in other control centers export point configuration.

The offered SCADA & ADMS system shall support the following data exchanges:

a) The transmission of data to and from the computer systems of Power System Control Centre, transmission SCADA, neighboring utilities, other application servers of Purchaser connected to the Control Center LAN / Enterprise WAN.

b) The exchange of information messages with the same computer systems.

c) The transfer of accounts, if any with the same computer systems.

The offered system shall be fully compliant with the IEC 870-6-503, TASE.2 Services and Protocol, and IEC 870-6-802, TASE.2 Object Models, and relevant Conformance Blocks etc. to meet the functional and integration requirements. Bidder shall clearly indicate the Conformance blocks which are included in the offer and the logic for selection of the same. Bidder shall indicate optional prices separately for other blocks. TASE.2 shall support Bi-directional and Uni-directional connections.

7.2.1 Bilateral Table

The SCADA/ADMS shall implement a Bilateral Table structure (or the functional equivalent) with the required access controls. Since access controls may be different for different clients, multiple Bilateral Tables (one per communicating partner) are required. The Bilateral Table shall be stored in the database and maintained by the database editor. Each object available to each remote client shall be stored including access rights to the object. No object may be served that is not in the database.

7.2.1.1 Contents

All data objects available for exchange shall be listed in a Bilateral Table. No data object shall be served unless it appears in a Bilateral Table. Each data object named in a Bilateral Agreement shall have a corresponding entry in a Bilateral Table. The Secured ICCP Specification includes models for Access Control Specification, List of Access Control Specification, and List of Permitted Access. There shall be exactly one Access Control Specification for each Secured ICCP client that may have one or more associations with the server. For each client, there shall be a List of Permitted Access for every Secured ICCP object in the server's Virtual Control Center (VCC); this indicates whether the object is visible to the particular client and which services the client may perform on the object.

7.2.1.2 Functionality

No data item shall be served to any client unless it appears in a Bilateral Table. It shall be possible to specify different access privileges for the same data object for different clients.

For example, for a data object named dataObject1, it shall be possible to grant read access to Client A, read and write access to Client B, and no access to Client C.

7.2.2 **Secured ICCP User Interface Requirements**

A User Interface (UI) shall be provided with operational tools to enable the user to maintain the Secured ICCP database and monitor Secured ICCP link performance. Displays shall also be provided to enable the Operator to view availability of Secured ICCP systems and the status of each Secured ICCP connection. The user shall be able to access the Secured ICCP system remotely, with required access security controls, for problem determination and resolution.

7.2.2.1 **Secured ICCP Bilateral Table Creation and Editing**

A user interface shall be supplied to facilitate entry and modification of the Bilateral Table data. The interface shall be designed to lead the user in a stepwise fashion to perform the desired editing or data entry function and to prevent accidental or intentional changes to the Bilateral Table data by unauthorized personnel.

It shall be possible to create or edit a Bilateral Table while the system is on-line and operating. It shall be possible to create a Bilateral Table by making a copy of existing data. The user shall be able to edit a Bilateral Table by entering data into a temporary area that is not activated until a specific command is issued. It shall be possible, by user command, to revert to a previous Bilateral Table. Purchaser prefers that the information used to model the Bilateral Table be maintained in a RDBMS. Secured ICCP database configuration (Data Engineering) shall be done using the RDBMS. Consistency checks and data type validation shall be performed. After the changes are completed and approved in the RDBMS, they may then be brought on line.

7.2.2.2 **Secured ICCP Data Set Creation & Editing**

The SCADA/ADMS shall include displays facilitating the creation and editing of data sets. The interface shall be designed to lead the user in a stepwise and logical fashion to perform the desired editing or data entry function and to prevent accidental or intentional changes to data sets by unauthorized personnel. Displays shall be provided to permit creation and editing of Transfer Account objects.

Displays shall be provided wherein a Secured ICCP client can view the Bilateral Table of a compliant server to determine what objects the client is permitted to access. The capability shall be provided via point–and-click to select desired data objects and create data sets for Block 1 data without having to manually enter the selected point information. Changes to

the Bilateral Table shall be highlighted to aid the client in determining what objects have changed (i.e. added, deleted, or modified) since the last update.

Messages that automatically and dynamically define datasets shall be sent when transfers are started. This ensures that the remote systems definition of the dataset matches the local definition. Secured ICCP shall also support incoming Dataset Creation and Deletion requests and shall dynamically create server datasets as necessary. It shall be possible for the client to create and delete Data Sets in the server, and to restart individual associations without restarting Secured ICCP.

Secured ICCP shall support collection of a data item under one Object ID and sending the same data item under another Object ID.

Data set creation shall validate all model changes (data items and connection) before Secured ICCP model deployment.

Data set creation shall support creating partial data sets. This feature allows Purchaser to create a partial data set when one or more items are missing or not granted access by the other end of a connection.

A display facility that can show the actual data that is available to each external entity that is data from Purchaser via Secured ICCP is required to check the functionality of the process. The users are periodically asked to verify information that is being supplied by the existing data links.

7.2.2.3 **Secured ICCP Connection & Association Control**

The SCADA/ADMS software shall include displays that enable a user to exercise control over Secured ICCP data link software and manage Associations (e.g., Associate, Conclude, and Abort). Secured ICCP functionality shall include the following display features:

a. An overview display shall be provided which shows the roles and availability of primary and backup Secured ICCP systems. This display shall include pages to show the roles and availability in both a tabular and graphical format. The graphical display shall use full graphics capabilities and color to visually diagram the Secured ICCP connections and indicate Secured ICCP system status (e.g. primary, backup) and availability (e.g. available, off-line). Both the status of SCADA/ADMS systems and other remote computer systems that are active shall be shown.

b. An overview display shall be provided which shows the status of each connection (e.g. active, available, off-line, or error). On a connection basis, controls shall be provided for:

separate bilateral agreement, bilateral agreement number, and retry connection rate. The User shall be able to control permissions on a point-by-point basis per connection. This display shall include pages to show the connection status in both a tabular and graphical format. The graphical display shall use full graphics capabilities and color to visually diagram the Secured ICCP connections and indicate their status. The connection status shall include status of SCADA/ADMS systems and other computer systems at the remote end. The connection status shall also be available for alarming.

c. Displays shall be provided which allows the Operator or User to view and control configured Associations. Color shall be used to distinguish active and inactive Associations. The time of creation of each Association shall be shown. This display shall show a list of the Secured ICCP systems and connections for User selection. The display shall provide the capability for a User to disable Associations. Disabling Associations implies a graceful close of any existing Associations. Entry capability shall be provided for the Operator or User to enter the In- service or Out-of-service status tag for each Association or possible Association. For example, Secured ICCP systems in alternate control centers will be placed out-of-service until needed. Secured ICCP shall dynamically control each Association based on the User– entered in or out of service tag.

Purchaser will work with the Supplier to design the Operator interface graphical displays and shall have reviewed and approval rights for all Secured ICCP displays provided.

7.2.2.4 **Secured ICCP Maintenance Tools**

The Secured ICCP system shall provide tools to allow the User to view and maintain the Secured ICCP system and database. These tools shall allow the User to select a particular data set, connection, or association (or all) to view and modify the selection. The maintenance tools shall provide the following features:

a. Display parameters of data set objects (created by both sides of a connection) including: descriptions, triggers, transmit, and time of creation. The tools shall allow the User to perform the following operations for manipulating Data Set objects: Create Data Set, Delete Data Set, Get Data Set Element Values, Set Data Set Element Values, Get Data Set Names, and Get Data Set Element Names.

b. Display each data point value, sign, time tagged (time last received), last time of change, and quality code (Secured ICCP quality codes). The tools shall allow the User to perform the following operations for manipulating Data Value objects: Get Data Value, Set Data Value, Get Data Value Names, and Get Data Value Type.

c. Display all data items by data set (Block 1 & 2) including: Object ID (including Indication Point or Control Point), the attributes Point Value/Sign, Secured ICCP Quality, Select-Before-Operate (if applicable), and Time Stamp and Change of Value counter (when available).

d. Display the complete contents of Block 4 messages.

e. Display all data items Source and Source Object ID along with Purchaser Object IDs.

f. Provide an interface to the MMS-EASE debug facility, which can be activated or deactivated on User command. The MMS_EASE debug tool shall provide the User with tools to help solve Secured ICCP problems.

g. Provide tools to perform OSI and IP pinging of any connection.

7.2.2.5 **Performance Monitoring**

The Secured ICCP Quality of Service (QOS) attribute shall provide the User with performance statistics on a connection and association basis. Performance statistics shall include: throughput, residual error rate, priority, transit delay, and protection. Displays shall be provided to allow the user to select the connection, association, or all connections or associations and view the performance statistics for the selection.

7.3 Data Exchange with Purchaser's Enterprise Historian System

Bidder shall propose the appropriate integration Socket/Application/Protocol for seamless data exchange between proposed SCADA & ADMS system and Purchaser's Enterprise Historian System. Purchaser prefers to integrate both MCC and BCC system at database level for seamless exchange of information. Bidder shall accordingly consider the solution.

The offered system shall consider the appropriate Socket/Application/Protocol bidirectional data exchange and with capability for future extension to interface to other systems of Purchaser. This connectivity may be for exchanging real-time / HIS data to Enterprise Historian System server for preparing the MIS report and data exchange with other Enterprise Systems.

7.4 Data Exchange with GIS System

SCADA Systems over CIM Models shall be used by SCADA & ADMS system, AMR/AMI & other Systems for getting network information, customer and interconnection information.

The GIS will interface using CIM adapters to other applications. SCADA / ADMS will have model aware adapters to read from GIS network model repository and update its own

models. The system shall utilize an IEC 61970 and IEC 61968 compliant interface. The system shall enable export of all data via a CIM-XML interface per IEC 61970-452 and IEC 61970-552-4 and shall utilize modelling from IEC 61968-11 as appropriate.

Data exchange shall be over model neutral messaging services and CIM/XML data exchange for real-time or historical data. The following standards as applicable shall be used to achieve the functional requirements:

a) Messaging interfaces shall be based on model neutral interfaces as per the IEC 61970-40X series for access to real-time and historical data and

b) Use the IEC 61968-3 and IEC 61968-9 standards for messaging interfaces that are model dependent for network operations and metering respectively.

c) The proposed system shall take the power system network data from the existing GIS System of the Purchaser. The **current version of GIS is GE Small World Version 5**. The data, which are not available on GIS, will be arranged by the Purchaser for network modelling.

d) The GIS interface with SCADA/ADMS need to be bidirectional for data migration

e) Export for GIS need to be available for network attribute data, loading data/analog values, historical values, energies, de-energies status and device status data

The projection system and coordinate system of existing GIS need to be maintained to equivalent system in SCADA/ADMS with configurations. The Graphic data import from a GIS system shall support native formats of GIS systems which shall be potentially used for data import. All Technological addresses (TAs) shall be automatically assigned within the system to the tags linking the graphic data to the attribute data in the GIS, the attribute data shall be loaded into the SCADA & ADMS system data base and the display diagrams shall be generated. The Graphics exchange between GIS and SCADA & ADMS should happen over IEC-61970-453 Scalar Vector Graphic base XML representation.

The complete network model including data of electrical network e.g. line (i.e. length, type of conductor, technical particular of conductor & transformer etc., land-base data. Suitable GIS interface adaptor to enable the compatibility with GIS software/ data format /model shall be provided. The Graphic data import from a GIS system shall support native formats of GIS systems which shall be potentially used for data import. The data shall be transferred on global & incremental basis on manual request & automatically, once in a day.

f) The offered solution should be Certified for CIM compliance as per IEC 61970,IEC 61968 and shall submit the Certification from international laboratories or group such as EPRI / CIM user group

The SCADA & ADMS System shall automatically move elements that overlap one another in congested areas so that the Control Centre Engineer can clearly see each segment of the network in the geographic view. In addition, the system shall automatically move and scale annotation text that come from GIS so that it is visible the user's current display SCADA & ADMS in the geographic view. The system shall include tools to edit annotations /text & symbology placements in geo –referenced displays, substation and distribution network. It shall be possible to import related reference layers such as streets, buildings, poles etc. and other background information.

All Technological addresses (TAs) shall be automatically assigned within the system to the tags linking the graphic data to the attribute data in the GIS, the attribute data shall be loaded into the SCADA /ADMS data base and the data /text shall be displayed on SCADA & ADMS diagrams if viewed in GIS mode shall display GIS in background with zoom, pan, scaling & UI navigation techniques in synch with SCADA & ADMS system displays. The GIS Network Model shall be exposed to the SCADA & ADMS Systems over CIM/XML Models using GID to IEC 61968-1 Enterprise Bus. The single model authority of repository maintained by GIS shall be used by SCADA & ADMS Systems.

It is the intent to explore the data exchange between a GIS and SCADA & ADMS system. GIS provides a robust relational data structure, coupled with a spatial component. Under this premise, the objective of integration of Purchaser's GIS system and proposed SCADA/ADMS system and other systems are:

a) To extend spatial analysis and display capabilities into traditional Power System studies.

b) To apply basic Commercial, Off-the-Shelf (COTS) GIS products to power system analysis.

c) To demonstrate that an existing GIS can provide the necessary data to run load flow analysis.

d) To display and query load flow results in a mapping environment, and

e) Transfer of information between GIS and SCADA/ADMS system

The integration of systems is envisaged to manage present and future power network of Purchaser for:

i. Network representation / visualization – Providing a consistent geographical view of the network with the on-line data.

ii. Network reconfiguration / optimization

iii. Preparing Designs/schemes

iv. What-if analysis

v. Improvement in revenue management

vi. Business development

vii. Strategically Planning: Arising a potential to consolidate multiple area control centers into a single automated SCADA/ADMS -GIS control center

7.5 **SCADA ADMS from/to CIS Interface**

The following are high level flows from CIS to the new SCADA/ADMS:

a. The SCADA/ADMS will need to receive trouble calls from the CIS on an interactive basis. This includes all IVR calls received by the CIS.

b. The SCADA/ADMS will need to receive a subset of the customer information along with trouble call details. This subset includes at a minimum the customer's name, phone, premise address, and its priority code.

c. The SCADA/ADMS will need to receive list of newly connected customers and any changes to the electrical network connectivity on a daily basis (this customer connectivity information may go to the GIS first and then to the SCADA/ADMS via daily incremental transfer).

The following are high level flows of information that need to go from the SCADA/ADMS to the CIS

a. The SCADA/ADMS will need to provide the following Outage status information: confirmed outage status, crew dispatched information, cause of outage and the estimated restoration time

b. The SCADA/ADMS will need to provide the number of times the customer has been part of an outage for a given date range

Bidders are required to indicate typical time (Provide reference examples of existing customers) that will be required for transferring information.

7.6 **SCADA/ADMS to IVR Interface**

Purchaser has an interactive voice response system (IVR). There is no direct interface from the SCADA/ADMS to the IVR, currently all information routed is through CIS. It is intended that the IVR to CIS interface will capture necessary information to create a trouble ticket that can in-turn pass to the SCADA/ADMS. The SCADA/ADMS, in-turn, will provide outage status

information on, but not be limited to, outage areas and customers affected by outages to the IVR system.

7.7 **SCADA/ADMS from/to Work Management System (WFM) Interface**

There will be an interface between the SCADA/ADMS and the proposed Work Force Management System (WFM) to create work orders/switching orders for planning different types of planned shutdowns. On creating these planned shutdowns for follow-up work from an outage, such as additional investigative work, clean-up, tree trimming, service and meter re-attachment, etc.

7.8 **SCADA/ADMS from/to FFM Interface**

There will be an interface between the SCADA/ADMS and a Mobile Field Force Management (FFM) system. The interface shall allow passing of outage condition and status information from the field to the SCADA/ADMS.

7.9 **SCADA/ADMS from/to AMR/AMI Interface**

AMI allows to ping meters, disconnect and reconnect meters, receive unsolicited outage and event reports from meters, and read voltages and other data on demand or on schedule.

SCADA/ADMS shall interface with Purchaser's AMR/AMI/ Meter Data Management System.

7.10 **SCADA/ADMS from/to VMS Interface**

SCADA/ADMS shall interface with Purchaser's VMS System. This shall be tightly integrated with SCADA System to provide real-time status of the equipment on the Same SCADA GUI.

7.11 **SCADA/ADMS from/to Business Intelligence Interface**

The System shall interface with Business Intelligence application of Purchaser, such as Power BI etc. for analytics and dash board.

7.12 **SCADA/ADMS from Weather Monitoring System Interface**

The system shall pick up the weather and related data from weather websites for accurately forecasting and further used by ADMS applications. The system shall be capable of generating Weather Forecast/Alert through SMS & Email.

7.13 **SCADA/ADMS from/to Renewable Portfolio**

The System shall interface with Renewable Portfolio System of the Purchaser, which shall be able to transmit / receive both real time and historian data from Renewable Portfolio system.

7.14 **SCADA/ADMS from/to IOT**

The System shall interface with IOT infrastructure of the Purchaser including EV Charging Portfolio, Home Automation Portfolio etc.

7.15 **Data in Various Systems**

7.15.1 **GIS System**

Geographical map consisting Generation, Transmission, Distribution System & Consumer area including spatial & attribute information of generator, power transformer, transmission & sub-transmission system (Breakers, Capacitors, Reactors, Overhead lines, Tower Structures), Distribution system (Cables, Distribution transformers, RMUs etc.), HV/MV/LV network (Distribution Pillars, Cable / Conductor Route, Section details, Joints, Street Lights, Underground conduit system, Service Points, Number of consumers connected to Service point. Feeding Point details etc.) and Land base data (Building, Roads, Landmarks, Water Bodies, Railway Lines etc.).

7.15.2 **SCADA / ADMS System**

a) Equipment Parameter Data

i. The Schematic diagram for Receiving Stations & sub-stations

ii. Power transformer rating, Impedance etc.

iii. Bus bar scheme.

iv. Isolators, circuit breakers type & ratings.

v. CTs and PTs - Ratio, OLTC – Nos. of taps & normal tap position etc.

b) Operational parameters

i. ON/Off Status of substation equipment, breakers, Isolators etc.

ii. Status/indication of OLTC Tap Position, Relays etc.

iii. On line Analog values of viz. voltage, current, PF, Active & Reactive Power etc.

iv. 220KV/110KV/ 33/22 kV Feeder Tripping.

v. Indication of Location/zone in case of Line fault.

vi. Network configuration.

vii. Failure of distribution transformers.

viii. HT/LT Consumer outages etc.

Bidder shall ensure that SCADA/ADMS database shall meet all the requirement of integration with GIS database, Enterprise Historian system and other 3rd Party system as mentioned in this chapter. Purchaser need not reproduce the database for integration with SCADA/ADMS and GIS. The proposed system shall include functionality to build the power network model database using CIM. The necessary software shall be provided by the Bidder to convert the incoming modelling information into a common format that can be accessed by the Bidder's applications and other third-party power system analysis products as required.

7.15.3 **Model Database**

The proposed tool shall use a database employing a common approach for data structures, database access, data editing, data area population, database maintenance, data validation, and error reporting. Information and data that is common among SCADA/ADMS and GIS functions shall only be entered once.

The following requirements shall be satisfied for all functions:

When a new database is generated, or an existing database is modified, previous save cases (those created prior to the modification) shall not be deleted unless requested.

a. Application data that is smoothed over time, such as parameter adaptation data shall not be lost after a database modification. Upon a database modification, this data shall be processed automatically in order to make it consistent with the new network model.

b. Any parameter input data, including data manually entered by the Control Centre Engineer shall be processed after a change in the network model or the parameters themselves in such a way that these data entries are not lost.

c. It shall be possible to create save cases from both real-time or study network analysis function executions.

d. It shall be possible to retrieve real-time save cases, to copy them to study save cases, to copy save cases to permanent storage medium, and to reload save cases from permanent storage medium.

e. It shall be possible, with appropriate authorization, to interactively modify individual network model parameters through displays without requiring a complete database generation.

f. It shall be possible to export the network model data including topology information to GIS via the Common Information Model (CIM), vice-versa.

g. It shall be possible to generate a power network model database from IEEE and PSS/E power flow formats as well as the CIM for initial database entry. The SCADA /ADMS system shall support the capability to import subsequent power system model updates from data files in the CIM format.

Modifications to the network model shall be initially applied to the Program Development System for testing purposes. Modifications to the network model will include the associated tabular and one-line diagram displays. After successful completion of the modification process, the user shall have the capability of importing the network model modifications on the on-line system from the Program Development System or from Control Centre Engineer Training Simulator. This shall in no way impact the periodic execution of the real-time sequence.

7.15.4 **Maintenance of the Network Database using CIM Toolkits**

Maintainability of the CIM-compliant Power System Model Database is critical to all Power System Analysis functions. The input CIM and the CIM-compliant Power System Network Database will change and evolve with similar changes to the actual power system network. The Bidder shall provide a tool set for the maintenance of the CIM-compliant Power System Network Database.

7.15.4.1 **CIM Tool Set Capabilities**

The functionality of the tool set shall include (but not limited to) the following capabilities:

a. Capability to extend the current CIM-compliant Power System Network Database to include other CIM packages.

b. Capability to extend the current CIM Power System Network Database to include other classes, attributes, types and relationships.

c. Capability to update any element in the CIM Power System Network Database using a user-friendly interactive interface.

d. Capability to update any element in the CIM Power System Network Database using stream data file(s) in XML format.

7.15.4.2 **Incremental Edit/Maintain of Station Data**

When Purchaser receives a new Network Model, the tool set shall be used to edit/maintain station incremental data in the existing CIM database while accepting new models.

7.15.4.3 **Data Exchange between SCADA & ADMS & GIS**

The SCADA & ADMS system applications shall be able to import and store spatial data, connectivity information as well as attribute information from the Geographic Information System (GIS) required for power network operations. The GIS contains the information about the feeder topology, and all devices associated with the electrical network including their features, attributes and connectivity. The SCADA / ADMS system shall provide adequate disk storage capacity capable of importing the data for entire Purchaser service territory in bulk initially and incremental updates on a periodic basis. The bidder shall explain in detail how this is accomplished, including the data validation process. The frequency of incremental update shall be a user definable parameter. Geographic maps shall display real time status of devices and measured values for all the points where such data is available in the SCADA / ADMS system. The maps shall reflect current connectivity of the network (e.g. energized, de-energized, grounded segments etc. in distinct Colors) based on the status (open, close etc., derived from the real time system or manually entered) of the devices.

The proposed system shall be able to use AutoCAD drawings output in .DXF format as input to the Bidder's display editor in order to add dynamic data to the display. In addition, the capability to import AutoCAD drawings in .DXF format and directly view static drawings in a viewport on the user's console shall be provided.

7.16 **Data Exchange with Network Planning Tool (CymeDIST)**

Bidder shall propose the appropriate bi-directional interface for data exchange between proposed SCADA & ADMS system and Purchaser's existing network planning tools.

7.17 **Data Exchange with SAP**

The proposed SCADA & ADMS system shall exchange various types of real-time as well as historical data (IS&R) with the SAP system for processes like Maintenance management,

Outage management, Operation reports etc. The system shall integrate with SAP PM module for transfer of orders and creation of notifications.

The type of data to be exchanged shall include device Status information, Device analog measurements, Alarms, Reports, Data stored in IS&R system. The proposed SCADA & ADMS system shall be able to exchange the data through CIM/GID interface, OPC interface, ODBC interface. The exact exchange mechanism shall be finalized during the detailed engineering in consultation with Purchaser's IT team. The CIM/GID interfaces shall be as per IEC 61970-3/61970-4. The proposed SCADA & ADMS system shall support navigation to the SAP system web-based displays through URLs (Universal Resource Locators) defined in the SCADA & ADMS displays.

7.18 Data Exchange with PC based applications

Proposed SCADA & ADMS system shall provide a multi-purpose interface opening the system to off the-shelf PC applications running under the Microsoft Windows™ environment. This interface shall be usable outside from the Control Centre on office PCs. This requirement includes data exchange with all office tools generally used in administrative tasks like Microsoft Office (MS Excel, MS Access, MS Word) etc.

This interface shall enable easy configuration of reports documents, by embedding links to real-time applications within the documents. Documents shall be kept up-to-date automatically as changes occur in the real-time databases. This interface shall be easy to use. It shall include a user-friendly graphical interface intended for use by non-programmers, without needing to understand the internals of the real-time applications, through only selection from displays and pasting in the documents. The specific requirements for the types of data are further defined in other part of the specification.

7.19 Data monitoring through Web Server

The Web servers of proposed SCADA & ADMS system shall provide access to the external users who are not involved in the control centres operation but need access to the real-time data reports. The external users will be using commercially available web browsers such as Internet Explorer, Mozilla, Google chrome etc. for accessing the Web servers. The web users shall be provided with a 'Username' and 'password' for accessing the Web servers. The 'password' shall be changeable by the users. These users shall have the access to same display as that of the SCADA & ADMS system but shall not be allowed to change any data or do supervisory controls. Any additional client software, if required by the external users, shall be made available from the Web server by prompting a download. There shall not be

any restriction to the number of clients downloading this software. All reports and SCADA & ADMS display shall have the data quality codes to indicate the validity of the data.

7.20 **Proposed SCADA & ADMS system APIs**

The supply of source code of the SCADA & ADMS software is not envisaged under this project. However, specified APIs (Application Programming interface) shall be provided to Purchaser along with its source code as required. Further, source codes for applications specifically developed for this project such as web applications are also to be supplied.

APIs must be published and will be used for potential software extensions done by Purchaser in the future. Using already existing APIs (Application Programming Interface) and standard interfaces, it shall be possible to adapt interfaces for the connection to any type of system in the company (SAP, inventory, maintenance management, network planning, geographical information system).

Application Programming interfaces to the following SCADA & ADMS functions are required as a minimum:

a. Database access – read and write all attributes of database points

b. Supervisory controls – initiate and receive reports on supervisory control actions

c. Alarming – initiate and manage alarms

d. Network analysis – retrieve and generate save cases, including input data, network topology, and model parameters

e. Application program controls – initiate, schedule, and terminate any applications.

b. The Software license agreement shall be prepared by the bidder and signed by both parties at the time of detailed engineering or system handover.

Chapter # 8

Information Storage & Retrieval System (Time Series Historian)

8.0 General Requirements

The Historian System shall capture raw production data in real-time and from other specified sources. Example – State Estimated Values, ADMS System Applications, solution statistics. The historian system shall have a common user interface such that the user does not need to login into a separate server.

Purchaser requires the IS&R shall be a logically separate node within the DMZ environment running on separate, redundant servers. The user interface to the IS&R shall be through the same user interface provided for the Operator.

The historian system shall have the capability to archive data either periodically (ranging from 1 seconds to 60 minutes) and by exception. The historian system shall store the data online for at least 5 years without the need of moving data from external sources like SAN, Tape etc. and without any manual intervention.

The system shall store the information in a time series database that can efficiently store data with minimal space and fast retrieval. The time series information shall be displayed in a trend or as a tabular data over a time range. It shall support data collection from heterogeneous sources into a common platform for analysis.

Any data value in the SCADA & ADMS System shall be available for collection, calculation, retention, and archiving by time series historian. This includes scanned data, data received via data exchange such as OPC, Secured ICCP, SCADA & ADMS, calculated data and data produced by SCADA & ADMS System applications.

Any authorized, designated SCADA & ADMS System user shall be able to access all IS&R functions, review scheduling and historical information, and edit information from any SCADA & ADMS System console. IS&R shall also be accessible from Purchaser's Enterprise LAN.

The IS&R system shall consist of two types of storage

a. Relational Database Management System (RDBMS) for all the data points

b. Time series historian for high speed Storage of data points at field scan rate for real time storage and playback

Bidder may offer separate systems for the above functionalities or a single high-speed historian system taking care of both the functions.

At a minimum, IS&R shall be time series historian, capable of supporting two-tier client/server or three-tier client/application/server architecture, through the TCP/IP protocol. ODBC (Open Database Connectivity) is required, with documented and demonstrable compatibility with Microsoft Access, Microsoft Excel, and other common front-end software. The RDBMS must be accessible by data management tools (e.g. DDE based). It shall also be possible to automatically save selected IS&R data to the Enterprise BW server, SAP and corporate data warehouse system.

The information storage and retrieval requirements are presented both as general capabilities and as specific applications using the general capabilities. The specific applications include:

a. Alarm and event storage and retrieval.

b. Periodic data storage.

c. Continuous data recording.

d. Sequence of events storage and retrieval

e. Operator actions (events).

f. Abnormal device states.

g. Topology such that the state of the system can be reconstructed.

It is expected that all the analog values are stored at a field scan rate (typically 2 sec). In order to meet the above requirement, Bidders shall consider their own time series historian packages or third-party products such as OSI Soft PI / EDNA, in addition to the RDBMS based system. If third party product is considered then, it will have the capability for all the data points. The historical trend / reconstruction feature should be capable of retrieving data from both the systems. The storage capacity of the systems shall be five years.

A solution that includes the capability to capture (for future analysis and/or replay) of all changes of real-time data (similar to a flight data recorder) is strongly preferred.

Any third-party license(s) provided to support these functions must allow Purchaser “full- use” of the software. It shall provide for all use by Purchaser for all databases and applications delivered with the system by the Bidder, as well as permit Purchaser to develop additional applications and/or databases generally related to the functionality of the system.

8.1 **IS&R Data Definition**

a. All data values, alarm/events list, communications statistics (RTU and Secured ICCP), and results of all applications, in the SCADA/ADMS shall be available for collection and storage into IS&R. Data points that are to be collected shall be defined in the SCADA/ADMS database and shall not require separate IS&R definition.

b. All IS&R data shall remain retrievable regardless of content or structure changes to the SCADA/ADMS or IS&R databases.

c. The SCADA/ADMS database process to define data to be stored within IS&R shall automatically handle any data point that is renamed in or deleted from the SCADA/ADMS database using techniques that allow the previously stored IS&R data to be retrieved and accessed, including any redefinition or renaming of the data in the IS&R or Historian databases that is required.

d. Historian shall also be able to show the Energization/De-Energization status during Playback along with Status and Analog Values and Qualities.

8.2 **Configuration of historian at MCC and BCC**

The Historian System shall support High Availability and automatic failover, interface data buffering to guarantee no data loss, and no impact to clients or applications in case of communication loss or data server shut down for maintenance or security patch installations, etc. Any time the data is buffered, an alarm shall be generated and shall be available in historian once the buffering has been completed (shall be alarmed as well).

Data to be written to IS&R and the historian shall be buffered such that data will not be lost if IS&R or the historian is not available at the time the data is collected. The SCADA/ADMS shall be sized to buffer a minimum of 1 month of data to protect against data loss in case the historian is down.

Data passed to IS&R and the historian shall be removed from the buffer only after positive feedback of the successful storage of data into both IS&R and the historian have been received.

The Bidder shall be able to support the following modes. During detailed engineering, Purchaser will choose any of the above configuration

a. MCC and BCC Synchronized – In this configuration the Active Site will synchronize the data to Nodal historian.

b. MCC and BCC – In this configuration both Site historian are independent and do not synchronize.

8.3 **Automated Data Capture**

It shall be possible to capture any analog or status value defined in the SCADA & ADMS System database either upon detection of its change (with associated data quality codes and appropriately time-tagged) or periodically in sets of associated data. Automated capture of alarms and events, user entries (including control, tag and flag requests, manual data entries including limit changes) and system maintenance log entries shall be provided. All alarms and events are captured upon occurrence and forwarded to the IS&R facility for storage and future access.

The alarms and events shall be stored in the RDBMS. The Bidder shall provide user-friendly forms that allow the Control Centre Engineer to build ad hoc queries of any combination of the individual fields stored with each entry. These fields include date, time, substation name, point name, alarm category, alarm priority, alarm type, data type, and message text. Queries may be saved, and query results may be viewed, printed or written to a file. In addition, each entry may have an Control Centre Engineer-entered comment.

Data shall be recorded in such a manner that it is possible to retrieve a complete picture of the power system from any date and time specified by a user (i.e., a “snapshot”). This snapshot shall include all power system telemetered and derived measurements and statuses (including quality codes, analog limits in effect at the time, etc.) as well as system alarm and events. The Bidder shall provide all tools necessary to retrieve this data using ODBC-compliant applications.

In addition to the above, the following types of data should also be stored and available for user access:

a. Sequence of Events (SOE) messages

b. Communications statistics and errors

c. Disturbance data

d. Energy Production, Scheduling and Accounting data

e. Environmental data (e.g. Temperature etc.)

8.4 **Data Quality Codes**

The IS&R database shall include all of the quality codes associated with each point. In addition, a distinct quality code shall be provided to denote that a correction has been made to a point's value while in the IS&R database.

8.4.1 **System message log Storage and Retrieval**

The system message log storage and retrieval function shall consist of a chronological listing of all SCADA & ADMS System alarm messages and event messages. Each entry shall consist of the same time tag, dynamic information, user identification, and text i.e. displayed on the SCADA & ADMS System alarm summaries and event summaries. System message log data shall be stored in IS&R and transferred to archival storage.

Facilities to sort and search and selectively display and print the contents of the system message log shall be provided through the IS&R user interface. A user shall be able to select the display of system message log entries based on the following sort or search parameters and combinations of these parameters:

a) **Alarms** – Select a set of alarms based on alarm priority and severity level

b) **Events** – Select a subset of events based on user action (including specific users) and application function detected condition (including specific applications)

c) **User log messages** – Select a subset of log messages based on specific or all users.

d) **Substation** – Select a subset of alarms or events based on a specific or all substations

e) **Device Type** – Select a subset of alarms or events based on specific device types

f) **Device** – Select a subset of alarms or events based on specific devices

g) **Time Period** – Specific time periods shall be supported.

A display shall be provided to permit the user to define the selection criteria for sorting or searching. When a user calls up the display, the user may select an existing selection criterion previously defined by the user.

8.5 Server Support Requirements

For the purposes of computer and memory sizing, the SCADA & ADMS System shall be capable of storing the information required by Purchaser. Enough capacity shall also be provided to extract and store the data needed for a query when that query covers the maximum number of retention days for the highest periodicity data retained.

IS&R shall also accommodate long-term archival storage and retrieval of information produced by the SCADA & ADMS System. An archival system shall be provided which allows Purchaser to save any completed month's data or retired application case files to long-term storage medium, such as cartridge tape, DVD, proposed Backup server or Purchaser's corporate data warehouse. The archival system shall also permit data to be restored from the long-term storage medium into the database. Purchaser prefers that the Bidder propose its standard (or commercially available third party) archival facility for this requirement.

The IS&R facility shall be logically separate, redundant nodes within the SCADA & ADMS System environment. It shall service a large number of information users while ensuring that the security and performance of the SCADA & ADMS System are not affected. (Note that specific number of users and their respective actions to determine resource utilization during performance scenarios will be finalized during detailed engineering. The Bidder shall advise Purchaser of any specific client licensing requirements.) The IS&R facility shall be configured such that impact to the SCADA & ADMS System processors and network is deterministic (i.e., fixed and not dependent on external users' activities). The response of SCADA & ADMS System applications shall in no way be affected by access to the IS&R from outside the SCADA & ADMS System environment.

8.5.1 IS&R System Monitoring

System and database administrators shall have a facility through which they can monitor RDBMS health, resource utilization and performance.

8.6 Client Capabilities

IS&R shall provide data access to the IS&R database by SCADA & ADMS System users, and users attached to Purchaser's Enterprise LAN using all of the data retrieval capabilities of the RDBMS. The PCs or consoles will be connected either to the SCADA & ADMS System LAN or Purchaser's Enterprise LAN/WAN which shall be connected to the SCADA LAN via firewalls, or gateways depending on the security requirements of Purchaser. Bidder to note that no client license shall be required to utilize the IS&R capabilities. The Bidder shall advise Purchaser of any specific client licensing requirements.

8.6.1 **User access**

SCADA & ADMS System users shall not require additional login (username and password) to the IS&R facility (i.e., their unique SCADA & ADMS System login shall be used). Purchaser prefers that "Single Sign-On" (SSO) technology be employed (i.e., a user logs on once to the SCADA & ADMS System using individually defined username and password which permits appropriate level of access to all SCADA & ADMS System facilities, including IS&R. Further, the facility should be compatible with Purchaser's enterprise wide SSO capabilities.

IS&R data shall be available for display in tabular and graphic form using all of the capabilities of the RDBMS, including an ad hoc query capability. The IS&R user interface shall comply with the general user interface requirements specified in User Interface. The user interface display creation capabilities shall be same as SCADA / ADMS application.

It shall be possible to display any calculated data value as a stand-alone value; that is, it shall not be necessary to display any collected data that is used in the calculation in order to display calculated data on a summary-type display. Any quality code, tag, or data value stored for any IS&R data value shall be displayable. The retrieval function shall incorporate the following features as a minimum:

a. Menu driven data selection process

b. Pre-formatted sets of data retrieval request displays built via the User Interface Development software

c. HRS Name display in Trend, HRS time appearance during Play back of Displays.

d. Historical data retrieval in graphical format should be user defined format like multiple graphs in a single selection.

e. Sets of predefined, generic access routines for typical types of access, such as all analog points at a specific time, maximum or minimum of a value over a specific time period, etc.

f. Capability to define ad hoc queries to call for any specific value(s) that have specified similar characteristics over specified periods of time

g. Capability to display data graphically

h. Restrictions on access to confidential information based on user access control.

i. A Web Browser User Interface is strongly preferred.

Sufficient relationships shall be maintained between the IS&R data and the SCADA & ADMS System database to ensure that selections can be made based on comparison between

stored IS&R values (such as a periodically saved bus voltage value) and any related, fixed SCADA & ADMS System value (such as the bus voltage limit). Data that is archived off-line must be manually brought on-line before viewing.

8.6.2 **Data Integration**

IS&R shall be designed to relate disparate data types at a specific period in time from data stored in the RDBMS. Examples of such data relations include operational data, alarms and events, dispatch instructions, and energy accounting data. Through this integration it shall be possible to easily recreate periods in history so that activities such as supporting dispute resolution can be handled efficiently.

8.6.3 **Data Entry & Edit**

Operating, maintenance, and other personnel will need to enter and edit data in the RDBMS. The data entry front-end shall be consistent and compatible with the GUI. Commercially recognized and available tools (e.g., RDBMS Forms, Access Forms, and other third party packages) are preferred. The Bidder shall describe the method by which this is accomplished in the proposed system.

8.6.4 **Audit Trail Event Report**

An audit trail of all changes made to the IS&R database shall be maintained and made available for display and printout. This audit trail shall identify every change made to the IS&R database content or structure, the time and date of the change, and the logon ID of the user making the change. The audit trail shall include both before and after values of all content and structure changes. Printouts and displays of the audit trail event report shall be available in formats sorted by period (from date/time to date/time), by data value(s), and by logon ID of the user making the change.

8.6.5 **Function Access**

The Bidder shall provide a library of programming interfaces to allow any function added by Purchaser to access IS&R for information storage and retrieval. The capability to embed special statements directly into the program (i.e., embedded compilers) shall be provided for all supplied programming languages. Program callable APIs shall also be provided. The data storage times closest to the date and time specified by the user shall be used to select values from the IS&R database.

The IS&R database shall also provide an interface to other commercially available software packages such as spreadsheets, word processors, report generators, and other RDBMS

products via the latest standard data requests or ODBC drivers. Information retrieved from IS&R shall be able to be imported into PC-based applications such as Microsoft Office Professional.

8.7 Database Generation and Maintenance

A commercial RDBMS shall be used to create and maintain the IS&R database. Analog and status data points that are to be collected shall be defined in the SCADA & ADMS System database and shall not require separate IS&R definition. It shall be possible to specify any SCADA & ADMS System data value to be collected upon occurrence. It shall also be possible to specify the calculations to be performed on selected data being collected. Data is stored in the Historical database by exception.

The Bidder shall provide a library of programming interfaces to allow any SCADA & ADMS System function added by Purchaser to access information from IS&R or send information to IS&R for storage.

Stored data shall not be affected by any subsequent database changes. All IS&R data shall remain retrievable regardless of content or structure changes to the SCADA & ADMS System or IS&R databases.

8.7.1 Data Model

To take maximum advantage of the IS&R RDBMS for data storage and retrieval, it is necessary to formally relate to each other the various items of data that are being stored. For example, Purchaser schedules a transaction with a particular Consumer, but each consumer has multiple contracts with Purchaser. When these relationships are determined and documented, the resulting document can be called a Data Model. The Data Model can then be used to set up the RDBMS. This Data Model shall be compatible with the specifications of the EPRI Common Information Model (CIM). The Bidder shall describe the process of developing the Data Model as well as using it to set up the RDBMS.

The domain of the data determines the form and content of a particular data model. Distribution Network Analysis data models may, for example, be very different from interchange transaction data models. The Bidder shall describe the structure of their proposed data model and the process of maintaining this model and developing new models, as they become needed.

8.7.2 **Time Oriented Data**

The IS&R database shall be structured for handling of leap year and century changes (a design that stores time in UTC is preferred).

8.7.3 **IS&R Data Calculation**

IS&R is primarily meant to be a data collection and storage subsystem. In general, the data shall be made available to the SCADA & ADMS System and other computer systems, workstations, and/or PCs on Purchaser Enterprise LAN/WAN for their data manipulation and analyses. Capability is required, however, for the IS&R to be able to perform the standard calculations described below, on any of the data.

The results of the real-time SCADA & ADMS System calculations and application programs shall be collected in the same manner as any other real-time data for storage in the IS&R database. This section specifies the additional calculations that can be performed on collected data prior to storage into the IS&R database. The IS&R Report Generator shall perform an additional set of calculations at the time of report printout.

It shall be possible to perform predefined calculations on any collected data value at specified periodicities. It shall also be possible to perform further calculations on previously calculated data and on constants. These calculations shall be definable by the users via the RDBMS. No SCADA & ADMS System database generation shall be required, nor shall a system restart be necessary, after calculation data has been edited or entered or calculation steps have been redefined.

Calculations of the following types within a data set (particular snapshot in time) shall be supported:

a. Algebraic summation and subtraction

b. Add if positive or add if negative

c. Absolute value

d. Modulo

e. Integer

f. Multiply if positive, or Multiply if negative

g. Divide if positive, or Divide if negative

h. Square root

i. Exponential

j. Conditional testing (>, ≥, =, ±, ≠, ≤,<)

k. Boolean functions

l. Nested If, Then, Else

m. Trigonometric functions [sin, cos, tan (radians or degrees), arc sin, arc cos, arc tan (radians or degrees)]

n. Calculations of multiple samples (over time) of the same data value shall be supported.

This includes minimum, maximum, average, and total for the following time periods:

i. Quarter hourly

ii. Half hourly

iii. Hourly

iv. Daily

v. Weekly (starting on a user-specified day of the week

vi. Monthly (starting on a user-specified day of the month, default to the 1st)

vii. Yearly (starting on a user-specified month, default to January).

All calculated data shall include a quality code derived from the quality codes of the data used in the calculation. The quality code of the calculated data shall be derived in a similar fashion to the quality code of calculated real-time data points.

It shall be possible to request recalculation of IS&R data after a manual modification of stored data by the user; the calculation definitions must be stored with each data set. As long as the data modified by the user lies within the specified minimum retention period (i.e., the data is still available online), the IS&R shall propagate the results of the calculation within the data set that the data was modified; except for totals such as, day total, monthly total, etc. The recalculation shall use the same formulas as the original calculation.

8.8 **Information Delivery**

The Bidder shall provide enterprise information delivery tools that support ad hoc data retrieval reports as well as the creation and maintenance of periodic and on demand reports. The tools shall be highly interactive and preferably web-based, allowing the user to see representative output from the report during the building procedures. The reporting

software shall have full read-only access to the IS&R database and real-time database and shall support sorting, filtering, algebraic, logical, and arithmetic functions such as spreadsheet calculations, to allow for creation of reports. The software provided shall be a commercially available package capable of generating complex reports. The IS&R shall provide the capability for Purchaser users to configure report formats. Version control of report definitions shall be integrated with the source control system established for the development system. Any report may be displayed on the screen, sent to any printer, or sent through an industry standard messaging system (e.g., Email) to any destination.

8.8.1 **Reports**

Any authorized SCADA & ADMS System user shall be able to schedule the generation of IS&R reports by time and date or on demand. In addition, the user shall have the capability to specify conditions detected by the SCADA & ADMS System where designated reports are automatically initiated. Reports shall have the capability of being regenerated if a value in the report is adjusted and all dependent values are re-calculated.

The facility shall be able to securely publish these reports in any format (including HTML, XML, PDF, delimited text, Postscript, and RTF) to any destination (including e-mail, Web browser, and file system). The user shall be able to designate the format and destination to which reports are generated. If the destination is a hard copy printing device, the system shall use available (i.e., base operating system) print file spooling logic. This shall include automatic redirection to a compatible output device and notification to the system administrator and to the report requestor of the redirection. The report shall not have to be rebuilt to send it to additional destinations. The IS&R shall track successful report distribution and receipt and shall generate a notification for any delivery failures.

8.8.2 **Ad Hoc Reporting Functions**

The IS&R database tool set shall include a method for extracting data using industry standard ODBC.

8.9 **Data Archiving**

The retention period is 5 years, is the minimum length of time the data shall be kept on-line for validation and editing purposes. Whenever the archived data is older than the retention period, it shall be capable of being transferred to the archival system. It shall be possible to manually archive any data set. Any data within the time range of the archiving periods shall be available on-line, through the same user interface and not require any manual intervention to load or unload archival media.

IS&R shall provide alarm messages that indicate when the archival media used for archiving is approaching its capacity so that it can be removed from the system for off-line storage.

IS&R shall include a directory containing information on all historical information that has been recorded by the IS&R, whether it is still in on-line retention or has been removed from the system for off-line archive storage. 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 and without requiring that any current on-line archives be removed from the IS&R system.

The data historian shall have failover capabilities for system redundancy to ensure high-availability and system shall be scalable easily by adding additional servers (add nodes online). It shall support timestamps stored with millisecond resolution for Sequence of Events (SOE) for the purpose of post fault analysis. The system shall display the sequence of events with two different times, source time and system time for analyzing the events for fault analysis.

8.10 **Historical Information Applications**

The SCADA & ADMS System shall have the capability to create a picture of the state of the power system at given points in the past. This picture not only requires a snapshot of the power system telemetered and derived measurements and statuses, but also the results of various application programs (e.g., limits and associated existing conditions), as well as prevailing alarms.

Historical information shall be used to support control Centre activities in the current day/hour operating timeframe. The IS&R shall record historical information in a manner that can be accessed quickly for control Centre functions. Outside of the control Centre operating timeframe, performance requirements are less stringent, but the ability to access data through ad hoc queries becomes more important. Historical snapshots of the power system are required to support the following processes:

a. Historical data required by Purchaser to support business processes and decision support. For example, various forecasting activities are based on past history.

b. Disturbance analysis by Purchaser to analyze and report on power system events defined by operating policy.

8.11 Disturbance data Collection

Data describing the condition of the power system just prior to, during, and immediately following disturbances shall be captured and stored on auxiliary memory. The user of the relevant SCADA & ADMS computer system shall be able to view captured disturbance data on displays and on printed reports for after-the-fact disturbance analysis.

8.11.1 Disturbance Detection

Disturbance data collection shall be automatically triggered upon detection of a defined condition or on demand by the user. The user shall be notified when a disturbance has been detected.

Disturbance data collection initiation conditions shall be system maintenance engineer-definable and shall consist of designated device state changes and designated analog values exceeding a trigger limit. The user shall be able to enable and disable any initiation condition. Disturbance data collection initiation conditions shall include the following:

a. Unauthorized change of state of selected switching devices

b. Violation of analog limits: The telemetered and calculated analog points, and the specific limit to be used as a trigger value for each point, shall be individually defined by the system maintenance engineer, for example, rate-of-change of power system frequency.

Disturbance data collection shall be aborted if the state of a status trigger point returns to its previous state or the value of an analog trigger point exits the trigger condition limit value within system maintenance engineer-definable system-wide time period. The user shall be able to abort disturbance data collection, however initiated.

For each disturbance, data samples for all analog points and all status points shall be collected during the disturbance, pre-disturbance and post-disturbance periods. Stored data for each disturbance shall be identified by the disturbance initiating condition and its time of occurrence.

Storage for up to ten independent, non-overlapping disturbances, with an average of one extension per disturbance, shall be provided. The user shall be notified when the available storage capacity is down to the storage required for one extended disturbance, and again when the storage capacity is fully utilized. Additional disturbances after this point shall overwrite the oldest stored disturbance. The user shall be able to delete stored data for a disturbance.

The system maintenance engineer shall be able to store data of a disturbance on any external storage media. When data for a disturbance is stored on auxiliary media, the system maintenance engineer shall be able to specify whether it shall be cleared from auxiliary memory and the storage space made available for future disturbances. The system maintenance engineer shall be able to retrieve a case from auxiliary media for analysis without affecting disturbance data collection or any of the disturbance data stored on auxiliary memory. All system maintenance engineer actions to store or retrieve disturbance data to or from external media shall be performed using console commands.

8.11.2 **Disturbance Data Retrieval**

The user shall be able to view disturbance data on SLDs, system overview well-organized tabular displays, trends, and printed reports. Formats shall be subject to Purchaser approval. The selection and presentation of disturbance data shall be under user control. Procedures shall be provided for selecting and sorting disturbance data according to criteria (and combinations thereof), such as:

a) Time,

b) Variable,

c) Magnitude of Analog changes, and

d) Power system substations of interest. These selection and sorting criteria shall be provided for displays, CRT trends, and reports.

8.12 **Network Analysis Save cases**

The Control Centre Engineers and users shall be able to save specified network analysis save cases in the archive save case library. The utility programs of the archive save case function shall be used to save network analysis data sets including input data, output data, and, if necessary, the power system network model associated with the save case. The archive save case function may save only the dynamic data, however, sufficient data shall be saved to reconstruct the original network analysis solution.

8.12.1 **Archive Save cases**

The Control Centre Engineers and users shall be able to manually or automatically save real-time or study save cases to the archive save case library. The user shall be able to specify the periodicity and length of time to automatically archive a set of real-time save cases. Study save cases shall be archived by manual user request. The utility program shall allow the user to enter a description of each save case. Archiving a save case to the archive library shall be

a simple function requiring a minimal number of steps for the user to implement the save case request. Archive save cases created shall be read only to prevent corruption of the original data. After a user-definable period of time (depending on the number of save cases that are archived), the older save cases in the archive library shall be transferred to permanent storage.

8.13 **Retrieving archived save cases**

The utility program shall be used to view the description of the save cases in the archive library and retrieve the save case. Archived save cases shall not become out-of-date due to power system configuration changes. The SCADA & ADMS System shall archive the power system network model whenever changes are implemented in the model. Each network analysis save case shall include an identifier specifying the version of the power system network model associated with the save case. Retrieval of a network analysis save case shall also retrieve the power system network model associated with the save case if required.

Chapter # 9

Programming Development & Quality Assurance System

9.0 General Requirement

The Programming development & Quality Assurance systems shall be installed at MCC for SCADA & Power System application system developmental activities. The development systems shall consist of sufficient hardware and software for Purchaser personnel to generate and test the database, displays, and reports that are required by the Purchaser's.

Purchaser maintenance engineers shall be able to maintain all system software, displays, database, and reports via the resulting SCADA systems.

9.1 Development System and its Functions

The development systems for SCADA & ADMS shall be considered part of this project and subject to all of its requirements unless otherwise stated in this section. Many of the development system requirements are defined by reference to the corresponding system requirements of the Specification.

The development systems shall include all functions required to support the generation and testing of the system software, database, displays and reports.

The user interface for each development system shall provide the same capabilities and features as the on-line system. Sufficient user interface functionality shall be included to enable Purchaser maintenance engineers to perform the following tasks:

a. View displays generated on the development system. Functions such as panning, zooming, and de-cluttering shall be provided so that every aspect of the displays generated by Purchaser can be verified.

b. Test linkages between the displays and the database and between the reports and the database.

c. View and print Purchaser-generated reports.

d. Produce hardcopy of display images

9.1.1 Development System Software Requirements

The development system software requirements shall include the following capabilities and features:

a. Programming languages

b. System services

c. Database and database management software

d. Display generation and management software

e. Report generation software

f. Software utilities

Versions of the system software shall be as closely as practical, the corresponding system software on the SCADA & ADMS systems. All the symbols/libraries and Color codes used in the display design for user interface shall be developed and made available in the development system. All necessary development tools shall be provided by the Bidder.

9.1.2 **Development System Configuration Characteristics and Availability**

The following sections describe the requirements for development system configuration characteristics and availability.

9.1.3 **Development System Configuration Characteristics**

Each development system configuration shall support the system functions, user interface, system software, and hardware as specified for the main system.

9.1.3.1 **Development System Availability**

The development system shall be non-redundant. It shall exhibit a minimum availability of 98% for the functions specified as for main system. Each development system device, including processor, shall also exhibit a minimum availability of 98%.

9.1.4 **Audit Trail Event Report**

An audit trail of all changes made in the database shall be maintained and made available for display and printout. This audit trail shall identify every change made to the database content or structure, the time and date of the change, and the logon ID of the user making the change. The audit trail shall include both before and after values of all content and structure changes. Printouts and displays of the audit trail event report shall be available in formats sorted by period (from date/time to date/time), by data value(s), and by logon ID of the user making the change.

9.1.5 **Development System Hardware**

The development system hardware shall be same from the respective SCADA systems to meet the following minimum requirements:

a. **Processor** : The development system processor shall be of the same make, model, and series required by the final SCADA system. The device interfaces and controllers shall be identical to those used in the SCADA system. The development system processor shall be sized such that the response times of the software, display, database, and report maintenance functions are the same as the function response times on the respective SCADA system. Main memory spare capacity and expandability shall meet the requirements as required to maintain the on-line system.

b. **Auxiliary Memory** : It shall be non-redundant.

c. **Peripherals** : Each development system shall include a logger, laser printer. These peripherals shall be of the same make, model, and series required by the final SCADA system.

d. **Consoles** : One high-performance system consoles of desktop type shall be delivered with development system. This console shall include a video monitor, keyboard, and cursor positioning device. The console shall be of the same make, model, and series required by the final SCADA system.

e. **Spare Parts** : Sufficient spare parts and test equipment required for the maintenance of the development system hardware shall be provided with the development system.

9.1.6 **Development System testing**

Prior to shipment, the Bidder shall demonstrate the functionality and performance of the development system software and hardware to Purchaser representatives. A list of the software and hardware to be demonstrated shall be prepared by the Bidder and submitted to Purchaser for approval at least 2 weeks prior to the demonstration. All problems identified during the demonstration shall be recorded. The resolution of all variances must be agreed-upon prior to shipment. Purchaser understands that the development system will be shipped early in the software development phase of the project.

Formal field installation, field performance, and availability tests shall be conducted on the development systems, but only as reconfigured components of the final SCADA & ADMS system. These tests shall meet the requirements of development system as specified in this document.

9.1.6.1 **Validation of Database Changes/Modification**

a. The System / Software linkages of every modifications in database / displays shall be highlighted in the PDS & QAS prior to roll out the changes into the production system.

b. Facility to get a trail of each modification done in the system database.

9.1.7 **Development System Training**

System training needed for efficient use of the development systems shall be completed in India / at site on the delivered system within the first month following delivery of system. The Bidder shall describe the proposed training program for the development system and how this training can be coordinated with the development system delivery schedules. Development system training shall include, but shall not be limited to the database, display, and report generation training courses.

9.1.8 **Development System Support Services**

The support services specified in this document shall also be provided for the development system.

The Bidder shall provide all software updates and problem resolutions necessary for Purchaser to fulfil its display, database, report and software generation responsibilities on the project. Any delays in Purchaser completing these responsibilities due to the failure of the Bidder to provide such updates and fixes in a timely manner shall be the Bidder's respon- sibility. Purchaser plans to integrate any updates or fixes under the Bidder's directions. However, if the attempts by Purchaser to integrate such updates or fixes are not successful, the Bidder shall provide on-site assistance at no additional cost to Purchaser.

9.1.9 **Development System Maintenance**

The maintenance requirements of specification shall apply to the development systems. The Bidder shall be responsible for the hardware and software maintenance of development system through completion of its reconfiguration as part of the respective systems. After this event, all hardware and software maintenance support specified for the SCADA & ADMS system shall apply.

9.1.10 **Development System – Project management, QA & Documentation**

The project management and quality assurance requirements as specified for on-line system in this specification shall apply to the development system also. For project management purposes, the development systems shall be considered part of the overall system project. The development systems shall be incorporated into the system quality assurance plan.

Documentation that is needed for the development systems shall be furnished to Purchaser for review and approval in advance. Such documentation shall include all relevant hardware, software, and test documents as specified therein as well as any documentation specific to the development systems. The quantities to be provided for each documentation category that applies to the development systems as per the specification for other systems.

9.1.11 **Database and Database Management**

The project management and quality assurance requirements as specified for on-line system in this specification shall apply to the development system also. For project management purposes, the development systems shall be considered part of the overall SCADA & ADMS system project. The development systems shall be incorporated into the system quality assurance plan.

Documentation that is needed for the development systems shall be furnished to Purchaser for review and approval in advance. Such documentation shall include all relevant hardware, software, and test documents as specified therein as well as any documentation specific to the development systems. The quantities to be provided for each documentation category that applies to the development systems as per the specification for other systems.

9.1.12 **Database Structure**

The SCADA & ADMS 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 & ADMS shall include a single logical repository for all data needed to model the historical, current, and future state of the power system and SCADA & ADMS – the Source Database (SDB). All information needed to describe the models on which the SCADA & ADMS operates, shall be defined once in the SDB and made available to all SCADA & ADMS

applications, real-time database, and user interface maintenance tools that need the information.

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

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

The SCADA & ADMS 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.

9.1.13 **Software maintenance and development tools**

9.1.13.1 **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:

a. Program and data editing

b. Program compiling and assembling

c. Linking

d. Loading, executing and debugging program.

e. Version management

f. Concurrent development

The following features shall be provided:

a. Library management

b. Programs allowing to copy and print any data or program files

c. Backup and restore

d. File comparison

e. Sort and merge

f. Programs that allow to partially save and recover volumes

g. Core and memory dump

9.1.13.2 **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.

9.1.13.3 **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.

9.1.13.4 **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.

9.1.13.5 **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 & ADMS functions. The capability to restore the system to its status prior to the new program integration shall be provided.

9.1.13.6 **System generation**

System generation software and procedures shall be provided to generate an executable object code of all software, databases, displays, and reports. Purchaser personnel shall be able to perform a system generation on site, using only equipment, software, procedures, and documentation supplied with the SCADA & ADMS. It shall not be necessary to return to the Bidder's facility or rely on the assistance of Bidder 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.

9.1.13.7 **Code management**

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

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

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

a. Manage source code and binary images

b. Allow tracking of code changes by date, author, and purpose

c. Manage documentation modules and associate them with source code, binary images, and other documentation

d. Support multiple teams of programmers working concurrently on the same modules

e. Provide an efficient link between modules

9.1.13.8 **Quality Assurance system**

Quality Assurance system (QAS) will be used for acceptance test of changes in data or software, including third party software and patches, signature updates.

The system shall allow testing of above changes without any implication on the production system. The Production system and QAS shall be independent from each other. The QAS shall take the role of the data model master before rolling over to production system.

The QAS & Production System shall be configured in the different zones.

9.2 **Database development software**

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

a. Data consistency

b. Compliance with the system performance requirements including both response times and expansion capabilities

c. 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 databases, non-relational run-time databases required to implement the functions of SCADA & ADMS system. All the facilities required for generating, integrating and testing of the database shall be provided with the SCADA & ADMS system. The delivered SCADA & ADMS 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 & ADMS 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 & ADMS 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 DCUs/RTUs/ FRTUs / FPI, data links, and local I/O

b. Add, modify, and delete application program data

c. Create a new database attribute or new database type

d. Resize the entire database or a subset of the database

e. Redefine the structure of any portion of the database

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

9.2.1 **Runtime 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.

9.2.1.1 **Data retention**

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

9.2.1.2 **Making database Online**

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

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

9.2.1.3 **On-line database editing**

Selected database management functions and changes to a run-time database shall be possible without requiring a database generation. These shall be limited to viewing functions and changes to the contents, but not the structure of the database. On-line changes shall be implemented in all applicable SCADA & ADMS 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 & ADMS system's reaction to hardware and software failures nor shall it require suspension of exchange of data among servers for backup purposes.

9.2.1.4 **Tracking database changes**

Audit trail files shall be maintained by the database manager for all changes made by all users. The audit trails shall identify each change including values prior to the change, include a date and time stamp for each change, and identify the user making the change. An audit trail of last 10,000 edit operations shall be maintained and another audit trail maintaining records of who/when performed the edit operation shall be maintained for a period of one year.

9.2.1.5 **Initial database generation**

The initial database shall contain all data required by the SCADA & ADMS systems. Default values shall be used in consultation with the Purchaser for data that is not provided by Purchaser. Population and maintenance of the distribution network model should be possible by using the database maintenance tools to build the database from scratch. In addition, if required data already exists within the Purchaser's existing Distribution Automation System and Geographic Information System (GIS) or otherwise the SCADA & ADMS database functions should leverage this effort by providing an interface/adaptor to extract GIS data using the CIM international standard IEC 61970/61968 and automatically generate the complete Network Operations Model. The data extracted should include network device information, connectivity, topology, nominal status and non-electrical data such as cable ducts, land base data etc. Further Land base data can be sourced from GIS in Shape files or DXF file or through interface/adopter.

9.3 Display generation and management

SCADA & ADMS 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:

a. Copy/move/delete/modify,

b. Building at different zoom level,

c. Linking of any defined graphics symbol to any database point,

d. Pop-up menus,

e. Protection of any data field on any display against user entry based on log-on

f. identifiers

g. 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 ADMS 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 & ADMS 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

g. Select, Group/Ungroup, Align, Zoom/Unzoom, Clutter, Pan, Navigate, Page fit, etc.

The display generation, compilation & loading shall not interfere with the on line SCADA & ADMS functions.

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

9.3.1 Display elements

The elements available to create a display shall consist of graphic primitive symbols, segments, User Interaction Field and layers. These elements shall be available to be linked to

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

9.3.1.1 **Segments**

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

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

9.3.1.2 **Dynamic transformation linkages**

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

9.3.2 **Display generation and integration**

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

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

define the periodic update rate of the dynamic information on the display and any programs called before or after presentation of the display.

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

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

Each SCADA & ADMS computer system shall include schematic and tabular displays for configuration management. The displays shall depict the state of each processor, device, and their interconnections, and include facilities for initiating user-commanded changes to the state and assignment of devices to processors and user-commanded function restarts, processor and device failovers, and processor start-ups. Displays to view and control the status of backup databases shall also be provided.

9.3.2.1 **Importing of Drawings**

The display generator shall support the import of drawings, including power system one-line diagrams, developed by Purchaser. The drawings may be used in the SCADA system as the static background for displays. The display generator shall provide the capability (through the display generation process), to add, delete, and modify the dynamic information supplied to the drawings using the specified features of the display generation and management software. As necessary, Purchaser will replace the static background by importing a new drawing and re-linking associated database elements. The display generator shall allow a user to update the dynamic information to reflect any changes required by the updated drawing.

9.4 **Report Generation software**

The SCADA & ADMS system shall include report generation software to generate new report formats for SCADA & ADMS 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. The SCADA & ADMS system should have a efficient report generation tool to generate reports of resolution also of <1ms. The SCADA & ADMS Report utility should be able capture the data of the resolution order <1ms from data source, if available, for reports and trending analysis.

Executing the report generating functions shall not interfere in any server of the system with the on-line SCADA & ADMS functions. Reports generation to display shall not exceed 10sec for complex reports.

The report application shall be free-form and user friendly. It should be compatible with Microsoft office tools and easily exportable to MS-Excel, MS-Word & PDF.

9.5 System generation and Build

System generation includes the activity of generating an executable object code of all databases, displays, and reports as required for SCADA & ADMS system. System build is the process under which all the above executables and the executables provided for SCADA & ADMS application software are ported to the SCADA & ADMS system hardware and configuring to make it operational.

The Bidder shall do the complete system generation and build as required for successful operation of the SCADA & ADMS system. The Bidder shall also provide the complete backup of the SCADA & ADMS system in electronic media such as tapes, CDs, MO disks etc. Purchaser personnel shall be able to restore the SCADA & ADMS system at site by using above backup tapes/CDs etc. The Bidder shall provide the procedures necessary to restore the system from the backup tapes/CDs etc. The DR system shall always have updated set of system build. It shall be synchronized with the SCADA & ADMS control Centre.

9.6 Software utilities

All software utilities used to maintain SCADA, ADMS, Purchaser's Specific application software, whether or not specifically required by this Specification, shall be delivered with the system.

The software utilities shall run in background mode without jeopardizing other SCADA & ADMS 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.

9.6.1 File management utility

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

9.6.2 Auxiliary memory backup utility

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

a. Server and workstation

b. File names (including directory and wildcard designations)

c. File creation or modification date and time

d. Whether or not the file was modified since the last backup

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

9.6.3 **Online Help**

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

9.6.4 **Failure Analysis**

Failure analysis programs 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. Failure analysis information shall include the following items:

a. Time and date of failure

b. The most recent operating system service routine requested

c. The pending, executing, and completed programs

d. I/O activity per system device at time of failure

e. The current system resource allocation

f. Contents of pertinent system software tables

g. Contents of hardware registers.

h. Contents of mapping tables

i. The contents of main memory

j. Paging parameters and tables.

All tools that are commercially available from hardware/operating system Bidder to meet Purchaser requirement must be supplied.

9.6.5 **Diagnostics**

This section describes both the on-line and off-line diagnostic capabilities that shall be provided with the SCADA & ADMS system.

9.6.5.1 **On-Line Monitoring Diagnostics**

On-Line monitoring diagnostic programs shall be provided for verifying the availability of the backup equipment and for limited testing of devices without interfering with on-line operations of the SCADA & ADMS system or the failover capability of the devices.

Redundant communication line interface equipment shall be tested by periodically retrieving data over these lines and checking for the ability to communicate with the redundant channel and for any errors.

Designated backup processor(s) and associated auxiliary memories shall be automatically tested for proper operation to ensure they are ready if needed for a failover contingency. Any failure to perform diagnostic functions correctly shall cause an alarm to be issued.

9.6.5.2 **Off-Line Device Test Diagnostics**

Device diagnostics shall be provided for testing each SCADA device including processors, main and auxiliary memory, peripherals, workstations, data links, communication interfaces, and RTUs. These diagnostic routines shall provide comprehensive printout and user inter- action capabilities.

The diagnostics shall operate automatically after initialization by the user. They shall report the status of each test to the initiating processor terminal and, if requested by the user, to any printer. The user shall specify the extent of testing (all or any combination of tests) to be performed and the number of times the test(s) must be repeated.

9.6.6 **System Performance Monitoring Software**

Software shall be provided in each processor and workstation to monitor hardware and software performance continuously and gather performance statistics. The performance monitoring shall occur in real-time with a minimum of interference with the normal SCADA & ADMS 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 statis- tics shall be available for printout and display after each period and on demand during the period.

The SCADA system shall include on-line services to enable, disable, and initialize individually each performance monitor function defined in the following sections.

9.6.6.1 **Processor Resource Usage Monitoring**

The values calculated by the resource usage monitoring function in each processor shall include:

a. Processor busy time in percent

b. Total processor idle time in percent

c. Processor idle time during main/auxiliary memory transfers in percent

d. Total number of transfers to/from auxiliary memory

e. Total transfer time for each auxiliary memory in percent

f. Time in percent when one or more tasks were blocked waiting for memory resources

g. Peak number of items in the various system and I/O queues

h. Page fault rate

i. Percent usage of the modified page file.

The resource monitor shall separately report the resources it uses. The statistics shall be used to demonstrate that the SCADA system meets the processing capacity required by Purchaser.

9.6.6.2 **Program Resource Usage Monitoring**

Performance statistics on individual programs in each processor and on their associated operating system overhead shall be calculated by the system when requested. The user shall be able to specify the programs for which statistics are to be gathered, the period over which statistics are to be accumulated, and the statistics to be collected. A complete summary shall be included with all the accumulated statistics for each program over the specified time. The values shall include:

a. Processor time used by the program in percent

b. I/O wait time in percent

c. Device usage statistics

d. Page fault rate

e. Time spent waiting for page faults in percent

f. Average number of pages in use in main memory

g. Average number of pages in use in the modified page file.

9.6.6.3 **System maintenance engineer Assistance**

Interactive, system maintenance engineer assistance displays shall be provided that describe the uses, syntax, sequence, and options of the software commands associated with all system services, software utilities, and SCADA application programs. The descriptions shall be accessible from any workstation, processor terminal, or programming terminal.

9.6.6.4 **Other Utility Services**

The SCADA shall include the following utility services:

a. A copy utility that transfers data or logic files from any storage device to another storage or output device, including any required format conversions.

b. A backup utility that can load and dump all or portions of auxiliary memory from and to other storage or input/output media and verify the transfer.

c. Comparisons of data or program logic on any combination of input or storage devices with the identification, display, and printing of differences, as selected by the user.

d. Source code search logic for single or multiple patterns shall be included. Searches by selected files or all files shall be provided. When the search is successful, the source shall be identified (document name, line number in source document, source line text), displayed, and printed, as selected by the user.

e. Loading and storage of information from labelled portable media storage units as dictated by the requirements of this Specification.

f. On line access to user and system manuals for all software products (e.g., Operating System and Relational Database Software) shall be provided.

9.6.6.5 **Configuration Characteristics and Availability**

The ability of the SCADA & ADMS system to perform their specified tasks under normal conditions and under conditions of hardware and software failure is of paramount importance to Purchaser. This section presents requirements for monitoring and managing the hardware and software configurations of these systems and quantifies their availability requirements.

9.6.6.6 **Processor and Device States**

Processor and device states shall identify the operating condition of each processor and peripheral device in SCADA & ADMS system and shall be used to determine the system's reaction when restart and failover operations take place. Processor and device states shall be assigned by the function restart, processor and device failover functions, and by user command.

9.6.6.6.1 **Processor States**

Each processor in SCADA, ADMS & Purchaser's Specific Applications computer system shall be assigned to one of the following states:

a. **Primary** : A primary processor performs any or all of the on-line functions described in this Specification. A primary processor shall concurrently perform maintenance functions (e.g., system update and development activities, including database, display, and software testing) at the discretion of the system maintenance engineer.

b. **Backup** : A backup processor replaces a primary processor in the event of primary processor failure or upon user command. It shall communicate with the primary processor(s) to maintain backup databases and monitor the state of the primary processor(s). A backup processor shall concurrently perform maintenance functions at the discretion of the system maintenance engineer.

c. **Off-Line** : An off-line processor is operational but does not communicate with the primary processor(s) for the purpose of assuming the primary state in the event of primary processor failure. Off-line processors shall be capable of executing maintenance functions at the discretion of the user. Off-line processors shall also be capable of running on-line functions. An off-line processor operating in this "pseudo-primary" manner shall not issue supervisory or generation control outputs to power system devices. Off- line processors shall have access to all real-time data from any data source without interfering with on-line functions executing in primary processors.

d. **Down** : A down processor is not communicating with the SCADA & ADMS computer system and is not capable of participating in any system activity.

9.6.6.6.2 **Device States**

Each device in SCADA & ADMS computer system shall be assigned to one of the following states:

a. **Primary** : The primary device is logically attached to a primary processor or primary processor group if the primary processor or primary processor group fails and its functions are reassigned to a backup processor or backup processor group, the device shall follow the reassigned functions.

b. **Backup** : A backup device is used to replace a primary device in the event of primary device failure. It shall communicate with the primary processor or primary processor group to maintain its readiness to be assigned as a primary device. A device may be assigned to the backup state by the processor restart function and by user action.

c. **Dependent** : A dependent device is logically attached to a designated processor or processor group and the state of the processor or processor group affects the state of the device. This mode shall be assigned to devices such as auxiliary memory devices physically connected to a single processor or processor group, where failure of the processor or processor group will preclude access to the device. This mode shall also be assigned by user command.

d. **Down** : A down device cannot be accessed by the SCADA & ADMS computer system.

9.6.6.6.3 **Critical and non-critical functions Redundancy**

Every critical function must be supported by sufficient hardware redundancy to ensure that no single hardware failure will interrupt the availability of the functions for a period exceeding the automatic transfer time. Non-critical functions are those that support maintenance and development of database, application software and training of users. Non- critical functions may be interrupted for specified period during which any necessary repairs or replacements will be performed.

9.6.6.6.4 **Processor and Device Interconnections**

A processor group is one or more processors that perform a subset of SCADA & ADMS computer system tasks in either a primary/backup manner or distributed manner (where the on-line functions performed by the processor group are distributed among multiple primary

processors). For example, one processor group may be configured to perform all SCADA functions, while other processor groups perform ISR, OMS, WFM and other functions.

All devices associated with a processor group, excluding processor terminals, auxiliary memory, magnetic tape drives, and optical disks operating in the dependent state, shall be accessible by any processor within the group without communicating through another processor. The failure of a processor or processor group shall not interfere with the access to devices by other processors or processor groups except for the failed processor or processor group dependent devices. Individual devices shall be both manually and automatically assignable to any processor within a group without affecting a primary processor's use of any other device. There shall be no restriction on the assignment of devices such as workstations, system maintenance engineer terminals, RTUs, data links, LAN/WAN interface equipment, and printers among processors whether in a group or not in a group. It shall be possible to assign workstations to either the real-time system or the DTS.

Redundant interconnections shall be provided among all processors, among all processors within a processor group, among all processor groups, and among all processors (including processor groups) and all workstations. This Specification assumes the use of LANs for the processor interconnections but does not preclude the use of other interconnections such as FDDI. The device state of each processor connection to a LAN and the LAN itself shall be changeable by the user. The interconnections shall support:

a. The exchange of data for the purpose of executing on-line, off-line, and maintenance functions

b. The exchange of data for the purpose of maintaining backup databases

c. The exchange of processor and device state information for the purpose of managing the system's configuration

d. Access to peripheral devices

9.6.6.6.5 **Backup Databases**

Backup copies of all databases shall be maintained so that system operations may continue in the event of processor, device, or software failure. The backup databases shall be updated with the current contents of the primary databases such that all changes to a primary database are reflected in the backup database within 30 seconds of the change. Failure of a processor shall not preclude access to a backup database by the processor assuming the functions of the failed processor. The backup databases shall be maintained in such a

manner as to be protected from corruption due to processor and device failure. Backup databases shall be preserved for system input power disruptions of any duration. The information maintained in the backup databases shall include:

a. Telemetered, calculated, and manually-entered values and their attributes, including quality codes, control inhibit state, and tag data

b. Data and associated attributes maintained by the Information Storage and Retrieval function

c. Alarm, event, and summary displays (such as off-normal, control inhibit, and alarm inhibit displays) or sufficient information to rebuild the displays in their entirety (including the time and date of the original data entries, not the time and date the display is newly created)

d. Application function execution, control, and adaptive parameters and input and output data, including power system analysis and other save cases.

Changes to the quantity of information to be backed up resulting from the addition or deletion of items in an existing database shall be automatically accommodated by the backup function. Similarly, the addition, deletion, or restructuring of databases shall be automatically accommodated by the backup function.

9.6.7 **Symbolic Access**

Interfaces to all SCADA & ADMS databases shall be provided through the facilities of the system's high-level programming languages. Database items shall be identified by symbolic names when the database items are defined. Subsequent references and linkages to any database item shall use these symbolic references. Each database item name shall be unique. Purchaser shall only have to define this item once to establish all internal database linkages to this item's attributes when creating the database.

Software utilities shall be provided that find all uses of specific database item names in displays and application functions. These search utilities will be used by Purchaser to find and revise name references when a database item name is changed.

9.6.8 **Database Management**

The database management functions shall be able to operate in a batch mode from auxiliary memory files and archive storage, and interactively from any processor terminal, workstation, or system maintenance engineer terminal. It shall be possible for multiple users to edit the global database data concurrently, protected by record-level interlocks.

The database manager shall locate order, retrieve, update, insert, and delete data; ensure database integrity; and provide for backup and recovery of database files. The database manager shall generate and modify all SCADA & ADMS data by interfacing with all database structures. In systems with a distributed database, the database manager shall have access to all portions of the database wherever stored. The location of database items shall be transparent to the user performing database maintenance.

Execution of the database manager in any processor of the system shall not interfere with the on-line functions of the SCADA including the normal updating of each processor's real- time database. In a primary processor, database editing shall be limited to viewing functions, database documentation functions, and functions that change the contents but not the structure of the database. Editing the on-line database shall not affect the operation of the primary/backup configuration nor shall it require that data transfer between primary and backup processors be suspended.

Database structures shall be defined and modified through standard windows-based generating and editing procedures so data files, records, and fields for functions added by Purchaser personnel can be readily included without additional database coding. The standard database structures shall be reviewed by Purchaser. Structures developed specif- ically for this project shall be subject to review and approval by Purchaser.

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.

The database manager shall include the mechanisms, in both interactive and batch processing modes, to perform the following functions:

a. Add, modify, and delete telemetered, non-telemetered, or calculated database items and data sources such as RTUs, data links, and local I/O.

b. Add, modify, and delete application program data

c. Create a new database attribute or new database type

d. Resize the entire database or a subset of the database

e. Redefine the structure of any portion of the database.

A utility function shall be provided that creates, from the run-time database, a source file suitable for submittal to the global database batch processing facility. This utility shall create a new global database file, suitable for editing, that reflects any changes made to the run- time database since the last time the database was compiled.

9.6.9 **Run-Time Database Generation and Maintenance**

The database manager shall generate incremental database changes as well as run-time (loadable) databases from the global database. Database structure changes shall not require regeneration of the entire database. Based on the nature of the structure change, the database management software shall determine which portion of the database must be regenerated and which displays, reports, and software functions must be relinked.

When errors that were not detected at data entry time are encountered during run-time database generation, the errors shall be flagged and rejected. The generation routines shall attempt to continue processing the database in an effort to detect all existing errors before terminating the generation task.

9.6.10 **Database Integration**

Newly generated run-time databases shall only be placed on-line by user command. After an error-free database generation, the new database shall be integrated into the system by assigning it to an appropriate processor. The user shall be able to test the database in an off-line processor prior to its use in an on-line processor. The previous run-time database of the processor 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. Following

the assignment of a new database to a processor and on user demand, the database management software shall access each SCADA processor to ensure that all databases are consistent. Inconsistencies shall be annunciated to the user.

9.6.11 **Symbols**

The display generator shall support the construction of custom symbols using graphic primitives and save these symbols in symbol libraries. The display generator shall support the addition, deletion, and modification of symbols, including the merging of one symbol with another to create a new symbol. Symbol size shall not be limited. Symbols shall be defined at an arbitrary scale factor selected by the user.

9.6.12 **User Interaction Field**

Using the symbols and segments described in the previous sections, the user shall be able to construct fields on the display that allow user interaction with the display. These fields may correspond to function keys on the standard console keyboard, pop-up menus and menu fields, and poke points. The display builder shall be able to assign linkages to these fields that will, once selected by the user, trigger standard library keyboard programs, special application subroutines, or programs specific to the display active on the console screen. These fields shall be assignable to field libraries and made available for use by the display builder. The SCADA system shall include a set of standard field libraries that are used for the application functions and the display build functions provided with the system.

9.6.13 **Display Layers**

Display layers shall be constructed by placing primitives, symbols, segments, and poke points onto a world coordinate space. The display generator shall support the following static transformation of primitives, symbols, and segments as the elements are placed on the layers:

a. Rotation of the element about a Centre point

b. Scaling of the element

c. Flipping the element about any axis

d. Snapping the element to a static grid whose dimensions (in pixels) may be varied by the user.

These static transformations shall apply to individual display elements and to sets of elements selected by the user. The display generator shall also support the replication

(copying of elements to other locations within the layer and between layers) of individual elements and sets of elements.

9.7 **Compilers, Assemblers, Linkers, and Loaders**

Compilers and assemblers shall be provided for all program languages supplied with the SCADA. Linkers and loaders shall be provided to link any object module from an assembly or compilation to produce an executable module and to load the executable module into the system. Program linkers and loaders shall also be supplied for programs created from cross-compilers and cross-assemblers.

9.8 **File Management**

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

a. Memory segmentation facilities to separate files into directories and logical paths

b. Capability to protect and unprotect files and directories

c. Logical file names to manipulate and access files

d. A memory usage optimization feature that:

i. Removes unnecessary files as specified by the user and

ii. if supported by operating system, organizes segmented programs efficiently to provide the most spare memory.

The file management services shall maintain a record of the auxiliary memory allocation of all programs, displays, and data. This record shall be available for display and printing upon request.

9.9 **System Management Tools**

The Bidder shall provide all necessary system management tools for the effective monitoring of the proper functioning of the system. These shall be capable of generating all the required alarms in case of any failure of the system automatically.

The offered tools shall be able to detect the possible reasons for any such abnormal function of the system.

a. Failure of any device of the system

b. Failure of data exchange between any two devices of the system which could be due to the failure of the device at either transmitting or receiving end or due to the failure of the communication link.

c. Failure of the data exchange due to the data congestion in the network.

d. Delayed processing due to system overload

e. The Bidder shall provide all necessary software tools for the development & maintenance of the SCADA & ADMS / Secured ICCP / report databases at Control Center. This tool shall be capable of managing all the system database. The database development software tool delivered with the SCADA & ADMS system shall be used to generate, integrate and test the database.

f. The database development tool shall facilitate IEC 61970 CIM data exchange for power system model. The bidder would submit the report of CIM certification testing with other Bidders product along with the bid. This tool shall contain database structure (format) definitions and all initialization data to support the generation of all relational and non- relational run-time databases required to implement the system's SCADA & ADMS functions. The tool shall include consistent, coordinated procedures to manage and access the databases regardless of the location of the data or the residency of the database management functions. This tool shall include definition of data fields, structure of application data sets using the global database, database population, correction of entry errors, checkout against telemetry definitions for SCADA functions, checkout against model definitions for power system analysis functions. 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. Help displays shall be available to provide additional, detailed information to the user on request.

Chapter # 10

Dispatcher Training Simulator

10.0 General Requirements

Dispatcher Training Simulator (DTS) shall be provided for SCADA & ADMS system for training of Control Centre Engineers during power system normal, emergency/ disturbance and restoration activities. The DTS shall be installed at MCC where it shall be used to train Control Centre Engineers, trainees and others.

The Simulator shall be a computer system designed to respond to the user's inputs the same way the real power system does, and to interface with and respond to the computer systems designed for monitoring and control of the real system with the same level of fidelity as the real system. The intent is to use such a Simulator as a training facility for Operation and Maintenance staff and other users who participate in the management and administration of the power system, as a facility for testing software, developing displays, applications and database changes, as a study facility for analyzing changes to the System, and as a test bed for developing and testing operating procedures. To support these goals, the Simulator shall also provide functionality to help setup simulation and manage simulation scenarios, for simulation oversight and control, and for review of simulation results and the trainees' performance.

10.1 DTS Features & Functions

The major DTS features shall include:

a. The DTS model shall simulate distribution power system in a realistic manner, including its response to simulated events, Instructor actions, and Trainee actions. The response shall be identical to the response observed by the Control Centre Engineer in the actual computer system environment.

b. The Proposed solution shall simulate all Power System Applications & Purchaser Specific applications mentioned under Chapter 4 & 5

c. The consoles shall be assignable as trainee or instructor consoles. The DTS shall support at least one instructor & five trainees

d. Instructor control features shall include the ability to set up, control, participate in, and review the results of a training session.

e. Control Centre Engineer control feature shall facilitate to train Control Centre Engineer to use all SCADA, operator & Power system application functions under normal & disturbed conditions.

f. An ability to obtain data from the SCADA & Power system Application systems automatically for DTS initialization. The initialization data shall include save cases, predefined & instructor defined scenarios.

g. It shall prevent actions & keep insulated the actions performed by the Instructor and Trainee using the DTS from affecting the real-time system database or the actual power system.

h. An ability to simulate actual system disturbances from historical data "snapshots" stored by the real-Time database Snapshots.

i. DTS function shall have ability to establish the following training conditions as a minimum:

   i. Normal steady state

   ii. Disturbed network conditions for both Transmission & distribution network

   iii. High & Poor Voltage conditions

   iv. Poor VAR conditions

   v. Indiscriminate tripping

   vi. Islanding

   vii. System blackout

   viii. System restoration

   ix. Conditions/functions included for SCADA & ADMS real time system

j. Following features as minimum:

   i. All SCADA & Power system applications functions as envisaged in the specification

   ii. Cry wolf alarms

   iii. Record / Playback / slow/ real time / fast forward

   iv. Record trainee actions

k. DTS Model features, functions & user interface shall be true replica of SCADA & Power system application system model. The DTS can be used in the following modes as minimum:

   i. Instructor Control

   ii. Trainee Control

10.1.1 **Instructor Control**

The Instructor shall be able to perform pre-session, session, and post-session activities. Each training session shall consist of executing a starting from a base case. The base case shall consist of a solved network output case from the load/power flow and one or more load curves. Pre-session activities consist of scenario building and development of events that occur during the training scenario. A load/power flow function shall be provided in the DTS to support this feature. Session activities performed by the Instructor include initiation, control, and participation in the training session.

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

10.1.2 **Trainee Control**

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

10.2 **Pre and Post session activities**

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

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

a. **Snapshot Review** : Shall initialize the DTS with a snapshot saved during a training session. After a snapshot has been loaded, the Trainee and Instructor shall be able to call displays to examine any data available during a session.

b. **Snapshot Resume** : Shall resume the simulation from a snapshot in the same manner as it would resume from a Pause.

c. **Evaluation report** : Based on the actions performed, timeliness & an evaluation report shall be created to review performance of trainee.

10.3 **DTS Database & Displays**

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

10.4 **Scenario Construction**

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

a) Base Case Construction shall allow Instructor to set conditions, parameters, and limitation for equipment in the network database. It shall be possible to initialize a base case from the following sources:

i. A stored base case created in the DTS

ii. A power flow solution obtained in the DTS

iii. A power flow or NCA /SE solution obtained from real-time system

iv. Output of real time SCADA & ADMS executed functions

b) Base Case Store shall allow instructor to save a base case for future use. It shall be possible to transfer saved base cases to auxiliary memory (e.g., magnetic tape) and to reload saved base cases from auxiliary memory.

c) Base Case Select shall allow instructor to select a specific base case for modification or further processing. Base case selection may be indexed by title or subject.

d) Base Case Review shall allow instructor to display the contents of the base case.

e) Base Case Editing shall allow instructor to modify a base case and to store the updated version.

f) Event Group Construction shall allow instructor to construct event groups containing one or multiple events. The Instructor shall be able to define the events within the event group to occur simultaneously or according to other parameters of time or system conditions. Checks shall be performed to assure that each event entered is one of the predefined set of events and that the equipment and parameters associated with the event are valid for the event specified.

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

g) Event Group Store shall allow the Instructor to save the event group constructed for future use.

h) Event Group Select shall allow the Instructor to select one or more event groups for incorporation into a training scenario.

i) Event Group Review shall allow the Instructor to display events within an event group.

j) Event Group Editing shall allow the Instructor to modify an existing event group and to store the updated version.

10.5 **Event Types**

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

a. Change of bus load

b. Change of system load

c. Fault application/FPI indication

d. Circuit breaker trip/close

e. Circuit breaker trip with successful reclosure

f. Circuit breaker trip with unsuccessful reclosure

g. Isolators switching's

h. Supervisory control disable/enable for specific device

i. Relay status enable/disable

j. Loss of DCU, RTU, FRTU due to telemetry failure for specified period of time

k. Loss of single DCU, RTU, FRTU point

l. Replace value of telemetered point

m. Messages to Instructor

n. Pause simulation

o. Demand snapshot.

p. Cry wolf alarms

10.6 **Event Initiation**

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

a. **Time Dependent Events** : These events shall be scheduled by the Instructor to occur at a specified simulated clock time or at time intervals relative to the start time of the scenario.

b. **Conditional Events** : Conditional events shall be based on simulated power system conditions obtained from DTS model. The Instructor shall be able to specify a conditional event by specifying a permissible event and a Boolean equation for the power system condition that will trigger the event. The Boolean equation shall allow the following triggers to be incorporated separately or in combination:

i. A status variable equal to a defined state

ii. An analog variable above or below a defined threshold

iii. Change in analog variable from one DTS cycle to the next by more than a defined amount (positive or negative)

c. **Demand Events** : The Instructor shall be able to demand the immediate execution of an event without having to insert it in the events list.

d. **Relay Initiated** : The operation of a relay shall result in the execution of one or more Instructor-specified events.

10.7 **Session Activities**

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

a. **Pause/Resume** : Shall allow the Instructor to suspend or resume the training scenario without affecting the scenario. While in the Pause mode, the Trainee and Instructor shall be able to call all displays but perform no other functions. The Resume command

shall resume the simulation from the point at which the pause occurred.

b. **Slow/Fast Forward** : shall allow the Instructor to move a training scenario forward at an Instructor-specified speed slower/faster than real-time.

c. **Event Insertion** : shall allow the Instructor to add new events when a training scenario is in progress without the need to interrupt the training scenario.

d. **Event Demand** : shall allow the Instructor to demand the immediate execution of an event.

e. **Event Omission** : shall allow the Instructor to omit a scheduled event from the training scenario in progress without interrupting the training scenario.

f. **Periodic Snapshot** : shall allow the instructor to create a historical file that is periodically updated with session data necessary to resume simulation as it occurs during the simulation. The DTS shall not pause while the snapshots are being collected and saved. The snapshot save area shall be circular in nature where the oldest snapshot will be overwritten each time a new snapshot is saved when the save area is full.

g. **Demand Snapshot** : shall allow the Instructor to create a historical file, identical to that created by a periodic snapshot, on demand during the simulation. The DTS shall not pause while the snapshots are being collected and saved.

10.8 **Simulator Functional Requirements**

The Simulator shall accurately reproduce the actions of the power system, Users, and the computer systems for monitoring and control of the power system as configured in the Centralized SCADA system. The simulation shall operate within such time constraints that the response is reasonably consistent with real-time operation as perceived in Centralized SCADA system.

The power system simulation shall include following:

a) Simulation of power flows in the power system network

b) Automatic Voltage Regulator (AVR) simulation

c) Area frequency dynamics simulation

d) Simulation of protection, including action of the special protection schemes.

e) Islanded operations, with each island having its own frequency.

f) Abnormal Conditions/Operations

i. Bus Fault Conditions

ii. Black Start Operation for a station

iii. Automatic Under Frequency Load Throw at Preset frequencies

iv. Power Transformer Tripping

v. Simultaneous Line Tripping

vi. Stuck breaker Condition

g) Normal Operations

i. Line Outage

ii. Feeder Outage

iii. Bus Outage

iv. Transformer Outage

v. Transferring Line on Transfer Breaker

vi. Transferring Transformer on Transfer Breaker

vii. PT Outages

viii. Reactor Cut in / Cut out / Capacitor Bank Outage

10.9 **System Specifications**

a) DTS package shall be of the same platform as offered for MCC.

b) A separate Standalone Redundant Simulator Server shall have the complete database of all MCC (I/O points as configured in the Real-time system)

c) The System shall be capable of handling 5 Trainee terminals and 2 Instructor terminals.

d) One client out of 5 trainee terminals shall be made available in MCC for Operational Engineers to simulate condition before executing the scenario in Real-time system.

e) Operator Guidance facilities such as logic based operating conditions, interlock logic, notepad, safety tagging etc. shall be made available as per the Purchaser's requirement.

f) Facility to simulate simultaneously different conditions by Instructor / Trainee for the selected station.

g) All functionality shall be same as real-time system such as display graphics, alarm/event, trend presentation etc.

h) Displays shall be custom built to suit Simulator requirement. All mimic displays, lists shall be provided in-line with real-time system. Such as

i. World map

ii. Single line diagram of the stations as configured

iii. SCADA Configuration displays (Station wise)

iv. Report displays

v. Trend Displays

vi. Alarm/Event lists

i) The Simulated Conditions & the Alarms and events generated during the session including the analog parameter variations should be stored in the History database (built-in DTS Server) for future analysis / Trainee's performance evaluation.

j) A facility to store different Scenarios for replay and reuse.

k) Facilities to change steps (conditions) during execution of a scenario by Instructor and evaluation of trainee's reaction. This shall also include the guidance & corrective actions by Instructor.

l) Facility to generate different set of quiz with random selection of questions from a set of question bank based on the topics covered during the training session.

m) User friendly database, display generation tools shall be provided to generate different scenarios by the Instructor. During detailed engineering purchaser will provide common scenario based on day to day operational requirement.

n) System shall support to attach help file in any format (Microsoft office, PDF, Picture) as mentioned below for any equipment and shall be available by click of a mouse button. These help files can consist:

i. Operating procedure

ii. Operator Guidance messages

iii. Interlock logic diagram

iv. Protection system details such as Relay setting

v. Equipment name plate details with picture of the equipment

vi. Station Specific conditions

vii. Dos & Don'ts etc.

o) Offered system shall support projection of any display on large video screen / projector from any of the Instructor and Trainees terminal.

p) The Simulator shall support all of the power system modelling functions required to perform the functions listed above.

10.10 **Power System Dynamics Simulator**

The simulation shall include all network automatic/manual controls, such as tap changing, control of voltage, equipment control and reactive power limiting. In aggregate, the simulator shall model the following:

a. Power system Network

b. Power system frequency dynamics

c. SCADA functionality

d. Over current relays

e. Over voltage relays

f. Under voltage relays

g. Over frequency relays

h. Under frequency relays

i. Synchronism check relays

j. Load Tap Changers (including delayed response)

k. Load Shedding in response to under frequency relay operation

l. Transfer tripping schemes

m. Modeling of multiple islands with individual frequencies, and allowing wide frequency excursions from nominal

n. Ability to simulate power system voltage collapse

o. Synchronization of live islands (internal and external to Purchaser)

p. Pick-up of dead lines

q. Load changes

r. Fault Isolation and Service Restorations

s. Ability to run what if scenarios.

t. Report Generation

10.11 **SCADA Components to be Included**

The Simulator shall provide simulation to a degree that functions associated with real-time operation may be used. The Simulator shall simulate the response of the power system to functional controls from Purchaser's Operators, as if the transmission Purchaser's receiving these controls complied and executed the controls. This means that, in the case of transmission Purchasers who normally receive directives from Load Despatch by means of communications requesting control actions, these messages shall be directed to the Instructor console. The Instructor will be expected to perform actions to model the response of the transmission Purchasers to the directives. The Simulator shall also offer the feature of an Instructor implementing the controls, after receiving a telephone dispatch from the trainee. The Instructor shall be able to perform each directive request with a minimal number of actions from the Instructor's console.

10.12 **SCADA Components to be approximated**

The Simulator shall permit the trainee to practice operations alone or together with an Instructor.

All purchasers' specified functional control actions shall be implemented such that the power system dynamic response may be observed in the simulation. External generation/Power Purchase shall also be simulated. The software and database for the Simulator shall be identical to that of the real-time system with the addition of simulation databases for items that are normally not present in the real-time system, such as the parameters for simulation of the dynamics.

The capability to use a snapshot of the real-time information shall be provided to initialize the starting conditions of a training session. In this regard, the Simulator shall simulate the

response of the power system accurately so that the trainee may study various scenarios as they relate to the current power system conditions.

The Simulator shall provide the function to permit the logging of all instructor, trainee, and power system activities.

The capability shall be provided to initialize the Simulator from historical data stored in the DTS Server. In addition, the Simulator shall also be used to replay historical data without running power system network or dynamic simulator models. Successive snapshots of historical data shall be read from the DTS server at a periodicity selected by the user. The simulated real-time database shall be replaced each time a historical snapshot is read. All Simulator displays shall be updated accordingly.

10.13 **Scenario Builder**

Scenario definition and building for a training session is one of the most important capabilities of the Simulator. The capability shall be provided by the Bidder to define up to a 48-hour long scenario. Provision shall be made for the definition of multiple training cases. Each training case shall be described by defining events. As a minimum, it shall be possible to create scenarios with the following dispatches, operations, and events:

a. Circuit Breaker Operation - Manual and Automatic

b. Trip or Trip/Close on a Breaker

c. Failure of a Breaker to Operate

d. Relay Malfunction

e. Local Control Malfunction (Load Tap Changers, Load Shedding)

f. Limit violations (all types)

g. Permanent Loss of Equipment

h. Change in MW and Mvar

i. Single Bus Load Change

j. Area Load Change

k. Loss of an Interconnection line

l. Occurrence of a Fault (meaning relay operation only, not the simulation of faults)

m. Loss of a Line or Transformer

n. Loss of information from Load Despatcher

o. Islanded operation

p. Receipt of operational alarms.

q. Receiving trouble calls and dispatching field crew.

10.14 **Simulation Management Capabilities**

The Bidder shall provide the Simulator user interface, including displays, control requests, and all other user interface activities that shall be identical to the user interface of the System and all of its features. In addition, the Bidder shall provide user interface for and the functionality to support the following operational capabilities, as a minimum:

a. Start the training sequence at any time within a scenario

b. Stop the training sequence at any time within a scenario

c. Pause the training sequence at any time in the scenario

d. Resume the training sequence at any point in the scenario

e. Replay of a session from an earlier state including all Operator actions

f. Variable real-time speed (fast, normal, slow)

g. Initialize the training base case from any of the following sources:

h. Measurement data as it exists on the System

i. Multiple Simulator save cases

j. A real-time snapshot case saved in the DTS server

k. Scale the system load for different operating conditions

l. Store a scenario and the associated initialization data in the Simulator database. Scenario recall shall be preserved through power system model changes, to the greatest possible extent.

m. On-line pre-defined operator guidance message, operating procedures, attaching note to Alarm/Event.

The operational capabilities described above shall be available in a convenient manner.

It shall be possible to connect any console to the Simulator as well as any number of consoles at the same time, right up to the maximum available on the System. The difference

between a trainee or instructor console shall be based on log-on security. All real time operational log-on authorities and restrictions shall apply within the Simulator, governed by the log-on security system.

The trainee's console shall be able to take on the functionality of the different Operator positions in Purchaser. The instructor shall be able to designate the desired trainee console operating position at the start of a training session.

The Simulator user interface shall contain all applicable displays provided on the SCADA such as:

a. Tabular displays

b. Alarm displays

c. Trend displays

d. Overload summaries

e. Single-Line Diagrams

f. Substation and plant status and control displays to allow the instructor to change device status.

These displays shall be available on the Simulator exactly as they DTS are available on the Real-time System. In addition, control displays shall be available to edit and create training cases for the definition and modification of training sequences and events as well as to re- execute a particular training sequence. It shall be possible for the instructor to modify the training scenario of a particular training sequence during the training sequence; e.g., cause outages for the trainee to respond to. The messages and alarms on the Simulator shall be identical to those of the Real-time system.

Chapter # 11

On-line Backup System

11.0 General Requirements

Growth plan for Automation systems in Purchaser are manifold with interconnected applications, it is a challenge to maintain the system around the clock. For 100% availability efficient and effective storage management has become more difficult than ever before. In view of this Purchaser is envisaging a single point of control for storage management needs, helping to increase the efficiency of automation system and control cost related to storage management. Increase business continuity by shortening backup and recovery times and maximizing application availability with advanced data restoration technology, Purchaser proposes to install On-Line Backup Server. In addition, an external tape drive is also proposed for taking backup any machine.

The backup system shall consist of a SAN storage and Backup software for automatically backing up the system, configuration and operational data. The system should be capable of taking backup of all the systems in the network. It would also be capable for bare machine recovery. The Tape drive attached to the Backup system shall be used for periodically backing up the data on tapes. Archive storage devices shall be used for backup of the all servers' data and software and archival storage for the Information Storage and Retrieval functions (History).

11.1 System Functions

External SAN storage shall be provided for back-up purposes and archiving. The storage drive shall have sufficient capacity for a complete backup of the data and software (including all source code) without requiring user action. The advanced, scalable product shall be considered for performing a variety of tasks through policy-based automation, including:

a. Backup and recovery

b. Single click Image backup and restore facility

c. Archiving and retrieval

d. Disaster recovery

e. Space management

f. Online database and application protection

g. Bare-machine recovery

h. Continuous data protection

On-line backup system shall be centralized, web-based administration and intelligent data move-and-store technique to ease storage management. It shall support PCs, servers of any operating system (Linux / UNIX / Windows). It shall also facilitate a multitude of connections such as, Internet; wide area networks (WANs) and local area networks (LANs) including:

11.1.1 **Automate migration**

Automatically migrate managed data from one media type to another.

11.1.2 **Conduct multilocation backups**

Write directly to disk, tape or optical pools, with the option to write to multiple locations at the same time.

11.1.3 **Conduct progressive incremental or sub file backups**

Use a relational database to track metadata and conduct progressive incremental backups of only files that have changed since the last backup to help shorten the backup window, eliminating resource consuming full backups.

11.1.4 **Facilitate disaster recovery**

Provide a daily-updated disaster recovery plan and restore only the files you need to conduct high-speed, policy-based disaster recovery, business continuance or both.

11.1.5 **Use hierarchical storage management**

Automate space management to achieve life-cycle management.

11.1.6 **Implement retroactive policy changes**

Apply policy changes retroactively to previously backed-up or archived data.

11.1.7 **Manage archives**

Retain important documents for a specific time period in long-term storage.

11.1.8 **Extend beyond traditional backup and recovery**

Utilize advanced disk replication capabilities to perform high-performance, low impact backups.

11.1.9 **Bare-machine recovery**

Return the system to the state of the last backup, recovering all the operating system changes and customizations, streamlining the recovery process and eliminating the need for skilled professionals to manually reinstall hardware, network configurations and patches.

11.1.10 **Storage Feature**

Intelligent data movement to save tapes, processing cycles and network bandwidth. Direct-to-disk storage so the number of client machines moving data is not controlled by how many tape drives are available.

11.1.11 **Other Features - Operational reporting:**

a. Daily updated information on the number of files backed up, missed backups, the number of tapes available & errors encountered.

b. Computers with failed backups

c. Sufficient tapes not available

d. Tape drive is offline

11.2 On-Line Backup Server

11.2.1 **Historical Information Data Retrieval**

The data stored in the IS&R 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 upto 24 hours. The features of Tabular/graphic trend is mentioned in the specification for User interface.

c. The HI retrieval shall expose the IS&R Data over SOA / Enterprise Services BUS Supplied by ITIA, over CIM/XML, Secured ICCP or OPC / ODBC Interfaces / Adapters.

d. The retrieval shall provide 100% accuracy and fidelity of data

11.2.2 **Mass Storage of Data / Files**

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

a. 20 save-cases for each ADMS application

b. 20 Output results of each ADMS applications

11.2.3 **Data Recovery Function**

The DR function is a repository of system build up software of all systems of MCC and BCC. One-year online backup shall be available at location identified by the Purchaser (i.e. Purchaser's ICT Data Centre) with data pertaining to all system i.e. system build ups shall be available of each system separately so that the same can be utilized upon setting up newer system after disaster. The data related to network model of SCADA & ADMS Control Centre i.e. MCC & BCC shall be sent to DR Centre periodically once a day & upon user request. The data shall be configured to be sent globally & incremental. All logs, data model etc. & necessary interfaces that are essential for complete system build up shall be stored at DR Centre. All requisite data which is builds the system from scratch shall be transferred to DR. An alarm shall be generated & send to SCADA & ADMS control Centre upon attaining user defined threshold e.g. 80% for storage at DR Centre

Chapter # 12

Communication Network Management System

12.0 Communication Network Management System

12.1 **Network Management System & Security Information and Event Management (SIEM)**

12.1.1 Reliable, Secured and highly available communication infrastructure is the backbone for any real-time system used for remote monitoring and control, and connects geographically spread Sub-Stations with the Central Systems.

12.1.2 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.

12.1.3 The NMS software provide the following network management capabilities:

a. Configuration management

b. Fault management

c. Performance monitoring

12.1.4 Bidder shall integrate all Network devices, Servers and workstation with existing NMS of Tata Power system.

Integration shall enable following network management functions

a. Maintain performance, resource usage, and error statistics for all of the above interfaces (i.e. servers, workstation consoles, devices, Routers, Layer-3 switches, 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 two years 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.

12.1.5 The network management platform proposed shall be capable of managing an infrastructure that consists of multi Bidder network elements. Integration shall also facilitate following Network management system activities as per ISO network management model:

a. Fault Management to recognize, isolate, log and identify fault on network and connected machines, nodes, devices.

b. Performance Management to monitor system and network performance as specified

c. Configuration Management to collect information about computers in the system such as processors, memory, peripherals and processes running on computers and configuration aspects of network devices such as configuration file management.

d. Security Management to protect systems and network from unauthorized access, manage user access, authorizing rights and privileges

The network management software shall be based on the secured version of Simple Network Management Protocol (SNMP) for fault management and performance monitoring platform for long term performance management and trending. The NMS system shall have a simple browser-based user interface to provide all the pertinent information about the system. The user interface software shall be installed on all the Operator as well as programmer workstations. The NMS shall not impact the availability and performance of SCADA system and shall load not more than 3% any host CPU, 1% Network bandwidth and shall have secure communication. The Network management system shall monitor the performance, resource usages and error statistics of all the servers, workstations, routers and LAN devices, SDH multiplexers, etc. including for networks extension

12.1.6 **Fault Management**

The following functions shall be included:

a. Network discovery

b. Topology mapping of network elements

c. Event handler

d. Performance data collector and graphic

e. Management data browser

Each monitored device shall be represented by a graphical element on the management platform's console. Different colors on the graphical elements shall represent the current operational status of network/device. A graphical display for connectivity and status of servers and peripheral devices for local area network shall be provided.

The monitored devices shall be configured to send notifications (SNMP traps) to the NMS. The graphical element representing the device shall change to a different color depending

on the severity of the notification received. The notification shall also be placed in a log file. The current version of MIB file of each of the devices shall be loaded on the NMS.

NMS system shall also be capable of handling RMON (Real-time monitoring) alarm and events from the critical network devices. RMON shall be generated in case of environmental factors (power supply, temp etc.) or resource utilization factor (CPU utilization, Bandwidth utilization etc.).

Issue alarms when error conditions or resource usage problems occur.

12.1.7 **Performance Management**

The performance management part of NMS shall maintain performance, resource usage, & error statistics and present this information via displays, periodic reports, and on-demand reports. Including the following:

a. Utilization (CPU utilization as applicable) for

i. Servers, Workstations, Storage Devices

ii. LAN, Router, Switches

iii. Data Links

b. Bandwidth utilization for Routers/Switches Various interface statistics such as input queue drops, output queue drops, and ignored packets shall be connected from network devices to measure the performance level.

c. Memory utilization, Auxiliary memory I/O utilization, of

i. Servers and Other Machines

ii. Mass Storage Devices

Apart from real-time monitoring, the above information shall be collected and stored at user configurable periodicities i.e. 5 minutes to 60 minutes. The Network Management System (NMS) shall be capable of storing the above data for a period of two years at a periodicity of 5 minutes.

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.

Chapter # 13

Cyber Security Management System

13.0 Cyber Security Management System

13.1 Cyber Security

Tata Power has existing cyber security system for operation technology as listed below. **Integration of offered ADMS system with existing cyber security system is in bidder scope.**

Sr.no	Cyber security components	Client - Model / Version	Server - Model / Version	No. of License to be supplied
1	Trend Micro Apex one (AV for Workstation)	14.0.10101	Trend micro-Apex one server Build- 10101	50
2	Trend Micro Deep security (AV for Server)	20.0.4185	Trend micro deep security Manager Version-20.0.703	60
3	Manage Engine (patch management)	11.2.2300.7	Manage Engine Endpoint Central 11 - 11.2.2300.7	100
4	Carbon Black suite (File integrity solution)	8.7.2.420	carbon black app control - 8.9.4.55	100
5	Tripwire (Central Syslog server)	10.0.17763	Tripwire Log Center Manager - 7.5.2.57	As per solution qty
6	Firewall management System - Fortinet	-	FortiMAnager-v7.0.7 build0419	As per solution qty

1. Bidder shall study existing cyber security infrastructure of Tata Power and confirm the compatibility of all software and applications supplied as part of ADMS system with existing cyber security system mentioned below. Bidder shall clearly mention if there is any non-compatibility of these cyber security software with ADMS software/applications.
2. Bidder shall supply and install all software component such as upgradation of license in central cyber security servers and installation of client software and necessary configuration at both server and client end.
3. Bidder shall ensure that there will not be any degradation of performance of ADMS system applications because of the computing resources shared by cyber security clients installed on ADMS system machines. The sizing of these machine shall be done considering the additional processing load of the cyber security software installed in these machines.
4. All necessary configuration tuning required for securing the ADMS infrastructure will be in bidders cope.
5. Bidder shall mention additional cyber security controls if anything is required and include the same in proposal for strengthening supplied ADMS system to comply to order and guidelines issued by CERT.IN and any other notified MoP/Nodal agency /CEA from time to time.
6. Bidders shall ensure compliance of FEP server interface with the equipment indicated in the MoP order no 12/34/2020-T&R dtd 08.06.21 & CEA/PLG/R&D/MII/2024 dtd 11.6.21 and any amendment from time to time shall be adhered to.

7. Offered product platform shall have enhanced cyber security feature such as Zero Trust software architecture, Multifactor authentication, Transport Layer Security (TLS) Protocol for secure connectivity between ADMS system applications and role based access control (RBAC)

Operating system

1. The operating system of all the equipment of ADMS system including network equipment shall be latest version prior to FAT. The operating system shall be hardened to provide robust security. The operating system and data file shall be placed in different disk partitions. In order to facilitate cyber security requirements including patch management, common operating system is preferable to be used by all server nodes within the ADMS system. It is preferred to have Linux operating system for critical servers.
2. Microsoft Windows operating system will be procured by Tata Power as enterprise element as per system requirement offered by bidder.

The existing Operational Technology systems requires robust cyber security implementation; therefore, it is intended to provide robust cyber security management system, including relevant cyber protection for field and control Centre devices. Bidder shall ensure that proposed system meet all requirement of cyber security mentioned in this section and propose any additional hardware or software if required to mitigate any Gap still exist in existing cyber security system mentioned above in 13.1 table

The cyber security risks which are compounded due to the distributed architecture at multiple interfaces/systems at MCC, BCC, it is proposed to provide centralized cyber security and communication network management system, which shall also include the appropriate measures for individual devices at sub-station and Control Centre.

Corporate networks also provide numerous points of access from the Internet to support marketers, billing specialists, consumers and regulators, these connections are protected through Firewalls-IPS. This increasingly open and complex architecture has dramatically increased security risks.

Regular review of vulnerabilities and risks, as well as administration practices, is absolutely necessary to identify new risks and reduce them to acceptable levels. In addition, regular assessment helps to measure progress toward the organization’s security management goals.

The proposed Centralized Cyber Security Management System shall felicitate purchaser for Firewall Management, Security Patching, IDS, IPS, Network Port Management, System Hardening, Remote Access Control and Monitoring, Customized Source Code Review and Revision, AAA, Patch Management, Anti- Virus Management, Anti-APT Management, Anti- Bot Management, Network Partitioning and Security Zones, Network Intrusion Detection.Bidders scope shall include designing of cyber security architecture and operation plans as per Critical Infrastructure Protection (CIP) guidelines of NERC (North American Electric Reliability Corporation) which shall be certified by a third-party Audit agency (approved by CERT-in, NCIIPC).

13.1.1 The Bidder shall certify that its systems and products have undergone cyber security testing by leading and independent government sanctioned organizations.

13.1.2 This solution should be designed to protect critical infrastructure, control systems and operational technology (OT) assets. It should monitor and block malicious activity and misconfiguration, providing easy-to-apply controls for network segmentation and improved visualization of the Electronic Security Perimeter. It should help mitigate the exploit of known equipment vulnerabilities as operators await Bidder patches or patch maintenance windows.

13.1.3 The Industrial Cyber security solution shall adhere and comply to IEC 62443 cyber security standards.

13.1.4 The bidder shall submit cybersecurity certification for ISO 27001, ISO 027701:2019, ISO 30111:2019, ISO 29147:2018, IEC 62443-4-1.

13.1.5 Product manufacturing and development shall adhere and comply to IEC62443-4-2. The product Bidder/OEM is responsible for the development and testing of the security system products comprising of the application (antivirus, whitelisting etc.), embedded device (PLC, DCS etc.), network device (firewalls, routers, switches etc.), host devices (operator stations, engineering stations etc.) working together as system or a subsystem defined in IEC 62443 3-3, IEC 62443 4-1, IEC 62443 4-2

13.1.6 The system integrator is responsible for the integration and commissioning of System using a process compliant with IEC 62443 2-4, IEC 62443 3- 2, IEC 62443 3-3

13.1.7 This solution shall provide multiple capabilities to support cyber security best practices. Functionality includes centralized patch management, anti-virus/host intrusion detection updates, centralized account management, logging and event management, intrusion detection, whitelisting, and automated backup.

13.1.8 The Vendor shall verify that the addition of security features does not adversely affect connectivity, latency, bandwidth, response time and throughput (including during the Site Acceptance Testing (SAT) when connected to existing equipment).

13.1.9 Security Solution that will be implemented should be have capability of all four Security Levels on the basis IEC 62443 3-3 and IEC 624434-2, description of which is given below for bidder's reference: -

13.1.10 Security Level (SL) concept focus on the zones of the OT/ICS. SLs provide a frame of reference for making decisions on the use of countermeasures and devices with different inherent security capabilities. The concept can be used to select the OT/ICS devices and

countermeasures to be used within a zone and provides the ability to categorize risks for zone or conduits. The SL can also be used to identify layered Defense-in-Depth strategy for a zone that includes hardware and software base technical countermeasures.

13.1.11 The security levels defined for components are based on the four types of device categories defines in the standard i.e. embedded device, host devices, network devices and application software, which are also depicted in the following table

Security Levels	Description
SL1	Capability to protect against casual or coincidental violation
SL2	Capability to protect against intentional violation using simple means with low resources, generic skills and low motivation
SL3	Capability to protect against intentional violations using sophisticated means with moderate resources, IACS specific skills and moderate motivation
SL4	Capability to protect against intentional violations using sophisticated means with extended resources, IACS specific skills and high motivation

Table A: Security Levels Categorization

13.2 **Solution Hardening**

Solution Hardening relates to reducing automation solution attack surface, including risk assessments, detection of threats and vulnerabilities, and management of USB ports. Bidder shall consider the following aspects for Solution Hardening

13.2.1 All user authentication shall be with Bio-Metric authentication.

13.2.2 Security-segmented reference architecture and hardening measures designed to reduce exposure to security threats.

13.2.3 System hardening evaluations specific to the security environment and policies of each site locations are conducted.

13.2.4 Firewall and IDS placement and their rules are specified as part of the architecture. Switches can be locked down.

13.2.5 Unnecessary ports, services, and programs are removed or disabled from workstations, servers, and controllers, thus eliminating them as an avenue of attack.

13.2.6 Workstations employ session locking for protection while unoccupied.

13.2.7 Identification of missing security patches is automated.

13.2.8 Workstations and servers employ anti-virus software and capabilities for validating and installing the latest virus definition files.

13.2.9 Tata Power procedures ensure that portable media used during integration and maintenance are authorized, virus-free, and not used for other purposes

13.2.10 All system constituents shall be hardened, i.e. all external access shall be controlled and set to deny/disable all by default. This shall involve closing/disabling network accessible ports/protocols and services, and implementation of proper authentication and encryption schemes of all external communication. Unnecessary ports and services shall be disabled. Documentation shall be provided describing the required service so that system administrators can set up the firewall appropriately. Also, scripts shall be provided to help harden the operating system. Network devices must also be configured to match the requirements of the SCADA system. All the unused ports on the Switches and Routers shall be disabled. Similarly, all USB ports in the computers shall be disabled

13.2.11 Network security and robustness testing should be conducted on products used in solutions to ensure reliability and integrity

13.3 **Network Security**

Network security Capabilities relate to supporting the segmentation and administration of networks.

13.3.1 Network security architecture should segment the WAN networks from the control system by firewall and Intrusion Detection System (IDS) configured with recommended rules

13.3.2 Network security architecture should protect internal interfaces with managed switches that can be locked down.

13.3.3 The solution provided should follow defense in depth security mechanism, full segregation on network wherever there is communication with external world.

13.3.4 Solution shall gather asset inventory and threat data to improve the safety and availability of OT environment. It shall happen by analyzing network traffic and conducting protocol deconstruction to inventory assets, create network topology, and more. Solution shall be

fluent on the native industrial protocols commonly found in OT & ICS making sense of the floods of data produced by Purchaser's entire range of IIoT connected industrial devices.

13.3.5 Solution shall analyze network communication by listening through mirror or SPAN port of Industrial switches, interpreting and dissecting protocols without disrupting normal operations. Legacy OT networks can be sensitive to latency and bandwidth changes, hence monitoring to help keep the network undisturbed.

13.3.6 Solution shall provide ICS / SCADA operators with holistic visibility into the devices and activity on their network. It should detect controller configuration and mode changes, with event logging capabilities for trending/dashboards, and performs threat modeling to help keep the most sensitive assets out of intruders' reach. This solution shall protect the core integrity and cyber resilience of your OT environment, using sophisticated monitoring and detection to keep you operating at peak availability and uptime.

13.3.7 Secure remote access connectivity should have customized upon request, typically through a combination of RDP firewalls and access controls. The solution should support administration of network devices and enforces multi-factor authentication and encryption of network administration traffic.

13.3.8 The solution should include Cyber Asset Protection Service, Network Intrusion Detection (NIDs), include Host Intrusion Detection (HIDs) and anti-virus.

13.3.9 Wireless access should have prohibited on the control system network.

13.3.10 Control systems should be designed and installed to reduce interactions between networks, specifically the supervisory/HMI network, the control network, and I/O networks. The I/O network, where control system I/O is located, is physically separated from all other networks.

13.3.11 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.

13.4 **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 Bidder shall provide a tightly integrated intrusion detection system to detect and prevent intrusion.

Followings are the functional requirement from the security system:

13.4.1 System shall have Multilayer (at least network, application layer) firewall which shall protect the complete system network from unwanted users. Further the preferably a 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.

13.4.2 Gateway Firewall should be capable of load balancing multiple links from different service providers.

13.4.3 LAN Firewall shall provide isolation/security services between the subsystems

13.4.4 Firewalls deployed should not become a bottleneck. It shall be Robust, Secure, Scalable and future-proof with Centralized Management.

13.4.5 Two types of IPS Host based & Network based shall be deployed with minimum hardware & they should not go blind in peak traffics.

13.4.6 IPS should have hybrid technology to detect attacks. It should detect through a combination of Protocol Anomaly and Signature matching.

13.4.7 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.

13.4.8 Shall have strong authentication containing user name and passwords which shall be very difficult to compromise.

13.5 **Coding Practices**

The proposal should include a section that describes the development practices and standards applied to Vendor-written control system software (including firmware) used to ensure a high level of defense against unauthorized access. Responses should also discuss assurances that source code is developed and supported within trustworthy countries and not circulating in unstable foreign areas. The Vendor must disclose all the countries in which the source code has been distributed. All critical control system software should be developed by the supplier in a contained environment with development and maintenance staff having undergone the required background checks. Outsourcing of development to off- shore entities with unproven security track records will not be accepted.

13.6 **Intrusion prevention system (IPS)**

The Bidder shall provide 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 the application server with NMS. 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 eight years shall be provided and there should be provision for creating customized signature.

13.6.1 **Intrusion Prevention System (Network Based)**

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

a. Capability for Detecting the intrusion attempt that may take place, intrusion in progress and the intrusion that has taken place

b. Reconfigure the firewall provided in this package.

c. Beep or play a .WAV file

d. Send an SNMP Trap datagram to the management console. The NMS server envisaged under the specification shall be used as management console also.

e. Send an event to the event log.

f. Send E-mail to an administrator to notify of the attack.

g. Save the attack information (Timestamp, intruder IP address, victim IP address/port, protocol information).

h. Save a trace file of the raw packets for later analysis

i. Launch a separate program to handle the event

j. Forge a TCP FIN packet to force a connection to terminate.

k. Detect multiple forms of illicit network activity: -Attempted

l. Vulnerability Exploits -Worms -Trojans -Network Scans -Malformed Traffic -Login Activity

m. 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 Bidder shall also apply its power control and security experience to enhance these detection rules for specific issues within the system.

13.6.2 **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

a. Send an SNMP Trap datagram to the management console. The NMS server envisaged under the specification shall be used as management console also.

b. Send an event to the event log. Send e-mail to an administrator to notify of the attack.

c. 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,

d. 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:

e. Terminate user Login (intruder)

f. Disable user Account (intruder)

g. Administrator can define the action to be taken

h. Forge a TCP FIN Packet to force an intruder connection to terminate.

i. Should provide events check for suspicious file transfers, denied login attempts, physical messages (like an Ethernet interface set to promiscuous mode) and system reboots.

13.7 **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 must features are as following:

a. It shall have Policy-based URL filtering and Dynamic Document Review.

b. It shall protect web traffic with high-performance, integrated virus scanning and web content filtering at the gateway

c. It shall ensure protection by combining list-based prevention with heuristic content analysis for both virus protection and web content filtering

d. It shall eliminate unwanted content and malicious code & Scan all incoming and outgoing HTTP and FTP traffic etc.

e. 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.

13.8 **Central Cyber Security Management System**

Bidder has to integrate supplied Fortigate firewall with existing Firewall management system. All necessary license and services required for integration of this firewall with existing firewall management system (FortiMAnager-v7.0.7 build0419) shall be in bidder scope

The Centralized threat management system shall be capable of displaying real time & historical information of the connected Firewall, IDS, IPS systems and the threats encountered / logged / quarantined. This system will be used for data acquisition and management of Station Level Intrusion Detection System (IDS) installed at the station level and Next Generation HA Firewalls installed at the MCC and NCC control centre interfaces.

Main Functionalities of this system will be as follows:

a) Gathering of cyber logs generated by IDS at various substation

b) Taking automated actions/raising alarms, whenever any vulnerability/anomaly is detected

c) Gathering patch updates include antivirus updates from patch management server

d) Rolling out patch updates to all the systems connected to CSMS such as IDS, Firewall, etc.

e) Automatically rolling out Zero-day updates at a particular time of the day to Firewalls and IDSs

f) This system shall have advanced machine learning capabilities to recognize pattern, algorithms and pre-diagnostic features.

13.9 **Web Browser Based View-Only Access**

The Bidder shall provide access to SCADA displays such as graphical world map, substation one-line and tabular displays using a web browser-based view-only user interface. The user interface shall support the use of multiple devices including desktops, laptops, tablets and smartphones. Multiple web browsers such as Internet Explorer, Chrome, or Firefox shall be supported and shall not require any special plugins, browser cookies, or Java. Panning and zooming shall be supported on each of the listed devices including touch screen pinch to zoom support on tablets and smartphones. The web browser-based user interface shall not require additional display creation tools but shall use the same standard display editing tools within the SCADA system.

The Remote User Server hosting the web browser-based GUI shall be located on a DMZ to allow secure access to remote users without affecting the critical production SCADA assets. The Remote User Server shall be configured in a way that high traffic or loss of integrity of the server will not affect the critical production SCADA servers. Secure login techniques shall be utilized including the use of encryption, complex passwords and limiting the number of incorrect login attempts by requiring a captcha or locking the account.

Login and role-based data and display Area of Responsibility (AOR) permissions shall be used to serve the data or displays only to authorized users. All activity shall be logged including login, logout, session timeout, and display requests.

The Bidder shall provide, within a pre-negotiated period, appropriate software and service updates and/or workarounds to mitigate all vulnerabilities associated with the product and to maintain the established level of system security.

The Bidder shall provide documentation of input sanitization for all Web-form inputs, including but not limited to, measures for prevention of command injection, SQL injection, directory traversal, RFI, XSS and buffer overflow.

The Bidder shall follow secure coding practices and reporting for all Web-based interface software. This requirement includes both Web applications and Web servers.

The Bidder shall provide an independent third-party security code validation of all Web- based interface software.

The Bidder shall provide web based SCADA/ADMS clients (thin, unlimited) for corporate users. The system shall support network view, geographic maps, tabular views, single line diagrams and shall have same look and feel as the real time SCADA/ADMS displays. It shall

be accessed by diverse set of external users through commercially available web browser e.g. Microsoft Internet explorer, Google Chrome etc. It shall also be possible to access the data and display by using mobile phones/ tablets on various OS i.e. android, iOS etc. It should also support mobile app features.

13.10 **Malware Detection and Protection**

The Bidder shall disclose the existence and reasons for any known or identified backdoor codes. The Bidder shall meet one of two conditions:

a. Provide a host-based malware detection scheme for the control system network. The Bidder shall verify adequate system performance for host-based malware detection, quarantine (instead of automatically deleting) suspected infected files and provide an updating scheme for the signatures. Prior to Factory Acceptance Testing (FAT), the Bidder shall also test major updates to malware detection applications and provide performance measurement data on the impact of using the malware detection applications in an active system. Measurements shall include, but are not limited to, network usage, CPU usage, memory usage and any other impact to normal communications processing.

b. If the Bidder is not providing the actual host-based malware detection scheme, the Bidder shall suggest malware detection products to be used and provide guidance on malware detection settings that will work with Bidder products.

13.11 **Firewall for OT systems**

13.11.1 **Introduction**

This specification has been prepared for Bidder to assist Purchaser for supply and commissioning of Central Cyber Security / Threat management systems along with all security systems and accessories at

Bidder shall supply internal firewall as per below specification of Fortinet make.

All necessary license and services required for integration of this firewall with existing firewall management system (FortiMAnager-v7.0.7 build0419)

a) Next Generation High Availability Firewall placed between the DMZ LAN-F network and the SERVER LAN-C network.

b) Next Generation High Availability Firewall placed between the DMZ LAN-F network and the external Corporate/ IT WAN network.

The proposed solution architecture should be robust enough to protect the infrastructure from unknown threats arising in the future. The Centralized threat management system shall be capable of displaying real time & historical information of the connected Firewall systems and the threats encountered / logged / quarantined.

Following are the key requirements for next generation Firewalls:

a) Solution should be Next-Generation Aware with Application & User Visibility.

b) Solution should detect and prevent both known and unknown threats at the Network level.

c) Should provide detailed Logging & advance reporting with forensic Analysis

d) Should provide ability to integrate with 3rd Party Intelligence

e) Should integrate & share threat intelligence with existing point solution.

f) Central Management

g) Incident Response service (in case of any threat/incident) will be on rate card basis in case required, Selection of agency to carry out IR service will be decided by the Purchaser.

The document covers the specific requirements for complete design, detailed engineering, manufacture, supply, inspection & testing at Bidder's work, packing, transportation, loading and unloading, delivery to site, storage at site, handling at site, erection, testing, commissioning, integrating with existing network system, performance testing and handing over of Communication - Firewall System at site

All equipment, system and services covered under this specification shall comply with all current applicable statutory regulations and safety codes in the locality where the equipment is proposed to be installed. The equipment and systems shall also conform to the latest version of applicable codes, standards and software versions on the date of offer made by the Bidder unless otherwise indicated. Nothing in this specification shall be construed to relieve the Bidder of this responsibility

13.11.2 **Technical Parameters of Equipment Including Data Sheet**

Minimum Technical Specification for Industrial Firewall (Next Generation Firewall)

13.11.2.1 **General Requirements**

a) The proposed security solution must be in the Leader’s quadrant in the Gartner "Magic Quadrant for Enterprise Network Firewalls" for atleast 2 years (within recent period of 5 years)

b) Proposed solution should have Multi-Layer Threat Prevention suits with controls embedded like IPS, Anti-malware, Anti-bot, application-visibility, Anti-APT etc. Bidder to confirm individually all the functional requirements

c) The proposed solution should have a Multi-tier engine to i.e. detect & Prevent Command and Control IP/URL and DNS

d) Network security appliance should support "Stateful" policy inspection technology. It should also have application intelligence for commonly used TCP/IP protocols like telnet, ftp etc.

e) Solution Architecture should be distributed deployment - NGFW firewall with threat Prevention features enabled & centralized Management for Policy management, advance Logging, Reporting features.

f) The security Bidder/OEM should have a local TAC support in India with 24x7 coverage.

g) The OEM should have an experience of selling/deploying similar solution in India based customer and should be willing to provide reference as and when asked

h) Proposed solution shall not have been reported for any backdoor vulnerability in their operating system of NGFW in past 3 years. Bidder shall submit an undertaking in this regard along with its

i) The proposed solution or hardware model should be at least 1 year old and deployed in the field.

13.11.2.2 **Performance and Availability**

a) Minimum 1 Gbps of enterprise mix Threat Prevention throughput (includes Firewall, Application Visibility Web Filtering, IPS, AV, Anti-spyware, anti-APT etc enabled). The Bidder must produce datasheet as publicly available document.

b) Min 150000 concurrent sessions shall be supported by the offered system

c) Min. 10,000 new sessions per second

d) Appliance should have 8Gb RAM which can be expandable in future.

e) The proposed solution should have an integrated solution for IPSEC, site to site, Client to site, and SSL VPN. Should support Perfect Forward Secrecy (PFS, ECDHE cipher suites) etc.

13.11.2.3 **Hardware & Interface requirements**

a) The platform must be supplied with minimum 8 x 10/100/1000GE RJ45 inbuilt interfaces & ready to support additional interfaces in future with expansion if required. Fiber ports 4

numbers (loaded with 80Kms Single mode SFP. Firewall supplied should be in HA configuration at each location. Additional spare slot for accommodating future ports (min. 4) to be suitable considered

b) Appliance should have minimum 1 no. of free network interface slots from day one. Appliance should also be compatible to support 2 x 1GE SFP ports for future scalability

c) Firewall Appliance should have separate console port, HA Port, Mgmt and USB Ports. No Traffic ports will be used for HA or Management.

d) Firewall Appliance should have a feature of holding multiple OS images to support resilience & easy rollbacks during the version upgrades. On-board storage for minimum period of one month and shall push the logs and other data to the central system before clearing these logs

13.11.2.4 **Routing Protocols**

a) Solution should support Dual Stack with IPv4 and IPv6 functionality & should support IPv6 NAT functionality NAT66 and NAT64. should support creating rules with IPv4 & IPv6 objects simultaneously

b) Solution should be supplied with High Availability with Active/Passive or Active/Active LS functionality

13.11.2.5 **Firewall Features**

a) Firewall should provide application inspection for LDAP, SIP, H.323, SNMP, FTP, SMTP, HTTP, DNS, ICMP, DHCP, SNMP, etc

b) Firewalls should seamlessly have integrated for reporting to any third-party systems or SOC solution at present or in future

c) The platform must be supplied with minimum 8 x 10/100/1000GE RJ45 inbuilt interfaces. Fiber ports 4 numbers (loaded with 80Kms Single mode SFP. Firewall supplied should be in HA configuration at each location. Additional spare slot for accommodating future ports (min. 4) to be suitable considered

d) Offered products should be of latest hardware / software versions and not obsolete for minimum of 10 years along with support for spares updates and services

e) The firewall should support transparent (Layer 2) firewall or routed (Layer 3) firewall Operation

f) Firewall should support 802.3ad link aggregation functionality to group multiple ports as single port

g) Firewall should support static NAT, Dynamic NAT and PAT

h) Firewall should support IPSec data encryption

i) It should support the IPSec VPN for both site-site and remote access VPN

j) Control SNMP access through the use of SNMP and MD5 authentication.

k) Firewall must support unlimited policy option.

l) The firewall must support more than 3500 Addresses/host objects by per address/object group

m) Firewall must have support of at least 1000-time based policies

n) Solution must support access control for at least 150 predefined services/protocols

o) Solution must support data integrity with AES-XCBC

p) It should support the authentication protocols RADIUS, LDAP, TACACS, and PKI-x.509 methods

13.11.2.6 **Integrated IPS Features**

a) IPS Engine should protect from at least but not limited to Vulnerability and Exploit signatures, Protocol validation, Anomaly detection, Behaviour-based detection, Multi- element correlation.

b) IPS should activate protection for both Client Protection and Server Protections. IPS Profile should allow tuning of IPS signatures that can be activated/de-activated as per Purchaser's environment

c) IPS should provide Protection against Injection Vulnerabilities SQL Injection, Command Injection, LDAP Injection, HTTP Command Injection, plus Application layer protections for Cross site scripting, Directory traversal etc. IPS should support customized blocking SQL and Command Injection by Keywords traced in form field GET, POST etc

d) IPS should provide detailed information on each protection, including: Vulnerability and threat descriptions, Threat severity, Release date, Industry Reference etc.

e) Protection against Malicious code for Buffer Overflow, Heap overflow and other malicious executable code attacks that target Web servers and other applications without the need of signature

f) Should be able to identify attacks based on Geolocation and define policy to block on the basis of Geo-location

g) Signature based detection using real time routine updated database & should have threat signatures to cover at least 6000+ CVE from day one, also Bidder must supply evi

h) dence of leadership in protecting Microsoft vulnerabilities

i) IPS must have one-click single option to predefine action such as detect and prevent for newly signature downloaded in signature updates.

j) The administrator must be able to automatically activate new protections, based on configurable parameters (performance impact, threat severity, confidence level, client protections, server protections)

k) IPS must support exceptions based on source, destination, service or a combination of the three.

l) IPS must have protections related to SCADA/ICS protocols and vulnerabilities

m) IPS events/protection exclusion rules can be created and view packet data directly from log entries with RAW Packets and if required can be sent to Wireshark for the analysis.

n) IPS must have a software based fail-open mechanism, configurable based on thresholds of security gateways CPU and memory usage

o) IPS must have protections for known ICS/SCADA Bidders such as Rockwell, Siemens, Schneider, GE, ABB etc.

13.11.2.7 **Antivirus & Antibot**

a) The proposed solution should be able to block traffic between infected bot Host & Remote C&C Operator and should allow the traffic to legitimate destinations

b) The proposed should inspect HTTP, HTTPS, DNS & SMTP traffic for the detection and prevention of the Bot related activities and Malware activities.

c) The proposed solution should have an option of configuring file type recognition along with following actions i.e. Scan, Block, pass on detecting the Known Malware. Should allow blocking of known malware file-types directly from firewall.

d) The known Malware scanning should not be restricted by the any specific limit on the size of the of the file(s) & should support achieve scanning to detect threat hidden in achieve

e) The proposed solution should be able to detect & prevent the malware by scanning at least 20 different file types with configurable option to inspect, bypass or blocked various file- types as per organization need.

f) Reverse engineer malware in order to uncover their DGA (Domain Name Generation)

g) The proposed solution should prevent the users to access the malware hosting websites and/or web resources.

h) The solution should have the intelligence to analyse & detect known threats as well as the unknown threats which are commonly known as zero-day threats by integrating with the threat protection solution which should be an appliance and implemented on-premise as sandbox solution.

i) The solution should detect C&C traffic according to dynamic ip/url reputation

13.11.2.8 **Application awareness, Web-filtering & User visibility**

a) Firewall should support Identity based controls for Granular user, group-based visibility and policy enforcement using Identity Awareness functionality.

b) Solution should support Upload / Download bandwidth control feature per User, Group or Application regardless of port, protocol etc

c) The proposed solution must delineate different parts of the application such as allowing Facebook chat but blocking its Facebook-post / file-upload capability etc.

d) Solution should be able to natively understand & should have ability to control ICS applications like Modbus, OPC (OLE for Process Control), TCP /IP.

e) In addition to afore mentioned protocols, solution must be able to understand any other protocol such as CIP-Ethernet-IP, Profinet, Cygnet-SCADA, IEC-60870-5-104, V-net, VL-net, V-net IP etc.

f) Solution must have more then 500+ SCADA related application signatures

g) Identity Awareness should support integration with multiple identity sources like AD, LDAP, Radius & 3rd Party customized identity sources such as NAC, WLC etc.

13.11.2.9 **Management & Reporting functionality**

a) Entire solution should be managed from appliance based centralized management solution. The communication between all the components should be encrypted with SSL or PKI.

b) Bidder to consider storage for minimum period of 2 years. Bidder to provide facility to push the stored data to external storage system and shall support which can be retrieved and analysed on the central system

c) Management should support automation & integration Open REST API Support.

d) Solution should be able provide auditing view / report for changes, Rule addition/Deletion & other network changes

e) Firewall Management system should also provide the real time health status of all the firewall modules on the dashboard for CPU & memory utilization, state table, total # of concurrent connections and the connections/second counter.

f) Role based administration with administrators & Separation of duties should be supported. Role based administration shall be configurable for system administration. Multiple administrators need not login at the same instance

g) Advance logging feature should have log indexing capability for faster log search & log optimization.

h) Security management should provide Compliance monitoring framework so that it can monitor compliance status of these devices in the real time. It is expected, the network solution to provide real-time and continuous assessment of all major regulations related to Power sector & others such as ISO27001, COBIT, NIST, FIPS 200, GLBA, ISO27002, HIPAA security, PCI DSS, SOX etc. For compliance feature 3rd party solution can be quoted

i) Bidder must have an option to Check compliance with every policy change for all Network Security controls and must recommend Security Best Practices

j) Centralized management should have capabilities to manage Firewall, APT and Endpoint anti-apt solution from single management and should have consolidated logging and reporting for both network and endpoint solution. The centralised system must be able to auto restore firewalls at remote locations in case of failure of device and replacement of firewall. This restoration should eliminate the need of any skilled technical person for restoration of device in case of device failures.

k) Solution must be able to segment the rule base in a sub-policy structure in which only relevant traffic is being forwarded to relevant policy segment for an autonomous system

l) Solution must have the granularity of administrators that works on parallel on same policy without interfering each other

m) Solution must include customizable threshold setting to take actions when a certain threshold is reached on a gateway. Actions must include: Log, alert, send an SNMP trap, send an email and execute a user defined alert

n) Solution must have consolidated Threat Prevention dashboard for full threat visibility across networks and endpoints.

o) Detailed Event analysis for Threat Prevention Controls Anti-Malware, Anti-Bot, IPS, Application Control etc need to be provided with Real-Time and Historical reporting all the components.

13.11.2.10 **Licensing**

a) Solution should have enterprise license without any restrictions.

b) Any third-party product required to achieve the functionality should be provided with the necessary enterprise version license of software/appliance and necessary hardware, database and other relevant software or hardware etc. should be provided

13.11.2.11 **Anti-APT Solution**

a) The Anti-APT solution should be hardware appliance, integration with firewall & should be designed to detect and prevent data breaches initiated from highly targeted/tailored Zero-days-Unknown attacks

b) The solution shall perform analysis on-premise and no files shall be sent outside the Purchaser network. All necessary additional devices, licenses required for such configuration should be quoted as part of the solution.

c) Solution should perform inspection in real time, including advance malware that uses evasion techniques and/or only executes with specific software versions.

d) Solution should provide comprehensive activity views into a wide range of network, system and file activity, categorized by risk, to help speed incident response.

e) Should inspect & record network behaviour of suspicious file for requests to visit malicious URL, establish communications with C&C servers and other activity indicative of a compromise.

f) Should allow security administrators to manually upload malware samples to perform analysing of suspicious files for forensics.

g) The solution should support at least but not limited to File types:

i. Archived: .tar, .gz, .tgz, .zip, .bz2, .cab, .rar,.7z, .tbz

ii. Executable files (eg: .exe), PDF,.swf, Windows Office Document and JavaScript

h) Should support protocols like HTTP, SMTP, HTTPS, SMB, CIFS, and FTP etc.

i) Solution would enable emulation of file sizes larger than 50 Mb in all types it supports & the file size limit for processing should be configurable.

j) Solution should detect botnets and Command & Control (C&C/2C) channels or activities during emulation.

k) Solution should be resilient to cases where the shell-code or malware would not execute if they detect the existence of virtual environment.

l) The Solution should support Call Back Detection to identify the ultimate aim, call back and exfiltration

m) Should support summary reports with captured packets, original file, tracer log and screenshot to provide rich threat intelligence and actionable insight after files are examined.

n) Solution should support report generation for malicious files like detailed reports on file characteristics and behaviours – File Modification, Process Behaviours, Registry Behaviours, Network Behaviours, VM snapshot

o) Should support Event dashboard like critical malicious events, malware name, rating, type, source, destination, detection time.

p) Should support WebUI and CLI configurations as well as should be integrated with centralized management.

q) Should support multiple administrator account creation

r) The solution should auto-update signatures/VM OS, detection engines frequently & send notification email when new updates are available.

s) The solution should detect the attack at the exploitation stage – i.e. before the shell-code is executed and before the malware is downloaded/executed.

t) The solution should be able to detect ROP and other exploitation techniques (e.g. privilege escalation) by monitoring the CPU flow

u) The Solution should have file sanitization capability or document scrubbing for Web download & Email Attachments for Microsoft office (Word, Excel, PowerPoint) & PDF format.

v) Real-Time Prevention-unknown malware patient-0 in web browsing

w) Real-Time Prevention-unknown malware patient-0 in email

x) The solution should support deployment in MTA (Mail Transfer Agent) mode

y) The solution should be able to emulate executable, archive files, documents, JAVA and flash specifically within CIFS (SMB) protocol

z) Average Emulation time of a suspected malware verdict as benign should be no more than 2 minutes

aa) The solution should be able to emulate, and extract files embedded in documents

bb) The solution should monitor for suspicious activity in Kernel code injection.

cc) The solution should monitor for suspicious activity in Kernel modifications (memory changes performed by kernel code)

dd) The solution should monitor for suspicious activity in Kernel code behaviour (monitor activity of non-user-mode code)

ee) Solution should be resilient to cases where the shell-code or malware would execute only upon a restart or a shutdown of the end point.

ff) The solution should Eliminate threats and remove exploitable content, including active content and embedded objects

gg) The solution should be able to Reconstruct files with known safe elements

hh) The solution should Maintain flexibility with options to maintain the original file format and specify the type of content to be removed

ii) The APT appliance should support at least min 8 simultaneously running images for inspection/sandboxing of files

13.11.2.12 **SCADA Threats Visibility**

a) Proposed solution must be capable of understanding ICS protocols: Modbus, CIP,DNP3, BACNet, IEC-60870-5-104, IEC-60870-5-103, IEC-60870-5-101,Modbus RTU/TCP-IP, IEC 60870-6 (Secured ICCP), IEC 61850, MMS,OPC DA,OPC UA, Ethernet Protocols, S7 (Siemens) and others

b) Proposed solution must have Deep Packet Inspection capability w.r.t to IEC- 104 protocol

c) Proposed appliance must support ACL (Access control list) based on IEC-104,ACL flow based limiting

d) Proposed solution must support stateful inspection capability

e) Proposed firewall must support Firewall rules (incoming/outgoing,

f) management), IP masquerading, 1:1 NAT, Double-NAT, Masquerading NAT,

g) Destination NAT, Hairpin NAT, DoS Protection, Access Control Lists (ACLs), Improper commands

h) Proposed appliance must have the ability to log all traffic of above-mentioned protocols and investigate commands down to the parameter level

i) Proposed Solution must have intrusion prevention capabilities for SCADA protocols

j) Proposed next generation firewall must support SCADA Apps/Commands and SCADA protocols

k) Proposed solution should have an automated discovery function to identify network devices and capture information such as IP address, OS, services provided, other connected hosts.

l) The Firewall Appliance shall operate on Dual Input AC power supply 230V -50 Hz

13.11.3 **Other Aspects of Security**

13.11.3.1 **Application Security Monitoring**

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

a. Application Software Error Conditions

b. Application Software Performance Issues

c. Application Configuration Changes

d. Application Logins, etc.

13.11.3.2 **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:

a. Instant notification through email or SMS

b. Logical grouping of security events by time, location, and device, etc.

c. Interactive dashboard window for viewing and acknowledgement

13.11.3.3 **Analysis and reports**

a. 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.

b. The Purchaser's personnel shall be trained to be capable of creating new custom analysis and reports, and revising existing, without requiring external consultation.

13.11.3.4 **Log Archiving**

The security system shall archive, record, and store all security related events in raw form for at least five years. 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.

13.11.3.5 **Data access through intranet**

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

The external users shall be licensed users of the Purchaser.

The following features are required:

a. The Web servers shall be sized to support atleast 100 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.

e. 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.

f. 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.

g. The Web server at Control Center shall also facilitate exchange of email messages from ISP (Internet Service Provider) and other mail servers supporting SMTP.

h. 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).

i. 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.

j. 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. The access mechanism shall identify and allow configuration of priority access to selected users.

k. 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.

13.11.3.6 **Signature updating requirements**

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

13.11.3.7 **Network encryption**

All communication with system constituents shall be encrypted on application level, regardless of the security zone. The mechanisms such as using service session keys through the Kerberos KDC and SSL shall be used.

13.11.3.8 **Malicious code and Anti-virus protection**

Each of the Windows computers in the system shall be provided with Anti-virus/Anti spyware software. This monitoring software shall be enabled at all times. Updates to the anti-virus/Antispyware software and antivirus signatures shall be performed in a manner similar to patch management. Update of the antivirus files on the central server shall be performed manually. The anti-virus application for end points (workstations/servers) shall be different from the gateway antivirus in the Firewalls.

13.11.3.9 **Security Patch Management**

Security Patch Management services shall be provided through which new Bidder patches and the precautions about installing these patches shall be provided. The cyber security architecture shall permit the distribution of patches without the need for each of the system's computer to be connected to the Internet. The patches shall be updated from the Web server located in the DMZ through Internet under the Employer's control. These patches shall then be distributed to all other computers and security equipment. The latest patches for all parts of the system shall be deployed before the Factory Acceptance tests.

The patches for Operating system shall be tested on the DTS or Development system before deploying on the real-time system. Similarly, any patches for an application shall be tested on the DTS or development system.

The Bidder shall share all the vulnerabilities with the Employer as and when they are discovered and shall provide the patches for them.

13.11.3.10 **Antivirus and Patch Management**

The Bidder shall also be responsible for providing & installing updates/patches for its own software product and Third party software products. All other patches of third-party product like Operating System and Antivirus shall be tested by the Bidder prior to installing in the Purchaser's network.

A secure patch management/deployment system is to be established which will be placed in DMZ. All the patches shall be downloaded through this single point of connection. Other products like IPS, Network IPS, Host based IPS, Firewalls shall also be provided with secure patch management.

The update of Antivirus and firewall signatures shall be preferably deployed on daily basis.

It is to be noted that Purchaser already has Enterprise level Symantec Antivirus Server, integration of this Antivirus Software with the Proposed Patch Management System is in bidder scope. Antivirus Update shall be rolled over to MCC and NCC Servers / workstations and all the other systems through the existing Corporate Antivirus Server.

Updates will be provided offline. No external internet access to system will be given.

The Bidder shall provide 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. Any patch shall be applied only with express permission of the Purchaser's representative.

Automated patch management tools shall be provided to expedite the distributions of patches to the system. These tools should consider the possibility to use standardized configurations for IT resources.

13.11.3.11 **Demilitarized Zone (DMZ)**

DMZ is a network (physical or logical) used to connect hosts that provide an interface to an untrusted external network usually the internet while keeping the internal, private network usually the corporate network separated and isolated form the external network.

As systems that are most vulnerable to attack are those that provide services to users outside of the local area network, such as e-mail, Web and Domain Name System (DNS) servers, they are 'quarantined' inside a DMZ, from where they have limited access to the private network. Hosts in the DMZ can communicate with both the internal and external network, but communications with internal network hosts is tightly restricted.

The DMZ should isolate using a security gateway (i.e. firewall) to filter traffic between the DMZ and the private network. The DMZ itself will have a security gateway in front of it to filter incoming traffic from the external network

Following systems shall be in the DMZ:

a) Jump Host Server

b) Internet Web Server

c) Antivirus & Patch management Server

d) Secured ICCP / OPC / PI interface server

e) GPS receiver

f) WAN router

g) Firewall for connectivity outside the DMZ to the production system

h) Firewall for connectivity outside the DMZ to the Corporate WAN

13.11.3.12 **Jump Host Server**

Jump servers should be typically placed between a secure zone and a DMZ to provide transparent management of devices on the DMZ once a management session has been established.

The jump server shall act as a single audit point for traffic and also a single place where user accounts can be managed. A prospective administrator must log into the jump server in order to gain access to the DMZ assets and all access can be logged for later audit.

Configuration of Jump host sever shall be hardened Unix machine configured with SSH and a local firewall. An administrator will connect to a target machine in the DMZ by making an SSH connection from the administrator's computer to the jump server and then using SSH forwarding to access the target machine.

Using an SSH tunnel to the target host shall allow the use of insecure protocols to manage servers without creating special firewall rules or exposing the traffic on the inside network.

13.11.3.13 **Cyber Security on equipment**

Cyber security system shall be provided in each substation and Control centers. It shall consist of redundant firewalls at each substation. Each station should also have IDS implemented

All devices IEDs/BCUs/Gateways/Protocol Converters, Cameras, NVR, Switches, Routers, Firewalls etc. at Substations used in the SCADA system shall have at least two levels of access, one for simply viewing the device information and other for configuration of the device.

13.11.3.14 **Access Control**

To ensure authorized user access and to prevent unauthorized access to systems and services.

a) **Certificate Authority and Digital Certificates**

A Certificate Authority (CA) entity shall be provided to manage digital certificates for secure data exchange within the distributed grid control system. The CA shall be only accessible to system administrators. Digital certificates shall be used for authentication and encryption of the following services:

i. Inter-process communication between servers

ii. Data exchange between remote partner systems

iii. User interface access

iv. Database access

b) **Digital Keys**

For secure data exchange between servers, the SCADA setup process shall create, install, and distribute digital keys.

c) **AAA and Single Sign-on**

The system shall require a username and password to authenticate the individual user. If the login is successful, the single sign-on system shall assign a unique (encrypted) token to the console. This token shall be used during the session to access services for which the user and console have authority. The token shall expire at logout. The administrator shall specify what applications the user is allowed to access. The SCADA shall log security-related events. Security events that are logged shall include topics that the system monitors. Security- related events shall be logged to the SCADA General Summary alarm list. It shall also support various reporting mechanisms.

If any Anomaly is detected at MCC, BCC and Station level it should be reported/alarmed to Central Cyber Security Management System depending on the level of severity. For Example,

if access to internet is detected at station level workstation, than a high alert flag should be raised at CSMS.

d) **Cryptography**

In the SCADA, encryption shall be used where confidentiality is required to protect user credentials. It shall also be used to ensure confidentiality of data exchanged with user interface consoles. The latter is important because some user interface consoles may be located remotely and communications with them traverse networks that are difficult to secure. User Interface HTTPS and TLS encryption shall use AES cryptography.

13.11.4 **Industrial Security Assessments**

The design and implementation of the cyber security system shall be audited by an agency certified by CERT-IN. Successful bidder has to get the cyber security audit done by the third party before handing over the system to Purchaser. Cyber security audit report is to be submitted to purchaser on its completion, and identified gaps, shall be addressed by the bidder, with no commercial impact on Purchaser.

Following are the basic expectations from the bidder -

a) Appoint a team with overall responsibility

b) Identify the risks in Purchaser overall system

c) Mitigate those risks with security solutions

d) Issue cyber security policies based on the risks identified

e) Train the staff on the risks and policies, and then test their awareness

13.11.4.1 **Phase 1: ICS/SCADA Architecture Review, Asset Inventory and ICS/Isolation Review**

Solution engineers shall meet with the ICS/SCADA managers and technical staff to acquire an in-depth understanding of the system/network architecture design. Interviews and documentation reviews will be focused to gain knowledge concerning information flow within the system, installation and administration procedures, operational methodology and existing security safeguards.

The interviews will identify:

a. A conceptual overview of network and serial information feeds into the control center

b. A conceptual overview of physical and third-party access points in the control center

c. Location and operational information on sensors and devices

d. Known or suspected issues with devices, operational functionality, unauthorized logical or physical access

e. Operations or communication issues during incidents or system events

The architecture review shall also include a review of planned authentication services, access controls, domain or tree structures, auditing processes, audit review procedures and any design issues that may impact recommendations which will be developed later.

In addition, it shall review the use of proprietary or open standards protocols, types and use of RTUs and systems that perform alarming, as well as other utility-specific design issues. Solution provider shall take a physical tour of the facilities to identify any physical issues that could influence the security controls requirements.

Solution provider shall meet with the manager and staff, also perform a walk- down of the facility (or facilities) and capture a definitive list of assets and asset metadata in order to develop a full asset inventory. The assessment of ICS/ SCADA systems shall be accomplished through a combination of:

a. Manual inspection

b. Network traffic analysis

c. Review of CAM tables or other network-level sources

d. Audit log data

Some scanning activity may be per- formed, but only on systems or devices known to be immune to network issues from scanning. The review will consider the actual data flow throughout the ICS/ SCADA system and application architecture, as well as the protections provided by the network itself.

Solution provider shall evaluate systems to be aligned with industry best practices using NIST or other guidelines. Each area shall be reviewed for the following criteria:

a. Architectural review and recommendations

b. Administrative complexity

c. Authentication and authorization

d. Secure host builds, configuration management and extraneous services

e. Information leakage

f. Vulnerability identification

g. Patch level/patch management

h. Backup and recovery

The review shall, at a minimum, include system configuration reviews for each unique operating system and functional server. The effort may also include an analysis of password complexity and configurations of remote monitored systems. The configuration reviews and other technical evaluation tasks shall be accomplished by a knowledgeable engineer for the applicable operating systems and technical environment.

Once understanding of the architecture, implementation of controls and operational philosophy of the installation is complete, Solution provider shall develop threat models and assess the control prioritization schemes to protect the implementation.

Solution provider shall identify gateways between the ICS/SCADA network and the business systems, and evaluate the security controls, logging implementation and other factors to determine the effectiveness of the separation of the ICS/SCADA network from the outside. Within the ICS/SCADA network, it shall examine the configuration of key devices and controls to determine internal protections within the system configuration.

During the technical assessment, areas of analysis should be broken down into more manageable tasks as identified below:

a. Microsoft systems/ Windows environment

b. Unix/Linux systems

c. Routers and switches

d. Firewalls

e. SCADA applications

f. HMI and other control and operational mechanisms

Solution provider shall evaluate systems to be in line with industry best practices using NIST or other guidelines. Each area shall be reviewed for the following criteria:

a. Architectural review and recommendations

b. Administrative complexity

c. Authentication and authorization

d. Secure host builds/configuration management/extraneous services

e. Information leakage

13.11.4.2 **Phase 2: Network Vulnerability Analysis**

Solution provider shall meet with the network managers and engineers to conduct a review of the network and security architecture design of the network. The effort shall be to obtain a comprehensive understanding of the architecture both external, internal and the controls that have been implemented to provide appropriate levels of network traffic segregation, monitoring and control.

This phase of the assessment shall include interviews to understand the network design, operational policies and network management infrastructure, as well as your business and technical requirements for the networks under review.

The information collected in the network review shall be utilized to provide recommendations and guidelines for network security optimization, as well as to potentially recommend network security controls to complement host-level security controls. Solution provider's assessment methodology shall ensure that all necessary information for successful risk analysis is captured, and all potential issues are identified.

Following the initial review, solution provider shall meet with the firewall and VPN administrators and network administrators to conduct a cooperative hands-on review of firewall configurations associate with the major network segments.

In addition, it shall also conduct reviews of selected router and network switch configurations that have an active role in network architecture definition and enforcement. This review shall focus on ensuring that firewall systems and other network devices have been deployed and configured according to industry best practices, and to determine if they adequately enforce the intended network and security architectures.

The last component of the security assessment phase shall be an examination of monitoring and control infrastructure to understand how the user is able to identify and take action on anomalies and malicious activities detected at the network perimeter or within the network itself

13.11.4.2.1 **External vs Internal Networks**

In the context of this assessment, the terms "internal" and "external" are relative to the OT/IT boundary—with internal representing the OT side. While methodologies are nearly identical for an internal network assessment and an external network assessment, the goals

and objectives of the assessments differ if the network under test in an internal or Internet facing network.

The external network security assessment shall identify security risks and vulnerabilities that may exist in the external network and systems, evaluate the risk associated with any identified vulnerabilities, and to develop strategies and recommendations to resolve these issues and reduce risks to an acceptable level.

Solution provider shall conduct a controlled assessment to identify weaknesses in the external security perimeter of network where potential vulnerabilities are identified, Solution provider shall validate them and eliminate false positive results from the reported findings.

Initial efforts of the assessment team shall be to identify vulnerabilities in systems that can be reached directly from the Internet and to logically map the gateway topology. The ultimate goal should be to determine if unauthorized access is possible to your internal systems.

External testing shall be with specific goals as listed below:

a. Identification of external points of access to your networks

b. Identification of vulnerabilities in externally- accessible systems

c. Identification of potential vulnerabilities in network access controls, firewalls, routers, and the designed network topology, even if they don't immediately provide access to the internal network

d. Determination through analysis if it might be possible to combine the identified vulnerabilities and the network design and topology to gain access to the internal network from the Internet

The assessment shall be accomplished across the Internet, from the Solution providers test labs, which are protected from intrusion by a combination of firewalls, router filters, and system-level controls (such as host-level firewalls with intrusion detection and encrypted logons).

Vulnerabilities of multiple components shall be compared with the gateway architecture to determine if multiple minor weaknesses could be combined into "steppingstones" to create a much greater likelihood of intrusion.

For an internal network VA, Solution provider shall analyze data gathered in order to execute appropriate, controlled vulnerability scanning against identified, in-scope systems.

Vulnerabilities generally fall into eight broad categories, as follows:

a. Authentication functionality

b. Account management

c. Service level software

d. Web applications

e. Core operating systems

f. Configuration-related

g. Network level

h. Trust domain

For the purposes of assessment, Solution provider shall combine the internal and external components into a single phase to reduce staff requirements and flow time to provide a more efficient assessment and achieve the schedule objective without compromising depth of analysis.

The methodology of the assessment steps are defined as follows:

a) **Internal Information Gathering/ Network Discovery**

The assessment typically shall begin with a network discovery and data collection effort. This is designed to logically map the network, fingerprint in-scope network devices and identify network services which may expose the respective system to elevated levels of risk.

As the systems are scanned and active services identified, Solution provider's analysts will probe them in order to uncover information like software versions and configuration data such as available authentication types.

b) **Vulnerability Discovery**

All vulnerability identification activity shall be carefully coordinated with the staff in order to reduce potential operational impacts such as the triggering of intrusion detection sensors and other network- and host-based security mechanisms.

c) **Manual Vulnerability Validation/ False Positive Elimination**

Collect data from automated vulnerability scanners, proprietary tools and manual assessment efforts in order to build a normalized list of identified exposures. Vulnerabilities shall then be manually validated in order to make a determination of whether the respective, reported vulnerability represents an actual exposure, how that exposure may impact the system, and any mitigating factors which may prohibit the vulnerability from being exploited in certain conditions, or without certain prerequisites (such as authentication credentials).

As with the external assessment, methodologies used to assess the reported vulnerabilities for the internal assessment will vary based upon the nature of the vulnerability being analyzed. The methodologies employed shall be chosen for being both viable in the time available, and benign in nature so as to minimize any potential operational impacts on the system.

Given a NIST CSF and UFC 4-10-06 perspective, vulnerabilities and issues identified during this phase can be restated as control omissions or opportunities for enhanced control implementation. These shall be documented and included in the assessment report.

13.11.4.3 **Phase 3: ICS/SCADA Security Assessment and Controls GAP Analysis**

Given the understanding gained in the first two phases, Solution provider shall begin a series of targeted activities to examine the security controls in the ICS/SCADA system. In this phase, Solution provider shall proceed device-by-device, system-by-system through the architecture and performs a security review of each component individually and in the context of its place in the architecture.

Solution provider shall employ a series of targeted activities focused on specific components of the overall architecture to assess security implications both at the component level and across the system architecture.

The nature of this part of the assessment is to catalog issues with the building blocks of the ICS/SCADA implementation, as choices made in system integration at one end of the system may have security implications elsewhere in the architecture. Generally, each of the tests defined in this section follow the following path:

a) Information-gathering tests: Attempt to identify live hosts, network topology, operating system, services provided, access control mechanisms, access servers and the interactions between systems

b) Generic vulnerability tests: Attempt to determine the presence of known vulnerabilities and to exploit them. This includes vulnerabilities related to legitimately-provided services, such as communication and control interfaces

c) Network characteristics and topology tests: Attempt to determine the presence of, and exploit vulnerabilities related to, network topology, network components configuration and design principles and protocol specific characteristics

Note: These include tests that consider spoofing techniques, protocol-specific tests such as usage of IP options, fragmentation, exploit of trust relationships, protocol encapsulation, routing tricks, and design and implementation flaws in several network protocols and related services

d) Misconfiguration tests: Attempt to identify and exploit typical misconfiguration problems

e) Backdoor tests: Attempt to identify the presence of backdoors in the infrastructure and exploit them

f) Authentication and access control schemes tests: Attempt to subvert authentication and access control mechanisms based on common attacks that exploit the lack of a strict security policy or the enforcement of such as Using the NIST CSF as a guide, Solution provider shall develop a mapping of existing and missing security controls across the ICS/SCADA environment.

The resulting product of this phase of the assessment is:

A set of gaps in the management/ operational controls in the ICS/SCADA system (developed from the Phase 3 activity)

A set of gaps in the technical implementation of the ICS/SCADA system (developed from the Phase 2 activity with corroboration from the Phase 3 activity)

13.11.4.4 **Phase 4: Documentation of Findings and Recommendations**

Solution Provider shall formally document the effort in the ICS/SCADA Security Assessment Report, which will be the written deliverable for the task.

The report will consist of three major sections:

a. The ICS/SCADA Architecture Review

b. The Security Assessment Findings and Controls Summary

c. Observations and Recommendations

Additionally, the asset inventory will be provided as a separate Microsoft Excel file attachment to the document.

The report shall be submitted in draft form. ICS/SCADA managers and technical staff will review the report and provide comments and questions. Solution provider shall revise the draft and submit a final report to clarify and expand any necessary areas.

The report will, at a minimum, include the following items:

a. A description of the methodology used during the assessment

b. A description of the ICS/SCADA network and system environment, to include all in/out connections and the level of isolation that was found between the ICS/SCADA and other networks

c. Specific identification of vulnerabilities, whether system configurations, network architecture, procedures, policies or any other issues

d. Each finding shall be accompanied by a description of its potential to impact on operations, an assessment of the level of risk it creates and recommendations to mitigate the risk

13.12 **Web Based Application for cyber security monitoring**

The bidder shall supply web based cyber security monitoring application to assist system operators identify potential security risks in the system by viewing the configuration of software versions, users, services and ports on each machine in the system. A machine can be defined as a server or as a workstation. The following features shall be supported as part of this application:

a. A URL shall be provided to enter into this application.

b. It shall provide with user credentials and passwords.

c. It shall support user and admin rights. Only users with administrative privileges will have access to the Admin drop-down menu.

d. The user interface shall contain a menu bar and the web page.

e. The application shall have system report window that allows operator to select an asset and view the last collected information for the required data type.

f. The client shall support any standard web browsers. The data collector shall run on Windows/Linux.

g. Following data type shall be supported

i. SCADA software versions

ii. SCADA users

iii. 3rd Party product versions

iv. OS users (including LDAP)

v. Patches

vi. Ports

vii. Services

h. The application shall provide with Active Compare window that allows an operator to actively compare assets. Assets can be compared with other assets, for example, for verifying the software version across the same type of asset (for example, different workstations). An asset can also be compared with itself based on dates or saved benchmarks, for example, for determining when a certain change may have occurred. All mismatched data are highlighted in red as a deviation. A benchmark is a user-defined label for a report of an asset which could be treated as a standard report. This report which is marked as a benchmark, could be saved and used to compare with other asset report. One use case is for patching – a benchmark could be created for an asset for data type ports, prior to patching and again after patching, so the two can be easily compared. Benchmarks are also well suited for troubleshooting and consistency checking – for example comparing third-party software installed on servers SCADA1 and SCADA2.

i. The application shall have the facility to import and export data into 3rd party tools such MS excel.

End of Section B

Document Title: **ADMS System for Tata Power Mumbai Distribution**

Document No: **TS/ADMS-SPEC/01/2024**

SECTION – C

SCHEDULES

Tata Power Company LIMITED
(Mumbai Distribution)

Revision	Date	Description	Approvals		
			Prepared By	Checked By	Approved By
R1	2 March 2024	Final specifications	BHS	SAW & RMP	GTJ

Section – C

SCHEDULES

CONTENTS:

C1 - SCHEDULE OF QUANTITIES

SUPPLY:

Sr. No	Description	Qty. Set / Nos.

SERVICES:	

Seal of the Company

Signature

Designation

Note: Please Refer Indicative Bill of Material for Schedule of Quantities and Prices attached in Excel Format with this Specification. However, bidder shall derive the detailed BOM based on the proposed solution in the same Excel format and submit along with the proposal.

C2- PROJECT TIME SCHEDULE

Seal of the Company

Signature

Designation

Note: The bidder shall indicate schedule of milestones and attach/furnish a detailed bar chart identifying customer inputs.

C3- SCHEDULE OF DRAWINGS & DOCUMENT SUBMISSION

As part of the proposal, the BIDDER shall furnish the schedule of drawing/document submission

Sr. No.	Title of Drawing/Document	Target Date of submission	For Information/Review/Approval	Remarks
1.0				
1.1				
1.2				
2.0				
2.1				
2.2				
3.0				
3.1				
3.2				
4.0				
4.1				
4.2				
5.0				
5.1				
5.2				

Seal of the Company

Signature

Designation

Note: The bidder shall list out all relevant drawings / documents as mentioned in Section-D.

C4- SCHEDULE OF MANDATORY SPARES

As part of the proposal, the BIDDER shall indicate below the list of recommended spares for Seven years of trouble free operation of the equipment/system offered by him.

Sr. No.	Equipment tag no.	Description of spare	Material of construction	Part no	Quantity recommended per unit of equipment	Delivery period from date of LOI	Remarks

Seal of the Company

Signature

Designation

C5 - SCHEDULE OF SPECIAL ERECTION/MAINTENANCE TOOLS & TACKLES

As part of the proposal, the BIDDER shall indicate below, the list of erection/maintenance tools & tackles offered by him.

Sr. No.	Description of spare	Quantity recommended per unit of equipment	Delivery period from date of LOI	Remarks

Seal of the Company

Signature

Designation

C6 - SCHEDULE OF PLACES OF MANUFACTURE, TESTS AND INSPECTION

For major equipment / systems, the Bidder shall indicate the name of the Manufacturer / SUBCONTRACTOR and place of test and inspection.

ITEM OF EQUIPMENT	Manufacturer / SUBCONTRACTOR	PLACE OF TESTING & INSPECTION

Seal of the Company

Signature

Designation

C7- SCHEDULE OF RECOMMENDED SPARES

As part of the proposal, the BIDDER shall indicate below the list of recommended spares for three years of trouble free operation of the equipment/system offered by him.

Sr. No.	Equipment tag no.	Description of spare	Material of construction	Part no	Quantity recommended per unit of equipment	Delivery period from date of LOI	Remarks

Seal of the Company

Signature

Designation

C8 – Manufacturer's Authorization

(To be obtained from all OEMs)

Date: _____

Bid Reference No.: _____

To: _____

WHEREAS _____ who are official manufacturers of _____ having factories at _____ do hereby authorize _____ 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 relevant Clauses mentioned in the Bid document (GCC, Section-A of Technical Specification), with respect to the Goods offered by the above firm in reply to this invitation for Bids.

Name: _____

In the Capacity of: _____

Signed: _____

Duly Authorized to sign the Authorization for and behalf of _____

Date: _____

Note: The bidder shall submit duly filled Manufacturer's Authorization letter from the respective OEMs for the Supply and Services rendered to meet the required functionalities mentioned in the RFP.

C9 – Undertaking for Presence in India

I hereby declare that <Name of the Bidder>, has Design/Engineering/Testing/Support and Service facility in India as on _____(i.e., release date of Bid).

The address of the facilities is provided hereunder

_____

_____

_____

Signature of Authorized Signatory :

Full Name :

Address :

Phone Number :

Email Id :

Note: Necessary proof of incorporation/registration shall be submitted along with the Bid.

End of Section-C

Document Title: ADMS System for Tata Power Mumbai Distribution

Document No: TS/ADMS-SPEC/01/2024

SECTION – D

DRAWINGs & DOCUMENTs

TATA POWER COMPANY LIMITED
(Tata Power Mumbai Distribution)

Revision	Date	Description	Approvals		
			Prepared By	Checked By	Approved By
R1	2 March 2024	Final specifications	BHS	SAW & RMP	GTJ

Section – D

Drawings & Documents

CONTENTS

1.0 Tender Purpose

1.1 Mandatory documents required along with the Bid

1.1.1 Duly signed copy of TENDER as an acceptance to all terms and conditions as mentioned in this tender.

1.1.2 **Bidder and Sub-Vendors - Company Statistics**

Details	Bidder Response
Bidder's Name	
Address	
Contact (s), Title (s), Telephone (s), E-mail id (s)	
Name of the Chairman/ MD/ CEO/ Partners	
Nature of Ownership	
Date of Incorporation of Company/Entity	
Headquarter Location	
Other Office Locations, Functions and Personnel Strength	
1) Number of Employees by Function 2) Implementation 3) Sales 4) Support 5) Quality Assurance 6) Administrative 7) Management	
Size of Team for the Proposed Solution	
Location of Support Centers for Proposed Solution	
Other Businesses	

Table # 1: Bidder & Sub-Vendors – Company Statistics

Similarly, Bidder to submit the above details of all sub-vendors.

1.1.3 Bidder should depict complete understanding of the as-is system of the Utility based on the information provided in the Bid Document. It should also require listing down all the deliverables that has been planned as a part of the overall project with timelines.

1.1.4 Submission of documents as mentioned in Pre-Qualification Requirement

1.1.5 Technical Literature / GTP / Type Test Reports etc.

1.1.6 Details of all databases proposed and its relationship with application. Data flow diagram with entity relationship shall be submitted for all applications. Bidder shall clearly mention the list of application which are required to build data models manually.

1.1.7 GTP to be furnished about computing, network and integration interface infra structure.

1.1.8 Submit details of methodology followed by the bidder and its sub-vendors in successfully implementing similar projects. Also highlight the special steps that bidder intends to take in order to ensure that the change from current system to proposed one will be smooth and effective.

1.1.9 Schedule of Deviations if any from specification strictly following the prescribed format.

1.1.10 Commercial specification details as per attached sheet.

1.1.11 Proper authorization letter to sign the tender on behalf of bidder shall accompany the bid.

1.1.12 Compliance to the approved vendor list.

1.1.13 List of major relevant experiences of the Principal, Bidder, Sub-Vendors and the Product respectively.

1.1.14 Technical support facilities including qualified man-power, testing tools & instruments and integration facilities available within India.

1.1.15 Technical data sheet of all equipment including Sub-vendors systems, product brochure, white papers and case studies.

1.1.16 System Architecture drawings.

1.1.17 Detailed Bill of Material, covering all aspects of proposed System Architecture and functionality required by Purchaser as per the RFP.

1.1.18 Compliance to technical requirement of SCADA & ADMS system covered in the specification. ***(Refer Annexure-6 - Technical compliance sheet)***

1.1.19 Product life cycle document of all equipment of Bidder's own and of Sub-Vendors.

1.1.20 Quality Assurance Plan (QAP), Manufacturing Quality Plan (MQP), Field Quality Plan (FQP).

1.1.21 Testing facilities in India

1.1.22 Confirmation on lifetime, spares, manufacturing, onsite & Offsite technical support of the supplied equipment for the period of 10 years.

1.1.23 **Project Team Structure**

Furnish the detail of the team that would be deployed by bidder to execute the project. Please provide details of the team structure in the following format:

Name of Staff	Position Assigned	International or Domestic	Firm	Employment status with the firm (Full time/ Associate)	Education (Degree, Year, Institution)	Area of Expertise and no. of years of relevant experience	Task Assigned
A. Professional Staff							
B. Support Staff							

Table # 2: Proposed Project Team Structure

Similarly, bidder shall arrange the team details of the Sub-vendors, that would be deployed to execute the project

1.1.24 **Team details (CVs)**

Use the following format for key personnel who would be involved in the project. Please include details of team members proposed to implement the project, install or manage hardware, install and manage LAN/WAN, ADMS and other solutions, interface development etc., please ensure that the CV covers all the required field and details.

1.	Proposed Position			
2.	Name of Firm and Role			
3.	Name of Staff			
4.	Date of Birth		Nationality	
5.	Education			
	Year	Degree/Examination	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 willful misstatement described herein may lead to my disqualification or dismissal, if engaged.		
	Signature of authorized representative of the staff	Date:	
	Full name of authorized representative:		

Table # 3 : Format for CV Submission

Similarly, Bidder to submit the key personnel details of the Sub-Vendors, who would be involved in the project. Please include details of team members proposed to implement the project, install or manage hardware, install and manage LAN/WAN, ADMS and other solutions, interface development etc.

2.0 After Award of Contract

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

2.1 General Requirement

a. The Bidder shall furnish the following drawings/documents during detailed engineering within 2 months from date of PO Placement Bidder to submit all datasheets, detailed GTP of the proposed BOM items during detailed engineering for the approval and finalization by Owner.

b. System Architecture Drawing and design documentation. This drawing should show in detail of the following:

i. Network connections

ii. Protocol used

iii. Type of interconnecting cable

iv. All equipment, systems, operator workstations, gateways, network switches etc. which are part of the complete proposed solution.

c. Panel GA and Complete wiring diagram

d. Functional Design Specification document

e. Step by Step test procedures for Factory Acceptance Test (FAT) and Site Acceptance Test (SAT)

f. SCADA I/O List with protocol details along with addresses

g. Interconnection Schedule (ICS) for Automation, detailed drawing indicating interconnections between various components.

h. Hardware, Software and Application manuals for all the equipment supplied including that of Third parties.

i. All Software Licenses (both own & third party), key for Hardware Locks

j. All interoperability tables

k. Software matrix indicating the details regarding versions, current license, expandability, tags/license limitations (if any) etc. along with the offer.

l. Guaranteed technical parameters & Guaranteed availability and reliability

m. Calculation for power supply dimensioning

n. Bill of Material listing equipment designation, make, type ratings, etc. of all the equipment's supplied

o. Interface and data exchange details of Third-Party Integration

p. Logic Diagram (Hardware & Software)

q. Submit the details of all databases proposed and its relationship with application. Data flow diagram with entity relationship shall be submitted for key applications. The detail shall clearly mention the list of application which are required to build data models manually.

r. Operator's Manual

s. Complete documentation of implemented protocols between various elements

t. IP addressing chart for all the systems, Operator Workstations, network switches and other components/equipment which are connected to the network

u. Detailed network layout in overlay pattern containing layered network layout showing all network components, Link capacities, Communication medium used with details of link/Service provider.

v. Other network diagram with all details pertaining to IP address and interfaces used to be provided as a controlled and restricted copy.

w. Password management policy document to be provided with mechanism for storage and changing of password at specified interval clearly defined.

x. Credentials created for all OEM systems for support to be provided as consolidated document stating clearly the SLA timelines agreed with each of the OEM.

y. SLA signed document for system support and restoration in case of breakdown to be clearly document and provided as submission document.

z. Network utilization detailing after “Go Live” to be clearly provided with loading of each of the communication link on the LAN and WAN segments. Bidder to provide recommendation on proposed network bandwidth required for smooth operation of the system in non- blocking mode. Diagnostic and performance evaluation software and hardware tools

aa. All tools and documents necessary to develop and maintain software such as complier, CASE tool-kits and version control software shall be delivered along with SCADA Software.

bb. Details of software (Operating systems, application software, engineering tools, communication systems management software, license details, I/O distribution protocol- wise etc.) for all computer systems (including PCs, Station HMI equipment and configuration laptop computers etc.) and loadable in CD/DVD ROM

cc. Final as built drawings of all automation and communication system as final documents in AutoCAD & PDF format

dd. Other documents as may be required / applicable during detailed engineering

ee. All drawings and data shall be annotated in English.

ff. Bidder shall furnish Four (4) hardcopies and 3 soft copies on reliable media of all drawings, manuals (Administration, Operation & Maintenance, Configuration, Troubleshooting and Installation), Technical catalogues, Test Certificates and Acceptance Test Reports.

gg. Two copies of the internal test report, FAT and SAT documents with test protocol formats shall be submitted for approval at least eight (8) weeks before Factory Acceptance Test.

Two copies of SAT protocol shall be submitted for approval at least eight (8) weeks before Site Acceptance Test.

hh. Bidder shall also furnish Original plus one copy of all System Software (OS, Application and tools) along with delivery. Bidder shall submit two copies of all the configuration, application, display, database backup of all equipment on reliable secondary media.

2.2 Definitions

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

a. **Documents or Documentation** – Textural and graphical information describing the SCADA/ADMS or equipment, systems, and other items peripheral to the SCADA/ADMS, whether embodied in hardcopy or electronic form such as common word processor files. Documents may also be referred to as manuals, guides, books, drawings, transmittals, and specifications. Documents are further divided into standard, OEM, and custom documents.

b. **Standard documents** – Documents produced by the Bidder and used prior to the award of this contract that are applicable to all users of the equipment and software, including Purchaser. It is expected that the Bidder will use a formal revision control scheme to maintain its standard documents. Documents not maintained under such a scheme shall be considered custom documents.

c. **OEM documents** – OEM (Original Equipment Manufacturer) documents are those standard documents produced by Sub-vendors. Documents produced by Sub-vendors for customized elements of the System shall be deemed custom documents.

d. **Custom documents** – All documents not categorized as standard or OEM documents including the Bidder's standard documents that are modified to meet Purchaser's specific requirements.

e. **Project Documents** – Project documents are those documents produced for the conduct of the project, but which do not directly describe the SCADA. Examples of project documents include meeting minutes, action item lists, test plans and procedures, and transmittal and document lists.

2.3 Project Planning Documentation

2.3.1 Documentation Plan

Bidder to note that after the order acceptance, the project kick of meeting will be arranged by the Purchaser, in which MDL will also be finalized, Bidder shall furnish the schedule for

submission of documents for the documents mentioned in the MDL and accordingly arrange submit the documents for Purchaser's Review and Approval.

It is expected that certain major documents, such as the detailed hardware and software design documentation, will consist of a series of submittals made over a period of time. The documentation plan shall address this by including a detailed list of all individual documentation submittals for the project.

Documents shall be submitted in a sequence as per the MDL, that allows PURCHASER to have all of the information necessary for reviewing or approving a particular document at the time of its submittal. The documentation plan shall be subject to PURCHASER approval.

2.3.2 **Project Progress Reports**

A project progress report shall be prepared by the Bidder and sent to PURCHASER every two weeks through the start of the warranty period. The report shall be submitted to PURCHASER's project manager no later than the 10th calendar day of each month. The report shall cover the project from the start of the contract through the last working day of the month.

The progress report shall include a general assessment of the progress on the project. This assessment shall reference the latest implementation schedule, which shall be included in the report. The schedule shall show the baseline and the current schedule, progress on individual tasks, and the forecasted completion dates for upcoming tasks and the entire project. Updated training and documentation plans shall be included.

The report shall include an explanation of existing and forecast schedule variances, the cause or source of the variance, alternatives considered, solutions adopted or recommended, and the outcome achieved or anticipated. In particular, the report shall note the needed delivery date of PURCHASER-furnished information. The Bidder shall be responsible for any schedule delays due to insufficient notification to PURCHASER of the need for such information.

The report shall identify unresolved contract issues. This shall include a description of the item and the current due date, the consequences of any delay in resolution, and any recommendations pertinent to the decision process. The report shall also include the following items:

a. A list of action items, including the following information:

i. The action item number

ii. The date the item was opened

iii. References to the originating transmittal and any reference documents

iv. Action item status (open, closed)

v. Resolution due date

vi. The responsible organization or person

vii. A description of the action required

viii. The date of action completion (when each item is closed)

ix. References to transmittals or other documents recording the resolution.

b. Correspondence logs, one for transmittals to PURCHASER from the Bidder and one for transmittals to the Bidder from PURCHASER. Each log shall have the following information for each transmittal:

i. The transmittal number

ii. The date of transmission (not the date written)

iii. The date received

iv. The subject of the transmittal

v. Identification of any action items addressed by the transmittal

vi. A list of any documents attached to the transmittal.

2.3.3 **Project Meetings, Agendas, and Minutes**

Project meetings shall be held to review project progress, to ensure correct interpretation of the contract, to review technical and commercial issues, and to maintain co-ordination between PURCHASER and Bidder. Meetings shall be scheduled at appropriate times. Purchaser prefer to schedule meeting every month on average. The meetings shall be divided between PURCHASER's and Bidder's offices. The Bidder's project manager shall prepare a meeting agenda in time for review by PURCHASER before the meeting.

The Bidder shall prepare minutes of each meeting. Both PURCHASER and the Bidder shall review and approve the minutes. The approved minutes shall be considered binding agreements, subject to concordance with the contract. Where the approved minutes conflict with the contract, either the minutes shall be revised or a change order to the contract shall be generated. Where the minutes of a meeting conflict with the approved minutes of a

previous meeting, the conflict shall be documented in the later minutes and those approved minutes shall have precedence.

2.3.4 **Project Correspondence**

All requests and transfers of information between the parties shall be made in writing and shall be documented with letters of transmittal. All correspondence from each party shall be dated (with the date of transmittal, not the date of writing) and uniquely numbered. With the exception of the meeting minutes, each letter or other project correspondence shall be limited to a single topic to simplify correspondence management. Correspondence transmitted via mail shall be considered as binding if a printed copy of the correspondence is delivered within four weeks of the mail transmission.

Correspondence may be exchanged by electronic mail. Such correspondence shall not be considered a substitute for formal correspondence, however. Agreements established through e-mail transmittals must be recorded as formal correspondence before they become binding. A printed copy of e-mail attached to a transmittal cover sheet shall be considered a formal transmittal.

All project management documentation, such as, correspondence, memos, meeting minutes, and monthly progress reports, shall be maintained. A mutually agreeable file numbering scheme shall be developed and used to minimize file storage and retrieval efforts.

2.3.5 **Detailed Implementation Schedule**

The Bidder shall submit for PURCHASER's approval a detailed implementation schedule. This shall describe all the project activities of both the Bidder and PURCHASER. As a minimum, this schedule shall include the following:

a. Kickoff Meeting

b. Preparation and finalization of MDL document

c. Hardware procurement, integration, and testing

d. Delivery dates for PURCHASER-furnished data, interface equipment, and software

e. Software development on a per-function or per-interface basis

f. Software unit testing

g. Subsystem integration and testing

h. Interface testing

i. Preparation of test plans and procedures

j. Factory and site tests

k. Variance correction and retest

l. System disassembly, delivery, and installation

m. Final system and user documentation

n. Training

o. Submittal dates, review cycles, and acceptance dates for the hardware, software, and interface requirements documents.

The training and documentation schedules may be maintained outside the implementation schedule. However, the implementation schedule shall include all of the dependencies of tasks contingent on documentation and training tasks.

The Bidder shall use a commercially available project management application (for example, Microsoft Project) to maintain the project schedule. This project management application shall be used to track the progress of the project from start through completion. Schedule monitoring shall be based on a comparison of completed tasks versus scheduled tasks and estimation of the required effort to complete the remaining tasks. The schedule presented to PURCHASER shall be that used by the Bidder to manage their internal resources.

2.4 Document Format

Documents shall be delivered in two phases:

a. Approval documents, submitted for Purchaser's review and approval

b. Final documents

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

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

Drawings and diagrams may be supplied embedded in the document files or may be supplied as separate files. Purchaser's standard drawing software is AutoCAD. If the Bidder uses other drawing software, four copies of the software, suitable for installation on a personal computer using the Windows10 operating system or newer versions, shall be provided.

Documents delivered as hardcopy shall be printed on both sides of 8½" x 11" paper and bound in three-ring binders. Divider pages with appropriately labeled tabs shall separate chapters. The spine of each volume shall be labeled with the document title and volume number so it may be easily identified when shelved.

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

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

i. The date of the change

ii. A brief description of the change

iii. An indication that the change has been reviewed and approved in accordance with the Bidder's quality assurance procedure

iv. The version or release of the hardware or software to which the document applies.

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

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

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

2.5 Document Review and Approval

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

2.5.1 Document Review

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

a. The documents have been produced in accordance with the documentation standards of the Bidder or Sub-vendors

b. All hardware and software is in full conformance with the contract

c. For software, that the software has been produced in accordance with the coding and display standards of the Bidder or Sub-vendors

d. The documents clearly and accurately describe the features and options of the hardware and software that pertain to the SCADA and other applications

e. The documents are written in English, and hard copies are printed legibly, and well bound.

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

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

2.5.2 **Document Approval**

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

The approval process shall proceed as follows:

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

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

Approved – If approved, the Bidder may proceed with the work covered by the document. No further approval action is required.

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

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

c. If desired by any party, the comments may be discussed to clarify Purchaser's intent.

d. The Bidder shall then revise and resubmit the documents within five working days after receipt of the comments from Purchaser. This time may be adjusted by mutual agreement to accommodate the other activities of Purchaser and the Bidder. Requests by either party to change the time shall be made within two working days of receipt of the comments by the Bidder.

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

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

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

2.5.3 **Scope of Reviews and Approvals**

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

All deliverable documentation shall be revised by the Bidder to reflect the delivered System. Any modifications to the SCADA/ADMS resulting from the factory and site acceptance tests shall be incorporated in this documentation. All previously submitted documents that have been changed because of engineering changes, contract changes, or errors or omissions shall be resubmitted for review or approval as appropriate.

2.6 Deliverable Documentation

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

Document	Delivery Date
Basic hardware documents i. List of deliverables, configuration diagram ii. Network configuration, interconnection lists iii. Site installation drawings and procedures	 i. One month after Award of Contract ii. One month prior to delivery of the System iii. Three months prior to delivery of the System
Equipment manuals	With each hardware delivery
Hardware maintenance manual	With each hardware delivery
Software list of deliverables	One month after Award of Contract
Software development standards	One month after Award of Contract
Database definition	i. For standard software – one month after Award of Contract ii. For other software – with the software

Interface Requirements Document	With the software functional description
Software functional description	Per the project schedule
Installation images and source code	With the System delivery
Detailed design document	Per the project schedule
System maintenance manual	With the System delivery
Display style guide	Per the project schedule
Simulation instructor user's guide	With Simulation training

2.7 Document Standards

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

a. The word processing or document production software used to create the documents

b. Templates for each document type

c. Definitions of the contents for each document type

d. Drawing standards to be followed

e. The approval process to be followed for document releases.

2.8 Hardware Documentation

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

a. List of deliverable hardware

b. Equipment configuration diagram

c. Network configuration diagram

d. Interconnection list

e. Site installation drawings and procedures.

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

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

2.8.1 **List of Deliverable Hardware**

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

2.8.2 **Equipment Configuration Diagram**

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

2.8.3 **Network Configuration Diagram**

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

2.8.4 **Interconnection List**

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

2.8.5 **Site Installation Drawings and Procedures**

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

a. Equipment physical drawings showing dimensions, cabinet internal arrangements, and the size and weight of each enclosure

b. Unpacking, moving, handling, and other installation details

c. The location of external connections including types and sizes of connectors

d. Input power and grounding requirements

e. Environmental requirements

2.8.6 **Equipment Manuals**

Equipment manuals shall contain the following:

a. A description of the function of the equipment

b. Installation, setup, and operating instructions

c. A block diagram showing the logical and physical interconnections among the major components

d. Expansion and upgrade capabilities and instructions

e. Preventative maintenance instructions

f. Detailed functional, logical, electrical, and mechanical characteristics of all interfaces to the device, including protocol descriptions

g. Troubleshooting and repair guides including a description and instructions for the diagnostics furnished.

2.8.7 **Hardware Maintenance Manuals**

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

a. Operating details – This information shall include a detailed description of how the equipment operates and a block diagram illustrating each major assembly in the equipment. Descriptions of external data transfers with other equipment, including data patterns, security check-codes, and transfer sequences shall be included. The operational sequence of major assemblies within the equipment shall be described and illustrated by functional block diagrams and timing diagrams. Detailed logic diagrams shall also be provided as necessary for troubleshooting analysis and field repair actions.

b. Preventive maintenance instructions – These instructions shall include all applicable visual examinations, hardware testing and diagnostic routines, and the adjustments necessary for periodic preventive maintenance of the equipment. Instructions on how to load and use any test and diagnostic program and any special or standard test equipment shall be an integral part of these procedures.

c. Corrective maintenance instructions – These instructions shall include procedures for locating malfunctions down to the field-replaceable module level. These guides shall include

adequate details for quickly and efficiently locating the source of an equipment malfunction. The instructions shall also include explanations for the adjustment or replacement of all items, including printed circuit cards. Schematic diagrams of electrical, mechanical, and electronic circuits, parts-location illustrations, photographs, cable routing diagrams, and sectional views giving details of mechanical assemblies shall be provided as necessary to replace faulty equipment. For mechanical items requiring field repair, information on tolerances, clearances, wear limits, and maximum bolt-down torque shall be supplied. Information on the loading and use of special off-line diagnostic programs, tools, and test equipment, as well as any cautions or warnings that must be observed to protect personnel and equipment shall be included.

d. Parts information – This information shall include the identification of each replaceable or field- repairable module. All other parts shall also be identified. The identification shall be of a level of detail sufficient for procuring any repairable or replaceable part. Cross-references between the Bidder's part numbers and the manufacturer's part numbers shall be provided.

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

2.9 Software Documentation

The following documents shall be provided for all software:

a. List of Deliverable Software

b. Software development standards

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

a. Database definition and data flow, along with an explanation of stored procedures

b. Interface Requirements Document

c. Software functional description

d. Installation images and source code

e. Source code version control and revision control documentation.

f. Software release / Patch details as consolidated document to be submitted by Bidder.

g. Recommended update frequency of all the software should be submitted as consolidated document by bidder.

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

a. Software Requirements Matrix

b. Detailed design documents

2.9.1 **List of Deliverable Software**

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

2.9.2 **Software Development Standards**

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

a. Program design disciplines

b. Cyber Security measures

c. Resources under which the program must operate

d. Basic services

e. Interface definitions

f. Linkage conventions

g. Input and output specifications

h. Database naming and access conventions

i. Storage rules

j. Quality assurance procedures

k. Configuration design review methods

l. Software configuration control schemes.

2.9.3 **Database Definition**

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

a. The name or identification of the database

b. A description of the intended use of the database. If the database is specific to a single application, the application shall be identified

c. A description of the organization of the database (the database schema or model)

d. A description of each field of each data item

e. Instructions for generating and populating the database

f. Details of programming interfaces. This shall encompass access methods, address schemes, and read, write, and modify actions

g. Initialization description – How or by what software is the data initialized and to what value(s)

h. Details of maintenance actions.

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

2.9.4 **Interface Requirements Document**

The Interface Requirements Document shall describe in detail the interfaces between the offered systems and PURCHASER provided/existing systems and networks. The Interface Requirements Document will be used by both the Bidder and PURCHASER as the definition of the interface between the SCADA/ADMS and all other systems, so that each system can be designed or modified to meet its requirements. PURCHASER will provide all required information to the Bidder so that it can prepare the document accordingly.

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

a. Description of the hardware interface

b. Description of the communication protocols, including the lower level network protocols, the upper level session, presentation, and application protocols, and the options and parameters selected

c. Description of the database access methods and capabilities, including specific displays, commands, and access and authorization requirements

d. Description of relevant database models, structures, and contents for these databases

e. Data exchange requirements including timing, priority, volume, and security requirements. A specific list of data to be exchanged during factory and site testing shall also be included.

f. Description of the performance requirements

g. Exception (for example, error) processing

h. Failover/Backup processing

i. Alarm conditions

j. Archiving requirements.

2.9.5 **Software Functional Description**

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

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

The software functional description shall include the following minimum content:

a. Functional description – A narrative description of each program. Where appropriate, solution algorithms shall be described

b. Performance requirements – The execution periodicity, processing capacity, and tuning and execution parameters that control or limit the capabilities of the software

c. Resource requirement – The expected minimum requirements for main memory, auxiliary memory, processor capacity, and other resources required by the software

d. User interface – A description of the interface used to control the software, including all user inputs and program responses

e. Software interface requirements – A description of the logic interfaces with other programs

f. Data requirements – A description of all data and databases accessed by the software, including execution parameters

g. Error messages – A concise description of all error messages and possible corrective actions

h. Diagnostic messages – Where the software generates a record of its internal operations, the messages shall be described

i. Maintenance and expansion procedures – A description of either maintenance procedures or expansion procedures that is relevant to maintenance of the program or expansion of the program.

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

2.9.6 **Installation Images and Source Code**

All software shall be delivered in three forms:

a. As a fully operational system installed on auxiliary memory

b. As distribution images suitable for installation on the system

c. Buildable source code including libraries, compilers, and linkers for building software.

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

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

For the purposes of this requirement, "software" shall specifically include the databases supplied with the System. That is, sufficient definition and content images shall be supplied such that the System databases can be created and installed on the SCADA/ADMS and other offered systems.

2.9.7 **Software Requirements matrix**

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

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

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

a. Item on the List of Software Deliverables

b. Software Functional Description

c. Operations Manual

d. Factory Acceptance Tests

e. Site Acceptance Tests.

2.9.8 **Detailed Design Document**

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

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

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

For each software module, the detailed software design documentation shall include, but shall not be limited to, the following items:

a. Program abstract

b. General technical description of the module

c. The module logic (the use of pseudo code or structured English is preferred)

d. External interfaces to the program including applicable calling sequences

e. Initialization considerations

f. Identification of any databases referenced or modified

g. A high-level flowchart or program design language to enhance the technical description of the module

h. Error codes and error handling processes.

Each program module, including subroutines, shall be sufficiently documented to allow an experienced programmer (with supervision of the designer) to perform the coding of the module, as well as allow PURCHASER personnel to maintain such software in the future. All job control files (batch or make files) required for compilation, assembly, and linking of each program shall be documented in detail as part of the detailed software design documentation.

2.9.9 **System Maintenance Manual**

The System Maintenance Manual shall describe all user procedures necessary to build and maintain the software system of the SCADA/ADMS and other supplied systems. It shall include complete instructions on performing a system generation from sources for all processors. It shall provide information on optimizing system performance. It shall describe the hierarchy of disk directories used by the SCADA/ADMS and other equipment software system, and the location of all categories of files: including executable programs, displays,

databases, sources, build files, etc. It shall also describe the procedures to configure the SCADA/ADMS and other computer system and backup the systems.

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

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

2.9.10 **Display Style Guide**

The Bidder shall furnish a Display Style Guide that describes the discretionary aspects of display design and implementation. This guide shall be used by the Bidder to develop all displays supplied with the SCADA/ADMS and other systems. PURCHASER will also use this guide as input to the development of its display conventions and standards. The objective of the display conventions and standards shall be to promote a consistent look and feel across all SCADA/ADMS and other systems displays.

2.10 Operating Manual

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

The manuals shall be organized for quick access to each detailed description of the user procedures that are used to interact with the SCADA/ADMS functions. The manuals shall present in a clear and concise manner all information that a user needs to know to

understand and operate the SCADA/ADMS satisfactorily. The manuals shall make abundant use of screen snapshots to illustrate the various procedures.

2.11 System Administration Documentation

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

2.12 Operator's Manual

The Operator's Manual shall be custom documentation written specifically for PURCHASER's SCADA/ADMS and for other delivered systems. All snapshots used as illustrations shall be of genuine displays on PURCHASER's actual SCADA/ADMS and of other delivered systems.

The Operator's Manual shall be written for system operators as the audience. It shall be organized in a logical sequence and shall fully describe the user interface of all operational functions of the systems. Each step of a multi-step procedure shall be described, with a clear indication of which menu items are selected to proceed to the next step.

The manual shall describe the required functionality in a manner and at a level of detail that allows the user to detect and isolate problems in the systems. All program-generated messages (such as, alarms, prompt messages, and error messages) shall be listed along with easily understood meanings and recommended remedial actions, where appropriate.

The Operator's Manual shall be provided on-line. The system operator shall be capable of accessing the Operator's Manual from the operator console via a one-click approach.

2.13 Database Editor's Manual

The Database Editor's Manual shall describe the procedures to define, build, edit, archive, and expand all the databases of the SCADA/ADMS and other delivered systems. It shall contain information describing how a user may define and add new attributes to an existing database entity. It shall also describe how to restore any database to a previously saved version if the database had been corrupted. The database editor's manual shall document development of application function models, such as the network analysis and load forecast models.

The Bidder shall provide documentation that describes the Bidder's implementation of the CIM. This documentation shall include the following:

a. The detailed model definitions and objects

b. Maintenance manual

c. User's guide for toolkit

2.14 Display Editor's Manual

The Display Editor's Manual shall describe and fully illustrate the capabilities of the Display Editor, including procedures to auto-generate and edit single-line displays for the SCADA/ADMS & other systems and to link display fields with entities in the database of the respective systems. It shall describe how to generate new device symbols. It shall present a clear description of the principles behind zooming and decluttering and shall explain how the user can assign declutter levels to display elements in order to achieve a satisfactory decluttering upon zooming.

2.15 Acceptance Test Procedures

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

a. The system hardware and software is fully present and fully integrated, and its documentation is complete.

b. All the functional and performance requirements of the contract are met.

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

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

2.16 Simulator Instructor User's Guide

This document shall describe the instructor-oriented capabilities of the Simulator and how to use them. The Simulator instructor user guide shall include:

a. How to operate the Simulator to provide training, including how to operate the:

i. Training case set-up

ii. Scenario builder (if supplied)

iii. Database management system, including retrieval of cases from historical data

b. How to start, pause, stop and interact with a training session

c. How to monitor students' performance, including the recording of the training sessions, for example:

i. Successful problem resolution

ii. Time taken for resolution

iii. Steps taken during resolution

d. How to replay scenarios for evaluation with students

End of Section-D

Document Title: ADMS System for Tata Power Mumbai Distribution

Document No: TS/ADMS-SPEC/01/2024

SECTION – E

ANNEXURES

TATA POWER COMPANY LIMITED
(Tata Power Mumbai Distribution)

Revision	Date	Description	Approvals		
			Prepared By	Checked By	Approved By
R1	2 March 2024	Final specifications	BHS	SAW & RMP	GTJ

Section – E

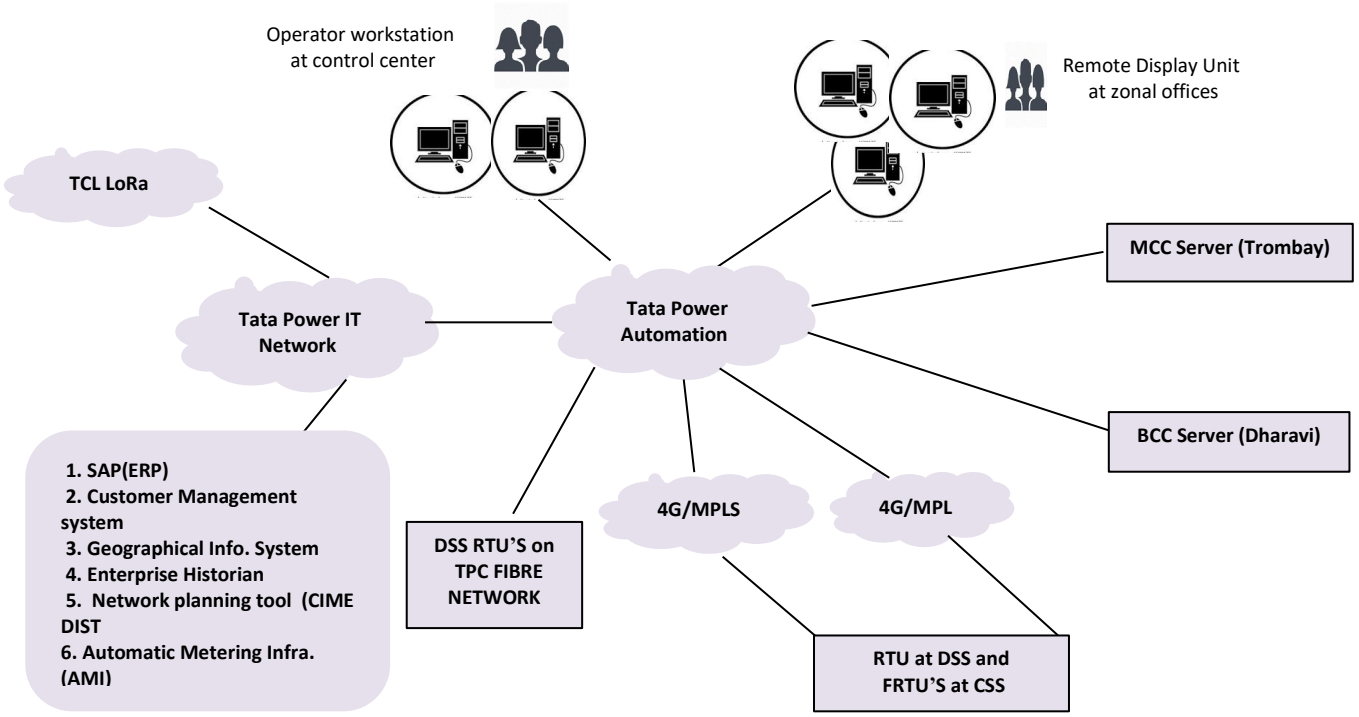
Annexures

CONTENTS:

The schematics, layouts, drawings in this section are indicative, bidder shall submit their best architecture, layout, drawings proposed as per specifications.

Bidder shall propose the architecture having different zones for various cluster of server such as SCADA, FEP, Display, Archival zone for Server Centre based on the inter application traffic and Cyber Security management.

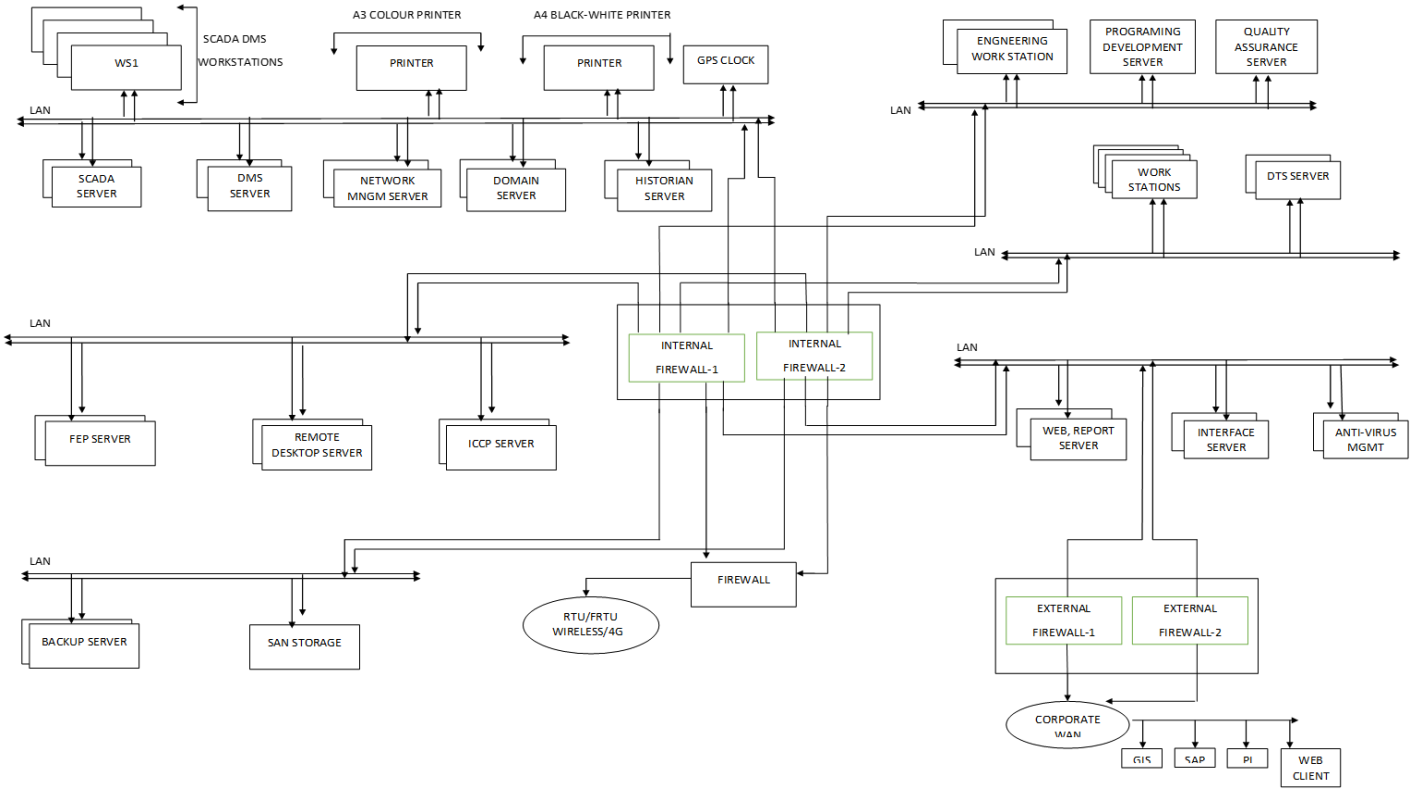
Annexure 1 : Proposed Overall SCADA, DMS & OMS System Landscape



Note for Bidder shall give more emphasis on the following aspects in the proposed architecture

- Reliability Centric
- High Availability
- Cyber Security Resilience

Annexure – 2 : Indicative Proposed SCADA/ADMS System Architecture – at MCC, BCC



Note:Bidder to submit proposed system architecture at MCC and BCC along with data flow diagram showing key databases and traffic flow

Annexure – 3: Preferred/Approved Make of Equipment/System

Sl. No.	Item Description	Preferred Make / Model
1	Servers, HMI	Dell / HP / IBM
2	Operator workstations	Dell / HP / IBM
3	Engineering workstations / Laptop	Dell / HP / IBM
4	Printers, Scanner	Ricoh / Cannon / equivalent
5	Next Generation HA Firewall	Fortinet
6	Industrial Grade Network Panels (42U)	Rittal
7	Industrial Grade Server Panels (42U)	Rittal
8	Rack-Mount Sliding Monitor with inbuilt Keyboard and Mouse along with Rack mounted KVM Switch	Aten / equivalent
9	External Tape Drive for each Server	IBM / equivalent
10	Layer 2 & Layer 3 Ethernet Switch	Cisco/Juniper
11	LIU (Fiber Optic)	CommScope
12	I/O Boxes	CommScope
13	Armored UTP CAT6 Cable	CommScope
14	Armored Fiber Optic Cable	Finolex / KEC / Apar
15	Unarmored UTP Cable	CommScope
16	Patch Panel (RJ45) with Connectors, I/O boxes	CommScope
17	Fiber Optic Patch Chords	CommScope
18	CAT6 UTP Patch Chords	CommScope
19	GPS Clock with remote display unit	Sertel / Masibus / SANDS/Meinberg
20	Droppable type Terminal Block for Digital	Connectwell – CBT4U or equivalent
21	Disconnecting type (Knife edge) Terminal Block for Digital Input	Connectwell - CKT4U or equivalent
22	Configuration Laptop	HP/DELL

Annexure – 6: Indicative Bill of Material for Proposed SCADA and ADMS System

Information to Bidder:

1	2
Sl. No.	**Information to Bidder**
1	Bill of Quantity mentioned in the tables are indicative, this may vary to meet the functional or site requirement. It is the responsibility of the Bidder to include all Hardware, Software and Services as per functional requirement specified in the RFP as per the phases mentioned.
2	Bidder to refer preferred make and model of the equipment to be considered for this project. All bidder's own and bought out items shall be subject to Purchaser's prior approval.
3	The bidder shall propose and design the solution considering all the functional requirement stated in the RFP and shall submit the overall System Architecture considering current and phase wised implementation.
4	System shall be modular in such a way that it shall allow flexible configuration of the system, adding modules as and when required. The system shall facilitate a gradual growth of the system through phased implementation as the Power System Network operating requirements expand or change.
5	Bidder shall include license for redundant server/applications as applicable. Bidder shall also consider the enterprise version of software as feasible to meet the required functionality and to reduce the overall cost.
6	All the servers / work stations are with Operating System and shall be of latest version at the time of order placement. Purchaser's preference of OS for Servers is REDHAT LINUX except servers required in DMZ zone.
7	All Systems and Operator Workstations shall be kept current with latest OS version and Application Software as and when the new applications will be implemented in a phased manner.

1	2
Sl. No.	**Information to Bidder**
8	All Servers shall be Rack-Mounted (MCC, BCC, DTS, PDS & QAS). Generally other than hard disk capacity all server shall be same.
9	Bidders shall 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 of the system. However, certain applications are to be hosted on independent hardware. Critical and Non-Critical applications are defined in the RFP for optimizing the overall architecture.
10	Configuration of all Operator workstations shall be identical.
11	The FEP should be modular such that adequate communication response speed is achieved with distributed parallel units.
12	The offered solution shall meet all the Cyber Security Requirement as per the IEC62351, IEC62443 standard and NERC_CIP, NISTR, ISO 27001 and NCIIPC guidelines. All the Cyber Security measures shall address Operational Technology requirement. Bidder shall ensure that the proposed architecture at MCC and BCC are certified by Cyber Security auditor for the compliance as per Industry standards. Bidder shall also ensure that the third party Cyber Security Audit is conducted and identified gaps are complied before handing over the system to Purchaser in a phased manner as and when the new applications will be implemented in a phased manner.
13	The proposed system will be integrated with other external systems and the required interfaces shall be considered accordingly. Since all external systems are different, special studies for interfaces have to be conducted for each individual case.
14	The platform services shall be common to the whole family of products (MCC, BCC, ADMS, DTS, PDS & QAS); thus, integrated control of power system network is possible from one base platform. Allows data to be distributed across a number of sites and systems.
15	Applications such as ADMS & other analytical Applications (PSA), Intelligent Alarm Processing, Operator Guidance Messages, Dispatcher Training Simulator, Energy Audit, user's own utility programs and any other selected applications shall be assigned to the appropriate Server as per functional & processing requirements.
16	The Bidder to ensure that the data modelling shall be network based and common across various applications as required by the Purchaser. This also includes Sub-Vendors applications.

1	2
Sl. No.	**Information to Bidder**
17	The bid shall include required hardware and software for managing the common database of MCC and BCC systems. The System shall provide common network CIM modelling. Unified data engineering environment for data take-on and data maintenance, facilitating a single point of entry for both graphical representations and the object data.
18	Bidder to indicate clearly the no. of Software licenses (proprietary & third party) included taking into account no. of Servers, Clients, Work-Stations, redundant equipment, I/O Tags etc. Bidder shall also indicate the (slab-wise) incremental price for each of these licenses as applicable. It will be deemed to be nil if not indicated separately. Bidder shall consider enterprise license for common applications for proposed system.
19	Each selected application shall include necessary prerequisites, if any.
20	All cabling (Communication, Power Supply, Interfaces) is in Bidder's scope. This includes supply, laying, termination and connection to equipment.
21	All Networking accessories and all types of Cables required for integration of other systems shall be considered by the bidder.
22	Necessary Communication equipment such as Layer2 switches, Firewall, Networking cables, patch cords etc. for integrating the Servers, Workstations through the L2 switches shall be in the scope of the Bidder. All structure cabling at MCC & BCC is in Bidder scope. All the Communication equipment shall be AC Powered.
23	Post Warranty Services - Resident Engineer Support shall be Common for all the supplied equipment (Bidder's Own and bought out items)
24	It is the responsibility of the Bidder's Resident Testing Engineer to carry out all activities under the supervision of Purchaser including data base updation as per the site requirement during Warranty and Post Warranty period as defined in the RFP.
25	It is the responsibility of the bidder to provide Patch Management, Software upgradation, Firmware Upgradation for Bidder's Owned items, Sub-vendor items, Communication and Networking items
26	Patch Management, Software upgradation, Firmware Upgradation, Minor and Major modification etc. is the responsibility of the Bidder's Resident Testing Engineer as per the SLA and activities specified in the RFP

1	2
Sl. No.	**Information to Bidder**
27	The bidder shall indicate the total FOR Site price in Indian Rupees including of all taxes & duties
28	Purchaser may procure any item from elsewhere. Integration of those with supplied system is in Bidder's scope.
29	All annual maintenance charges of supplied Hardware, OS & Software are inclusive in the Warranty and Post Warranty of Bidder's Owned items, Sub-vendor items, Communication and Networking items, software licenses their renewal, upgrades etc.

Indicative Bill of Material for Proposed SCADA and ADMS System at MCC and BCC

Note: The BOQ provided in below table is indicative only. Bidder may also include material as consider appropriate for implementing specified functionalities.

S.No.	Equipment	Unit	Quantity
A	**Server & workstation Hardware for MCC & BCC with 7 years comprehensive warranty**		
SCADA, DMS and other system			
1	Server 1) SCADA- 4 nos (2 at MCC and 2 at BCC) 2) FEP- 4 nos (2 at MCC and 2 at BCC) 3) DMS- 4 nos (2 at MCC and 2 at BCC) 4) ICCP- 4 nos (2 at MCC and 2 at BCC) 5) Active directory- 4 nos (2 at MCC and 2 at BCC) 6) ISR (time series historian) server with report functionality software- 4 nos (2 at MCC and 2 at BCC 7) DTS- 2 nos (at MCC) 8) Developmental server- 2 nos (at MCC) 9) Quality Assurance Server - 2 (at MCC) 10) Web server with load balancing (50 concurrent client)- 4 nos (2 at MCC and 2 at BCC) 11) Interface Server (Main & Standby) for Third Party and Other System Integration on Secured ICCP, OPC, ODBC, Web Services, CIM-XML, Mail and SMS gateway etc.- 4 nos (2 at MCC and 2 at BCC) 12) On-Line Backup Server with pool of storage media- 4 nos (2 at MCC and 2 at BCC)	No.	42

2	Work-Station w 2 x 24" LED Monitors (with RGB Provision for LVS) with WINDOW OS and external speaker Operator Workstation MCC- 2 nos Operator Workstation BCC- 2 nos DTS Workstation - 4 nos Developmental console - 6 nos	No.	14
3	Remote VDUs with one 24"LED Monitors with WINDOW OS and external speaker	No.	10
OMS System with 7 years comprehensive warranty			
4	OMS Server - 4 nos (2 at MCC and 2 at BCC)	No.	4
Storage & Backup System with 7 years comprehensive warranty			
5	SAN Box (30TB or higher) for log storage (2 at MCC and 2 at BCC)	No.	4
6	LTO-9 OR better Tape Drive with Auto Loader (1 at MCC and 1 at BCC)	No.	2
Rack and network devices with 7 years comprehensive warranty			
7	Modular Rack for Servers and networking devices with all necessary accessories (Cables, Connectors etc. required at MCC and BCC)- 8 nos (4 at MCC and 4 at BCC)	NO.	8
8	Rack-Mount Sliding Monitor with inbuilt Keyboard and Mouse along with Rack mounted KVM Switch- 4 nos (2 at MCC and 2 at BCC)	No.	4

9	Layer II switch (SCADA/DMS LAN, Planning and Development System LAN, Server LAN, etc), Port: 24(Minimum)- 22 nos (12 at MCC and 10 at BCC)	No.	22
Cyber Security with 7 years comprehensive warranty			
10	High Availability NGFW Firewall & network IDS/IPS. External - 4 Qty. (will be provided by Tata Power) & Internal - 4 Qty . Bidder to supply Fortinet make Internal firewall only and same to be integrate with existing FMS- 4 nos (2 at MCC and 2 at BCC)	No.	4
Other Active Devices with 7 years comprehensive warranty			
11	GPS Time synchronisation system- 4 nos (2 at MCC and 2 at BCC)	Set	4
12	GPS Display for Time and Frequency- 1 no at MCC	Set	1
	Sub-Total A (Hardware)		

B	Services		
1	Services for installation, Commissioning and Testing of MCC and BCC system. This also includes, Services for integration with thrid party system 1) integration with existing System such as PI,GIS,AMI,CYMDIST,SAP,ICCP, mail server and 2) installation of cyber security system and installation & integration of cyber security system with existing infrastucture	Lot	1
2	Additional years Warranty & Services for both MCC & BCC infra after completion of 7 years comprehensive warranty period	Per anum	3
3	Resident Engineer Support (1 Engineer) for 7 years after successful completion of SATfor the following acitivites 1) For all Supplied system including sub-vendor equipment & 3rd party Solutions/systems. 2) Hardware & Software - Maintenance, Upgradation and Patch Management Services for all supplied systems.	Per anum	7
	Grand Total (A+B)		

S.No.	Equipment	Unit	Quantity
A	**Software for MCC & BCC Centre(For Main & Standby Server with 7 years comprehensive warranty)**		
SCADA, DMS and other system			
1	SCADA Server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
2	FEP server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
3	DMS Server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
4	ICCP Server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
5	Active directory server Software (1 lot at MCC and 1 lot at BCC)	Lot	2
6	ISR (time series historian) server with report software - (1 lot at MCC and 1 lot at BCC)	Lot	2
7	DTS server Software (at MCC)	Lot	1

8	Developmental server Software (at MCC)	Lot	1
9	Quality Assurance Server Software (at MCC)	Lot	1
10	Web server software with load balancing (50 concurrent client)- (1 lot at MCC and 1 lot at BCC)	Lot	2
11	Interface Server software (Main & Standby) for Third Party and Other System Integration on Secured ICCP, OPC, ODBC, Web Services, CIM-XML, Mail and SMS gateway etc.- (1 lot at MCC and 1 lot at BCC)	Lot	2
12	On-Line Backup Server software with pool of storage media- (1 lot at MCC and 1 lot at BCC)	Lot	2
13	Operator Work-Station Software- (2 lot at MCC and 2 lot at BCC)	Lot	4
14	Remote VDUs Software with WINDOW OS	Lot	10
15	DTS Work-Station Software (at MCC)	Lot	4
16	Developmental console Software (at MCC)	Lot	6

OMS System with 7 years comprehensive warranty			
17	OMS Server Software- (1 lot at MCC and 1 lot at BCC)	Lot	2
Cyber security components with 7 years comprehensive warranty			
18	License upgradation of existing cyber security servers to integrate all server and workstation proposed in MCC & BCC.(ref. CH-13 for detail)- (at MCC)	Lot	1
	Grand Total		

Annexure 5: System Sizing

Sr.No.	Asset/Item	Existing Qty	Expected growth in 5-7 years - To be considered for System Sizing	Compliance Yes/No
1	No of Distribution S/S (33KV,22KV/11KV)	38	70	
2	No of Consumer S/S (11KV/415V)	1115	2000	
3	No of feeders at Primary side (Incomer)	151	250	
4	No of 11 KV feeders	440	1000	
5	No of 22 KV feeders	151	250	
6	No of RMUs	1480	2500	
7	No of FPIs	1302	2200	
8	No of Breakers	3527	5000	
9	No of Isolators	10223	18000	
10	No of Power Transformers at DSS	70	140	
11	No of transformers at CSS	1072	2000	
12	No of Consumers	767686	1500000	
13	SCADA Points (inclusive of Analog, Digital, Accumulator(10000),setpoint (1000) and unlimited pseudo points)	300000	500000	
14	ICCP Points	10000	13000	
15	No of existing RTU	38	100	
16	No of existing FRTU	471	2000	

Annexure 6: Technical compliance sheet

Section No	Description	Compliance (Yes/No)
B	**Detailed Technical Specification**	
Chapter # 1	Hardware Specification (all clauses)	
Chapter # 2	Software Requirements (all clauses)	
Chapter # 3	SCADA Functional Requirements (all clauses)	
Chapter # 4	ADMS Applications (all clauses)	
Chapter # 5	Purchaser's Specific Applications (all clauses)	
Chapter # 6	Communication Network Requirements (all clauses)	
Chapter # 7	System Integration & Data Exchange Requirements (all clauses)	
Chapter # 8	Information Storage & Retrieval (IS&R) (all clauses)	
Chapter # 9	Program Development & Quality Assurance System (PDS & QAS) (all clauses)	
Chapter # 10	Dispatcher Training Simulator - Study Mode Simulator with SCADA/ADMS Applications (all clauses)	
Chapter # 11	On-Line Backup System (all clauses)	
Chapter # 12	Communication Network Management System (all clauses)	
Chapter # 13	Cyber Security Management System (all clauses)	

Note: 1) Bidder shall ensure that the offered product platform shall have modular, standards-based and integrated, DER management system (DERMS) as a part of platform. Same can be seamlessly integrated with ADMS system in future whenever procured by purchaser.

Annexure 7 : Guaranteed Technical particulars - Computing Infrastructure ADMS system at MCC & BCC

1	2	3	4	5	6	7	8	9	11	12
Sr. No.	**ADMS System Server/WS**	**Hardware Details**					**Software Details**			
		Make & Model	**Virtual Machine Yes / No**	**CPU detail (Make, Model, No. of Core Allocated and Speed)**	**Memory detail (Type, capacity & speed)**	**Hard disk detail (Type, Speed and capacity with RAID)**	**Operating System Details (Win/linux, version, server/enterprise / desktop grade)**	**Installed Applications Details (platform, name, version)**	**Licensing detail (No. of Client / tag / Port / Interface Supported)**	**Built in Redundancy (Available/ Not available, Considered, Not considered)**
1	SCADA Server									
2	FEP Server									
3	DMS server									
4	OMS Server									
5	ICCP Server									
6	Active directory server									
7	Operator Work-Station									
8	24" LED Monitors (with RGB Provision for LVS)									
9	Remote VDUs work station									
10	ISR (time series historian) server									
11	Report Server									

12	DTS server									
13	DTS Work-Station									
14	Developmental server									
15	Quality Assurance Server server									
16	Developmental work station									
17	Web server with load balancing									
18	Interface Server for Integration on Secured ICCP/OPC/ODBC/ Web services/Mail/CIM etc.									
19	SMS & email gateway									
20	On-Line Backup Server									
21	SAN Box (30TB usable or higher)									
22	LTO-9 OR better Tape Drive with Auto Loader									
23	High Availability NGFW Firewall with network IDS/IPS functionality									
24	GPS Time synchronisation system with display									
25	Layer 2 switch									
26	Layer 3 switch									

Annexure 8 : Guaranteed Technical particulars – Software Licencing details

Sr.No	Software Name (Make, Model & version)	Type of licence (Commercial / open source/Third Party)	Licence model perpetual /subscription-based	Number of concurrent client	Number of concurrent users	Number of I/O tags	Number of substation	Number of Switching devices	Number of IEC 104 session (RTU/FRTU)	Number of ICCP points & links	Number of digital tele-metered point	Number of analog tele-metered point	Number of feeder/lines	Number of consumers	Number of substation buses & Transformers	Transferable Yes/No
1																
2																
3																
4																
5																
6																
7																

Note:

1) Bidder to submit detail document on software license management clearly mentioning the functionality and quantity of various aspect of usage, capability and component of software product included in this offer - especially of all commercial license product such as SCADA, DMS, OMS, ICCP historian, FEP, DTS, PDS, Web server etc..
2) Bidder to submit detail Product Lifespan Plan of both software (platform and version offered) and hardware product clearly mentioning the lifecycle, the date of launch and obsolescence including both product and maintenance support.
3) Bidder to note that any product offered which will be out of sale in next five years will not be acceptable and bids will not be considered for evaluation
4) Bidder shall offer a product which is most latest offering in the global market
5) The offered solution shall have clear product plan for Advance Distribution modules like DERMS, Advance functions & analytics for LV network in future for at least 10 years. In this regard the bidder shall submit the roadmap document issued by principal

RFQ No.: CC25VKD002

ANNEXURE III

Schedule of Deviations

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 this schedule and submit the same as a part of the ***Technical Bid.***

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

S. No.	Clause No.	Tender Clause Details	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 Bidder:

Signature:

Name:

ANNEXURE IV

Schedule of Commercial Specifications

(The bidders shall mandatorily fill in this schedule and enclose it with the offer Part I: Technical Bid. In the absence of all these details, the offer may not be acceptable.)

S. No.	Particulars	Remarks
1.	Prices firm or subject to variation (If variable indicate the price variation clause with the ceiling if applicable)	Firm / Variable
1a.	If variable price variation on clause given	Yes / No
1b.	Ceiling	-------- %
1c.	Inclusive of Excise Duty	Yes / No (If Yes, indicate % rate)
1d.	Sales tax applicable at concessional rate	Yes / No (If Yes, indicate % rate)
1e.	Octroi payable extra	Yes / No (If Yes, indicate % rate)
1f.	Inclusive of transit insurance	Yes / No
2.	Delivery	Weeks / months
3.	Guarantee clause acceptable	Yes / No
4.	Terms of payment acceptable	Yes / No
5.	Performance Bank Guarantee acceptable	Yes / No
6.	Liquidated damages clause acceptable	Yes / No
7.	Validity (180 days) (From the date of opening of technical bid)	Yes / No
8.	Inspection during stage of manufacture	Yes / No
9.	Rebate for increased quantity	Yes / No (If Yes, indicate value)
10.	Change in price for reduced quantity	Yes / No (If Yes, indicate value)
11.	Covered under Small Scale and Ancillary Industrial Undertaking Act 1992	Yes / No (If Yes, indicate, SSI Reg'n No.)

ANNEXURE V

Checklist of all the documents to be submitted with the Bid

Bidder has to mandatorily fill in the checklist mentioned below:-

S. No.	Documents attached	Yes / No / Not Applicable
1	EMD of required value	
2	Tender Fee as mentioned in this RFQ	
3	Company profile/organ gram	
4	Signed copy of this RFQ as an unconditional acceptance	
5	Duly filled schedule of commercial specifications (Annexure IV)	
6	Sheet of commercial/technical deviation if any (Annexure III)	
7	Balance sheet for the last completed three financial years; mandatorily enclosing Profit & loss account statement	
8	Acknowledgement for Testing facilities if available (duly mentioned on bidder letter head)	
9	List of Machine/tools with updated calibration certificates if applicable	
10	Details of order copy (duly mentioned on bidder letter head)	
11	Order copies as a proof of quantity executed	
12	Details of Type Tests if applicable (duly mentioned on bidder letter head)	
13	All the relevant Type test certificates as per relevant IS/IEC (CPRI/ERDA/other certified agency) if applicable	
14	Project/supply Completion certificates	
15	Performance certificates	
16	Client Testimonial/Performance Certificates	
17	Credit rating/solvency certificate	
18	Undertaking regarding non blacklisting (On company letter head)	
19	List of trained/untrained Manpower	

RFQ No.: CC25VKD002

ANNEXURE VI

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, TPC intends to use the reverse auctions through SAP-SRM tool 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 deemed as accepted by the bidder on participation in the bid event:

1. TPC 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. TPC will make every effort to make the bid process transparent. However, the award decision by TPC would be final and binding on the supplier.
3. The bidder agrees to non-disclosure of trade information regarding the purchase, identity of TPC, bid process, bid technology, bid documentation and bid details.
4. The bidder is advised to understand the auto bid process to safeguard themselves against any possibility of non-participation in the auction event.
5. In case of bidding through Internet medium, bidders are further advised to ensure availability of the entire 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 TPC.
6. In case of intranet medium, TPC shall provide the infrastructure to bidders. Further, TPC 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 of an auction event is restarted, the best bid as already available in the system shall become the start price for 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 TPC.
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 TPC 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 TPC.
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.

Signature & Seal of the Bidder

ANNEXURE VII

Inspection Test Plan

Please refer Specifications.

ANNEXURE VIII

General Conditions of Contract

The Tata Power Company Limited is hereunder referred to as the "Purchaser" or "Company". The person, firm or company selling the goods, the subject of this purchase order is referred to as "Vendor" or "Contractor". The subject of this purchase order is hereinafter referred to as the "Material(s)"or "Goods".

The Contract shall mean the contract as derived from the following:

1. Purchase Order (with 'Commercial Notes' and Annexures to the Purchase Order referred thereon)
2. Technical Specifications.
3. General Terms & Conditions

The documents including all reference document (s) and Annexures forming the Contract are to be read together as a whole and are to be taken as mutually explanatory.

1. Price:

Unless otherwise specifically stipulated, the price shall be firm and shall not be subject to escalation for any reason till the validity of this Contract.

Unless otherwise specifically stipulated, the price shall be inclusive of road/ rail worthy water-proof packing & forwarding charges up to effecting delivery at FOT/ FOR despatch point, GST and shall also be inclusive of inland freight, terminal taxes and entry taxes as leviable on the transportation or entry of goods into any local area limits pursuant to the Contact.

2. Taxes and Duties:

2.1 The Contract Price shall be inclusive of all taxes, duties, including but not limited to GST or any local taxes, levies imposed by State/Central/Local governments

2.2 Taxes as mentioned in the Contract Price or Price Schedule shall be paid to the contractor subject to the Contractor complying with all the statutory requirements and furnishing the relevant documents including error free invoices containing detailed break-up of the taxes

2.3 However the payment of GST or local levies shall be restricted to the total amount as indicated in the price schedule.

2.4 Any duties, levies or taxes not mentioned in Contract Price or Price Schedule but applicable as per any statute (s) shall be deemed to be included in the Contract price and shall be to the account of the Contractor.

2.5 Any statutory variation in duties, levies or taxes if applicable and specified in this Contract till the scheduled date for supply of Goods and limited to direct invoices of the Contractor shall be to the account of Purchaser. The Contractor shall have the obligation to provide the necessary documentary evidence / supporting by way of gazetted notifications etc. to prove the change in such levies or taxes between the due date of submission of the Bid and the scheduled date of supply of goods to claim the difference.

2.6 The Contractor shall pass on to the Purchaser all the benefits of either reduction in tax rates, exemptions, concessions, rebate, set off, credits etc. or introduction of new tax rates exemptions, concessions, rebate, set off, credits etc. pertaining to all taxes, duties, imposts, fees and levies in respect of the supplies of Goods or performance of obligations under the contract. This would specifically include reduction of tax rates as a result of statutory changes or judicial rulings.

2.7 Any other taxes, levies and duties not mentioned in Contract Price or Price Schedule but applicable as per any statute (s) or introduction (omission) of new taxes, levies and duties shall be deemed to be included in the Contract Price and shall be to the account of the Contractor.

2.8 For facilitating availment of a credit, set-off, rebate, drawback or like benefit available to the Purchaser, the Contractor will facilitate the Purchaser by providing the necessary documentary and/or procedural support. In any process of assessment or re-assessment, of taxes payable by the Purchaser. Wherever expressly agreed the purchaser would provide the statutory form 'C' to the seller for availing the concessional rate of Central sales tax.

2.9 The Contractor shall bear and pay all the costs, liabilities, levies, interest, penalties in respect of non-compliances of any legal requirements as per various statutory provisions. The contractor shall keep the owner indemnified at all times from any tax liability, interest, penalties or assessments that may be imposed by the statutory authorities for non-compliances or non-observation of any statutory requirements by the Contractor.

2.10 Purchaser shall pay the invoices to the Vendor after necessary deductions as prescribed under the applicable law, income – tax or other

deductions under the State Tax laws as may be applicable to the Contract.

3 Packing details:

Packing details: The material must be packed in suitable packing to suit the mode of transport and to ensure its safe receipt at point of delivery. Any damage to material noticed at the time of delivery at site, due to improper packing or any other reason whatsoever shall be the responsibility of the Vendor. Such damaged goods shall be replaced within 14 days from intimation from the Purchaser.

4 Transportation and Unloading at Site:

The Vendor shall deliver the Material(s) at site/ Stores as per the delivery address specified in the Purchase order. The unloading at delivery shall be organised by the Purchaser unless otherwise specified. The receipt of the material/ equipment is subject to inspection and rejection if Material(s) is found unsatisfactory or any of the clauses under this purchase order are violated.

5 Insurance:

Unless otherwise specified, Purchaser will be responsible to obtain transit insurance for the Material(s). The Vendor shall intimate the Order Manager (as mentioned in the Purchase Order) along with Invoice, packing list, the Railway Receipt/Truck or Lorry Receipt etc. immediately after the consignment is booked, at the e-mail id mentioned in the Purchase order.

6 Payment Terms:

100% payment shall be made within 60 days from the receipt and acceptance of the material at the Consignee Stores/ Site/ Location as per the Contractual terms and conditions herein.

7 Bills and invoice:

The tax invoices should contain the details to comply with the GST Law. The supplier shall:

i) Furnish (electronically) and communicate to the Owner, the details of Goods or Services supplied by the 10th of the month succeeding the said tax period,
ii) Upon discovery of any discrepancy, rectify it and shall pay the tax and interest thereof,
iii) Furnish the returns (electronically), for the inward and outward supplies of Goods and/or Services, before the specified dates as per the GST Law,
iv) Communicate the tax paid, credits etc. as and when credited.
v) The Invoice should clearly state the description of the goods, quantity, sale price, tax %, and tax amount;
vi) The Invoice should be signed by an Authorized Signatory.

Bills/Invoices in the name of The Tata Power Company Ltd. with packing lists in triplicate shall be forwarded along with the equipment.

Contractor to furnish GST Registration no. in all invoices as well as Purchaser's (Tata Power's) GST no.

8 Transfer of Title and risk:

The transfer of property and risk of Material(s) shall be deemed to take place as follows:

a. For delivery F.O.R. or F.O.T. despatch point: Transfer of property on handing over the Material(s) to the carrier against receipt of clean Railway Receipt/Truck or Lorry Receipt and such receipt having been handed over to Purchaser. However, the risk of loss shall pass to the Purchaser on delivery of goods at the specified destination.

b. In case the Material(s) are procured by the Vendor from sub-vendors on receipt of duly endorsed documents of title to the goods.

9 Contract Performance Bank Guarantee (In case applicable):

9.1 The Vendor shall within 15 days of issue of this Purchase Order furnish an unconditional irrevocable bank guarantee duly stamped and strictly as per the prescribed format of the Purchaser from any nationalized bank or any scheduled bank having a branch in Mumbai and approved by the Purchaser for a sum equivalent to 10% of the Total value of Order valid for a period not less than 6 months from the expiry of the Warranty period.

9.2 Irrespective of the performance demonstrated as part of the Factory Acceptance Tests Take-over tests / Performance Tests etc, the Purchaser may call for re-validation of performance of the system during the performance guarantee period by conducting fresh performance tests if in its opinion, the

system is not able to deliver the designed performances based on its operational performance results. If the equipment fails to prove the performance during such performance tests, the Purchaser may allow the Vendor to either rectify the system by addition / modification of equipment etc at the Vendor's costs & risk to restore the performance levels. Failure to rectify the system to achieve the designed performance levels may result in imposition of penalties including revocation of the Performance Bank Guarantee and forfeiture of the entire amount under the Performance Guarantee.

9.3 In case the Vendor fails to furnish the requisite Bank Guarantee as stipulated above, then the Company shall have the option to terminate the contract besides other contractual remedies.

10 Price reduction:

10.1 The Vendor agrees that time of supply of Material(s) is of prime importance.
If the Vendor fails to supply Material(s) before the respective scheduled / fixed date for supply. Company may without prejudice to any other right or remedy available to the Company: -

10.1.1 Recover from the Vendor ascertained and agreed, genuine pre-estimate liquidated damages, and not by way of penalty, a sum equivalent to 1% (of total value of order) per week or part thereof for each week's delay, beyond the scheduled supply date each subject to maximum of 10% of the total order value, even though the Company may accept delay in supply after the expiry of the scheduled supply date. The Company may, at its discretion, set off the aforesaid amounts from any other amounts owed by the Company to the Vendor or recover such amounts in other manner as may be permissible under applicable laws.

10.1.2 Arrange to get supply from elsewhere on account and at the sole risk of the Vendor, such decision of the Company being final and binding on the Vendor; or

10.1.3 Terminate the contract or a portion of supply of the supply work thereof, and if so desired, arrange for the supply in default by the Vendor to be attained from elsewhere at the sole risks and costs of the Vendor.

10.2 Liquidated damages for performance shortfall (if applicable) shall be specified in the Technical Specifications.

10.3 The Liquidated Damages referred in this clause 10 may be recovered by the Company from the Vendor as set off against any monies owed by the Company to the Vendor or in any other manner permissible under applicable laws.

11 Warranties:

11.1 Materials and Workmanship: Vendor shall fully warrant that all the stores, equipment and component supplied under the order shall be new and of first class quality according to the specifications and shall be free from defects (even concealed fault, deficiency in design, materials and workmanship).

11.2 Should any defects be noticed in design, material and/or workmanship within 12 months after the Material(s) or any portion thereof as the case may be have been commissioned or for 24 months from the date of delivery, whichever period concludes earlier. Purchaser shall inform Vendor and Vendor shall immediately on receipt of such intimation, depute their personnel within 7 days to investigate the causes of defects and arrange rectification/ replacement/modification of the defective equipment at site, without any cost to Purchaser within a reasonable period. If the Vendor fails to take proper corrective action to repair/replace defects satisfactorily within a reasonable period, Purchaser shall be free to take such corrective action as may be deemed necessary at Vendor's risk and cost after giving notice to the Vendor, including arranging supply of the Goods from elsewhere at the sole risk and cost of the Vendor.

11.3 In case defects are of such nature that equipment shall have to be taken to Vendor's work for rectification etc., Vendor shall take the equipment at his costs after giving necessary undertaking or security as may be required by Purchaser. After repair Vendor shall deliver the equipment at site on freight paid basis. Any taxes applicable in relation to this repair shall be to the Vendor's account. All risks in transit to and fro shall be borne by the Vendor.

11.4 Equipment or spare parts thereof replaced shall have further warranty for a period of 12 months from the date of acceptance.

12 Quality, Testing, inspection, installation:

12.1 All Material(s) supplied under this Contract shall be new and unused.

12.2 Wherever a specific Quality Assurance Plan is provided with the Request for Quotation (RFQ) or agreed as part of the commercial/ technical discussions, the same shall be binding on the Vendor.

12.3 The material shall be inspected

a. At consignee end by Purchaser.

b. At factory premise of the Vendor/ sub-vendor by Purchaser or third party duly nominated by Purchaser. The Vendor shall extend all necessary co-operation to Purchaser/ third party inspector carrying out the inspection. The Inspector(s) shall have the right to carry out the inspection or testing, which will include inspection and testing of the raw materials at manufacturers shop, at fabricators shop and at the time of actual despatch before and/or after completion of packing.

12.4 The Vendor will inform Purchaser at least eight (8) days in advance of the exact place, date and time of tendering the Material(s) for required inspection and provide free access to the Inspector(s) during normal working hours at Vendor's or his/ its sub-Suppliers works, and place at the disposal of the Inspector(s) all useful means for undertaking the Inspection, checking the results of tests performed, marking the Material(s), getting additional tests conducted and final stamping of the Material(s).

12.5 Even if the inspection and tests are fully carried out, the Vendor shall not be absolved from its responsibilities to ensure that the Material(s), raw materials, components and other inputs are supplied strictly to conform and comply with all the requirements of the Contract at all stages, whether during manufacture and fabrication, or at the time of Delivery as on arrival at site and after its erection or start up or consumption, and during the defect liability period. The inspections and tests are merely intended to prima facie satisfy Purchaser that the Material(s) and the parts and components comply with the requirements of the Contract.

12.6 *All costs associated with the inspection shall be included in cost of Material(s).*

12.7 Original material test certificate/ performance test certificate/ fitment certificate/ test reports etc. relevant/ applicable as per the specifications/ standards shall be dispatched along with the material supply failing which the material may be rejected.

13 Rejection:

13.1 Rejected goods shall be removed and replaced within 14 days of the date of communication of rejection.

13.2 Claim in respect of breakage/shortages in any cases shall be referred on the Vendor within ninety (90) days from the date of receipt of Goods by the Purchaser which shall be replaced/made good by the Vendor at his own cost. All risk of loss or damage to the material shall be upon the Vendor till it is delivered to the purchaser/consignee.

14 **General Indemnity:**

The Vendor shall indemnify and keep the Purchaser indemnified from and against any and all claims, costs, liabilities (financial), litigations, compensations, judgments, expenses or damages (including attorney's fees and other related expenses) arising out of any breach or alleged breach of any of the conditions of this Contract, performance of the obligations hereunder, or any representation or misrepresentation made by the Vendor or any third party with regard to the subject of this Contract.

15 **Indemnity against IPR:**

The equipment, system, drawings, and other materials that shall be supplied against the order will become the Purchaser's property. Without limitation of any liability of whatsoever nature, the Purchaser shall be indemnified and kept indemnified against any claim for infringement or breach of any of the statues, rules & regulations by the use of or sale of any article or material supplied by the Vendor. The indemnity shall include any infringement of patent, trade mark, design, copyright or other property rights whether in Country of Origin, or elsewhere resulting from the Vendor's design, manufacture, use, supply or re-supply & would also cover use or sale of any article or material supplied by the Vendor to the Purchaser under the Purchase Order. The Indemnity shall cover any claim/action taken by a third party either directly against the Purchaser or any claim/action made against the Vendor & where under the Purchaser is made liable. The

Indemnity shall be for losses, damages, and costs including litigation costs, attorney fees etc incurred by the Purchaser in relation to the Purchase Order.

16 Latent Defects Liability period (if applicable):

Notwithstanding the inspections, acceptance tests, quality checks etc carried out by the Vendor and witnessed/accepted by the Purchaser, the Vendor shall further warrant the equipment for any latent defects in its design, material or workmanship against the specifications set forth and shall make good any such defects by way of repair or replacement of the part or whole of the defective product at its own cost & risks as and when such latent defects are observed and intimated by the Purchaser and intimated to the Vendor within 36 months of completion of warranty period.

17 Force Majeure:

17.1 In the event of either party being rendered unable by force majeure to perform any obligation required to be performed by it under this Contract the relative obligation of the party affected by such force majeure shall, after notice under this articles be suspended for the period during which such cause lasts. The term 'Force Majeure' as employed herein shall mean acts of God, wars (declared or undeclared), riots or civil commotion, fire, floods, and acts and regulations of the Government of India or State Government or any of the statutory agencies. Both the party shall pay to the other party, the amount payable upon the date of the occurrence of such force majeure.

17.2 Upon the occurrence of such cause and upon its termination, the party alleging that it has been rendered unable as aforesaid, thereby shall notify the other party in writing immediately but not later than twenty four (24) hours of the alleged beginning and ending thereof giving full particulars and satisfactory evidence in support of the claims.

17.3 During the period, the obligations of the parties are suspended by force majeure, the contractor shall not be entitled to payment of any rate.

17.4 In the event of the force majeure conditions continuing or reasonably expected to continue for a period more than thirty (30) days, Purchaser shall have the option of terminating the contract by giving seven (7) days notice thereof to the contractor.

18 Variation:

Except for any provisions in this Purchase Order, any change /modification to the terms and conditions of this Order can be issued only by Purchaser or with the prior written approval from Purchaser.

19 Termination

19.1 The Contract shall be deemed to be terminated on completion of delivery of Material(s)

19.2 Termination of Default by Vendor:
Purchaser may terminate the contract at any time if the Vendor fails to carry out any of his obligations including timely delivery under this Contract. Prior to termination, the Vendor shall be advised in writing of the causes of unsatisfactory performance to be improved upon 15 days of the receipt of notice. In case, if the Vendor fails to bring about the improvement to the satisfaction of the Purchaser, then the order shall be terminated.

19.3 Without prejudice to the rights and remedies available to Purchaser, Purchaser may terminate the Contract or part thereof with immediate effect with written notice to the Vendor if,:

19.3.1 The Vendor becomes bankrupt or goes into liquidation.

19.3.2 The Vendor makes a general assignment for the benefit of creditors.

19.3.3 A receiver is appointed for any substantial property owned by the Vendor.

19.3.4 The Vendor has misrepresented to Purchaser, acting on which misrepresentation Purchaser has placed the Purchase Order on the Vendor.

The Vendor/ Contractor shall not be entitled to any further payment under the Contract if the Contract is terminated. If the order is terminated under clause 19.2 and 19.3, the Vendor shall not be entitled to any further payment, except that, if Purchaser completes the supply of Material(s) and the costs of completion are less than the Total Order value, the Purchaser shall pay Vendor an amount properly allocable to supply of Material(s) fully performed by Vendor prior to termination for which payment was not made to Vendor. In case, the cost of completion of Material(s) exceed the total Order value, the additional cost incurred by Purchaser for such completion shall be paid by the Vendor.

19.4 Purchaser shall be entitled to terminate the Contract at it's convenience, at any time by giving thirty (30) Days prior notice to the Contractor. Such notice of termination shall specify that termination is for Companies convenience and the date upon which such termination becomes effective. Upon receipt of such notice, the Contractor shall proceed as follows:

19.4.1 cease all further work, except for such work as may be necessary and instructed by the Company/ Company's representative for the purpose of protecting those parts of the supplies already manufactured;

19.4.2 stop all further sub-contracting or purchasing activity, and terminate Sub-contracts;

19.4.3 handover all Documents, equipment, materials and spares relating to the supply of goods prepared by the Contractor or procured from other sources up to the date of termination for which the Contractor has received payment equivalent to the value thereof; and

19.4.4 handover those parts of the supplies manufactured by the Contractor up to the date of termination.

Upon termination pursuant to clause 19.4, the Vendor shall be entitled to be paid the full value on the Material(s) delivered in accordance with the Contract.

19.5 The Contractor shall not be released from any of his obligations or liabilities accrued under the Contract on termination. For the avoidance of doubt, the termination of the Contract in accordance with this clause shall neither relieve the Contractor of his accrued obligations for Warranty or his accrued liability to pay (liquidated) damages for Delay nor shall entitle him to reduce the value of Performance Security.

20 Sub letting and assignment:

The contractor shall not without prior consent in writing of the Purchaser, sublet, transfer or assign the contract or any part thereof or interest therein or benefit or advantage thereof in any manner whatsoever, provided nevertheless that any such consent shall not relieve the contractor from any obligation, duty or responsibility under the contract.

21 **Dispute Resolution**:

Dispute or differences arising out or relating to this Order shall be resolved amicably by the parties. Failing such amicable resolution of dispute / differences either party may refer the matter to arbitration of a Sole Arbitrator to be appointed jointly by both the parties. The award of the Arbitrator shall be final, binding and conclusive on the parties. The venue for arbitration shall be Mumbai. The Arbitration proceedings will be governed and regulated by the provisions of Indian Arbitration and Conciliation Act, 1996 as amended from time to time and the rules framed there under.

22 Governing laws

This Contract shall be construed in accordance with and governed by the Laws of India without giving effect to any principle of conflict of law.

23 Jurisdiction

This Contract and the transaction contemplated herein shall be subject to the exclusive jurisdiction of the competent Courts in Mumbai only.

24 Limitation of Liability

Notwithstanding anything contained in the Contract, the Contractor's aggregate liability under this Contract shall be limited 100% of the Total order value. This shall however, exclude liability arising pursuant to clause 2.8- tax indemnity, clause 14- General Indemnity, clause 15- Indemnity against IPR, clause 25 – Confidentiality and liabilities arising due to wilful misconduct, gross negligence, third party claims and corrupt acts attributable to the Vendor.

25 Confidentiality:

The Vendor shall use the Confidential Information of the Purchaser only in furtherance of this Contract and shall not transfer or otherwise disclose the Confidential Information to any third party. The Vendor shall (i) give access to such Confidential Information solely to those employees with a need to have access thereto; and (ii) take the same security precautions to protect against disclosure or unauthorized use of such Confidential Information that the party takes with its own confidential information but, in no

event, shall a party apply less than a reasonable standard of care to prevent such disclosure or unauthorized use.

26 Consequential Damages:

Unless otherwise specified, neither Party shall be responsible for and nor shall be liable to the other Party for indirect/consequential losses and damages suffered by such Party including for loss of use, loss of profit whether such liability or claims are based upon any negligence on the part of the other Party or its employees in connection with the performance of the Purchase Order.

27 New Legislation (The Micro, Small and Medium Enterprise Development Act 2006)

a. This Act has been enacted and made effective from 2nd October 2006. The Interest on Delayed Payments to Small Scale and Ancillary Industrial Undertaking Act, 1993 is repealed.

b. Vendor is requested to inform the purchaser if vendor fall under The Micro, Small and Medium Enterprises Development Act, 2006 legislation and provide the purchaser, registration number and date to enable purchaser to take necessary care. The vendors are also requested to mention the same on their invoice / bill.

28 Relation between parties:

The Purchase Order shall be entered into on a principal-to-principal basis only. The Purchase order shall not be construed as a partnership or an association of persons. There is no agent and principal relationship between the parties. Each party shall be responsible for its own conduct. The Vendor shall ensure at all times that all the work carried out under this contract either by its own person or through any of its sub-Vendors shall be always done under its own direct supervision.

29 Environment / ISO 14001 Certification:

The Vendor to confirm whether their organization is ISO 14001 certified. If not, the Vendor must certify that the handling, use and disposal of their product / by-products conform to practices consistent with sound environmental management and local statutes. The Vendor shall ensure that all the wastes are disposed in environmental friendly way with strict compliance to applicable laws including adherence to MoEF guidelines with respect to disposal of batteries, lead waste, copper cables, ash, waste oil, e-waste etc which shall be disposed through MoEF approved parties only. The Vendor shall also be responsible to collect and recycle all the e-waste generated at the end of the product life cycle at its own costs and risks as per the MoEF guidelines/ orders.

30 Tata Code of Conduct

The Purchaser abides by the Tata Code of Conduct in all its dealing with stake holders and the same shall be binding on the Purchaser and the Vendor for dealings under this Purchase Order. A copy of the Tata Code of Conduct is available at our website: http://www.tatapower.com/aboutus/code-of-conduct.aspx. The Vendor is requested to bring any concerns regarding this to the notice of our Chief Ethics Officer on the e-mail ID: cecounsellor@tatapower.com.

31 Responsible Supply Chain Management:

The Purchaser is committed for a cleaner environment and respect of Human rights through its Responsible Supply Chain Management policy. The Vendor is required to comply with all the environment & Human rights related laws, including emission norms, Labour and environmental regulations. The Purchaser encourages its Vendors/ Contractors/ Business partners to pay more attention to green design, green supply, green production, green logistics and green packaging in performing their business obligations.

The Vendor is required to abide by the Tata Power Corporate Environment policy, Energy Conservation and Corporate Sustainability Policy.

A copy of the Responsible Supply Chain Management Policy along with Environment policy, Energy Conservation policy, Sustainability policy, Health & Safety policy and Human Rights policy is available at website: http://www.tatapower.com/sustainability/policies.aspx.

Vendor/Bidder is required to completely fill the attached "Supplier Sustainability Questionnaire" in support of their Green Supply Chain Management initiatives and submit the same with their offer.

The Owner recognizes that diversity in the workplace positively impacts business. The Owner is committed to help people from SC/ST background either by helping them to become entrepreneurs or by engaging workforce from SC/ST community under the contracts agreed herein. To encourage engaging SC/ST community, the owner may consider on the merit to incentivize the Contractor by paying additional 1% of the service contract portion if the number of SC/ST workforce engaged in the contract exceeds 30% of the total deployed strength and 2%, if the strength goes beyond 50%. While the Contractor will assist the workforce so engaged to become self-reliant in meeting the work expectation, the Owner may also volunteer its training resources to the extent possible to improve their employability. The Contractor shall maintain the proper documentation of such category of the workforce engaged and the owner may consider to pay the incentive after its verification.

The Owner may also consider extending price preference of 5% in the bid evaluation for an order value up to Rs.50 Lacs, provided the company is owned by a person from SC/ST community having minimum 50% holding in the company.

32 Vendor rating

You are requested to ensure compliance to the terms of the individual orders with regards to timely delivery, provision of all applicable documents / challans / test certificate, quality of the material etc. Your performance with respect to the said factors will be taken into consideration for future business.

33 Vendor Feedback:

33.1 In this dealing Vendors feedback is important for the purchaser to improve its processes. If vendor have to report any grievance, problem or require any clarification, information, vendor is requested to contact purchaser at email ID: CC_CUSTOMERFEEDBACK@tatapower.com

33.2 Vendor is requested to ensure compliance to the terms of the individual orders with regards to timely delivery, provision of all applicable documents / challans / test certificate, quality of the material etc. Vendor performance with respect to the said factors will be taken into consideration for future business.

34 Non-Waiver:

Failure of Purchaser or its representatives to insist upon adherence to any of the terms or conditions incorporated in the Contract or failure or delay to exercise any right or remedies herein or by law accruing, or failure to promptly notify the Vendor in the event of breach or the acceptance of or the payment of any Material(s) hereunder or approval of any design or Material(s) shall not release the Vendor and shall not be deemed a waiver of any right of Purchaser to insist upon the strict performance thereof or of any of its rights or remedies as to any such Material(s) regardless of when the Material(s) are shipped, received or accepted not shall any purported oral modification or revisions of the Contract by Purchaser or its representative(s) act as waiver of the terms hereof.

35 **Repeat Order**:

Purchaser may place the repeat order for 100% of ordered quantities within a span of 6 months from the date of issue of this Purchase Order & Vendor shall execute it at same rates, terms and conditions.

36 Severability

If any provision of this Contract is invalid, unenforceable or prohibited by law, this Contract shall be considered divisible as to such provision and such provision shall be inoperative and shall not be part of the consideration moving from any Party hereto to the others, and the remainder of this Contract shall be valid, binding and of like effect as though such provision was not included herein.

ESG FRAMEWORK FOR BUSINESS ASSOCIATES

Tata Power's Sustainability philosophy sits at the core of its Business Strategy. Tata Power Sustainability Model has an overarching objective of 'Leadership with care' with key elements of 'Care for the Environment'; 'Care for the Community'; 'Care for our Customers / Partners' and 'Care for our People'. These sustainability objectives encompass the Environmental, Social and Governance objectives driven as integrated elements.

Tata Power, together with its stakeholders is determined to achieve sustainable growth while creating shared value for all.
As a part of future ready roadmap, Tata Power has targeted following as our Environment, Social and Governance priorities:

- Being Carbon Net Zero before 2045
- Growing Clean capacity (80% by 2030)
- Customer centricity
- Becoming water neutral before 2030
- Achieving zero waste to landfill before 2030
- No net loss of biodiversity before 2030
- Positively impacting 80 million lives by 2027

In order to create a sustainable business ecosystem, Tata Power expects that all its Business Associates (BA) which includes its suppliers, vendors, consultants and service providers to align to its ESG and sustainability commitments.

Tata Power encourages improved efficiencies and scaling up of green initiatives through technology and innovation taking us farther on the journey of reducing carbon emissions and preparing the entire eco-system towards products and services that would have net positive impact on the environment and communities that we operate in.

The Vendors/ bidders wishing to associate with Tata Power are expected to share their own sustainability and ESG journey. We at Tata Power promote all Business Associates to have a sustainable procurement policy for their supplier and service providers to contribute to our integrated approach in achieving a sustainable supply chain. The BA is encouraged to carry out the assessment of their sub-contractors and sub-vendors on sustainability readiness so that they are aware of the expectation/ business requirement.

The Vendor/ Bidder shall fill-in the 'Environment, Social and Governance Compliance Screening Questionnaire for Business Associates' attached at Annexure-I and submit the same along with the Bid in Ariba online platform.

Responsible Supply Chain Management:

Tata Power is committed for a cleaner environment and respect of Human rights through its Responsible Supply Chain Management policy.
Tata Power Business Associate (BA) shall comply with all the environment & Human rights related laws, including emission norms, Labour and environmental regulations.

Tata Power encourages its BA to focus on green design, green supply, green production, green logistics and green packaging in performing their business obligations. The BA is expected to abide by the Tata Power Corporate Environment policy, Energy Conservation and Corporate Sustainability Policy (enclosed with this document as Annexure-II).

The BA is expected to:

- Strive towards Conservation of Energy, Water, Resources and optimize transportation of Men & Materials to minimize environmental impact and reduce carbon footprint.
- Carry out the assessment of materials used for construction, operation & maintenance, consumables and accordingly phase out those materials which are environmentally hazardous.
- Be cognizant that diversity in the workplace positively impacts business.
- Promote affirmative action by supporting people from SC/ ST background by engaging workforce from SC/ ST community under the contracts agreed herein.
- Share the commitment of 'No child labour', 'No forced labour', Non-discrimination on the basis of caste, colour, religion, gender, disability, maternity or pregnancy or any other factor unrelated to the requirements of the job
- Pay the wages or remuneration to the workforce, personnel deployed in compliance to all applicable laws and regulations.
- Provide its employees/ deployed labor with an employment environment that is free of physical or psychological harassment.
- Carry out the assessment of their Sub-contractors on their Sustainability Readiness so that they are aware of the above expectation/ standards
- To ensure usage of suitable package material which is more environmentally sustainable. Further the packing material shall be recycled to the extent possible. The material used for packing is expected to suit the mode of transport and to ensure its safe receipt at point of delivery.

Waste Disposal:

The BA is expected to follow best practices for disposal of waste, few of which are listed below:

- Have a detailed project plan that includes the waste management, segregation of all designated waste material (Recyclable/ Non-Recyclable), collecting, storing, disposing and transferring the same to pre-arranged facility/ destination in timely and safe manner as per environmental legislations. The project plan shall also include the innovative construction practice to eliminate or minimize waste, protect surface/ground water, control dust and other emissions to air and control noise.

- Have purchase policy to encourage the procurement of material with recycled and minimum packaging of goods during delivery and appropriate means for site-to-site transportation of materials to avoid damage and litter generation.

- Ensure that the residents living near the site are kept informed about proposed working schedule and timings/ duration of any abnormal noise full activity that is likely to happen.

- Ensure the regular maintenance and monitoring of vehicles and equipment for efficient fuel use so that emissions and noise are within acceptable limits to avoid air pollution.

Water Management:

The BA is expected to follow best practices for water management, few of which include a management and monitoring system for water withdrawals and consumption, procedures to reduce water usage or reuse/recycle water, and pretreatment of wastewater before disposal.

Compliance to Law:
The BA shall adhere to responsible business practices and comply with the provision of all the Statutory Acts Applicable. Special attention of the BA is drawn towards the compliance of provision of the following statues: (along with the latest amendments/additions, as applicable):

- The Child Labour (Prohibition and Regulation) ACT, 1986.
- The Contract Labour (Regulation and Abolition) ACT, 1970.
- The Employee's Pension Scheme, 1995.
- The Employee's Provident Funds and miscellaneous provisions Act, 1952.
- The Employees State Insurance Act, 1948.
- The Equal Remuneration Act, 1976.
- The Industrial Disputes Act, 1947.
- The Maternity Benefit Act, 1961.
- The Minimum Wages Act, 1948.
- The Payment of Bonus Act, 1965
- The Payment of Gratuity Act, 1972.
- The Payment of Wages Act, 1936.
- The Shops & Establishment Act, 1954.
- The Workmen's Compensation Act, 1923.
- The Employer's Liability Act, 1938.
- and any other applicable statutory act

Social Accountability (SA 8000):

Tata Power expects its BAs to follow guidelines of SA 8000:2014 on the following aspects

- Child Labour
- Forced or Compulsory Labour
- Health & Safety
- Freedom of Association & Right to Collective Bargaining
- Discrimination
- Disciplinary Practices
- Working Hours
- Remuneration
- Management System

Health and Safety

The BA is expected to ensure the health and safety of his and his Sub-contractor’s staff and labour. The BA shall, in collaboration with and according to the requirements of the local health authorities, ensure that medical staff, first aid facilities, sick bay and ambulance service are available at the accommodation and on the Site at all times, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. The BA shall maintain records and make reports concerning health, safety and welfare of persons deployed, and damage to property, as the Owner’s Representative may reasonably require. The BA shall be responsible for the medical treatment / hospitalization of his and his Sub-contractor’s staff/ labour.

The BA shall appoint a qualified Safety officer at the Site to be responsible for maintaining the safety, and protection against accidents, of all personnel on the Site. Such Safety officer shall have the authority to issue instructions and take protective measures to prevent accidents.

The BA shall comply in toto with the Tata Power's Contractor Safety Terms & Conditions, Health Safety & Environment Manual while working on Tata Power Site/ Services/ Contracts.

Grievance Mechanism

The BA is expected to have grievance procedures that allow stakeholders to anonymously bring environmental and/or work-related violations and/or concerns to the attention of management. In addition, the BA is expected to have procedures for examining reports of environmental and/or work-related violations or concerns and/or privacy complaints.

Data Protection

The BA is expected to have a formal process to address data security or privacy issues.

ANNEXURE-I

Sr. No.	Question Description	Response (Y/N)	Remarks
Organization			
1	Does your Company have Sustainability Policy at Organization Level? If Yes, Please attach		
2	Do you have sustainable procurement policy in place for your own suppliers? If Yes, Please attach		
3	Does your company do regular assessment of its suppliers on ESG parameters?		
4	Are there ESG risks, or negative impacts identified in your supply chain		
Governance			
1	Is diversity taken into consideration when appointing board members/ senior management? Do you have an independent director/s?		
2	Has your company taken initiatives to ensure ethical practices at workplace? Please share the details, Policies etc.		
3	Does your company have a formal process to address data security or privacy issues? Please share the details, Policies etc.		
4	Does your company have grievance mechanism for stakeholder issues and track resolution?		
Environment/ Planet			
1	Does your company have Environmental Policy? If Yes, Please attach		
2	Do you have a formal process for waste management including solid wastes, liquid wastes and hazardous waste?		
3	Does your company track greenhouse gas emission? Also, what percentage of own consumption comes from the renewable energy?		
4	Does your company have a formal process for water management including monitoring of water consumption and withdrawals, and if applicable, pretreatment of wastewater?		
Green Technology/ Innovation			
1	Are your facility/ Product/ Services provided by you is based on green design, green production, green packaging or green logistics considerations? Please elaborate.		
2	Do your products or services have any environmental or social features or benefits (e.g. environmental/energy certification, ecolabels, fair trade certification, etc.)?		
Social/ People			
1	Does you facility/ Company have written personnel policies in place Are you an equal opportunity employer?		
2	Please describe any formal programme / campaign in place to promote company involvement with the community (volunteering, etc.). What is the percentage of profit spend on community activities?		
3	Does your company have a written Health & Safety Policy or Program? If Yes, Please attach		
Certifications: Does your company have following certifications (valid till date-please mention validity)			
1	ISO9001 accreditation		
2	SA8000 or equivalent		
3	ISO 14001 certification		
4	ISO 18001/45001 or equivalent		
5	ISO/IEC 27001 or equivalent		
6	Any Other (Please specify)		

Signature

Business Associate Name

ANNEXURE-II

CORPORATE SUSTAINABILITY POLICY

At Tata Power, our Sustainability Policy integrates economic progress, social responsibility and environmental concerns with the objective of improving quality of life. We believe in integrating our business values and operations to meet the expectations of our customers, employees, partners, investors, communities and public at large

- We will uphold the values of honesty, partnership and fairness in our relationship with stakeholders
- We shall provide and maintain a clean, healthy and safe working environment for employees, customers, partners and the community
- We will strive to consistently enhance our value proposition to the customers and adhere to our promised standards of service delivery
- We will respect the universal declaration of human rights, International Labour Organization's fundamental conventions on core labour standards and operate as an equal opportunities employer
- We shall encourage and support our partners to adopt responsible business policies, Business Ethics and our Code of Conduct Standards
- We will continue to serve our communities:
    - By implementing sustainable Community Development Programmes including through public/private partnerships in and around our area of operations
    - By constantly protecting ecology, maintaining and renewing bio-diversity and wherever necessary conserving and protecting wild life, particularly endangered species
    - By encouraging our employees to serve communities by volunteering and by sharing their skills and expertise
    - By striving to deploy sustainable technologies and processes in all our operations and use scarce natural resources efficiently in our facilities
    - We will also help communities that are affected by natural calamities or untoward incidence, or that are physically challenged in line with the Tata Group's efforts

The management will commit all the necessary resources required to meet the goals of Corporate Sustainability.

(Praveer Sinha)
CEO & Managing Director

Date: 15th June, 2018

TATA POWER
Lighting up Lives!

Supplier Code of Conduct

Tata Power follows the Tata Code of Conduct (TCoC) and the Whistle blower Policy and expect all its Suppliers to adhere to the same principles. **"Supplier"** here means any business, company, corporation, person or other entity that provides, sells or seeks to sell, any kind of goods or services to Tata Power, including the Supplier's employees, agents and other representatives. The suppliers are expected to adhere to the following Do's and Don'ts:

Do's

1. The Suppliers shall be committed to supplying products and services of high quality that meet all applicable standards and laws, including product packaging, labelling and after-sales service obligations.
2. Comply with all applicable laws and regulations, both in letter and in spirit, in all the territories in which it operates.
3. Strive to provide a safe, healthy and clean working environment for its employees.
4. Strive for environmental sustainability, particularly with regard to the emission of greenhouse gases, consumption of water and energy and the management of waste and hazardous materials.
5. The Supplier shall represent our company (including Tata brand) only with duly authorised written permission from our company.
6. Safeguard the confidentiality on the use of intellectual property, information and data of the Company.
7. Gifts and hospitality given or received should be modest in value and appropriate as per Company Policy.
8. The assets of Tata Power shall be employed primarily and judiciously for the purpose of conducting the business for which they are duly authorised.
9. All actual or potential conflicts due to financial or any other relationship with a Tata Power employee shall be disclosed.

Don'ts

1. The Supplier shall not make unfair or misleading statements about the products and services of competitors.
2. Children shall not be employed at workplaces.
3. Forced labour shall not be used in any form.
4. The Suppliers shall neither receive nor offer or make, directly or indirectly, any illegal payments, remunerations, gifts, donations or comparable benefits that are intended, or perceived, to obtain uncompetitive favours for the conduct of its business with Tata Power.

Reporting Violations

The Supplier shall notify the Company regarding any known or suspected improper behaviour of other suppliers or employees relating to its dealings with Tata Power, by email to: cecounsellor@tatapower.com.

The same can also be raised through our 3rd party ethics helpline facility:

1. Email id: tatapower@ethics-line.com ; Website: www.tip-offs.com
2. Helpline numbers: Toll free - 0008001004382 and 0008001008277. Also accessible at normal domestic call rates within India: +91-11-71279005
3. Postal address: Deloitte Touche Tohmatsu India LLP
   c/o Arjun Rajagopalan, Partner (Ethics Helpline Services)
   19th Floor, 46 - Prestige Trade Tower, Palace Road,
   High Grounds, Bengaluru, Karnataka – 560001

The Tata Power Company Limited is hereunder referred to as the "Owner" or "Company". The person, firm or company offering the services, the subject of this order is referred to as "Contractor". The subject of this order is hereinafter referred to as the "Work".
"Sub-Contractor" means any person named in the Contract as a Sub-contractor, sub-vendor, manufacturer or supplier for a part of the Works or any person to whom a part of the Works has been subcontracted and the legal successors in title to such Person, but not any assignee of such Person.

The Contract shall mean the contract as derived from the following:

1. Work Order (with 'Commercial Notes' and Annexures to the Work Order referred thereon)
2. Scope of Work.
3. General Terms & Conditions - Service

The documents including all reference document (s) and Annexures forming the Contract are to be read together as a whole and are to be taken as mutually explanatory, provided however, in the event of any inconsistency or discrepancy between the aforementioned documents, the order of precedence in interpretation of the documents shall be as set out above. For the avoidance of doubt, it is clarified that the terms set forth in the Work Order (with 'Commercial Notes' and Annexures to the Work Order referred thereon) shall take precedence over the terms set out in the Scope of Work, which shall in turn take precedence of the terms set out in the General Terms & Conditions – Service.

1. Contractor's obligation:

1.1 Contractor warrants that it is a competent, qualified and experienced contractor, equipped, organised and financed to perform and complete the services in the operating area in an efficient and professional manner and capable of meeting all the requirements of the Contract.

1.2 The Contractor has the overall responsibility of executing the contract, conducting Planning, Job Scheduling, Maintenance Planning, Maintenance Job Scheduling, executing the Work and maintenance jobs as per the Scope of work & schedule.

1.3 Except to the extent that it may be legally or physically impossible or create a hazard to safety, the Contractor shall comply with the Owner's representative(s) instructions and directions on all matters relating to the Work.

1.4 Contractor shall at all times have full responsibility for control of the Equipment and for the direction and supervision of operations being carried out under the Contract.

1.5 In the performance of the Work, Contractor shall be and act as an independent Contractor fully responsible and accountable for the proper execution of its responsibilities, obligations and liabilities under this Contract and for its own acts and the acts of its Sub-Contractors and the Personnel. Owner's supervision, examination or inspection of the (performance of the) Work or omission to carry out the same shall not be construed in any manner whatsoever as relieving Contractor from its responsibilities, obligations or liabilities under this Contract.

1.6 Contractor shall submit list of tools & tackles with details of make, year of manufacturing, valid certification to the Project Manager/ User for their approval.

Project Manager may during the execution of project inspect & verify that the tools & tackles are as per the qualification requirements approved by him and will have right to seek replacements in case of any discrepancies. The Contractor shall always comply with such directives.

1.7 Contractor shall engage Tata Power Skill Development Institute (TPSDI) certified labour force at the site for execution of the job. Requirement & fees for TPSDI certification shall be as per Company Policy.

1.8 Contractor shall take full responsibility for the protection and security of Owner's materials and equipment while such materials and equipment are temporarily stored in Contractor's facility or otherwise in Contractor's custody.

1.9 All notices, instructions, information, and other communications given by the Contractor to Owner under the Contract shall be given to the Order Manager/ Owner's representative, except as otherwise provided for in this Contract.

1.10 The Contractor shall make its own arrangements for movement of personnel and equipment, within and outside the sites / units / offices at the various locations covered by the Contract.

1.11 The Contractor shall acquire in its name all permits, approvals, and/or licenses from all local, state, or national government and other statutory authorities and/or public service undertakings that are necessary for the performance of the Contract.

1.12 Neither the Contractor nor its personnel shall during the term of this Contract, engage in any business or professional activities in India/abroad which would conflict with the activities assigned to them under this Contract.

2. Service Warranties:

Contractor warrants that all services performed for or on behalf of Owner will be performed in a competent,

workmanlike manner and shall be free from faults and defects. Said warranties shall be in addition to any warranties of additional scope given by Contractor to Owner. None of said warranties and no other implied or express warranties shall be deemed is claimed or excluded unless evidenced by a change notice or revision issued and signed by Owner's authorized representative.

3. Compliance of Local Laws:

Contractor shall be responsible and shall comply with the provision of all the Statutory Acts Applicable. Special attention of the Contractor is drawn towards the compliance of provision of the following statues: (along with the latest amendments/additions, as applicable):

a) The Child Labour (Prohibition and Regulation) ACT, 1986.
b) The Contract Labour (Regulation and Abolition) ACT, 1970.
c) The Employee's Pension Scheme, 1995.
d) The Employee's Provident Funds and miscellaneous provisions Act, 1952.
e) The Employees State Insurance Act, 1948.
f) The Equal Remuneration Act, 1976.
g) The Industrial Disputes Act, 1947.
h) The Maternity Benefit Act, 1961.
i) The Minimum Wages Act, 1948.
j) The Payment of Bonus Act, 1965
k) The Payment of Gratuity Act, 1972.
l) The Payment of Wages Act, 1936.
m) The Shops & Establishment Act, 1954.
n) The Workmen's Compensation Act, 1923.
o) The Employer's Liability Act, 1938.
p) and any other applicable statutory act

Site Specific requirements shall be as Annexure at I. The compliance to these Site Specific requirements shall not absolve the Contractor of its obligation to comply with the Owner's Contractor Safety Management Policy.

4. Owner's Obligation:

4.1 The order manager (As specified in the 'Commercial Notes') shall have the authority to represent Owner on all day-to-day matters relating to the Contract or arising from the Contract. All notices, instructions, orders, certificates, approvals, and all other communications under the Contract shall be given by the order manager, except as otherwise provided for in this Contract. The order manager may appoint the Engineer-In-Charges for different areas for monitoring the work progress, inspections and signing of bills.

4.2 Owner shall ensure the availability of site access, all information and/or data to be arranged/ supplied by Owner to the Contractor for execution of the Work . The terms on which the Contractor shall be allowed access to the site shall be specified by the Owner prior to commencement of the execution of the Work and thereafter shall be governed in accordance with such policies as the Owner may provide in writing to the Contractor from time to time.

5. **Contractor's/ Sub-contractor's employees**:

5.1 The Contractor shall engage appropriately qualified persons to provide the services with the prior approval of Owner. Owner may withhold such approval for any reason whatsoever.

5.2 The Contractor hereby represents and warrants that:

i) the personnel are duly qualified, and are, and will remain, sufficiently qualified, careful, skilful, diligent and efficient to provide the services to Owner; and
ii) the Services will be rendered carefully, skilfully, diligently and efficiently, and to the professional standard reasonably expected by Owner of a contractor qualified and experienced in providing services substantially the same as the Services.

5.3 The Contractor must ensure that the Contractor's personnel conduct themselves in a proper manner and comply with the procedures and all policies, regulations and directives of Owner including any occupational, health and safety policies and the relevant prevailing laws and regulations in the Country of operations and specifically in the area where Work is being executed.

5.4 Owner may inform the Contractor to immediately remove Contractor's personnel from the relevant premises in the event of misconduct or incompetence on the part of the Personnel. The Contractor shall at all times remain liable for all acts and/or omissions of its Personnel.

5.5 It is made clear that no relationship of Owner and employee is created between Owner and the Contractor's resident engineers, employees and no claim for employment of any such personnel shall be tenable or entertained.

6. Title of Property:

6.1 Unless otherwise provided in this order or agreed to in writing, property of every description including but not limited to all tooling, tools, equipment and material furnished or made available to Contractor, title to which is

in Owner, and any replacement thereof shall be and remain the property of Owner. Such property other than material shall not be modified without the written consent of Owner. Such property shall be plainly marked or otherwise adequately identified by Contractor as being owned by Owner and shall be safely stored separately and apart from Contractor's property.

6.2 Contractor shall not use such property except for performance of work hereunder or as authorized in writing by Owner. Such property while in Contractor's possession or control shall be listed in writing and kept in good condition, shall be held at Contractor's risk, and shall be kept insured by Contractor, at its expense, in an amount equal to the replacement cost with loss payable to Owner. To the extent such property is not material consumed in the performance of this order, it shall be subject to inspection and removal by Owner and Owner shall have the right of entry for such purposes without any additional liability whatsoever to Contractor. As and when directed by Owner, Contractor shall disclose the location of such property, prepare it for shipment and ship it to Owner in as good condition as originally received by Contractor, reasonable wear and tear excepted.

7. Work Completion schedule:

Contractor shall plan and execute the Work in accordance with a detailed schedule mutually agreed upon by the Parties (Owner and Contractor).

8. Contract Price and Payment:

8.1 The Contract Price shall be a firm & fixed Contract Value for the Work inclusive of all the taxes, levies & duties and shall remain firm till the validity of this contract.

8.2 Unless Specifically stated elsewhere in the contract, the Contractor is solely liable for payment of , and warrants that it will pay, or ensure the payment of all taxes imposed, assessment made in relation to the Work.

8.3 An amount as stated in the table below shall be retained towards Contractor's safety performance against every RA bill:

Contract Value	Retention Amount (%)
Upto Rs. 10 lakhs	2.5
Above Rs. 10 lakhs and below Rs. 50 lakhs	2
Above 50 lakhs and upto Rs. 10 Crores	1.5
Above Rs. 10 Crores	1

The above mentioned safety retention shall be over and above any other retentions/ deferred payments as may have been specifically agreed in the Contract.

8.4 For Contract Price Rs. 1 crores or above and Contract Completion Schedule 12 months or more, the above safety retention will be released half yearly against the Safety Performance Score (methodology for evaluation enumerated in the Safety Terms & Conditions attached as Appendix to this General Terms & Condition) which will be evaluated by the Order Manager every month. For all other contracts, the above said safety retention shall be released along with the final settlement only at the end of the contract period.

8.5 The Owner shall have the right to stop any work which in its opinion is not meeting the safety standards/ guidelines of the Owner and good engineering practice. The Contractor shall not be eligible for and shall not be granted any extension in Completion Schedule due to such stoppage of work by the Owner.

8.6 The above retention towards safety shall not absolve the Contractor of its liabilities including statutory liabilities towards safety violations, injury or death (whether by accident or otherwise). An amount between Rs. 5 to 50 lakhs as deemed appropriate by Owner's appointed Committee for incident investigation and/ or as determined by statutory authorities (whichever higher), will be payable by the Contractor in case of such severe incidents of injury leading to loss of property or partial/ permanent disablement (e.g. loss of limb/s, vision etc.) or death.

8.7 Notwithstanding anything else stated in the Contract, the Contract shall be liable for termination without any notice and without recourse to Owner in case of three (3) or more severe safety violations. There shall be no termination fees/ compensation payable to Contractor for such termination.

8.8 In case the Contractor achieves 100% on the Safety Performance Score, the Contractor shall be awarded a discretionary bonus of 1% of invoiced value subject to a maximum of Rs. 50 lakhs towards Safety Performance.

8.9 Payment shall be released within 60 days of submission of error free invoice with supporting documents duly certified by the Order Manager/ Engineer-in-Charge after deducting taxes at source as prescribed under the applicable law, income – tax or other deductions under the state value added tax laws . If such payment release

day falls on a holiday of Owner, payment will be released on the next working day. Against deduction of statutory taxes, tax deduction certificates where ever applicable shall be issued as per the applicable provisions of the statute. The Order Manager may recover any amount wrongly paid in excess in any previous bills certified by him.

8.10 *Mode of Payment*: All payments shall be made direct to the Contractor or his authorized representative in the shape of RTGS or Electronics Transfer method, on certification of the Order Manager/Engineer-in-Charge and on compliance of contractual terms & conditions.

9. **Taxes and Duties:**

9.1 The Contract Price shall be inclusive of all taxes, duties, including but not limited to Customs duty, GST or any local taxes, levies imposed by State/Central/Local governments.

9.2 Taxes as mentioned in the Contract Price or Price Schedule shall be paid to the contractor subject to the Contractor complying with all the statutory requirements and furnishing the relevant documents including error free invoices containing detailed break up of the taxes.

9.3 The tax invoices should contain the details to comply with the GST Law. The supplier shall:

i) Furnish (electronically) and communicate to the Owner, the details of Goods or Services supplied by the 10th of the month succeeding the said tax period,
ii) Upon discovery of any discrepancy, rectify it and shall pay the tax and interest thereof,
iii) Furnish the returns (electronically), for the inward and outward supplies of Goods and/or Services, before the specified dates as per the GST Law,
iv) Communicate the tax paid, credits etc. as and when credited.
v) The Invoice should clearly state the description of the goods, quantity, sale price, tax %, and tax amount;
vi) The Invoice should be signed by an Authorized Signatory.

Bills/Invoices in the name of The Tata Power Company Ltd. with packing lists in triplicate shall be forwarded along with the equipment.

Contractor to furnish GST Registration no. in all invoices as well as Purchaser's (Tata Power's) GST no.

9.4 However the payment of tax shall be restricted to the total amount as indicated in the price schedule.

9.5 Any statutory variation in duties, levies or taxes if applicable and specified in this Contract till the scheduled date for completion of Work and limited to direct invoices of the Contractor shall be to the account of Owner. The Contractor shall have the obligation to provide the necessary documentary evidence / supporting by way of gazetted notifications etc. to prove the change in such levies or taxes between the due date of submission of the Bid and the scheduled date of completion of work to claim the difference.

9.6 The Contractor shall pass on to the Owner all the benefits of either reduction in tax rates, exemptions, concessions, rebate, set off, credits etc. or introduction of new tax rates exemptions, concessions, rebate, set off, credits etc. pertaining to all taxes, duties, imposts, fees and levies in respect of the supplies of Goods or performance of obligations under the contract. This would specifically include reduction of tax rates as a result of statutory changes or judicial rulings.

9.7 Any other taxes, levies and duties not mentioned in Contract Price or Price Schedule but applicable as per any statute (s) or introduction (omission) of new taxes, levies and duties shall be deemed to be included in the Contract Price and shall be to the account of the Contractor.

9.8 For facilitating availment of a credit, set-off, rebate, drawback or like benefit available to the Owner, the Contractor will facilitate the Owner by providing the necessary documentary and/or procedural support. In any process of assessment or re-assessment, of taxes payable by the Owner,

9.9 The Contractor shall bear and pay all the costs, liabilities, levies, interest, penalties in respect of non-compliances of any legal requirements as per various statutory provisions. The contractor shall keep the owner indemnified at all times from any tax liability, interest, penalties or assessments that may be imposed by the statutory authorities for non-compliances or non-observation of any statutory requirements by the Contractor.

9.10 All formalities required under statutes, for availing any concessions under relevant tax laws shall be adhered to by the Contractor.

9.11 Deduction at source: Recovery at source towards income tax calculated at the rate prescribed from time to time under the Income Tax Act 1961 and other relevant sections of Income Tax Act shall be made from the bills of the Contractor and the amount so recovered shall be

deposited with the Income Tax Department. Necessary TDS certificate to this effect will be issued to the Contractor in the prescribed pro-forma.

9.12 If any other taxes / duties / cess etc are to be recovered at source as per government regulations / Legislation from time to time, the same shall be recovered from the bills payable to the Contractor. Necessary receipt to this effect will be issued to the Contractor in this regard as per the applicable legislation.

10. Contract Performance Guarantees (If applicable)

The Contractor shall within 15 days of issuance of this Order/Contract furnish an unconditional irrevocable bank guarantee duly stamped, strictly as per the prescribed format of Owner from any nationalized bank or any scheduled bank having a branch in Mumbai and approved by the Owner for a sum equivalent to 10% of the Total Contract Price valid for the Contract Period and with a claim period of not less than 6 months from the completion of Contract Period. The issuing bank should be advised to send a direct confirmation of issue of bank guarantee to Owner.

In case the Contractor fails to furnish the requisite Bank Guarantee as stipulated above, then the Owner shall have the option to cancel the Contract besides other contractual remedies.

11. Price Reduction:

11.1 In case the Contractor fails to deliver the service/ Complete the work as per the agreed Completion Schedule including intermediate milestones (if applicable), the Owner shall recover from Contractor, as ascertained and agreed Liquidated Damages, and not by way of penalty, a sum equivalent to 1% of the Contract Value per week of delay. The Liquidated Damages referred above may be recovered by the Owner as set off against any amounts payable by the Owner to the Contractor or in any other manner in accordance with applicable laws.

11.2 The overall cap on liquidated damages shall be limited to 10% of the Contract Price.

12. Insurance

12.1 The Contractor agrees to indemnify and protect Owner against all liability, claims or demands for injuries or damages to any person or property growing out of the performance of this order/ Contract.

12.2 The Contractor further agrees to furnish evidence of insurance showing that Contractor has and will maintain adequate insurance coverage during the life of this Contract/ order in the opinion of Owner, including but not limited to comprehensive general liability insurance. Such evidence of insurance must set forth the name of the insurer, policy number, expiration date, and limits of liability. Compliance by Contractor with insurance requirements does not in any way affect Contractor's indemnification of Owner under Indemnification clause

13. Indemnification:

The Contractor shall indemnify, save harmless and defend the Owner and keep the Owner indemnified from and against any and all claims, costs, liabilities (financial), litigations, compensations, judgments, expenses or damages (including attorney's fees and other related expenses) arising out of any breach or alleged breach of any of the conditions of this Contract including compliance to statutory laws of provisioned under clause 3, performance of the obligations hereunder, or any representation or misrepresentation made by the Contractor or by any third party in respect of death or bodily injury or in respect to loss or damage to any property with regard to the subject of this Contract.

14. Indemnity against IPR:

The equipment, system, drawings, and other materials that shall be supplied against the Contract will become the Owner's property. Without limitation of any liability of whatsoever nature, the Owner shall be indemnified and kept indemnified against any claim for infringement or breach of any of the statues, rules & regulations by the use of or sale of any article or material supplied by the Contractor. The indemnity shall include any infringement of patent, trade mark, design, copyright or other property rights whether in Country of Origin, or elsewhere resulting from the Contractor's design, manufacture, use, supply or re-supply & would also cover use or sale of any article or material supplied by the Contractor to the Owner under the Contract. The Indemnity shall cover any claim/action taken by a third party either directly against the Owner or any claim/action made against the Contractor & where under the Purchaser is made liable. The Indemnity shall be for losses, damages, and costs including litigation costs, attorney fees etc incurred by the Owner in relation to the Contract.

15. Free Issue Material:

Wherever contracts envisage supply of Free Issue Material (FIM) by the Owner to the contractor for fabrication/ use in service performance, such Free Issue Material shall be safeguarded by an insurance policy to be provided by the Contractor at his own cost for the full value of such materials and the insurance policy shall cover the following risks specifically and shall be valid for six months beyond the Contract Validity date :

RISKS TO BE COVERED: Any loss or damage to the Owner's materials due to fire, theft, riot, burglary,

strike, civil commotion, terrorist act, natural calamities etc. and any loss or damage arising out of any other causes such as other materials falling on Owner' s materials.
The amount for which insurance policy is to be furnished shall be indicated in the respective Contract.

Free Issue material (FIM) will be issued to the Contractor only after receipt of the Insurance Policy from the Contractor. The contractor shall arrange collection of the FIM from the Owner's premises and safe transportation of the same to his premises at his risk and cost. Notwithstanding the insurance cover taken out by the Contractor as above, the Contractor shall indemnify the Owner and keep the Owner indemnified to the extent of the value of free issue materials to be issued till such time the entire contract is executed and proper account for the free issue materials is rendered and the left over/surplus and scrap items are returned to the Owner. The contractor shall not utilize the Owner's free issue materials for any job other than the one contracted out in this case and also not indulge in any act, commission or negligence which will cause/result in any loss/damage to the Owner and in which case, the Contractor shall be liable to the Owner to pay compensation to the full extent of damage/loss. The Contractor, shall be responsible for the safety of the free issue materials after these are received by them and all through the period during which the materials remain in their possession/control/custody. The Free issue materials on receipt at the Contractor's works shall be inspected by them for ensuring safe and correct receipt of the material. The contractor shall report the discrepancies, if any, to the Owner within 5 days from the date of receipt of the material. The contractor shall take all necessary precautions against any loss, deterioration, damage or destruction of the FIMs from whatever cause arising while the said materials remain in their possession/custody or control. The free issue materials shall be inspected periodically at regular intervals by the Contractor for ensuring safe preservation and storage, the Contractor, shall also not mix up the materials in question with any other goods and shall render true and proper account of the materials actually used and return balance remaining unused material on hand and scrap along with the final product and if it is not possible within a period of one month from the date of delivery of the final product/ completion of Service covered by this Contract. The Contractor shall also indemnify the Owner to compensate the difference in cost between the actual cost of the free issue material lost/damaged and the claim settled to the Owner by the insurance company.

16. Relation between parties:

The Contract shall be entered into on a principal-to-principal basis only. The Contract shall not be construed as a partnership or an association of persons. There is no agent and principal relationship between the parties. Each party shall be responsible for its own conduct. The Contractor shall ensure at all times that all the work carried out under this contract either by its own person or through any of its sub-Vendors shall be always done under its own direct supervision.

17. Safety:

Contractor shall comply with all legal and statutory provisions including all rules and regulations pertaining to Safety, Health and the Environment and will be responsible for all legal liabilities arising due to any of their acts or of their personnel.

The Contractor shall comply with the Owner's Contractor Safety Policy and Safety Terms and Conditions. Any misconduct and/ or violation with respect to the Owner's Contractor Safety Policy and Safety Terms and Conditions or any other legal and statutory provisions pertaining to Safety, Health and Environment shall be dealt with as per the Safety Terms and Conditions.

Prior to commencement of any work at site Contractor shall submit an undertaking in writing to adhere to and comply with all the provisions of Owner's Contractor Safety Code of Conduct.

The Contractor shall have a valid ISO 14001/ OHSAS certification. In absence of the same, the Contractor shall obtain the same within 6 months from the date of the Effective Date of Contract.

18. Suspension of Work

Owner may instruct Contractor at any time to suspend performance of the Work or any part thereof with a notice of 7 days for whatever reason. Provided Contractor is not in default under this Contract subject to Articles 1 and 5 inclusive, the Contractor shall be paid a mutually agreed fee, if any, necessarily incurred by Contractor as a direct consequence thereof of suspension and the Project Completion Schedule may be revised accordingly.

Without prejudice to any other rights Owner may have under this Contract or at law if Contractor is in default under this Contract, Owner may instruct Contractor to suspend performance of the Work or any part thereof by giving 7 days notice till such default has been corrected to the satisfaction of Owner. Also Liquidated Damages in accordance with Clause 11 shall continue to be applicable during such period until the default is cured. The costs incurred by the Contractor for such correction shall be to the Contractor's account, and furthermore no payment shall become due to the Contractor. Any cost incurred due to non - performance of the Contractor by the Owner shall be charged to the Contractor.

19. Change Management:

Owner shall have the right at any time to order any change in the Work in accordance with the following procedure. Contractor shall furnish to Owner upon request as soon as reasonably possible but no later

than five (5) days following the request, a written statement specifying:

(a) the increase or decrease, as the case may be, in the costs of the Work which will result from a change in the Work as requested by Owner,

(b) any effect such change in the Work may have on any other provision of this Contract originating from either parties, and

(c) such other details as Owner may require.

Any change in costs shall be reasonably related to the proportional change in the Work and any other costs incurred by Contractor. If Owner agrees to Contractor's statement Owner shall notify Contractor thereof in writing in the form of a change order, whereupon the change in the Work shall be incorporated in the Work and immediately implemented. In the event that the change relates to a reduction in Work, the work in question shall not be undertaken pending the issue of an appropriate Change Order.

20. Governing Laws

This Contract shall be construed in accordance with and governed by the Laws of India without giving effect to any principle of conflict of law.

21. Jurisdiction

This Contract and the transaction contemplated herein shall be subject to the exclusive jurisdiction of the competent Courts in Mumbai only.

22. Dispute settlement:

Dispute or differences arising out or relating to this Order shall be resolved amicably by the parties. Failing such amicable resolution of dispute / differences either party may refer the matter to arbitration of a Sole Arbitrator to be appointed jointly by both the parties. The award of the Arbitrator shall be final, binding and conclusive on the parties. The venue for arbitration shall be Mumbai. The Arbitration proceedings will be governed and regulated by the provisions of Indian Arbitration and Conciliation Act, 1996 as amended from time to time and the rules framed there under.

23. Force majeure:

23.1 In the event of either party being rendered unable by force majeure to perform any obligation required to be performed by it under this Contract the relative obligation of the party affected by such force majeure shall, after notice under this articles be suspended for the period during which such cause lasts. The term 'Force Majeure' as employed herein shall mean acts of God, wars (declared or undeclared), riots or civil commotion, fire, floods, and acts and regulations of the Government of India or State Government or any of the statutory agencies. Both the party shall pay to the other party, the amount payable upon the date of the occurrence of such force majeure.

23.2 Upon the occurrence of such cause and upon its termination, the party alleging that it has been rendered unable as aforesaid, thereby shall notify the other party in writing immediately but not later than twenty four (24) hours of the alleged beginning and ending thereof giving full particulars and satisfactory evidence in support of the claims.

23.3 During the period, the obligations of the parties are suspended by force majeure; the contractor shall not be entitled to payment of any rate.

23.4 In the event of the force majeure conditions continuing or reasonably expected to continue for a period more than thirty (30) days, Owner shall have the option of terminating the contract by giving seven (7) days notice thereof to the contractor.

24. Sub letting and Assignment

The contractor shall not, without prior consent in writing of the Owner, sublet, transfer or assign the contract or any part thereof or interest therein or benefit or advantage thereof in any manner whatsoever, provided nevertheless that any such consent shall not relieve the contractor from any obligation, duty or responsibility under the contract.

25. Limitation of Liability:

Notwithstanding anything contained in the Contract, the Contractor's aggregate liability under this Contract shall be limited 100% of the Total Contract value. This shall exclude liability arising pursuant to clause 3-Compliance to Local Laws, clause 9.10, clause 14-Indemnity against IPR, clause 13- Indemnity, clause 26 – Confidentiality, liability arising due to loss of or damage to the Free Issue Material (FIM) issued by Owner to Contractor for completion of the Work and liability arising due to wilful misconduct, gross negligence, third party claims and corrupt acts attributable to the Contractor.

26. Confidentiality:

The Contractor shall use the Confidential Information of the Owner only in furtherance of this Contract and shall not transfer or otherwise disclose the Confidential Information to any third party. The Contractor shall (i) give access to such Confidential Information solely to those employees with a need to have access thereto; and (ii) take the same security precautions to protect against disclosure or unauthorized use of such Confidential Information that the party takes with its own confidential information but, in no event, shall a party apply less than a reasonable standard of care to prevent such disclosure or unauthorized use.

27. Termination:

27.1 The Contract shall be deemed to be terminated on completion of the Contract period.

27.2 Termination of default by Contractor:
Owner may terminate the contract at any time if the Contractor fails to carry out any of his obligations under this Contract. Prior to termination, the Contractor shall be advised in writing of the causes of unsatisfactory performance to be improved upon 15 days of the receipt of notice. In case, if the Contractor fails to bring about the improvement to the satisfaction of the Owner, then the Contract shall be terminated.

27.3 Without prejudice to the rights and remedies available to Owner, Owner may terminate the Contract or part thereof with immediate effect with written notice to the Contractor if,:

27.3.1 The Contractor becomes bankrupt or goes into liquidation.

27.3.2 The Contractor makes a general assignment for the benefit of creditors.

27.3.3 A receiver is appointed for any substantial property owned by the Contractor.

27.3.4 The Contractor is in breach of any representation or warranty made to the Owner by the Contractor.

The Contractor shall not be entitled to any further payment under the Contract if the Contract is terminated. If the order is terminated under clause 27.2 and 27.3, the Contractor shall not be entitled to any further payment, except that, if Owner completes the Work and the costs of completion are less than the Contract Price, the Owner shall pay Contractor an amount properly allocable to services fully performed by Contractor prior to termination for which payment was not made to Contractor. In case, the cost of completion of Work exceeds the Contract Price, the additional cost incurred by Owner for such completion shall be paid by the Contractor.

27.4 Owner shall be entitled to terminate the Contract at it's convenience, at any time by giving thirty (30) Days prior notice to the Contractor. Such notice of termination shall specify that termination is for Companies convenience and the date upon which such termination becomes effective. Upon receipt of such notice, the Contractor shall proceed as follows:

27.4.1 cease all further work, except for such work as may be necessary and instructed by the Owner/ Owner's representative for the purpose of preserving and protecting Work already in progress and protect materials, facilities and equipment on the Work Site or in transit;

27.4.2 stop all further sub-contracting or purchasing activity, and terminate Sub-contracts;

27.4.3 handover all Documents, equipment, materials and spares relating to the portion of Work already executed by the Contractor or procured from other sources up to the date of termination for which the Contractor has received payment equivalent to the value thereof; and

27.4.4 handover those parts of the supplies manufactured/ work executed by the Contractor up to the date of termination.

Upon termination pursuant to clause 27.4, the Contractor shall be entitled to be paid (a) all sums properly due to the Contractor under the Contract up to the date of termination; and (b) any direct and substantiated charges already incurred or committed for cancellation of the procurement of third party goods or services which were to have been supplied by the Contractor in connection with this Contract provided that the Contractor shall use its best endeavours to minimise such charges

25.5 The Contractor shall not be released from any of his obligations or liabilities accrued under the Contract on termination. For the avoidance of doubt, the termination of the Contract in accordance with this clause shall neither relieve the Contractor of his accrued obligations for Warranty or his accrued liability to pay (liquidated) damages for Delay nor shall entitle him to reduce the value of Performance Security.

28. Consequential Damages:

Unless otherwise specified, neither Party shall be responsible for and nor shall be liable to the other Party for indirect/consequential losses and damages suffered by such Party including for loss of use, loss of profit whether such liability or claims are based upon any negligence on the part of the other Party or its employees in connection with the performance of the Contract.

29. Environment / ISO 14001 Certification:

The Contractor to confirm whether their organization is ISO 14001 certified. If not, the Contractor must certify that the handling, use and disposal of their product / by-products conform to practices consistent with sound environmental management and local statutes. The Contractor shall ensure that all the wastes are disposed in environmental friendly way with strict compliance to applicable laws including adherence to MoEF guidelines with respect to disposal of batteries, lead waste, copper cables, ash, waste oil, e-waste etc which shall be disposed through MoEF approved

parties only. The Contractor shall also be responsible to collect and recycle all the e-waste generated at the end of the product life cycle at its own costs and risks as per the MoEF guidelines/ orders.

30. Non-Exclusive Agreement

This Contract is non-exclusive and Owner reserves the right to engage other contractors to perform similar or identical work. Contractor shall accord such other contractors adequate opportunity to carry out their contracts and shall accomplish the Work in co-operation with those contractors and with Owner, in accordance with such instructions as may be issued by the Owner from time to time.

31. Severability

In the event that any of the provisions, or portions or applications thereof, of this Contract are held to be unenforceable or invalid by any court or arbitration panel of competent jurisdiction, Contractor and Owner shall negotiate an equitable adjustment to the provisions of the Contract with a view towards effecting the purpose of the Contract and the validity and enforceability of the remaining provisions, or portions or applications thereof, shall not be affected thereby.

32. Housekeeping & Removal of scrap:

The Contractor shall be responsible for keeping the areas of his work at site, neat and tidy throughout the period of his work. All excess material/ spares/ consumables taken by Contractor, as well as the scrapped items and wooden logs/ crates/ planks shall be returned, from time to time, to the Stores, and transported/ unloaded by Contractor's personnel at the place shown by Order Manager/Engineer-in charge.

The Contractor shall so arrange that all the scrap generated during the progress of his work, is separated into two categories, viz.

i) Saleable scrap like steel, copper or other metals, etc., and,

ii) Others, which have nil or negligible resale value, like insulation material, jute, debris, etc. (or as directed by the Order Manager/Engineer-in charge).

The saleable scrap shall be shifted to and unloaded at a central place as per directions of the Stores-in charge, while the other scraps shall be shifted to other locations as per directions from Order Manager/ Engineer-in Charge, or as per terms of the order.

The Contractor shall arrange to remove the scrap on regular basis, or even on daily basis, depending upon the requirement, to keep the area around his work-place neat and tidy. In case, it is observed that the Contractor is not carrying out regular cleaning of his areas of work, or, is not returning the excess materials/ scrap, etc., to the Stores, Owner reserves the right to arrange the same through other sources, and back-charge the Contractor the cost of doing so, along-with overheads, by deducting the amount from Contractor's bills.

Contractor's final bill will be cleared by Owner only after confirming that proper clearing of his areas of work has been completed by the Contractor, and same is certified by the Order Manager/ Engineer in-charge

33. Tata Code of Conduct

The Owner abides by the Tata Code of Conduct in all its dealing with stake holders and the same shall be binding on the Owner and the Contractor for dealings under this Order/ Contract. A copy of the Tata Code of Conduct is available at our website: http://www.tatapower.com/aboutus/code-of-conduct.aspx. The Contractor is requested to bring any concerns regarding this to the notice of our Chief Ethics Officer on the e-mail ID: cecounsellor@tatapower.com.

34. Responsible Supply Chain Management:

The Owner is committed for a cleaner environment and respect of Human rights through its Responsible Supply Chain Management policy. The Contractor is required to comply with all the environment & Human rights related laws, including emission norms, Labour and environmental regulations. The Owner encourages its Vendors/ Contractors/ Business partners to pay more attention to green design, green supply, green production, green logistics and green packaging in performing their business obligations.

The Contractor is required to abide by the Tata Power Corporate Environment policy, Energy Conservation and Corporate Sustainability Policy.

A copy of the Responsible Supply Chain Policy along with Environment policy, Energy Conservation policy, Sustainability policy, Health & Safety policy and Human Rights policy is available at website: http://www.tatapower.com/sustainability/policies.aspx.

Contractor/Bidder is required to completely fill the attached "Supplier Sustainability Questionnaire" in support of their Green Supply Chain Management initiatives and submit the same with their offer.

The Owner recognizes that diversity in the workplace positively impacts business. The Owner is committed to help people from SC/ST background either by helping them to become entrepreneurs or by engaging workforce from SC/ST community under the contracts agreed herein. To encourage engaging SC/ST community, the owner may consider on the merit to incentivize the Contractor by paying additional 1% of

the service contract portion if the number of SC/ST workforce engaged in the contract exceeds 30% of the total deployed strength and 2%, if the strength goes beyond 50%. While the Contractor will assist the workforce so engaged to become self-reliant in meeting the work expectation, the Owner may also volunteer its training resources to the extent possible to improve their employability. The Contractor shall maintain the proper documentation of such category of the workforce engaged and the owner may consider to pay the incentive after its verification.

The Owner may also consider extending price preference of 5% in the bid evaluation for an order value up to Rs.50 Lacs, provided the company is owned by a person from SC/ST community having minimum 50% holding in the company.

35. Vendor rating:

You are requested to ensure compliance to the terms of the individual orders with regards to timely delivery, provision of all applicable documents / challans / test certificate, quality of the material etc. Your performance with respect to the said factors will be taken into consideration for future business.

36. Vendor Feedback:

34.1 In this dealing Vendors feedback is important for the purchaser to improve its processes. If Contractor have to report any grievance, problem or require any clarification, information, Contractor is requested to contact purchaser at email ID: CC_CUSTOMERFEEDBACK@tatapower.com

34.2 Contractor is requested to ensure compliance to the terms of the individual orders with regards to timely delivery, provision of all applicable documents / challans / test certificate, quality of the material etc. Contractor performance with respect to the said factors will be taken into consideration for future business.

37. Non-Waiver:

Failure of Owner or its representatives to insist upon adherence to any of the terms or conditions incorporated in the Contract or failure or delay to exercise any right or remedies herein or by law accruing, or failure to promptly notify the Contractor in the event of breach or the acceptance of or the payment of any Material(s) hereunder or approval of any design or Material(s) shall not release the Contractor and shall not be deemed a waiver of any right of Owner to insist upon the strict performance thereof or of any of its rights or remedies as to any such Material(s) regardless of when the Material(s) are shipped, received or accepted not shall any purported oral modification or revisions of the Contract by Owner or its representative(s) act as waiver of the terms hereof.

ESG FRAMEWORK FOR BUSINESS ASSOCIATES

Tata Power's Sustainability philosophy sits at the core of its Business Strategy. Tata Power Sustainability Model has an overarching objective of 'Leadership with care' with key elements of 'Care for the Environment'; 'Care for the Community'; 'Care for our Customers / Partners' and 'Care for our People'. These sustainability objectives encompass the Environmental, Social and Governance objectives driven as integrated elements.

Tata Power, together with its stakeholders is determined to achieve sustainable growth while creating shared value for all.
As a part of future ready roadmap, Tata Power has targeted following as our Environment, Social and Governance priorities:

- Being Carbon Net Zero before 2045
- Growing Clean capacity (80% by 2030)
- Customer centricity
- Becoming water neutral before 2030
- Achieving zero waste to landfill before 2030
- No net loss of biodiversity before 2030
- Positively impacting 80 million lives by 2027

In order to create a sustainable business ecosystem, Tata Power expects that all its Business Associates (BA) which includes its suppliers, vendors, consultants and service providers to align to its ESG and sustainability commitments.

Tata Power encourages improved efficiencies and scaling up of green initiatives through technology and innovation taking us farther on the journey of reducing carbon emissions and preparing the entire eco-system towards products and services that would have net positive impact on the environment and communities that we operate in.

The Vendors/ bidders wishing to associate with Tata Power are expected to share their own sustainability and ESG journey. We at Tata Power promote all Business Associates to have a sustainable procurement policy for their supplier and service providers to contribute to our integrated approach in achieving a sustainable supply chain. The BA is encouraged to carry out the assessment of their sub-contractors and sub-vendors on sustainability readiness so that they are aware of the expectation/ business requirement.

The Vendor/ Bidder shall fill-in the 'Environment, Social and Governance Compliance Screening Questionnaire for Business Associates' attached at Annexure-I and submit the same along with the Bid in Ariba online platform.

Responsible Supply Chain Management:

Tata Power is committed for a cleaner environment and respect of Human rights through its Responsible Supply Chain Management policy.
Tata Power Business Associate (BA) shall comply with all the environment & Human rights related laws, including emission norms, Labour and environmental regulations.

Tata Power encourages its BA to focus on green design, green supply, green production, green logistics and green packaging in performing their business obligations. The BA is expected to abide by the Tata Power Corporate Environment policy, Energy Conservation and Corporate Sustainability Policy (enclosed with this document as Annexure-II).

The BA is expected to:

- Strive towards Conservation of Energy, Water, Resources and optimize transportation of Men & Materials to minimize environmental impact and reduce carbon footprint.
- Carry out the assessment of materials used for construction, operation & maintenance, consumables and accordingly phase out those materials which are environmentally hazardous.
- Be cognizant that diversity in the workplace positively impacts business.
- Promote affirmative action by supporting people from SC/ ST background by engaging workforce from SC/ ST community under the contracts agreed herein.
- Share the commitment of 'No child labour', 'No forced labour', Non-discrimination on the basis of caste, colour, religion, gender, disability, maternity or pregnancy or any other factor unrelated to the requirements of the job
- Pay the wages or remuneration to the workforce, personnel deployed in compliance to all applicable laws and regulations.
- Provide its employees/ deployed labor with an employment environment that is free of physical or psychological harassment.
- Carry out the assessment of their Sub-contractors on their Sustainability Readiness so that they are aware of the above expectation/ standards
- To ensure usage of suitable package material which is more environmentally sustainable. Further the packing material shall be recycled to the extent possible. The material used for packing is expected to suit the mode of transport and to ensure its safe receipt at point of delivery.

Waste Disposal:

The BA is expected to follow best practices for disposal of waste, few of which are listed below:

- Have a detailed project plan that includes the waste management, segregation of all designated waste material (Recyclable/ Non-Recyclable), collecting, storing, disposing and transferring the same to pre-arranged facility/ destination in timely and safe manner as per environmental legislations. The project plan shall also include the innovative construction practice to eliminate or minimize waste, protect surface/ground water, control dust and other emissions to air and control noise.

- Have purchase policy to encourage the procurement of material with recycled and minimum packaging of goods during delivery and appropriate means for site-to-site transportation of materials to avoid damage and litter generation.

- Ensure that the residents living near the site are kept informed about proposed working schedule and timings/ duration of any abnormal noise full activity that is likely to happen.

- Ensure the regular maintenance and monitoring of vehicles and equipment for efficient fuel use so that emissions and noise are within acceptable limits to avoid air pollution.

Water Management:

The BA is expected to follow best practices for water management, few of which include a management and monitoring system for water withdrawals and consumption, procedures to reduce water usage or reuse/recycle water, and pretreatment of wastewater before disposal.

Compliance to Law:
The BA shall adhere to responsible business practices and comply with the provision of all the Statutory Acts Applicable. Special attention of the BA is drawn towards the compliance of provision of the following statues: (along with the latest amendments/additions, as applicable):

- The Child Labour (Prohibition and Regulation) ACT, 1986.
- The Contract Labour (Regulation and Abolition) ACT, 1970.
- The Employee's Pension Scheme, 1995.
- The Employee's Provident Funds and miscellaneous provisions Act, 1952.
- The Employees State Insurance Act, 1948.
- The Equal Remuneration Act, 1976.
- The Industrial Disputes Act, 1947.
- The Maternity Benefit Act, 1961.
- The Minimum Wages Act, 1948.
- The Payment of Bonus Act, 1965
- The Payment of Gratuity Act, 1972.
- The Payment of Wages Act, 1936.
- The Shops & Establishment Act, 1954.
- The Workmen's Compensation Act, 1923.
- The Employer's Liability Act, 1938.
- and any other applicable statutory act

Social Accountability (SA 8000):

Tata Power expects its BAs to follow guidelines of SA 8000:2014 on the following aspects

- Child Labour
- Forced or Compulsory Labour
- Health & Safety
- Freedom of Association & Right to Collective Bargaining
- Discrimination
- Disciplinary Practices
- Working Hours
- Remuneration
- Management System

Health and Safety

The BA is expected to ensure the health and safety of his and his Sub-contractor’s staff and labour. The BA shall, in collaboration with and according to the requirements of the local health authorities, ensure that medical staff, first aid facilities, sick bay and ambulance service are available at the accommodation and on the Site at all times, and that suitable arrangements are made for all necessary welfare and hygiene requirements and for the prevention of epidemics. The BA shall maintain records and make reports concerning health, safety and welfare of persons deployed, and damage to property, as the Owner’s Representative may reasonably require. The BA shall be responsible for the medical treatment / hospitalization of his and his Sub-contractor’s staff/ labour.

The BA shall appoint a qualified Safety officer at the Site to be responsible for maintaining the safety, and protection against accidents, of all personnel on the Site. Such Safety officer shall have the authority to issue instructions and take protective measures to prevent accidents.

The BA shall comply in toto with the Tata Power's Contractor Safety Terms & Conditions, Health Safety & Environment Manual while working on Tata Power Site/ Services/ Contracts.

Grievance Mechanism

The BA is expected to have grievance procedures that allow stakeholders to anonymously bring environmental and/or work-related violations and/or concerns to the attention of management. In addition, the BA is expected to have procedures for examining reports of environmental and/or work-related violations or concerns and/or privacy complaints.

Data Protection

The BA is expected to have a formal process to address data security or privacy issues.

ANNEXURE-I

Sr. No.	Question Description	Response (Y/N)	Remarks
Organization			
1	Does your Company have Sustainability Policy at Organization Level? If Yes, Please attach		
2	Do you have sustainable procurement policy in place for your own suppliers? If Yes, Please attach		
3	Does your company do regular assessment of its suppliers on ESG parameters?		
4	Are there ESG risks, or negative impacts identified in your supply chain		
Governance			
1	Is diversity taken into consideration when appointing board members/ senior management? Do you have an independent director/s?		
2	Has your company taken initiatives to ensure ethical practices at workplace? Please share the details, Policies etc.		
3	Does your company have a formal process to address data security or privacy issues? Please share the details, Policies etc.		
4	Does your company have grievance mechanism for stakeholder issues and track resolution?		
Environment/ Planet			
1	Does your company have Environmental Policy? If Yes, Please attach		
2	Do you have a formal process for waste management including solid wastes, liquid wastes and hazardous waste?		
3	Does your company track greenhouse gas emission? Also, what percentage of own consumption comes from the renewable energy?		
4	Does your company have a formal process for water management including monitoring of water consumption and withdrawals, and if applicable, pretreatment of wastewater?		
Green Technology/ Innovation			
1	Are your facility/ Product/ Services provided by you is based on green design, green production, green packaging or green logistics considerations? Please elaborate.		
2	Do your products or services have any environmental or social features or benefits (e.g. environmental/energy certification, ecolabels, fair trade certification, etc.)?		
Social/ People			
1	Does you facility/ Company have written personnel policies in place Are you an equal opportunity employer?		
2	Please describe any formal programme / campaign in place to promote company involvement with the community (volunteering, etc.). What is the percentage of profit spend on community activities?		
3	Does your company have a written Health & Safety Policy or Program? If Yes, Please attach		
Certifications: Does your company have following certifications (valid till date-please mention validity)			
1	ISO9001 accreditation		
2	SA8000 or equivalent		
3	ISO 14001 certification		
4	ISO 18001/45001 or equivalent		
5	ISO/IEC 27001 or equivalent		
6	Any Other (Please specify)		

Signature

Business Associate Name

ANNEXURE-II

CORPORATE SUSTAINABILITY POLICY

At Tata Power, our Sustainability Policy integrates economic progress, social responsibility and environmental concerns with the objective of improving quality of life. We believe in integrating our business values and operations to meet the expectations of our customers, employees, partners, investors, communities and public at large

- We will uphold the values of honesty, partnership and fairness in our relationship with stakeholders
- We shall provide and maintain a clean, healthy and safe working environment for employees, customers, partners and the community
- We will strive to consistently enhance our value proposition to the customers and adhere to our promised standards of service delivery
- We will respect the universal declaration of human rights, International Labour Organization's fundamental conventions on core labour standards and operate as an equal opportunities employer
- We shall encourage and support our partners to adopt responsible business policies, Business Ethics and our Code of Conduct Standards
- We will continue to serve our communities:
    - By implementing sustainable Community Development Programmes including through public/private partnerships in and around our area of operations
    - By constantly protecting ecology, maintaining and renewing bio-diversity and wherever necessary conserving and protecting wild life, particularly endangered species
    - By encouraging our employees to serve communities by volunteering and by sharing their skills and expertise
    - By striving to deploy sustainable technologies and processes in all our operations and use scarce natural resources efficiently in our facilities
    - We will also help communities that are affected by natural calamities or untoward incidence, or that are physically challenged in line with the Tata Group's efforts

The management will commit all the necessary resources required to meet the goals of Corporate Sustainability.

(Praveer Sinha)
CEO & Managing Director

Date: 15th June, 2018

TATA POWER
Lighting up Lives!

Supplier Code of Conduct

Tata Power follows the Tata Code of Conduct (TCoC) and the Whistle blower Policy and expect all its Suppliers to adhere to the same principles. **"Supplier"** here means any business, company, corporation, person or other entity that provides, sells or seeks to sell, any kind of goods or services to Tata Power, including the Supplier's employees, agents and other representatives. The suppliers are expected to adhere to the following Do's and Don'ts:

Do's

1. The Suppliers shall be committed to supplying products and services of high quality that meet all applicable standards and laws, including product packaging, labelling and after-sales service obligations.
2. Comply with all applicable laws and regulations, both in letter and in spirit, in all the territories in which it operates.
3. Strive to provide a safe, healthy and clean working environment for its employees.
4. Strive for environmental sustainability, particularly with regard to the emission of greenhouse gases, consumption of water and energy and the management of waste and hazardous materials.
5. The Supplier shall represent our company (including Tata brand) only with duly authorised written permission from our company.
6. Safeguard the confidentiality on the use of intellectual property, information and data of the Company.
7. Gifts and hospitality given or received should be modest in value and appropriate as per Company Policy.
8. The assets of Tata Power shall be employed primarily and judiciously for the purpose of conducting the business for which they are duly authorised.
9. All actual or potential conflicts due to financial or any other relationship with a Tata Power employee shall be disclosed.

Don'ts

1. The Supplier shall not make unfair or misleading statements about the products and services of competitors.
2. Children shall not be employed at workplaces.
3. Forced labour shall not be used in any form.
4. The Suppliers shall neither receive nor offer or make, directly or indirectly, any illegal payments, remunerations, gifts, donations or comparable benefits that are intended, or perceived, to obtain uncompetitive favours for the conduct of its business with Tata Power.

Reporting Violations

The Supplier shall notify the Company regarding any known or suspected improper behaviour of other suppliers or employees relating to its dealings with Tata Power, by email to: cecounsellor@tatapower.com.

The same can also be raised through our 3rd party ethics helpline facility:

1. Email id: tatapower@ethics-line.com ; Website: www.tip-offs.com
2. Helpline numbers: Toll free - 0008001004382 and 0008001008277. Also accessible at normal domestic call rates within India: +91-11-71279005
3. Postal address: Deloitte Touche Tohmatsu India LLP
   c/o Arjun Rajagopalan, Partner (Ethics Helpline Services)
   19th Floor, 46 - Prestige Trade Tower, Palace Road,
   High Grounds, Bengaluru, Karnataka – 560001

Appendix 2:

Safety Terms and Conditions

Reason for Change	Date of Last Revision	Prepared By	Reviewed By	Approved by
Periodic Revision and Inclusion of Procedures and formats from BASCC.	*1 Aug 2023 (Rev 5)*	All Discom and CFT members	Corporate Safety Team	Suresh H Khetwani (*Chief safety and Environment*)

1.0 Objective:

The Objective of Safety Terms and Conditions is to apprise the Business Associates about various expectations from the BA to implement Tata Power Health & Safety Management System without fail.

2.0 Scope:

This procedure applies to all operating and project sites of The Tata Power Company Ltd and Group companies including new businesses like Electric Vehicle charging, Home Automation, Microgrid, Roof top solar etc. This Code of Conduct also applies to all operating and project sites of four Odisha Discoms and New business based on mutually agreed timeline for implementation.

3.0 Safety Organization & Responsibilities

3.1 Business Associate Site Management and Supervision

Each Business Associate will be responsible for fulfilling all statutory and safety requirements as per the laws of the land and not limited to Factory Act, Electricity Act, Electricity Rules and Regulations, Shop and Establishment Act etc.

Each Business Associate shall provide at least one competent full-time safety supervisor for workforce of every 50 workers or less than that. When workforce ranges to 500, the Business Associate must provide at least one qualified safety officer (This may be subjected to change as per applicable act). Thus, for work force of 500 workers there will be one qualified safety officer and 10 safety supervisors. For every 500 additions in workforce, the Business Associate must add 1 safety officer and 10 safety supervisors. The Order Manager or Safety Department of the Tata Power Division /Discoms will review and approve the appointment of all safety officers and supervisors. The safety supervisors/officers will work with the guidance from Tata Power Division /Discoms Safety Department and align themselves with Tata power Division/Discom safety requirements.

For O&M related AMC activities, minimum one qualified safety officer to be deployed for each Division of the Discoms.

(For any specific & specialized work, site safety supervisor will be decided by SCG)(R6)

Qualified safety officer means he or she has completed PDIS or ADIS from a recognized institute.

Site Safety Officer/Safety Supervisor / Safety Coordinator shall be interviewed by the Order Manager/ Safety head of the Tata Power Division/Discom and then gate passes shall be issued if the interview is successful.

Site Manager of Business Associate /Sub Vendor is responsible, and will be held accountable, for the safety of their own workforce as well as that of sub-Business Associate s. He should also ensure that all equipment, materials, tools, and procedures remain in safety compliance at job site.

Responsibility of Site manager includes, but not limited to:

3.1.1 Holding officer/supervisors accountable for safety and actively promote safe work performance.
3.1.2 Participate in and cooperate with all safety program requirements to be implemented to meet Tata Power Division /Discoms safety objectives
3.1.3 Ensure timely reporting of safety incidents, near misses, unsafe acts, and conditions.
3.1.4 Identify the training needs of BA employees and maintain all safety training documents.
3.1.5 Provide Safety Performance Report at an agreed frequency.
3.1.6 Stopping of unsafe work (Acts and/or Conditions) immediately. Work to start only after corrective actions are implemented.
3.1.7 Ensure and participate in daily toolbox talk for all the jobs.
3.1.8 Ensure that only tested and certified tools and equipment are issued to the workers and being used at the site.

3.2 Business Associate Supervisors and General Staff.

Business Associate s' site supervisors and general staff members in charge of job site functions such as field engineering, warehousing, purchasing, costing, and scheduling etc. are responsible for the safe performance of the work of those they supervise. They must set an example for their fellow employees by being familiar with applicable sections of the Site Safety program and ensuring that all site activities are performed with SAFETY as the primary objective.

Each site supervisor is responsible and will be held accountable for identifying, analyzing, and eliminating or controlling all hazards through implementation of an aggressive, pro-active Health, Safety and Environmental Program. Each supervisor will proactively participate in the Safety program by observing, correcting, and recording unsafe acts and conditions at plant / sites.

The BA's supervisor is the link between Tata Power Management and the BA (including his employees). (R6)

- He coordinates the work of his company's employee on site and is responsible & accountable for the safety of BA workforce. He will collaborate with site safety supervisor (SSS). BA's supervisor shall review the Safety requirements with his employees prior to the beginning of each job. Documentation of this review shall be forwarded by him to the Order Manager.(R6)

- Assigning jobs to his workers, inspection of tools, equipment & PPEs , reporting of incidents & near-misses, housekeeping of work area and carrying out Safety Audits.(R6)
- Deployment of all applicable Safety standards & procedure as mention in Safety Term& Condition CSMF2 during execution of the jobs.(R6)
- Ensuring job specific training prior to execution of the job.(R6)
- Conducting Tool - box meeting and compliance of SOP & statutory requirements at work place, correction of all unsafe conditions and acts.(R6)
- BA'S Supervisor will deeply involve in making JSA through participation of work force.(R6)
- BA's Supervisor will invite all BA employees for participation & engagement daily ensuring 100% in either observation reporting, TBT, Mass Meeting and discussion for Risk Assessment & implementation of control measure.(R6)

3.3 BA Site Safety Supervisor (SSS)(R6):

3.3.1 SSS will carry out daily safety audit and inspections of tools, tackles, equipment and PPEs. They will identify and help in correcting the unsafe acts and unsafe conditions created while executing job t site with the help of BA's supervisors (R6).

3.3.2 SSS will ensure his participations in TBT and Mass Meetings regularly. They will also ensure reporting of all incidents & near-misses and participate in incident investigation (R6).

3.3.3 SSS will help in risk assessment of activities while developing SOP for the job (R6).

3.3.4 SSS will deeply involve in making JSA through participation of work force.(R6)

3.3.5 SSS will assist for participation & engagement of 100% BA employees daily in either observation reporting, TBT, Mass Meeting and discussion for Risk Assessment & implementation of control measure.(R6)

3.4 Business Associate Workforce

3.4.1 Business Associate shall provide adequate quality and quantity of manpower as mutually agreed. Generally, for each 10-15 workforce one supervisor is suggested. *For all high risk jobs there shall be one Business Associates supervisor shall be deployed.(R6).*

3.4.2 All the Business Associate employees shall attend "SHE L0(Other than new business and Odisha Discom)/L1 Foundation Course in Safety". Depending on the critical procedure in job employees shall also be required to attend "SHE L2 course of critical/high risk operations". All Supervisors shall be required to attend "SHE L3 Supervisory Training". All the above trainings will be conducted by TPSDI/Skill development

institute of Disco, or other equivalent institute approved by Tata Power.

3.4.3 Business Associate employees shall be required to attend any other additional training if suggested by Order manager or Site Safety Head. The cost of such additional training shall be borne by the Vendor.

3.4.4 Business Associate / Vendor shall mobilize their manpower well in advance to complete the training through TPSDI/Sill development Institute.

3.4.5 The Vendor / BA shall arrange or bear the conveyance and food expenses incurred during training of BA employees in Odisha Discom.

3.4.6 The validity of the training L1, L2 and L3 is 3 years. There will be competency assessment as Revalidation test in every three months for Tata Power Division and six months for Odisha Discom till one year from implementation of BASCC. Those who fail in the competency assessment shall undergo training again.

3.4.7 Supervisors/Welder/Electricians/Line man /Fitters /Radiographers/ Riggers engaged by the Business Associate shall have valid competency certificates issued by authorized agency/Institute.

3.4.8 Business Associate workforce must make safety a part of their job by following safety rules and regulations and by using all safeguards and safety equipment. They must take an active part in the Safety programs for the Site.

3.4.9 Every member of the workforce is expected to report for work without influence of any Drug/Alcohol. Failure to comply with this requirement shall result in immediate termination of employees under the influence of drug and alcohol plus show cause notice/penalty to the vendor.

3.4.10 All employees shall report hazardous conditions, practices and behaviours in their work areas and correct wherever possible.

3.4.11 Workforce is responsible for active participation in safety and health programs, suggestion systems, trainings and reporting of unsafe act/practices, Unsafe conditions incidents and injuries to their supervisors.

3.5 Business Associate (Vendor) /sub-Vendor

3.5.1 Vendors/Business Associate shall always comply with and ensure that their workforce comply with all site safety rules and regulations. Specifically, with applicable provisions of the Site Safety Management Plan and all statutory safety rules and regulations.

3.5.2 After receiving the work order/ purchase order vendor/Business Associate /bidder shall not appoint Sub-Business Associate without safety assessment of the sub-Business Associate through safety concurrence group Under Business Associate Safety Code of Conduct. Penalty of 5% of contract value will be applicable to the Business Associate if sub-Vendor is appointed without the permission of SCG and without evaluation through BASCC process.

3.5.3 For engaging any sub-Vendor, the Prime Vendor as well as the sub-Vendor should be individually registered with Tata Power. Sub-contracting or hiring of others, by the BA to perform the services is subjected to specific, prior approval by the CA/OM. Such approval shall depend upon compliance with the following minimum requirements (R6)-

i. Sub-vendors identified by the Prime vendor will be subject to the same Safety Potential Evaluation Criteria as the Prime vendor for all Medium-risk/High-risk job where supervision will be done by the sub- vendors. In such cases, vendors must have a Star-rating of 4 or above, for becoming a sub- vendor(R6).
ii. The SCG team shall evaluate the Safety and technical competency of the sub-contractors for High risk job(R6)
iii. The Departmental Head will have the authority to approve any sub-contracting process based on requirement as submitted by the Prime Vendor (See CSM F-14 Sub-Vendor Engagement Request Form).
iv. No Safety potential evaluation shall be conducted for sub-letting of Low risk work(R6).
v. The Prime vendor shall be fully liable and responsible to Tata Power for the acts, errors, and omissions of its sub-vendors and shall be relieved neither of any obligation to Tata Power under the contract, nor of any other legal requirements(R6).
vi. The Prime vendor shall use only sub-vendors of demonstrated experience and reliability regarding the services to be provided(R6).
vii. The Sub-vendor shall agree in writing to be bound by all obligations of the Prime vendor set forth in the Contract.(R6)
viii. Safety performance evaluation shall be done for both prime vendor & sub-vendor.(R6)

Types of Sub-contracts and Associated Requirements (R6):

I. Sub - Vendor working with his own supervision:- Sub-vendors must achieve a minimum Star-rating of 3 for performing High risk jobs under Tata Power supervision or under the Principal/Main Vendor (Prime Vendor).(R6)

II. Sub-vendor working under Prime vendor's supervision (as supplier of manpower):- Manpower-supply contracts have to be supervised by the Prime vendor and the Prime vendor's Star- rating has to be taken into consideration. Vendors supplying manpower need not qualify in the Star-rating assessment.(R6)

III. 3. Only one level of sub-contracting is allowed, and the use of any sub-vendors must be authorised by Tata Power before any contract is finalised. Sub-vendors shall be subject to the same registration and selection/screening processes, as well as the same Safety performance requirements as those required of all Tata Power vendor's. Sub- vendor details are to be attached to the main contract during the RFQ stage. The process of sub-contracting is to be approved by the Chief / Head of the department (BASCC - Appendix#14).(R6)

4.0 Procedure (R6).

4.1 Registration of Business Associates (Vendors):

For Vendor Registration, Contract Department will issue following documents for evaluation of Business Associate's safety capability.

1) ***CSM F2 Safety Terms and Conditions (R6):*** The document **CSM F2 Safety Terms and Conditions** provides the information about Tata Power-Division /Odisha Discom safety System to the Business Associate
2) **CSM F3 Safety Category Qualification Form*(R6):*: ** Business Associate will submit the **CSM F3 Safety Category Qualification Form** with all relevant details and documents to Vendor Registration Initiator, which will in turn forward it to Safety Concurrence Group (SCG) for evaluation.

CSM F3 *(R6):* - Safety Category Qualification form

1. "**Safety Category Qualification Form**" is part of vendor registration form. It needs to be filled by the Business Associate at the time of Registration and should be submitted to Requester / Order Manager with all relevant documents.
2. The same will be evaluated by Safety Concurrence Group of the Division (SCG).
3. Information provided by Business Associate will be verified during site visit.

Safety Category Qualification Form

Please consider my application for

Category A Vendor: Vendor eligible to carry out Very High- and High-risk O&M/Project jobs
Category B Vendor: Vendors eligible to carry out technical jobs, classified as Medium /~~low~~ risk
Category C Vendor: Vendors eligible for to carry out low or very low risk administrative and office job
Category D vendor: All Consultants, Medical Practitioners or vendors taking job from Tata Power and working from their own premises.

Name of the Vendor:			
Sr. No	**Safety Information**	**Yes / No**	**Remarks**
1	Certified for i. ISO 45001, ii. ISO: 14001 iii. ISO: 9001	i. Y/ N ii. Y/ N iii. Y/ N	If Yes, Attach copy of the certification. If No, mention plan to get the certification.

Name of the Vendor:

	(ISO certificates to be issued from reputed accreditation agencies specified by Tata Power)		
2	Safety Statistics for current and Last Three (3) Years - LTIFR - LTISR	Yes/No	<table><tr><td></td><td>Current Year</td><td>Year 1(Last FY)</td><td>Year 2</td><td>Year 3</td></tr><tr><td>LTIFR</td><td></td><td></td><td></td><td></td></tr><tr><td>LTISR</td><td></td><td></td><td></td><td></td></tr></table>
3	Any Compensation paid due to accidents during current and last three years?	Yes/No	<table><tr><td></td><td>Amount (INR)</td><td>Manhour</td></tr><tr><td>Current Year</td><td></td><td></td></tr><tr><td>Y1 (Last FY)</td><td></td><td></td></tr><tr><td>Y2</td><td></td><td></td></tr><tr><td>Y3</td><td></td><td></td></tr></table>
4	Any prosecution against you by statutory bodies/clients during last three years due to statutory violations, criminal negligence towards safety and dereliction of duty of care towards your employees? Is any case still pending against you?	Yes/No	If yes, give details. If no, give an undertaking that no case is pending against you and you have not been prosecuted by statutory bodies or clients.
5	Do you have Safety Policy? Safety Principles? And Lifesaving Rules?	Yes/No	If yes, attach copy of the documents available.
6	Do you have Safety training process?	Yes/No	If yes, attach safety training process and average training manhour of your employees for the last three years.

Name of the Vendor:			
7	Do you have a system for recording, reporting, and investigating all incidents or near misses?	Yes / No	If yes, show the incident statistics of last three years and implementation of CAPA.
8	Do you have a disciplinary action program against your employees for violation towards safety rules and procedures?	Yes/No	If yes, show the records of disciplinary action taken the last three years.
9	Do you have a reward and recognition scheme for your employees who show exemplary safe behavior and contribute to overall safety improvement at site?	Yes/No	If yes, show the records of Reward and Recognition given during. the last three years.
10	Do you engage in safety promotional activities?	Yes/No	If Yes, Show the proof of engagement in safety promotional activities.
11	Have you been recognized or awarded or rewarded by government bodies of clients for showing excellence in safety management in your jobs during last three years?	Yes / No	If Yes, Show proof.
12	Do you provide adequate quality of PPEs to your workmen?	Yes/No	If yes, please provide details of PPE Matrix and if required, samples for inspection.
13	Do you have Safety organization structure e.g., Safety Officers and Safety Committees?	Yes/No	If yes, attach copy of the safety organization structure, details of safety committees and safety professionals.
14	Name and address of sites where work is in progress or worked earlier	Yes/No	Site details to be attached for inspection by Tata Power-Division /DISCOM Officials.

Note: If you respond NO to any of the above questions, you can mention your plan to get the required documents.

I hereby confirm that the information provided above are true. I give my consent to be penalized as deemed fit in case any information given above are found to be false.

I will abide the general safety guidelines mentioned in the purchase order / work order and will ensure to prepare and follow site specific safe operating practices in consultation with the site-in-charge and safety professional. I will abide by penalty scheme in case of non-compliance.

Signature :

Name and Designation :

Stamp of Organization :

3) **CSM F4 Safety Potential Evaluation Criteria :** The SCG will evaluate the details submitted by the Business Associate based on a predetermined criteria **CSM F4 Safety Potential Evaluation Criteria** *along with Star Rating***(R6)** for Vendor Registration and will determine the category (Category A/B/C/D) for which the Business Associate will be registered. As mentioned in the above criteria, a site visit may also be organized by SCG prior to registration under Category A and B. In case, the Business Associate does not qualify the safety criteria, the Business Associate will not be registered. However, he may apply afresh for registration after 6 months**.**

CSM F4 - Safety Potential Evaluation Criteria for Vendor Registration *(For Information to BA-Not to submit by BA) R6*

At the time of vendor registration, vendor will be registered under 4 categories

1) **Category A**- Vendors eligible to carry out High risk Jobs
2) **Category B**- Vendors eligible to carry out technical jobs that are Medium/~~low~~ risk
3) **Category C**- Vendors eligible to carry out administrative and office jobs
4) **Category D**- Outsourced Jobs / Consultants /Medical Practitioners / Suppliers etc

For vendors to be registered under **Category A/B**, a safety potential evaluation will be carried out based on following parameters. (Actual **score is safety capability score)**

Star rating criteria score: 5 Star- 90 to 100, 4 Star- 80 to 90, 3 Star- 70 to 80(R6)

Sr No	Description	Weightage (%)	Actual Score
1	Does the service provider have a valid 45001 Certification?	10	
2	*Performance Measure: Lead Indicator (Ref to Safety Performance evaluation report CSM F11 (A) Lead indicator score)(R6)*	*40*	

3	*Performance Measure: Lag Indicator (Ref to Safety Performance evaluation report CSM F11 (B) Lag indicator score)(R6)*	*20*	
4	Has there been any prosecution / conviction for any Contravention regarding safety and Health provision under the factories Act/Electricity Act / BOCW Act and Rules framed there under? If yes Give Zero otherwise 5 Marks.	5	
5	Check the Safety orientation & training process of Service provider- Records of Safety training provided to safety officer/supervisor /workmen during last 1 year as percentage (%) of total employed by service provider ✓ **Safety Officer:** >80% of employees: 5 Marks, 50 to 79% of employee: 2.5 Marks and <50%: Zero. ✓ **Safety supervisor**: >80% of employees: 5 Marks, 50 to 79% of employee: 2.5 Marks and <50%: Zero. ✓ **Workmen:** >80% of employees: 10 Marks, 50 to 79% of employee: 5 Marks and <50%: Zero	20	
6	Check the organizational structure for safety professionals & engineers / supervisors. ✓ Check Availability of number of Safety Supervisor from government recognized institute as per workforce strength. 1 in 50 employees than 5 Marks *otherwise Zero.* (R6)	5	
	Total	100	

Evaluation Criteria for Category C

Sr no	Description	Weightage (%)	Actual Score
1	Does the Business Associate have a valid ISO 9001 certification?	40	
2	Check the Safety statistics of Service provider (If available than 10 otherwise Zero)	10	
3	Check the trend LTIFR/LTISR for last 3 years (If less than 0.2 than give 20 Marks if between 0.2 to 0.3 than give 10 marks and otherwise Zero	20	
4	Has there been any prosecution / conviction for any Contravention regarding safety and Health provision under the factories Act/Electricity Act / BOCW Act and Rules framed there under? If yes Give Zero otherwise 10 Marks.	10	
5	Check the Safety orientation & training process of Service provider- Records of Safety training provided to safety officer/supervisor /workmen during last 1 year as percentage (%) of total employed by service provider ✓ **Safety Officer:** >80% of employees: 5 Marks, 50 to 79% of employee:	20	

	2.5 Marks and <50%: Zero. ✓ **Safety supervisor**: >80% of employees: 5 Marks, 50 to 79% of employee: 2.5 Marks and <50%: Zero. **Workmen:** >80% of employees: 10 Marks, 50 to 79% of employee: 5 Marks and <50%: Zero		
	Total	100	

Evaluation Criteria for Category D

Category D does not require any evaluation as it is for outsourced job outside the Tata Power company premise.

For vendor to be registered for any category, vendor's safety capability score should be ≥ 70%.

4.1.1 ***Star Rating(R6):***

SCG will evaluate Star Rating as per following -

- *Initially potential Star Rating based on **CSM F4 Safety Potential Evaluation Criteria***
- *After 6 month actual star rating assessment to be carried out based on **CSM F4 Safety Potential Evaluation Criteria** and safety performance evaluation.*
- *Odisha Discom & New Business Star Rating process will be applicable only 1 year after implementation of it.*
- *Based on Safety capability score Vendors rating will be evaluated (For 3 star rated vendors - within 12 months from previous assessment date and for 4 &5 Star rated vendors – within 24 months from previous assessment and Re-assessment within three months from previous assessment date when a vendor is unable to achieve Star rating 3)*
- *Category A - Vendor must require Safety Star Rating 4 and above.*
- *Category B - Vendor must require Safety Star Rating 3*

Star Rating will be evaluated by Third Party from FY 26

4.2 Contract Preparation(R6).

*Safety bid Evaluation will be done only for medium and high risk (R6). The RFQ will be attached with **CSM F2 Safety Terms and Conditions which includes following Documents***

1) **CSM F6 Safety Competency Assessment Form**
2) **CSM F8 PPE requirements**
3) **CSM F9 Site Safety Management Plan Job Specific Safety Requirement (Educational and Professional Qualification, Skill & Experience Manpower, Tools,**

and Tackles, e.g., man lifter, use of drone, use & availability of rescue kit, Work Methodology etc.)

Safety bid evaluation will not be done for category C and D.

BA shall submit duly filled **CSM F6 Safety Competency Form** along with the bid. SCG will evaluate the document as per the **CSM F7 Safety bid evaluation criteria**. **Site Safety Management Plan CSM F9**, defining the complete procedure of executing the job at site will be signed by the Business Associate and SCG after mutual agreement. BA will attach a copy of Site Safety Management Plan along with PO to the successful bidder. Please refer **CSM F5 Process Flow Chart for issuing RFQ and PO significant health and safety risk associated with it.**

CSM F6 - Safety Competency Assessment Form (Template)

Name of the Vendor/Bidder:
Name of the Sub Vendor (If job is given to Sub Vendor):
Description of the Job:
Request for Quotation (RFQ) No.:

Vendor/Bidder to mandatorily provide the below safety competency related information:

1. Proposed Manpower Deployment Schedule : -

Type of manpower	Qualification	Experience	Month 1	Month 2	Month 3	…….
Project /*AMC Manager( )*						
Site In Charge						
Safety Manager						
Safety Officer						
Supervisors						
Technicians						
High Skilled workmen						
Skilled workmen						
Semiskilled workmen						
Lineman						
Helpers						
Drivers						
Unskilled						

Others( )						

Instruction to Bidders:

i. Indicate the overall site manpower deployment schedule as above

ii. Indicate direct or subcontracted employees by using color code given below:

Direct Bidder Employee – Green

Partly Direct / partly Subcontracted – Yellow

4.1.1 **Subcontracted – Red** If subBusiness Associate detail is not available at stage of Bid evaluation, then this can be agreed with Order manager or Engineer in charge before deployment Ensure that all sub-Business Associate s follow the Tata Power Safety Procedure and agreed CSM F9 Site Safety Management Plan**.**

iii. Against each category, indicate minimum educational qualification and work experience

iv. Add rows to include other specialized manpower, if any.

v. Extend columns to cover the entire duration of the proposed contract.

vi. If the operation is in shifts, then indicate shift in charge and / or safety officers required for each shift operation.

2. List of Tools, Tackles, Machines and Equipment: -

Bidder/ Vendor to provide the list of tools, tackles, equipment **to be used during the job / project execution**. Bidder/Vendor to ensure that all the lifting tools and tackles, pressure vessels are duly certified by the competent person authorised by the Chief Inspector of Factories of the respective state prior to start of the job

Sr. No	Description of Tools / Tackles	Capacity / Rating	Quantity	Make	Year of manufacture	Remarks
1						
2						
3						
4						
5						
……						

3. Safety Records:

Bidder to provide the details of fatalities and lost workday cases (LWDC), occurred in last three years (data to be provided for the last completed FY and preceding 2 years).

Description	Safety Data for current and Last 3 Years			
	Current Year	Year 1 (Last FY)	Year 2	Year 3
		20__ - __	20__ - __	20__ - __
Fatalities (Nos.)				

Lost Workday Cases (Nos.)				

In case of no fatalities, LWDC during any year, the form may be filled stating NIL against the respective year. Bidders are encouraged to also submit the RCA / incident investigation reports and the learning's implemented out of the above reported incidents

4. Job Safety Plan/ Method Statement:

Bidder to provide / enclose a detailed Site/Job Safety Plan along with a Method statement detailing the execution philosophy (how the bidder intends to execute the Job/Project), identifying all key activities which are required to be performed by the Business Associate at Site. Bidder to also list down all high-risk activities and provide the Hazard Identification and Risk Assessment (HIRA) for all such high-risk activities involved in the site work.

(Use Method Statement template attached as Appendix 9)

5. PPE Requirement -

Division/DISCOM Requirement	**Bidders Response**
The Bidder/Vendor shall ensure that all PPE of Approved standards as per CSM F8 – PPE Requirements shall be always available and shall be used by his employees with no exception whatsoever. Bidders to also ensure Standard PPE matrix of Tata Power to be followed for all activities.	
10% Buffer stock of PPEs to be provided by bidders at each circle to meet any contingency	
Bidder will ensure that sample PPEs to be submitted/approved by Safety Department along with EIC at the time of submission of Safety bids for evaluation In case bidder manpower found using substandard or any PPEs which are not approved by the Tata Power-Division /DISCOM representative, then Tata Power-Division /DISCOM will provide the same to manpower deployed at the cost of bidders.	

6. ***Vehicle Deployment*:** Bidders to provide details of all vehicles deployed during execution of work-( )

S. No.	Vehicle No.	Vehicle Type	Location	EV/CNG/Diesel/Petrol	Year	Whether CNG endorsed on RC

7. ***Crane Deployment***-( )**:** Bidders to provide details of crane to be deployed during the execution of work as and when required. Bidders to provide approved new gen crane ACE Model SX150, ACE FX150 and Escorts Model TRX 1550.

Sl No	Crane No	Location	Year

8. ***Training Records***-( )**:** Bidders to provide training records of employees deployed for the execution of work during last one year. These training includes OHS (Occupational Health and Safety) Training, Training on SOP/Work Procedures and Medical Emergency trainings imparted at their own facility, cost, and expenses. Bidders to provide the following details:

Tata Power-Division /DISCOM **Requirement**	**Bidders Response**
Training records of employees at their own facility, cost, and expenses for last one year	
Training facility available with Bidders	
Future road map for enhancing the competency of workforce	

9. ***Rewards and Recognition***-( )**:** Bidders to provide the details of process deployed in their organization for sharing and resolution of safety concerns raised by their employees. Also, bidders to provide the details of Rewards and Recognition process in their organization for safety to encourage the morale of their workforce.

10. **Management System Certification: -**

Sr.No	Certification	Yes / No	If Yes, Year of Certification	If No, Target date for Certification
1	ISO 9001			

2	ISO 14001			
3	ISO 45001			
4	Any other (Specify….)			
Note: Please attach certificates to support above. In case not accredited for above but applied for, application letters may be attached.				

CSM F7 Safety bid evaluation criteria. If any specific condition related to Contract is required to be conveyed to the Business Associate, Site safety team will attach the same as Annexure for specific conditions of job and submit it to contract team along with safety bid evaluation form. Commercial bid of Business Associate will be considered for evaluation by contract team only if Business Associate is qualified in safety bid. Site Safety Management Plan, defining the complete procedure of executing the job at site will be signed by the Business Associate and SCG after mutual agreement. Contract shall attach a copy of Site Safety Management Plan along with PO to the successful bidder.

CSM F7 - Safety Bid Evaluation Criteria (For Information to BA-Not to submit by BA) (R6)

Safety Bid Evaluation will be based on following parameters.

Evaluation Criteria

S. No.	Description	Max Marks	Criteria for evaluation
1.	Qualification and Experience of manpower	15	As per Clause No. 1 ***CSM F6 (R6)***
2.	Tools and Tackles to be provided by bidder	15	To be evaluated as per approved tool list of concerned departments.
3	PPE Requirements	5	To be evaluated as per approved PPEs standard and PPE Matrix specified in ***CSM F8.(R6)***
4	Job Safety Plan/ Method	15	To be evaluated as per as per SOP/WI/HIRA
5	Vehicle Deployment	5	***Weightage will be given for CNG/Electrical Vehicles with endorsement of CNG kit on RC (R6)***
6	Crane and Mechanized heavy equipment Deployment	15	***Date of manufacturing or running hours or stipulated in laws.(R6)***
7	Training Records	5	Training records to be evaluated with evidence and scoring to be done as per availability of records
8	Certificate Accreditation	5	ISO 9001-2.5 Marks ISO 45001- 2.5 Marks ISO14001- 2.5 Marks. Total Max 5 Marks for all Three

9	Safety Initiative for learnings implemented in accidents in organization and work force (Fatal / Non-Fatal)	15	Maximum 15 marks will be awarded for visible evidence in terms of safety initiative deployed based on learning of accident in organization and workforce in case of accident
10	Rewards and Recognition Process	5	Maximum 5 marks will be awarded for R&R process evidence
Total		**100**	
Safety Records (Lag Parameter)-			
1.	Fatal Accident	(-) 10 Marks for each case with max of 15 marks	For any fatality in Tata power /Other company in Current and last three years 10 marks will be deducted with maximum up to 15 marks. For new entrant BA, these marks will be deducted for Past safety records. If and BA found hiding such facts, then contract will be terminated immediately during the execution stage.
2	LWDC (Non-fatal)	(-) 5 Marks for each case with max of 10 marks	For each LWDC (Non-Fatal) case in Tata power /Other company in Current and last years, 5 marks will be deducted with maximum up to 10 marks. For new entrant BA, these marks will be deducted for past safety records. If and BA found hiding such facts, then contract will be terminated immediately during the execution stage.

Final Qualifying Criteria

S. No.	Description	Max Marks	Criteria for evaluation
1.	Qualified Bidders	More than 70 marks	Marks Obtained. 60 Marks for New business-like Odisha Discom for one year from CSCC implementation date.

		Minimum Requirement	Weig ht age (%)	Score Obtained
Manpower	**Safety Officer (1 per 500**	**Qualification** - Safety Officer shall possess recognized degree in any branch of engineering with practical experience in similar industries of Min 2 years and Advance Diploma In Industrial	5	

	workers) or as per requirement	Safety by State technical board. (Each state government prescribes the qualification of safety officer.). Require knowledge of Local language. **Experience**- Minimum 2-year experience in relevant field as mentioned in the job in PR.		
	Safety Supervisor (1 per work site up to max. 50 workers) ***(For any specific & specialized work, site safety supervisor will be decided by SCG)(R6)***	**Qualification-** Supervisor shall possess ITI/ Diploma in relevant field. PDIS is desirable, but not mandatory. Require knowledge of Local language. **Experience**- Minimum 5-year experience in relevant field as mentioned in the job in PR. **Training** – Trained and certified by Tata power Skill development Institute or equivalent institute in relevant safety procedures. **Note:** On request of the Business Associate /Users -TPDSI should vet & certify the skilled & experienced Technician if Technical Qualification is not adequate.	5	
	Qualified Technician (Skilled workers as electrician, rigger, fitter, welder, cable jointer, line men etc.)	**Experience**- Minimum 2-year experience (or experience prescribed by state government) in relevant field as mentioned in the job in PR. **Training** – Trained and certified by TPSDI or equivalent institute in relevant safety procedures.	5	
Tools & Tackles	Equipment / Machines/ Tools & Tackles (lifting and shifting tools)	The list of Equipment /Machines / Tools and tackles to be used for job to be submitted by the Business Associate . Evaluation of the list will be carried out based on 1) Suitability as per the relevant job	15	

		2) Make and age of the tools from authorized agencies defined by the user. 3) Certification by the competent authority of respective state.		

CSM F8 - PPE requirements

The Business Associate shall ensure that the following PPE of Approved standards shall be always available and shall be used by his employees with no exception whatsoever. • PPE shall be conforming to BIS/DGMS/DIN specifications, in good condition and shall be comfortable to his employees, when used. This is indicative. For better clarification refer PPE procedure- ***TPSMS/GSP/PPE/023.*** as per safety terms and condition Appendix 3 CFM 3 in detail.

PPE Requirement

1	All Business Associate 's employees at site	Safety Florescent Jacket (orange color), Safety helmet & safety shoes with composite or steel toe cap
2	Workers mixing asphalt, cement, lime / concrete	Safety goggle & protective Hand gloves and footwear, Nose mask.
3	Welders / Grinders/Gas cutters	Welding screen/goggles, safety shoes, leather hand gloves, aprons, leg guard
4	Stone breaker	Protective goggle, hearing protection, anti-vibration hand gloves and Protective clothing.
5	Electricians / Linemen	Rubber hand gloves *with correct voltage rating and expiry date normally one year from Manufacturing date-( )* & Electrical resistant shoes, Safety helmet with induction strip to alert about presence of voltage for those linemen who climb the poles or work on electrical equipment
6	Workers working at a height of 1.8 Meter or above.	Double lanyard full body harness, fall arrestor and safety net made of reinforced nylon fiber ropes firmly supported with steel structures, Work positioning attachment

PPE Type and Testing Frequency

Sl. No.	Name of PPE	IS / EN Standard	Testing Frequency	Remarks
01	Leather Safety Shoes (Color – Black) with PU toe cap.	IS:15298 (Part-2)	Monthly and visual check every day for any crack or damage in the leather or sole.	
02	HDPE Safety helmet with chin strap and ratchet type for adjustment for non-Electrical work	IS:2925-1984	Monthly and visual check every day for any crack in shell.	
03	Full body harness (Safety belt)	EN 361	Monthly and visual check every day of the bends and the harness.	
04	Electrical Safety Gloves	EN: 60903 CE marked	Weekly and visual check for any crack and blow test before every work.	Manufactured not beyond 12 months.
05	Full face visor with safety helmet	EN: 166 CE marked (Visor)	Monthly and visual check every day for any crack in shell.	Clear acrylic visor attached with safety helmet.
06	Fireproof jacket for chest protection		Monthly and visual check every day.	
07	Safety helmet with induction Strip for linemen and working for electrical work-Class E	EN 397/2012	Monthly and visual check everyday	Induction Strip alerts presence of voltage
08	Shorting clamps, crocodile clamps, Discharge Rod and Neon tester		Monthly and visual check everyday	For discharging the residual voltage and test before touch

Pictorial View of PPEs for reference purpose

Sl. No.	Name of PPE	IS / EN Standard	Picture

01	Leather Safety Shoes (Color – Black) with PU toe cap.	IS:15298(Part-2) and with test report of electrical resistance.	
02	HDPE Safety helmet with chin strap and ratchet type for adjustment for Nonelectrical work and electrical work	IS:2925-1984/ EN 397/2012	
03	Full body harness (Safety belt) The straps at shoulder and thigh shall have full pad for comfort. The back shall be so designed that harness straps do not tangle with each other.	EN 361:2002 EN 358 : 2000 IS: 3521:1991/2002	
04	Electrical Safety Gloves – Composite type Soft electrical gloves as per size of individual.	EN: 60903 CE marked	
05	Full face visor with safety helmet	EN: 166 CE marked (Visor)	
06	Fireproof jacket for chest protection		

08	Reflective jacket to each workman	As per Tata Power standard	

These pictures are indicative. Actual product may vary.

Note:

1. Any other Personal Protection Equipment required beyond above list will be according to BIS or EN Standards.
2. All Personal Protection Equipment will be checked by the engineer in-charge or SAFETY group of company.
3. Safety Representative of the BA must maintain the record of the availability, condition and checking of the PPEs.
4. All tools required as per the contract must be according to respective IS / EN standards.
5. Company may revise or add the above list of PPE and their specifications as and when feel necessary. The information about new specifications /models will be circulated by the Engineer In-charge (EIC), which shall adhere by the business associated in the shortest possible time. The EIC shall issue a memo / instruction to BA with timeline for implementation. Any delay will be treated as non- compliance / safety violations.

CSM F9 - Site Safety Management Plan / Method Statement

Site Safety Plan / Method Statement (Template)

This Method Statement describes the specific safe working methods which will be used to carry out the described work. It gives details of work procedure with control measures to counter health and safety issues related to this work. The listed content of this Method Statement can be changed/modified subjected to job scope / specifications, but task specific method statement once finalized & approved, that should not be modified during work execution without permission from the approving authority.

Project/Job Name	
Scope of work: -	
Drawing References: -	

Detail of Sub Business Associate s involved: -		
Method Statement Prepared By: - Designation: - (e.g., Site Manager)	Signature	Date

1.0 Introduction (*Describe purpose of the work, give details of type and scope of work being carried out)*

2.0 Location of Work ***(****Give site address and precise location on site where work is to be carried out)*

3.0 Safety Document /Specific Approval Required (Details of any safety documents or specific approval i.e., Client specific approval required to undertake the work)

5.0 Role & Responsibilities of Personnel/Parties Involved in activities: Clearly define roles and responsibilities of all personnel involved in activity i.e., Site management staff including sub-Business Associate s' staff, Project Manager/Site Manager of principal Business Associate , Sub Business Associate Site Manager, Project Engineer, Safety officer, Competent Supervisory Staff etc.)

6.0 Working/Activity Description: - *It is important that all operatives should have clear idea of those operational sequences and responsible supervisor must verify their competency prior to their engagement in operation.*

6.1 Pre-Working Checks

6.2 Resources (Equipment, tools including manpower) Details *i.e., Equipment and Tools, specific operational equipment, test kits, lifting resources, Details of materials to be used in operation, including any reference to COSHH assessments in case of use of any chemicals, Details of the manpower allocated to the task, e.g., titles, qualifications, competences, direct manpower, Business Associate s. Details of plant, tools, and equipment to be used for the work, including the availability of relevant statutory documents, checks or inspections etc. Details of fencing, barriers, cones, chains, dangers notices, warning signs etc.*

Tools required for work:

Sr.No	Tools /Equipment /Machine	UOM	Required Qty.	Remark
1				
2				
3				
4				
5				
6				

7				
8				
9				
10				

6.4 Operational Sequence of work: *- Full description of the work, setting out the methodology in a sequential manner, including any reference to any identified operational restraints. Also refer here sec. 5.0 responsibilities part for every step of work sequence).*

S. No	Activity	Details of job sequence	Risk Involved	Control Checks
1.				
2.				
3				
4				
5.				

6.7 Final Checks & restoration of work area after completion of work: *Those checks to be carried out by responsible supervisor in witness of his line hierarchy by use of specific checklist of certain operational checks and once those completed satisfactory, PTW (if applicable) to be closed and isolation arrangements to be restored by removing barricades/cautionary tags.*

7.0 Task Specific Hazards: - *Refer to Task Specific Risk Assessment and attach in appendix*

Attachment: - Specific Risk Assessment

In addition, please provide below control measures in risk assessment *(as applicable).*

Fall Protection Measures: (Where Work at height cannot be avoided)	

Control Measures for Electrical Hazards	
Others Hazard if any (please provide details)	
Hazardous Substances to be used in job: (Attach MSDS if required)	

Y/N	Y/N	Y/N	Y/N	Y/N	Y/N	Y/N

7.0 Emergency Provisions: *Relevant operational possibility of a programme in the case of emergency situation i.e. electrical supply restoration. In addition, emergency response provisions i.e., first aiders, firefighting, and first aid arrangements, nearest onsite/offsite emergency response also to be considered during emergency planning.*

8.0 "5S issues" / Waste Disposal/ Housekeeping and Environmental issues: *Details waste disposal processes and or housekeeping activities, Details of environmental impacts and control measures.*

9.0 Personal Protective Equipment (PPE): *Tick on PPE requirements for the task/Job*

Safety Helmet / Hard Hats		*Safety Shoe / Safety Boots*	
Gum Boot		*Double Lanyard Safety Harness with work positioning attachment*	
Electrical Hand gloves		*Other hand gloves*	
Eye protection		*Respiratory protection*	
Ear Protection		*Electrical Arc flash suit*	
Chemical resistant suit		*Reflective Jackets*	
Any Other		*Any Other*	

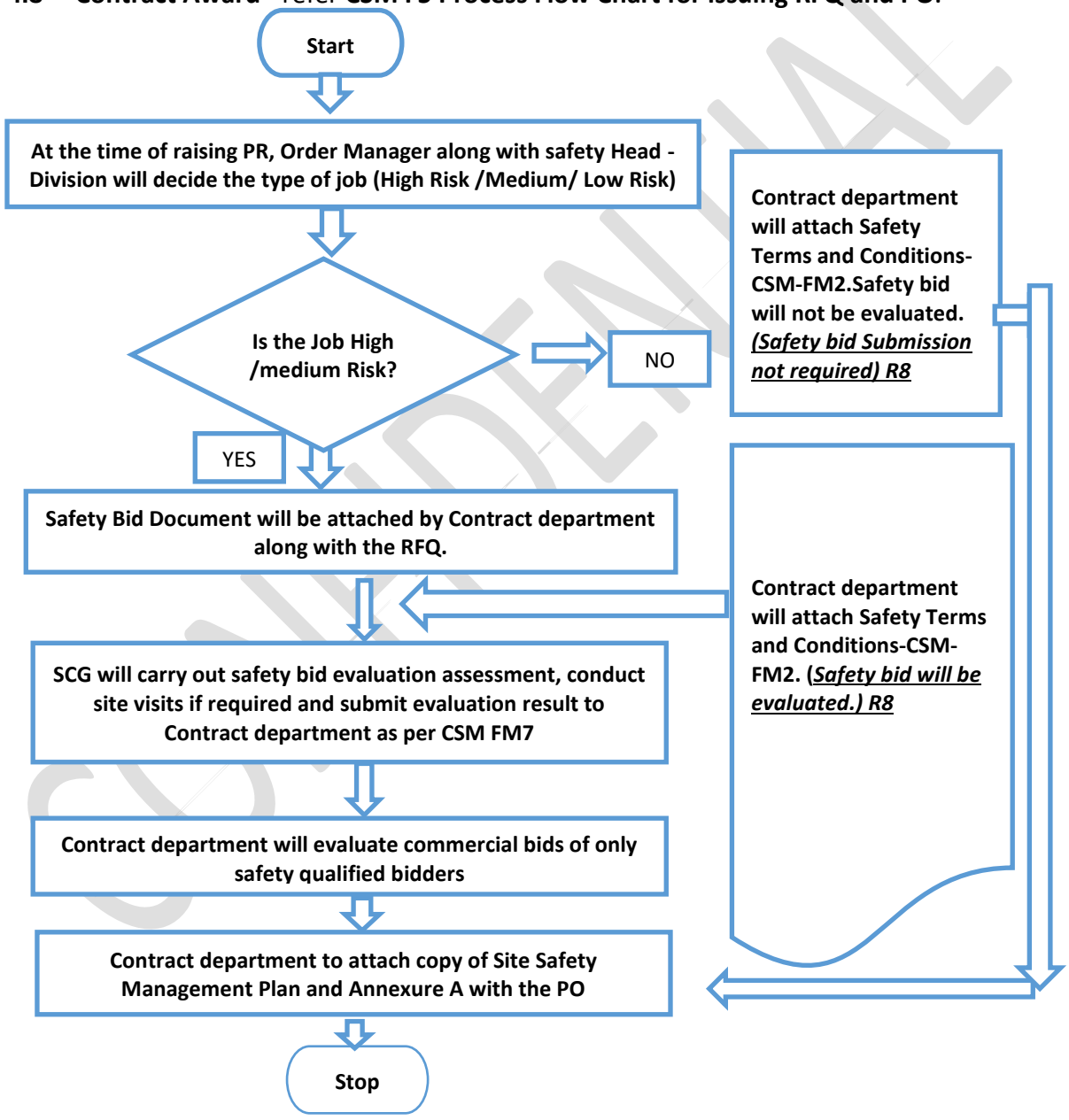
10.0 First Aid facilities and Nearby Hospitals Details

- Name of On Site First Aider
- First Aid Box Location
- Location of nearest hospital

11.0 Occupational Health, Fitness and COVID-19 related Preparedness:

- Please give a brief writeup / methodology of your organization's plan to avoid impact of the COVID-19 pandemic at Tata Power working site.
- Please give brief details of occupational health and hygiene related interventions planned by your organisation to ensure good health and fitness of workforce at Tata Power site.

4.3 Contract Award - refer **CSM F5 Process Flow Chart for issuing RFQ and PO.**



4.4 Capability Building: Safety Training and capability building of workforce is a major component of safety management program. All training required must be provided and documented as specified by Tata Power and Indian Regulations. Tata Power Division /Discoms Safety department will audit Business Associates training and related documentation to assure its adequacy.

4.4.1 Before issuing gate pass:

***For Odisha Discom/New Business*:** All Tata Power Business Associate and sub Business Associate workforce is required to attend Site Safety Orientation Training to receive a Safety Training Card, which is required to obtain a Gate Pass to the site, prior to entry. This Safety Orientation Course will be for duration of minimum half day. The information provided during the orientation will include, but is not limited to Job rules, personal safety, and conduct, Hazard's reporting, reporting of injuries, Emergency procedures, Safety Activities and Program including disciplinary measure and incentives, Critical safety procedure relevant to the job

***For Tata Power Divisions*:** All Tata Power Business Associate and sub Business Associate workforce is required to attend L1 Training to receive a Safety Training Card, which is required to obtain a Gate Pass to the site, prior to entry.

4.4.2 Before start of actual work:

- Appropriate practical training such as SHE L1, L2& L3 (As per Competency Skill Matrix Annexure - 15 of BASCC) is given to ensure that a jobholder, either supervisor or worker, is competent to do his/her job safely. The skill training is provided through TPSDI, and other agencies authorized by Tata Power followed by Post Assessment on the list of 15 critical Safety procedures mentioned under safety procedures. Duration of course is as specified by Division/Discom
- Business Associate shall ensure that concerned workmen are provided with adequate training before he/she is allowed to execute the work. An evaluation test will be conducted after the completion of the training. Those employees who meet the minimum required competency will be provided with Certificate (Card), which will be valid for 3 years, post which the workmen have to reappear for assessment.
- *BA Employee who Fail in assessment to be removed from work.(R6)*
- *BA Employee who achieved Bronze card can work for assisting Silver and Gold.(R6)*
- *BA Employee who achieved Silver card can Work under competent supervisors.(R6)*
- *BA Employee who achieved Gold card can Work independently.(R6)*
- *BA Supervisor who achieved Bronze card can be treated as Learner & can only supervise low Risk Job.(R6)*
- *BA Supervisor who achieved Silver can not take permit, Tata Power employee will take permit in such cases.(R6)*
- *BA Supervisor who achieved Gold card can take permit & supervise work.(R6)*
- *BA Safety Supervisor who achieved Bronze card can be treated as Learner.(R6)*
- If the workman is not able to qualify the assessment, he/she will be given 3 additional attempts to clear in 3-month time failing which he/she will not be allowed to work in the Division /Discoms.

- After expiry of Certificate or Training /Competency Card again one day recertification of L1, L2 and L3 skill training will be provided.
- Quarterly /Half yearly(For Odisha and New business) Revalidation Test - "SHE L1 Revalidation test" will be conducted for the Business Associate 's employees to revalidate their safety awareness and knowledge.
- Order Manager and Safety In charge of the Division/Site /Plant will conduct a Competency Assessment of all workforces, going to be deployed at site / plant for high-Risk job.
- The Contactor shall bear the conveyance and food expenses of his staff for attending training sessions and capability building sessions in new business-like Odisha Discom.
- The Contactor shall bear the entire cost of L1/L2/L3, the costs towards training, salaries/wages, boarding and lodging of his staff for attending training sessions and capability building sessions. These trainings are offered on nominal chargeable basis payable by Business Associate and rates shall be decided by TPSDI from time to time in case of training trough TPSDI. Generally, L0 is of one day, L1 is for 2 days for each critical procedure and L3 is for one day. Around Rs 700+GST is approx. cost /Day/Candidate.
- Competency assessment of all critical workforce to be carried out for all who has taken L2 training.

4.4.3 Recognition to the Prior Learning in Safety

If "Order Manager" recommends and "Head of the Safety Department of Discom" is satisfied with the safety knowledge and competency of the employee of Business Associate , a test may be conducted by Tata power Skill development Institute/ other recognized institute to assess the prior learning in safety. If employees of the Business Associate s pass in such test, he will be exempted from appearing in SHE L1 training. This assessment is on nominal chargeable basis and rates are decided by TPSDI from time to time.

4.5 Managing Work:

Order Manger shall -

1) Comprehensively assess and ensure field Safety implementation against Contract requirements and the Safety Management Plan.
2) Maintain a follow up process that drives continuous improvement in Safety practices and avoids repetition of common errors.
3) Order Manager and BA should aim at optimizing Safety performance of the Contract by working in a collaborative manner during the execution of the work. This can be achieved by:
   - Ensure that potential safety hazards are identified and controlled before any contracted work starts. Hazard identification should be conducted using multi-disciplinary teams which includes members from competent safety professional/execution team/competent BA supervisor & workforce to understand and identify project-specific safety hazards.

- Monthly inspection and replacement of damaged Personal Protective equipment -PPE & Critical Equipment, lifting Tools & Tackles and hand tools used at site.

- **PTW** - PTW procedure must be adhere and implement at site.

- Reviewing the Safety Management Plan (**CSM F9– Site Safety Management Plan)** before each stage of work begins.
- **TBT & Mass Meeting**: Every day Tool box talks to be conducted based on JSA/SOP with maximum participation of BA Workforce & Safety points to be shared by BA employee & line manager and 100% participation of BA employee & workmen in to mass meeting/communication.

- **BA Self safety audit:** BA Safety Supervisor will carry out daily safety audit and inspections of tools, tackles, equipment and PPEs. They will identify and help in correcting the unsafe acts and unsafe conditions created while executing job at site with the help of BA's supervisors.

- All respective **Critical safety Rules & Procedures and General safety Rules & Procedures** to be use and implement at site during job.

- **"Suraksha Samwad"** also known as Safety Interaction is a proactive safety initiative. In this program, leadership engages with BA workmen and employees in a scheduled 30-minute session to discuss and observe safety practices in the workplace.

- **Reporting safety observations by BA employee:** This involves the active participation of the workforce in identifying and reporting safety observations, which can help prevent accidents and improve safety performance.

- **Felt Leadership for Business Associates Proprietor /Co-ordinators**: This program aims to develop leadership skills within the Business Associates Proprietor/Co-ordinators. It encourages individuals to take ownership of their work and fosters a culture of responsibility and accountability.

- **Behavior based safety program (Jivan Ki Aur):** It aims to create regular awareness among all ground staff. It seeks to sensitize them, establish relationships, foster teamwork, enhance communication, motivate and empower everyone, promote good health, and enable a happy and safe life. The program will cover various activities such as morning meetings, home visits, personal meetings, group meetings, short training sessions, games, and other forms of engagement.

4.6 Periodic Evaluation:

1. During the time of job execution, regular site inspection will be carried out by the Tata Power-Division /DISCOM officials ***mainly Line manager (R6)*** to evaluate monthly safety performance of the Business Associate as per ***CSM F11 Safety Performance Evaluation Report (R6)*** and monthly score will be maintained by the Order Manager. Violations will be dealt as per **CSM F12 Safety Violation Penalty Criteria**. Please refer **CSM F10 Process Flow Chart for Safety Performance Evaluation**. Percentage of retention amount is usually mentioned in safety terms and conditions.
2. The evaluation criteria include Lead Indicators such as percentage of workers trained in TPSDI, inspection of critical equipment. Lag indicators such as Fatalities, LWDC and man-days lost.
3. In case of job stoppage due to safety violations / unsafe observations at the site, no time extension from PO completion date shall be given to the Business Associate, if such delays are attributable to Business Associate.
4. In case of fatality, limb loss or loss of property, vendor must pay for liability, legal, statutory, and additional mutually agreed settlement charges imposed by the appointed committee by Division Chief/CEO. This charge is over and above the retention amount. The committee will finalize penalty amount based on factors such as advice by statutory authorities, contract value and impact of accident etc.
5. Order Manager, Head of Business and functional Chief have the authority to terminate the contract as per **CSM F12 Safety Violation Penalty Criteria** Through contract department.
6. *Site contract team will arrange Quarterly meeting with Order Manager to take feedback for Safety performance of Business Associates In-turn Site Leadership and Site Contract team will give feedback of safety performance so as to take Corrective actions (R6).*
7. ***CSM F11 Safety Performance Evaluation Report (R8) to be used*** *to evaluate Star Rating of Business Associate for lead & Lag Indicator.*

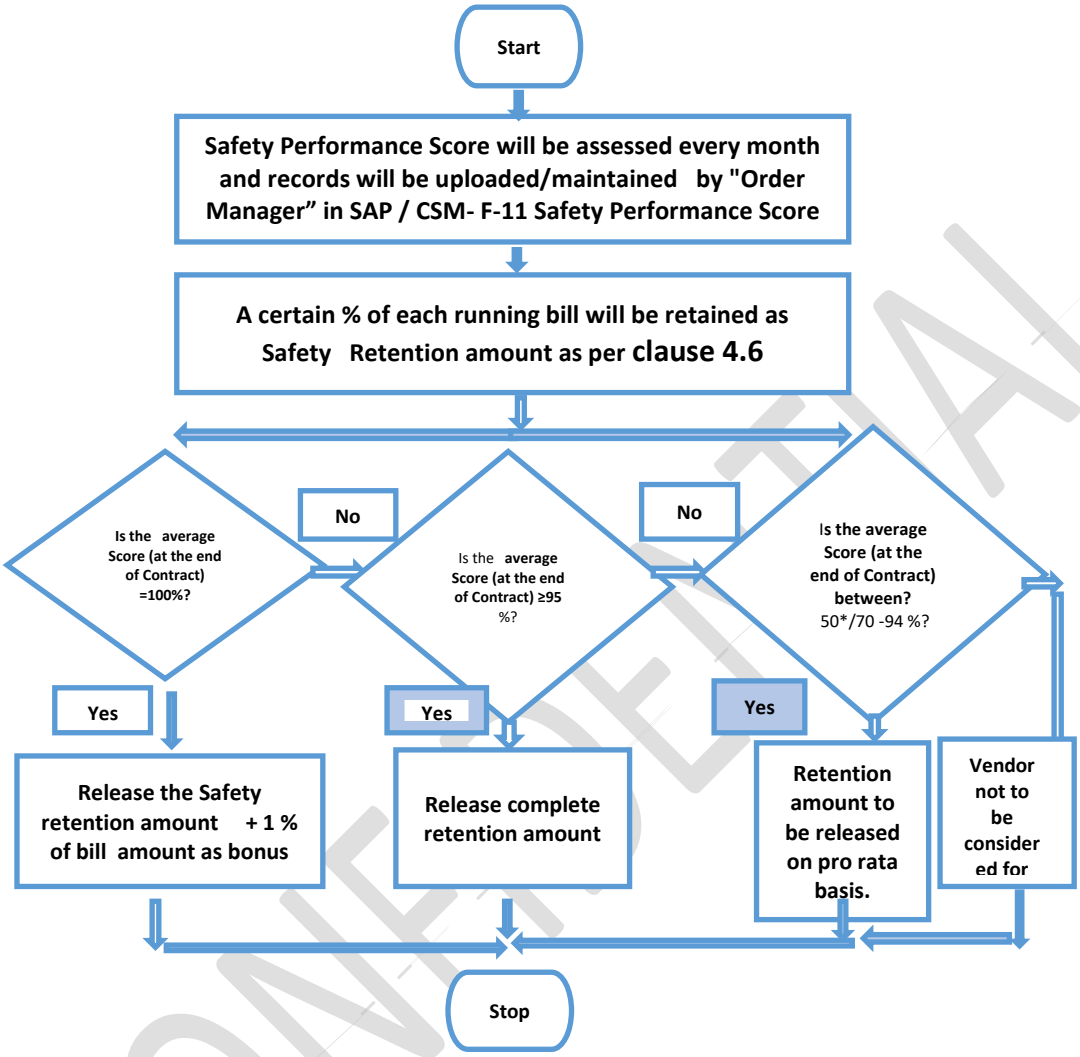
4.6.1 Safety performance retention: A certain percentage of the bill value will be retained against every running bill as safety performance retention. The amount will be released with the last invoice or every six-month based on Safety Performance Score of Business Associate s. The retention amount will be calculated based on contract value as below.

Risk Category	Contract Value	Retention Amount (%)
Very high/High risk job/ Medium Risk jobs	Up to 10 Lakhs	2.5
Very high/High risk job/ Medium Risk jobs	10 – 50 Lakhs	2
Low/Very Low Risk jobs	10 – 50 Lakhs	1
Very high/High risk job	0.5 to 10 Cr	2
Medium Risk jobs	0.5 to 10 Cr	1.5

Low/Very Low Risk jobs	0.5 to 10 Cr	1
Very high/High risk job	>10 Cr	1.5
Medium Risk jobs	>10 Cr	1

1. The safety retention amount will not be applicable if there is clause of Contract Performance Bank Guarantee (CPBG) and safety performance of Business Associate is as per desired criteria.
2. If safety performance of Business Associate is not as per desired criteria (as per Appendix 10 – CSM F10 – Process Flow Chart for Safety Performance Evaluation and Appendix 11: CSM F11 - Safety Performance Evaluation Criteria-then safety retention percentage as mentioned in table above will be deducted from running bill.
3. Bidder to give understanding that if there are any deductions required to be made for safety non-performance as per the Safety Performance Score, then Tata Power shall recover any such deductions against safety non-performance directly from the monthly bills / final settlement or it shall be within its right to recover such sum from accounts payable or the CPBG or the retention of the Business Associate available with Tata Power for the said contract between the Business Associate and Tata Power.
4. The retention amount against non-safety performance saved and Penalty will go to a separate Safety Improvement Fund.
5. For the contract value of more than Rs 1 Cr or contract duration more than 12 months, the retention amount shall be released half yearly based on safety performance. For all remaining contracts, the retention amount will be released with the final bill.
6. Safety performance bonus 1% (limiting to 50 lakhs) of the invoice value will be considered at the end of the job if the contractual safety performance score is 100%

CSM F10 – Process Flow Chart for Safety Performance Evaluation



CSM F11 - Safety Performance Evaluation Criteria (R6)

Safety Performance Evaluation Report- CSM F11

BA field safety audit (Safety Performance Evaluation for BA).							
Division		**Function**					
Name of BA		**Month**					
Nature of Work		**PO**					
	A. Lead Indicators		**100 (for star rating score will dividend scale of 2.5)**				**0**
	-	UOM	**Target**				Actual score for the month
1	% of employees certified in Skill development institute/ authorized agency/Card issued.	% Workforce covered	100%	51% to 99%	50%	<50%	
	Score		**10**	**Pro-rata**	**5**	**0**	
2	Business Associate Safety Field Audit score	Severity score	2 to 3	3 to 4	>4		
	Score		**10**	**5**	**0**		
3	Monthly inspection and replacement of damaged Personal Protective equipment -PPE by contractor(Safety shoes, Induction helmet, full body safety harness with work positioning lanyard, rubber insulated gloves, reflective jacket etc.as per Job requirement)	% of total workforce	100%	99% to 50%	<50%		
	Score		**10**	**5**	**0**		
4	Monthly inspection and replacement of damaged Critical Equipment, lifting Tools & Tackles and hand tools used at site by BA (Neon Tester, Discharge rod,	% Total T&T	100%	99% to 50%	<50%		

	ladders Vehicle, Tools & tackles carried out and defective equipment replaced as required.						
	Score		**10**	**7**	**0**		
5	Unsafe Conditions/Acts (Potential Hazards), near miss(Close calls), minor injury(First aid cases and MTC) cases reported	Observation / Nos of workforce	0.50	0.25	<0.25		
	Score		**10**	**7**	**0**		
6	Monthly R&R for workforce along with Tata power reparative monthly	% of total workforce	10%	5%	**0**		
	Score		**10**	**5**	**0**		
7	Nos of workforce covered under program under Jivan Ki Aur/Ghar se Ghar tak/Surkhshit Pariwar ki aur	% of total workforce	10%	5%-10%			
	Score		**10**	**0**			
8	Safe (designated way) Disposal of Waste generated, Records of waste (Hazardous Waste – Oily cotton waste – E-waste etc.) generation. No effluents to drain/discharges to ground		YES	NO			
	Score		**10**	**0**			
9	*Daily Toolbox talk and Weekly Mass communications covering 100 % workforce and records maintained or not(R6).*	% of total workforce	100%	50-100 %			
	Score		**10**	**5**			
10	*Check for housekeeping at site(R6)*	At least 3S.	YES	NO			
	Score		**10**	**0**			

	B. Lag Indicators		**50** (for star rating score will dividend scale of 2.5)				0
			Target				
1	Number of Fatalities		0	>0			
Score	**Score**		30	0			
2	No of LWDC - Reportable		0	>0			
Score	**Score**		10 / 20*	0			
3	Major Fire		0	>0			
Score	**Score**		10 / 0*	0			
	Total score		**150**				0
	* Odisha					%	0

CSM F12 - Safety Violation Penalty Criteria

Major Violations and Escalation matrix-

Consequence of safety violation observed not related to incidents or accidents		Violations				
Sl. No.	**Safety Violation**	**1st**	**2nd**	**3rd**	**4th**	**Subsequent violation**
1	Working without required PPE such as Helmet/gloves/safety shoes/Safety harness etc.	**A**	**B**	**C**	**D**	Will Attract the same penalty as 4th violation
2	Working without proper tools and tackles	**A**	**B**	**C**	**D**	
3	Poor or bad condition of Crane/Hydra/Vehicle and/or Incompetent driver and/or helper).	**B**	**C**	**D**	**E**	Termination of Contract and blacklisting after repetition of violations (3 to 4 times as the case may be)
4	Improper Working at Height	**B**	**C**	**D**	**E**	
5	Untrained /unauthorized workman engaged in high-risk jobs	**B**	**C**	**D**	**E**	
6	Violation of SOP or WI or LOTO	**C**	**D**	**E**		
7	Working without PTW or LC / Without authorization / Without creating Safe Zone	**C**	**D**	**E**		

Legend	Action to be Taken	Responsibility	Penalty (INR)	Repeat Violations

A	Levy of Penalty	Order manager / EIC	5000	The no. of repeat violations shall be calculated cumulative during the FY and deduction will be done from the monthly bills.(R6)
B	Memo to BA and Levy of Penalty	Order manager / EIC	10000	
C	Memo to BA and Levy of Penalty	Order manager / EIC	25000	
D	Memo to BA and Levy of Penalty	Order Manager / EIC	50000	
E	Memo to BA, Levy of Penalty, Termination of Contract, Blacklist	Order Manager / EIC	100000	

Other Violations and Penalty

Penalty shall be imposed on the Business Associate s under the following circumstances for breaching the contractual agreements. The list is not exhaustive, but indicative.

Sl. No.	Description of Violation	Severity	Penalty (INR)
1.	Unhygienic/Bad condition of PPE	2	500
2.	Unsafe Act/Condition of Severity 4	4	4000
3.	Unsafe Act/Condition of Severity 5	5	5000
4.	No Earthling of Electrical equipment	5	5000
5.	Working without efficient supervision	4	4000
6.	Non-reporting of incidents	3	3000
7.	Starting the job without Toolbox Talk	4	4000
8.	Electric cable tied with metal wire / Use of damaged electrical cable / Use of two core cable	3	3000
9.	Rubber mat not available in front of electrical panels.	3	3000
10.	Inserting naked wire into the socket instead of a plug	5	5000
11	Inflammable materials stored inside PSS/FCC/Distribution Room	5	5000
12	Water accumulation found near electrical panels / equipment	5	5000
13	Grinding wheel/ Coupling/ Piling winch/other rotating parts without guard	4	4000
14	Inadequate illumination of working area	3	3000

15	Bringing inside PSS/FCC or any other work area any chemicals without approval.	5	5000
16	Loose materials in work area which can fall down or fly during a storm	5	5000
17	Misusing emergency facilities like fire hydrant line/ hose box/ spray system/ eye wash etc.	3	3000
18	Entering restricted areas like switch yard, hazardous material storage room etc. without authorization	3	3000
19	Not using 24 V lamp inside confined spaces	3	3000
20	Bypassing/overriding safety interlocks	5	5000
21	Working besides road without proper barricading and monitoring of traffic	5	5000
22	Smoking in prohibited area (Closed Go-downs, Storage of flammable material, Storage of Gas cylinders, PSS , Offices etc.)	3	3000
23	Improper stacking of materials in Storage Yard	4	4000
24	Sleeping at workplace	3	3000
25	First aid box not available / in locked condition	2	2000
26	Appointment of subBusiness Associate without his Safety Bid Evaluation and/or without the permission of engineer in charge or Order manager.	5	5% of order value
27	Bad Housekeeping with respect to ***TPSMS/GSP/GHK/022*** • 1st Instant • 2nd instant • 3rd instant • 4th instant • Subsequent instants	2	• 1000 • 2000 • 5000 • 10000 • 10000
28	Violations related to vehicles with respect to ***TPSMS/CSP/RSP/015.*** • Parking without wheel choke • Parking in undesignated area • Heavy vehicle without helper or co-driver • Seat belt not available / not used • Driver without license • Heavy vehicles without reverse horn • Using mobile phone while driving • Lights/mirrors not working /broken	3	1000 per each violation

28	Violation in Gas cutting and Gas cylinder handling • Cylinder valve without guard • No flashback arrester • Leaky DA/Oxygen hose • Cylinders not kept in secured manner • Cylinder trolley not available • Cylinders are transported by manual rolling	5	2000 per each violation
29	Violations in Lifting Operations w.r.t. to *TPSMS/CSP/HEMS/005* • Hook latch missing • Load raised or swung over people or occupied areas of building • Persons standing within the swing area of the crane • No barricading of crane working area • Use of damaged lifting tools and tackles • Lifting tools and tackles not tested / Test certificate expired • Crane operator without proper license • Angular loading • Lifting / shifting heavy material without guide rope • Using mobile phone during loading and unloading jobs	5	2000 per each violation
30	Violation in Scaffolding work w.r.t. to TPSMS/CSP/SCAF/007 • Unstable scaffolding/nonstandard Scaffolding in use • Handrails/mid rails/toe guards missing • Safety harness not anchored on fixed structure • Opening found in working platform	5	2000 per violation
31	Violation in Excavation Work w.r.t. to TPSMS/CSP/EXS/002 • Loose material falling into excavated pit • Water logging in excavated pits / trenches • Inadequate or no barricading • Undercut / cave in found on sides of excavated pits	4	2000 per violation
32	Caution boards, danger signs (luminescent /red) along with emergency contact number are not found displayed.	3	3000
34	Spillage of hazardous material/chemicals during transportation	4	4000

Penalty for Incidents / Accidents-( )

Consequence of incident / Accident		Incident / Accident				
Sr.No.	**Type of Injury**	**1st**	**2nd**	**3rd**	**4th**	**Action Required**
1	Major Injury (Bone injury or burn or hospitalization >48 hrs.) Non-fatal	**F**	**F**	**G**	G	
2	Major Injury (Bone injury or burn or hospitalization >48 hrs.) Non-Fatal (Two or more non-Fatal in one event)	**G**	**G**	**H**		**Intolerable**
3	Single fatality	**G**	**H**			
4	Multiple fatalities (Two or more fatalities in one event). Anywhere in Tata power.	**H**				

Legend	Action to be taken	Responsibility	Penalty (INR)	
F	Memo to BA and Levy of Penalty	Order Manager/Engineer in charge	200000	The no. of violations shall be calculated cumulative during FY and deduction will be done just after Consequence of incident / Accident(R6)
G	Memo to BA and Levy of Penalty	Order Manager/Engineer in charge	500000	
H	Memo to BA, Levy of Penalty, Termination of Contract and Blacklisting the BA	Order Manager/Engineer in charge	1000000	

5.0 Tools and Tackles

5.1 Tools & Tackles used to carry out the job shall be checked and inspected by Order Manager and safety Officer.

5.2 Vendor must submit a valid Certificate from Competent person under the Factories Act 1948 and State Factories Rule for all Lifting Tools and Tackles (like Hoist, D

Shackles, chain Block, wire ropes etc.).

5.3 All Electrical Hand Tools must be tested for leakage of current by a person /agency authorized by Tata Power Division /Discoms. Electrical power must be taken though RCCB of 30mA. Electrical hand tools should not have cord more than 3 meters in length. If power source is at > 3 meters, extension boards with RCCB of 30 mA and ON/OFF switch, shall be used.

5.4 Removal or inclusion of tools any new tool /tackles / machinery / equipment at site should only be done with concurrence of the order Manager / Head Safety.

6.0 Site Safety Rules and Procedures:

The work in the safest possible manner can only happen when it has been carefully planned and all applicable procedures are followed. The Tata Power Safety Procedures are derived from Tata Power best practices and the applicable Government acts regulations. In each case, the most stringent regulation is used. All safety rules and procedures developed from time to time shall be mandatorily followed by the vendor and his employees while working at Site.

7.0 Critical safety Rules and Procedures:

Following is the list of Tata Power's critical Safety Rules and Procedures. Business Associate shall refer to approved Rules and Procedures for detailed requirements and ensure conformance

7.1 Lock Out and Tag Out Procedure.

This procedure is intended to be used for the protection of Personnel while servicing or performing maintenance on distribution network/ equipment / pipeline / vessel / process systems. This is a general procedure that shall be used as the minimum requirements for isolation of equipment, pipelines, machines, system from all possible sources of hazardous energy and / or material such as Steam, Hot Water, Compressed Air, any other process fluid / chemical energy /Mechanical energy or Electrical energy. For complete procedure kindly refer Procedure Document No. **TPSMS/CSP/LOTO/001**

7.2 Excavation Safety (Shoring and Sloping) Procedure

This procedure is developed to cover the safe practices required for shoring and sloping in excavation and trenching jobs. This procedure is developed to establish mandatory requirements for practices to protect personnel, property and equipment from hazards associated with above activities. For complete procedure kindly refer Procedure Document No TPSMS/CSP/EXS/002

7.3 Confined Space Entry Procedure:

This procedure outlines the steps required to perform the confined space entry and to protect personnel from the hazards of entering and conducting operations in confined spaces. For complete procedure kindly refer Procedure Document No – TPSMS/CSP/CSE/003.

7.4 Working at Height Procedure:

This procedure describes the rules and procedures to protect employees from the hazards of working at heights. This procedure is developed to cover the safe practices

required for Working at Heights. This procedure is developed to establish mandatory requirements for practices to protect personnel from hazards associated in this area. For complete procedure kindly refer Procedure Document No – TPSMS/CSP/WAH/004.

7.5 Heavy Equipment Movement Safety Procedure.

Heavy equipment lifting and movement is an activity involving loading, unloading, storage and movement from one place to another including lifting and erection or repairing of equipment with cranes or hoists. Material, machinery and equipment handling operations are being carried out by large capacity cranes and hoists, which make the job safer and faster. This procedure addresses the hazards and precautions associated with such equipment and their use. For complete procedure kindly refer Procedure Document No –TPSMS/CSP/HEMS/005.

7.6 Mobile Crane Safety Procedure.

Mobile cranes are responsible for many incidents, injuries. Falling loads from mobile cranes pose a severe hazard to operators and nearby workers and property. Many types of cranes, hoists, and rigging devices are used for lifting and moving materials. To maintain safe, appropriate standards must be adhered to and only qualified and licensed individuals shall operate these devices. For complete procedure kindly refer Procedure Document No –TPSMS/CSP/MCS/006.

7.7 Scaffold Safety Procedure.

This procedure is developed to provide information on the safe erection, use, dismantling and maintenance of access scaffolding in the workplace. It is developed to establish mandatory requirements for practices to protect personnel from hazards associated with erection, use and dismantling of scaffolds. For complete procedure kindly refer Procedure Document No –TPSMS/CSP/SCAF/007.

7.8 Permit to Work Procedure.

Given the inherent hazards of the power generation and distribution industry, a significant number of TATA POWER operations and installations are critical. Work Permit (WP) System is an essential element in controlling the workplace risks in an effective manner. For complete procedure kindly refer Procedure Document No – TPSMS/CSP/PTW/008.

7.9 Job Safety Analysis (JSA) Procedure.

This objective of this procedure is to have a task-based risk assessment process in place that identifies, evaluates and controls the risks associated with work activities, and as a result, prevents those involved in the task or those potentially affected by the task, from being harmed. For complete procedure kindly refer Procedure Document No- TPSMS/CSP/JSA/009 REV 01.

7.10 Electrical Safety Procedure.

The objective of these standards is to specify minimum mandatory requirements and advisory guidance for identifying and controlling hazards to ensure 'Zero Harm' regarding operation maintenance and testing of electrical equipment. For complete procedure kindly refer Procedure Document No- TPSMS/CSP/ELEC/010

7.11 Fire Safety Management Procedure.

Objective of This standard is to specify the minimum mandatory requirements and advisory guidelines to ensure prevention of fire related incidents and managing / controlling their impacts if they do occur. For complete procedure kindly refer Procedure Document No - TPSMS/CSP/ELEC/011

7.12 Hazard Identification & Risk Assessment (HIRA) Procedure:

Objective of this procedure is to define guidelines for Hazard identification, Risk assessment and determination of controls. For complete procedure kindly refer Procedure Document No - TPSMS/CSP/HIRA/012.

7.13 Management Of Change (MOC) Procedure:

The objective of this document is to establish the procedures necessary to ensure that HSE risks are managed to an acceptable level in Tata Power Management of Change (MOC) process. For complete procedure kindly refer Procedure Document No - TPSMS/CSP/MOC/013.

7.14 Pre-Start-up Safety Review (PSSR) Procedure.

Objective of this procedure is to provide guidelines for safe initial startup of a new facility or restart of a modified facility. The PSSR process verifies that the new/modified facility meets the original design and operating parameters. The intent is to prevent incidents caused by inadequate, incomplete, unauthorized design, construction, installation, and/or commissioning. For complete procedure kindly refer Procedure Document No - TPSMS/CSP/MOC/014.

7.15 Road Safety procedure:

To provide Safety Rules for road travel management and safe usage of all types of vehicles viz. passenger/ commercial, owned/ hired by company, driven by employees or Business Associate s. For complete procedure kindly refer Procedure Document No - TPSMS/CSP/RSP/015.

8.0 General safety Rules and Procedure:

8.1 Lift (Elevator) Safety Procedure:

To provide safe operating procedure for taking control of lift car before entering and existing the pit of OTIS make elevators. For complete procedure kindly refer Procedure Document No – **TPSMS/GSP/LIFT/001**,

8.2 Working on conveyor belt Procedure:

This procedure is developed to cover the safe practices required for Working on live equipment and to protect personnel from hazards associated with it. For complete procedure kindly refer Procedure Document No – **TPSMS/GSP/CONV/003**

8.3 Batteries Handling & Disposal

To provide procedure for recycling and / or safe disposal of used / waste batteries in compliance with all legislation. For complete procedure kindly refer Procedure Document No – ***TPSMS/GSP/HAZM/003***

8.4 Material Handling and Storage Procedure:

The purpose of this document is to provide procedures to assist the safe handling

of materials (manual handling and mechanical handling). For complete procedure kindly refer Procedure Document No – **TPSMS/GSP/MATL/004.**

8.5 Office Safety Procedure:

The objective is to provide a safe working environment to those working in office premise, who may be exposed to emergency situations and other chronic / cumulative risks that may arise due to various reasons of unsafe act, unsafe condition, fire and or pandemic crisis like COVID-19 etc. For complete procedure kindly refer Procedure Document No -***TPSMS/GSP/OFS/006***

8.6 Earth Leakage Circuit Breaker (ELCB) Testing Procedure):

The objective of this procedure is to define the minimum requirements for testing of Earth Leakage Circuit Breaker (ELCB). For complete procedure kindly refer Procedure Document No - ***TPSMS/GSP/ELCB/008.***

8.7 Occupational Health & Safety Legal Compliance Procedure:

Objective of this procedure is provide guidelines for compliance of Occupational Health & Safety (OH&S) legal requirements and all ratified protocols and agreements are incorporated in Tata Power Safety Management System (SMS). For complete procedure kindly refer Procedure Document No - ***TPSMS/GSP/LEGL/009*.**

8.8 Incident Reporting & Investigation Procedure:

Objective of this procedure is to outline the process for reporting, recording and investigating an incident, recommending corrective and preventive actions and to communicate the lessons learned to prevent recurrence of similar incidents. For complete procedure kindly refer Procedure Document No - ***TPSMS/GSP/IRI/011*.**

8.9 Business Associate Safety Management Procedure.

The purpose of this document is to engage with Business Associate s in a way to create safe work environment for everyone working for Tata Power. For complete procedure kindly refer Procedure Document No – **TPSMS/GSP/CSM/015**.

8.10 Tree Trimming Procedure:

The objective of this procedure is to define guidelines and minimum requirements for Tree trimming. For complete procedure kindly refer Procedure Document No – ***TPSMS/GSP/TTRM/017***

8.11 Safe Lone Working Procedure:

Objective of this procedure is to lay down guidelines for reduction and safe managing of any additional risk arising from lone working. For complete procedure kindly refer Procedure Document No – ***TPSMS/GSP/LONE/019.***

8.12 Good Housekeeping(5S) Procedure:

Objective of this procedure is to explain the meaning, importance and provide guidelines for implementation of Good Housekeeping(5S) at workplaces across organization. For complete procedure kindly refer Procedure Document No – ***TPSMS/GSP/GHK/022***.

8.13 Personal Protective Equipment:

This procedure describes the basic requirements, applicability, minimum specifications of Personal Protective Equipment (PPE). For complete procedure kindly refer Procedure Document No – ***TPSMS/GSP/PPE/023.***

8.14 Process Safety Management Procedure:

The objective of this document is to provide a standardized & uniform guideline to implement Process Safety Management in Tata Power, its JVs, and subsidiaries to prevent or minimize the consequences of releases of toxic, flammable, pressurized or uncontrolled chemicals/Steam/Water or any other material which may result in toxic, fire, explosion, burn or flood like situation. For complete procedure kindly refer Procedure Document No – ***TPSMS/GSP/PSM/024***

The above procedures will be updated time to time and the updated version of the procedures as well as any additional critical procedure will be available on official website of Tata Power (www.tatapower.com) for your reference.

9.0 Pre-Employment and Periodic Medical check-up:

Business Associate shall arrange to conduct a pre-employment and periodic medical check-up for its entire workforce by Tata Power medical officer or Tata Power authorized medical officer. The Business Associate shall be able to produce the certificate prior to the employment. The Business Associate shall also organize to conduct periodical medical checkup (six monthly) for the following category of employees:

- Drivers (Check for Vision & Hearing)
- HEM Equipment Operators (Check for Vision & Hearing)
- Workforce working at Height (Check for Vision, Hearing, Vertigo & Height Phobia)
- Workforce Handling the hazardous substances - Coal, ash and chemicals (Chest X-ray and Lung Function T)
- Workforce in high Noise area (> 90 Decibel), Check for Hearing
- Workforce handling radiography equipment for conducting NDT.
- Workforce, working in specific areas requiring specific medical attention should conduct the medical tests test as laid down in the respective Site Safety Management Plan.

10.0 Other Conditions:

10.1 The manpower/vehicles/Tools & Tackles/Equipment provided shall be as per mutually agreed SLA.

Sr. No	Type of Audit	Frequency
1	Tool Bag and PPE audit	Weekly
2	First Aid Box Maintenance Record	Fortnightly
3	Fire Extinguisher Record(Applicable for the BA involved in major construction works and have storage of flammable material at worksite)	Monthly
4	Safety Talk Register	Weekly
5	Site Safety Audit	Daily

10.2 No Supervision No work policy should strictly be followed.

10.3 Test Before Touch must be ensured every time a job is being carried out in electrical network.

10.4 HIRA /JSA as per the job scope must be prepared in detail and submitted along with Site Safety Plan by the successful bidder.

10.5 Personal protective equipment (PPE) must always be checked before use to ensure that they are in good condition and clean. Replace them if necessary.

10.6 All relevant PPE shall be provided by the vendor while working at the site.

10.7 Housekeeping shall be maintained all the time while execution of work. All the unwanted material shall be removed from the site at the end of the day's work. Old/damaged parts if taken out of the system shall be kept at identified placed and it shall be shifted to scrap yard or disposed of as per instruction of order manager.

10.8 Site Safety Plan shall be prepared by successful bidder along with order manger. Appendix 1 to be filled by successful bidder and submitted to Tata Power safety in-charge, before mobilization of team at site and start of the work.

10.9 The Owner or Proprietor of BA must visit worksite at least once in a month and meet Order Manager every month. In case of incidents, the Owner or Proprietor of BA is required to attend Time Out Meetings to understand the gaps that contributed to the incident.

11.0 Schedule of Safety Audits by BA Safety Staff

Safety Undertaking of BA by way of Affidavit

I_____ s/o_____R/o_____ (AUTHORIZED REPRESENTATIVE/PARTNER/DIRECTOR/PROPRIETOR) of M/S _____(name of company/firm)__ having its office at (Complete address of Company), authorized vide power of attorney dated ------/Board resolution dated----/letter of authority dated----, hereinafter referred to as **Business Associate [or Business Associate (BA)]** which expression shall, unless it be repugnant to or inconsistent with the meaning or context thereof, be deemed to include its heirs, executors, administrators, and assigns do hereby affirm and undertake as under :

1. The present undertaking shall remain in force from the date of execution of contract and shall be valid till the date of termination of the said contract by either party. The undertaking is binding on me (Business Associate) as well as my sub-Business Associate and its employees, representatives etc.
2. That I (the Business Associate) will be responsible and liable to comply and abide by all the safety rules, instructions and regulations as may be specified and laid down by the Discom to achieve its goal of Zero for on-site incidences.
3. That the Business Associate shall be fully responsible for ensuring occupational health and safety of its employees, representatives, agents as well as of its subBusiness Associate 's employees, at all times during the discharge of their respective obligations under the contract including any methods adopted for performance of their tasks / work.
4. That Business Associate shall ensure ,at its own expense to arrange for and procure, implement all requisite accident prevention tools, first aid boxes, personal protective equipment, fire extinguisher, safety training, Material Safety Data Sheet, pre-employment medical test, etc. for operations & activities including as & when so specified by Discom specifically. , failing which Discom shall be entitled, but not obliged, to provide the same and recover the actual cost thereof from the Business Associate 's payments.
5. That the Business Associate shall engage adequate and competent Safety – Supervisor / Engineer / Manager / Skilled persons at site as per the Para 5 (Qualification and experience of safety personnel) and Annexure 3 of Contract Safety Management.
6. That the Business Associate shall engage the competent Site – Supervisor with each group of workers for safe and correct workmanship, proper co-ordination of material and site work as per contract.
7. That the Business Associate shall immediately replace supervisor in case it is found to be not up to the level of skill and experience required, but any such replacement shall be only with the prior concurrence of the Discom representative.
8. That the Business Associate and its sub Business Associate s shall abide by all the safety guidelines as per Safety Manual, Contract Safety Management and other guidelines issued from time to time by Discom during the contract period.

9. That in case the Business Associate and/or any of its Sub Business Associate fail to ensure the compliance as required in terms of this undertaking the Business Associate shall keep and hold Discom / its directors / officers / employees indemnified against any / all losses / damage / expense / liability / fines / compensation / claims / action / prosecutions or the like which might be suffered by Discom or to which Discom might get exposed to as a result of any breach /wilful negligence /deliberate default on the part of the Business Associate /Sub Business Associate in complying with the same. Business Associate shall also furnish any press release, clarification etc. if sought by Discom for any near miss or safety violations, accidents, which are attributable to fault of Business Associate .

DEPONENT

VERIFICATION

Verified at ……on this _Day of _____20__ that the contents of the above affidavit are true and correct and nothing material has been concealed therefrom.

12.0 General Safety Conditions for various contracts Specific to Odisha Discom

12.1 Safety Conditions for maintenance of STS (Sub Transmission System) Network.

A BA awarded a major contract work of maintenance of sub – transmission network in area of a power system will be required to fulfil the following conditions:

- Availability of Discharge Rods - Minimum 6 Nos. in each maintenance vehicle, fit for purpose and in good conditions and defective rods are removed from service.
- Availability of Neon tester - Minimum one Neon Tester in each Maintenance Vehicle, in good and working condition and defective or non-standard neon testers are removed from service.
- Electrical hand Gloves - Minimum two sets of 33 KV and two sets of 11 KV in maintenance vehicles.
- The BA linemen must be having required ELBO certification for the voltage level involved.
- BA shall provide Safety Policy, Safety Objectives, Organogram showing structure and responsibility of Safety management of his company and shall document the work practices and procedures in terms of Safety Management.
- BA shall comply with all statutory requirements like applicable acts, regulations, codes of practice, OHSAS Standards, Labour laws, etc.
- The BA shall participate in Safety promotional activities like celebration of Lineman day on 4th March, National Fire Service Day on 14th April and Theme based safety campaigns undertaken by the Discoms every month.
- BA shall abide by Safety manuals and guidelines of Discom issued from time to time.

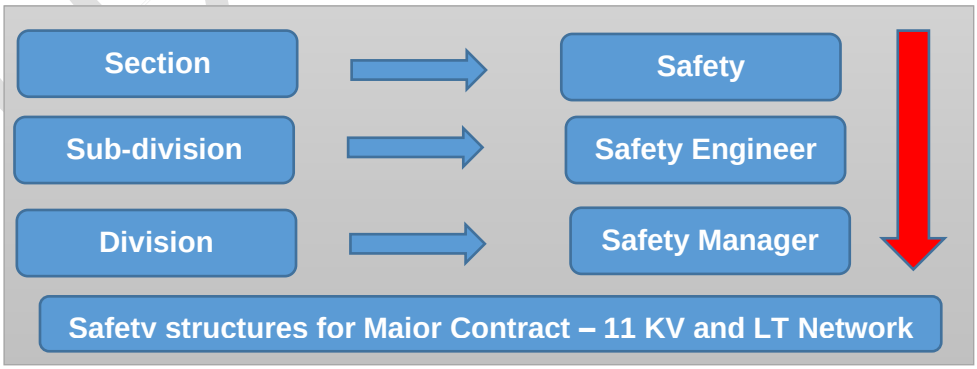
- BA shall ensure safety training and induction program for the employees. The BA employees must carry safety training card / competency card to the worksite and produce the card on demand.
- All BA employees must be given valid ID card issued by BA cell of Discom who will check statutory compliances before issuing ID cards.
- BA shall not employ a new workman without training and issue of ID card.
- BA shall conduct safety audits & inspections as per Discom procedures.
- BA shall provide proper PPEs as per CSM F-8 ensure periodic inspection of PPE, Tools and tackles to ensure their serviceability.
- BA shall ensure the adherence to standard operating procedures or guidelines laid down by the Discoms.
- BA shall ensure that no job shall be carried out without efficient supervision.
- BA shall ensure reporting of any unsafe act, unsafe conditions, near miss, incident, or accident to engineer in-charge and SAFETY team of the Discom.
- BA shall provide safety performance and Safety MIS to engineer in-charge and Discom SAFETY group periodically. Based on any non-confirmation to the safety procedures and guidelines, BA is liable to be negatively marked for his performance and suitable penalty will be imposed.
- BA safety staff shall work as per the guidance of the Discom safety department and functionally report Safety Head of Discom. Any leaves by safety staff of the BA shall have to approved by Discom Safety Department.
- BA shall ensure to depute Safety Staff for managing safety in worksites. In case the BA has been awarded work in more than one area power system, then the following safety structure will be adopted.
- Safety manager and Safety engineer must be having PDIS or ADIS.

12.2Safety Conditions for maintenance of 11 KV and LT Network.

A BA awarded a major contract work of maintenance of 11 KV and LT Network in area of a power system will be required to fulfil the following conditions:

- Availability of Discharge Rods - Minimum 6 Nos. in each PSS/FCC and maintenance vehicle, fit for purpose and in good conditions and defective rods are removed from service.
- Availability of Neon tester - Minimum one Neon Tester in each PSS/FCC/ Maintenance Vehicle, in good and working condition and defective or non-standard neon testers are removed from service.
- Electrical hand Gloves - Minimum two sets of 33 KV and two sets of 11 KV in each PSS/Maintenance vehicles and two sets of LT hand gloves at each FCC.
- The BA linemen must be having required ELBO certification for the voltage level involved.

- BA shall provide Safety Policy, Safety Objectives, Organogram showing structure and responsibility of Safety management of his company and shall document the work practices and procedures in terms of Safety Management.
- BA shall comply with all statutory requirements like applicable acts, regulations, codes of practice, OHSAS Standards, Labour laws, etc.
- BA shall abide by Safety manuals and guidelines of Discom issued from time to time.
- BA shall ensure safety training and induction program for the employees. The BA employees must carry safety training card / competency card to the worksite and produce the card on demand.
- All BA employees must be given valid ID card issued by BA cell of Discom who will check statutory compliances before issuing ID cards.
- BA shall not engage new workman without training and issue of ID card.
- PSS operator shall not be involved in maintenance activities.
- BA shall conduct safety audits & inspections as per Discom procedures.
- BA shall provide proper PPEs as per CSM F-8 ensure periodic inspection of PPE, Tools and tackles to ensure their serviceability.
- The BA shall participate in Safety promotional activities like celebration of Lineman day on 4th March, National Fire Service Day on 14th April and Theme based safety campaigns undertaken by the Discoms every month.
- BA to ensure that all LT complaints are routed through Call Centre and recorded in FCC. Rectification of fault shall be done only after call centre logging and with the knowledge of BA supervisor.
- No one will work alone or unsafely under public pressure or otherwise.
- BA shall ensure the adherence to standard operating procedures or guidelines laid down by the Discoms.
- BA shall ensure that no job shall be carried out without efficient supervision.
- BA shall ensure reporting of any unsafe act, unsafe conditions, near miss, incident, or accident to engineer in-charge and SAFETY team of the Discom.
- BA shall provide safety performance and Safety MIS to engineer in-charge and Discom SAFETY group periodically. Based on any non-confirmation to the safety procedures and guidelines, BA is liable to be negatively marked for his performance and suitable penalty will be imposed.
- BA safety staff shall work as per the guidance of the Discom safety department and functionally report Safety Head of Discom. Any leaves by safety staff of the BA shall have to approved by Discom Safety Department.
- BA shall ensure to depute Safety Staff - One safety supervisor per section, One safety engineer per sub-division and one safety manager per Division Safety manager and Safety engineer must be having PDIS or ADIS.



12.3 Safety Conditions for the major contract work in Civil Projects:

A BA awarded a major contract work of / in civil project will be required to fulfil the following safety conditions:

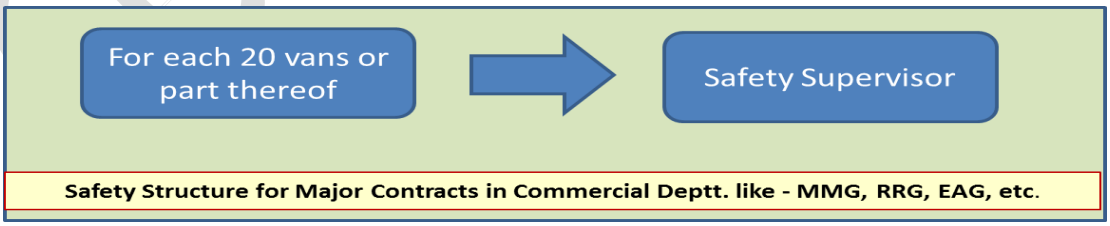
- BA shall provide Safety Policy, Safety Objectives, Organogram showing structure and responsibility of Safety management of his company and shall document the work practices and procedures in terms of Safety Management.
- BA shall comply with all statutory requirements like applicable acts, regulations, codes of practice, OHSAS Standards, Labour laws, etc.
- BA shall abide by Safety manuals and guidelines of Discom issued from time to time.
- BA shall ensure safety training and induction program for the employees. The BA employees must carry safety training card / competency card to the worksite and produce the card on demand.
- All BA employees must be given valid ID card issued by BA cell of Discom who will check statutory compliances before issuing ID cards.
- BA shall not employ a new workman without training and issue of ID card.
- BA shall conduct safety audits & inspections as per Discom procedures.
- BA shall provide proper PPEs as per CSM F-8 ensure periodic inspection of PPE, Tools and tackles to ensure their serviceability.
- BA shall ensure the adherence to standard operating procedures or guidelines laid down by the Discoms.
- BA shall ensure that no job shall be carried out without efficient supervision.
- BA shall ensure reporting of any unsafe act, unsafe conditions, near miss, incident, or accident to engineer in-charge and SAFETY team of the Discom.
- The BA shall participate in Safety promotional activities like celebration of Lineman day on 4th March, National Fire Service Day on 14th April and Theme based safety campaigns undertaken by the Discoms every month.
- BA shall provide safety performance and Safety MIS to engineer in-charge and Discom SAFETY group periodically. Based on any non-confirmation to the safety procedures and guidelines, BA is liable to be negatively marked for his performance and suitable penalty will be imposed.
- BA safety staff shall work as per the guidance of the Discom safety department and functionally report Safety Head of Discom. Any leaves by safety staff of the BA shall have to approved by Discom Safety Department.
- BA shall refer Construction Safety Manual of the Discom for details.
- BA shall ensure to depute a Safety Supervisor (for workforce up to 100 at site) / a safety engineer (for workforce up to 250 at site) / safety manager (for more than two safety engineers) for managing safety at the project site. In case the BA has been awarded more than one major contracts, then the following safety structure will be adopted.
- Safety Engineers and Safety Managers must be having PDIS or ADIS.

Safety Structure for Major Contracts in Civil, EHV & Distribution Projects Groups

12.4 Safety Conditions for the major contract work in Commercial Department like - MMG, RRG, EAG, etc.:

A BA awarded a major contract work in meter management group & energy auditing group will be required to fulfil the following safety conditions:

- BA shall provide Safety Policy, Safety Objectives, Organogram showing structure and responsibility of Safety management of his company and shall document the work practices and procedures in terms of Safety Management.
- BA shall comply with all statutory requirements like applicable acts, regulations, codes of practice, OHSAS Standards, Labour laws, etc.
- BA shall abide by Safety manuals and guidelines of Discom issued from time to time.
- BA shall ensure safety training and induction program for the employees. The BA employees must carry safety training card / competency card to the worksite and produce the card on demand.
- All BA employees must be given valid ID card issued by BA cell of Discom who will check statutory compliances before issuing ID cards.
- BA shall not employ a new workman without training and issue of ID card.
- BA shall conduct safety audits & inspections as per Discom procedures.
- The BA shall participate in Safety promotional activities like celebration of Lineman day on 4th March, National Fire Service Day on 14th April and Theme based safety campaigns undertaken by the Discoms every month.
- BA shall provide proper PPEs as per CSM F-8 ensure periodic inspection of PPE, Tools and tackles to ensure their serviceability.
- BA shall ensure the adherence to standard operating procedures or guidelines laid down by the Discoms.
- BA shall ensure that no job shall be carried out without efficient supervision.
- BA shall ensure reporting of any unsafe act, unsafe conditions, near miss, incident, or accident to engineer in-charge and SAFETY team of the Discom.
- BA shall provide safety performance and Safety MIS to engineer in-charge and Discom SAFETY group periodically. Based on any non-confirmation to the safety procedures and guidelines, BA is liable to be negatively marked for his performance and suitable penalty will be imposed.
- BA safety staff shall work as per the guidance of the Discom safety department and functionally report Safety Head of Discom. Any leaves by safety staff of the BA shall have to approved by Discom Safety Department.
- BA shall ensure to depute a Safety Supervisor for managing safety at worksite.
- The BA for the RRG work shall depute one Safety supervisor.

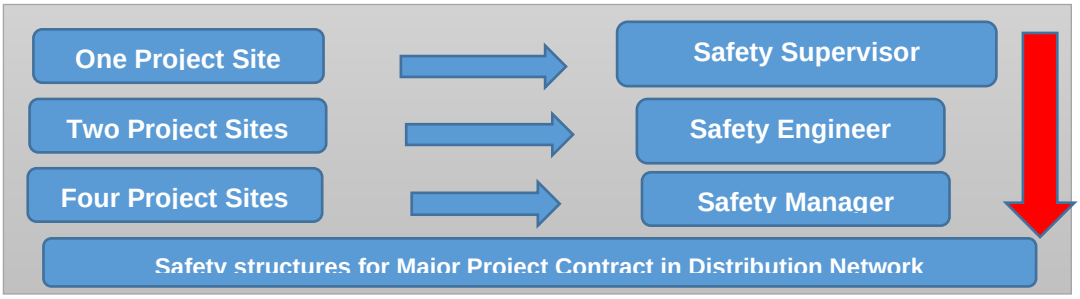


Safety Structure for Major Contracts in Commercial Deptt. like - MMG, RRG, EAG, etc.

12.5 Safety Conditions for Major Projects in Distribution Network

A BA awarded a major Projects in Distribution Network shall be required to fulfil the following conditions:

- Availability of Discharge Rods - Minimum 6 Nos. for each project site, fit for purpose and in good conditions and defective rods are removed from service.
- Availability of Neon tester - Minimum one Neon Tester in each project site, in good and working condition and defective or non-standard neon testers are removed from service.
- Electrical hand Gloves - Minimum one sets of 33 KV, 11 KV and LT in each project site.
- The BA linemen must be having required ELBO certification for the voltage level involved.
- BA shall provide Safety Policy, Safety Objectives, Organogram showing structure and responsibility of Safety management of his company and shall document the work practices and procedures in terms of Safety Management.
- BA shall comply with all statutory requirements like applicable acts, regulations, codes of practice, OHSAS Standards, Labour laws, etc.
- BA shall abide by Safety manuals and guidelines of Discom issued from time to time.
- BA shall ensure safety training and induction program for the employees. The BA employees must carry safety training card / competency card to the worksite and produce the card on demand.
- The BA shall participate in Safety promotional activities like celebration of Lineman day on 4th March, National Fire Service Day on 14th April and Theme based safety campaigns undertaken by the Discoms every month.
- All BA employees must be given valid ID card issued by BA cell of Discom who will check statutory compliances before issuing ID cards.
- BA shall not employ a new workman without training and issue of ID card.
- BA shall conduct safety audits & inspections as per Discom procedures.
- BA shall provide proper PPEs as per CSM F-8 ensure periodic inspection of PPE, Tools and tackles to ensure their serviceability.
- BA shall ensure the adherence to standard operating procedures or guidelines laid down by the Discoms.
- BA shall ensure that no job shall be carried out without efficient supervision.
- BA shall ensure reporting of any unsafe act, unsafe conditions, near miss, incident, or accident to engineer in-charge and SAFETY team of the Discom.
- BA shall provide safety performance and Safety MIS to engineer in-charge and Discom SAFETY group periodically. Based on any non-confirmation to the safety procedures and guidelines, BA is liable to be negatively marked for his performance and suitable penalty will be imposed.
- The BA shall participate in Safety promotional activities like celebration of Lineman day on 4th March, National Fire Service Day on 14th April and Theme based safety campaigns undertaken by the Discoms every month.
- BA safety staff shall work as per the guidance of the Discom safety department and functionally report Safety Head of Discom. Any leaves by safety staff of the BA shall have to approved by Discom Safety Department.
- BA shall ensure to depute Safety Staff for managing safety in worksites. One safety supervisor per project site or 100 persons, one safety engineer for 2 project sites of 250 persons, and one safety manager for four project sites or 500 persons.
- Safety manager and Safety engineer must be having PDIS or ADIS.



Annexure IX

BG Format (EMD BG , PBG/ CPBG)

Section A6 : Earnest Money Deposit Bank Guarantee Format

Note: a) Format shall be followed in toto

b) Claim period of six months must be kept up

c) The guarantee to be accompanied by the covering letter from the bank confirming the signatories to the guarantee on the Bank's letter head.

The Tata Power Co Ltd

34,Sant Tukaram Road

Carnac Bunder,

Mumbai 400 009

Whereas (Name of the Contractor), a Company incorporated under the Indian Companies Act 1956, having its Registered office at _____, (hereinafter called the "BIDDER") has in response to your Invitation to Bid against Enquiry No. _____dated _____, for (name of work), offered to supply and/or execute the works as contained in Employers letter dated _____.

AND WHEREAS BIDDER is required to furnish to you a Bank Guarantee for the sum of Rs._____/-(Rupees ____ only) as Earnest Money against Bidder's offer as aforesaid.

AND WHEREAS we, (name of the bank) having our Registered Office at _____and Branch office at _____, have at the request of Bidder, agreed to give you this Guarantee as hereinafter contained.

NOW THEREFORE, in lieu of earnest money deposit, we, the undersigned, hereby covenant that the aforesaid Bid of the BIDDER shall remain open for acceptance by you during the period of validity as mentioned in the Bid Document or any extension thereof as requested by you and if Bidder shall for any reason back out, whether expressly or impliedly, from this said Bid during the period of its validity or any extension thereof as aforesaid, we hereby guarantee to you the payment of the sum of Rs._____/- (Rupees ____ only) on demand and without demur and notwithstanding the existence of any dispute between you and the BIDDER in this regard and we hereby further agree as follows:

(a) You shall have the right to file/make a claim on us under the Guarantee for a further period of six months from the said date of expiry.

(b) That this guarantee shall not be revoked during its currency without your written express consent.

(c) That you may without affecting this guarantee grant time or other indulgence to or negotiate further with BIDDER in regard to the conditions contained in the said Bid document and thereby modify these conditions or add thereto any further conditions as may be mutually agreed upon between you and BIDDER.

(d) That the guarantee hereinbefore contained shall not be affected by any change in the constitution of our Bank or in the constitution of BIDDER.

(e) That any account settled between you and BIDDER shall be conclusive evidence against us of the amount due hereunder and shall not be questioned by us.

(f) That this guarantee commences from the date hereof and shall remain in force till BIDDER, if his Bid is accepted by you, furnishes the Contract Performance Guarantee as required under the said specifications and executes formal Contract Agreement as therein provided or till ____Days (__days) from the date of submission of the Bid by the BIDDER i.e. (expiry date), whichever is earlier.

(g) That the expression, BIDDER and Bank, and OWNER herein used shall, unless such an interpretation is repugnant to the subject or context, include their respective successors and assignees.

(h) Notwithstanding anything herein contained, our liability under this guarantee is limited to Rs._____/-(Rupees _____only) and the Guarantee will remain in force upto and including and shall be extended from time to time for such period or periods as may be desired by you. Unless a demand or claim under this Guarantee is received by us in writing within six months from (expiry date), i.e. on or before (claim period date), we shall be discharged from all liabilities under this guarantee thereafter.

(i) Any claim/extension under the guarantee can be lodgeable at issuing outstation bank or at the Mumbai branch and the claim will also be payable at Mumbai Branch. **(To be confirmed by Mumbai Branch by a letter to that effect)**

Notwithstanding anything contained herein above:

a) Our liability under this Bank Guarantee shall not exceed Rs._____/-(Rupees _____ only).

b) This Bank Guarantee shall be valid upto ---------- 200.

c) Our Liability to make payment shall arise and we are liable to pay the guaranteed amount or any part thereof under this Bank Guarantee only and only if you serve upon us a written claim or demand on or before ---------- 200.

For any correspondence in relation to extension/invocation / discharge of bank guarantee

contact us at Tel No._____ and Bank branch email id_____

FORMAT OF CONTRACT PERFORMANCE BANK GUARANTEE/ PERFORMANCE BANK GUARANTEE

Note: a) Format shall be followed in toto
b) Claim period of six months must be kept up
c) The guarantee to be accompanied by the covering letter from the bank confirming the signatories to the guarantee on the Bank's letter head.

The Tata Power Co Ltd
34,Sant Tukaram Road
Carnac Bunder,
Mumbai 400 009

Our Letter of Guarantee No.....

Contract/Purchase Order No.....dated.....

1.0 You have entered into a Contract No..... with..... .....(hereinafter referred to as " the Vendor") for the supply and delivery of ..... (hereinafter referred t o as "the said equipment") for the price and on the terms and conditions contained in the said contract.

2.0 In accordance with the terms of the said contract, " the Vendor" has agreed to furnish you with an irrevocable and unconditional bank guarantee in a form and from a bank acceptable to you as security for the due performance by " the Vendor" of all his contractual obligations under the said contract in an amount equal to 10% (ten percent) of the total value of the contract to be valid from the date of contract and up to 12 months from the date of satisfactory commissioning of the said equipment into service or 18 months from the date of delivery whichever is earlier.

3.0 In consideration thereof, we, ... hereby irrevocably and unconditionally guarantee to pay to you on demand and without demur and without reference to " the Vendor" such amount or amounts not exceeding the sum of Rs.....(Rupees ..... only) being 10% (ten percent) of the total value of the contract on receipt of your intimating that " the Vendor" has not fulfilled his contractual obligations. You shall be the sole judge for such non-fulfilment and " the Vendor" shall have no right to question such judgement.

4.0 You shall have the right to file/make your **claim** on us under the guarantee for a **further period of six months** from the said date of expiry.

5.0 This guarantee shall not be revoked without your express consent and shall not be affected by your granting time or any other indulgence to " the Vendor", which shall include but not be limited to, postponement from time to time of the exercise of any powers vested in you or any right which you may have against " the Vendor" and to exercise the same in any manner at any time and either to enforce or forbear to enforce any covenant contained or implied in the said contract or any other course or remedy or security available to you, and our Bank shall not be released from its obligations under this guarantee by your exercising any of your rights with reference to matters aforesaid or any of them or by reasons of any other act or forbearance or other acts of omission or commission on your part or any other indulgence shown by you or by any other matter or thing whatsoever which under the law would, but for this provision, have the effect of relieving our bank from its obligation under this guarantee.

6.0 We also agree that you shall be entitled at your option to enforce this guarantee against our bank as a principal debtor, in the first instance, notwithstanding any other security or guarantee that you may have in relation to " the Vendor" 's liabilities in respect of the premises.

7.0 This guarantee shall not be affected by any change in the constitution of our Bank or " the Vendor" or for any other reason whatsoever.

8.0 Any claim/extension under the guarantee can be lodged at issuing outstation branch or at Mumbai branch and also become payable at our issuing outstation bank or at the Mumbai branch as per confirmatory letter/letters of the concerned bank branches as attached. **(This Confirmatory letter is to be obtained from Mumbai Branch by the vendor and submitted along with the Performance Bank Guarantee and is applicable for PBG submitted from Banks located outside Mumbai).**

9.0 Notwithstanding anything herein contained, our liability under this guarantee is limited to Rs..... (Rupees .... only) and the guarantee will remain in force up to and including .....(Date) and shall be extended from time to time for such period or periods as may be desired by " the Vendor" .

10.0 Unless a demand or claim under this guarantee is received by us in writing within six months from ..... (expiry date) i.e. on or before .....(claim period end date) we shall be discharged from all liabilities under this guarantee thereafter.

11.0 For any correspondence in relation to extension / invocation / discharge of bank guarantee contact us at Tel No._____and Bank branch email id_____

Dated at ..... , this ..... day of .....2020 .