

**KARNATAKA POWER TRANSMISSION CORPORATION**  
**LIMITED**

TECHNICAL SPECIFICATION

SUB-STATION AUTOMATION SYSTEM FOR SUB-STATIONS IN  
KPTCL

***TECHNICAL SPECIFICATION FOR SUB-STATION AUTOMATION SYSTEM FOR  
SUB-STATIONS IN KPTCL***

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ANNEXURE – I (GTP IAS)  
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**1.0 GENERAL:**

1.1 The Substation Automation System shall be offered from a manufacturer who must have designed, manufactured, tested, installed and commissioned Substation Automation System which must be in satisfactory operation on 220kV system or higher for at least 2 (two) years as on the date of bid opening.

1.2 The Substation Automation System (SAS) shall be installed to control and monitor all the substation equipments from Remote Control Centre (RCC) as well as from Local Control Centre

The SAS shall contain the following main functional parts:

- Station Human Machine Interface (HMI):Redundant (Hot/Hot mode)
- Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- Redundant Gateway for remote control via industrial grade hardware through IEC 60870-5-104 protocol. It shall be contractor's responsibility to integrate his offered system with existing SLDC/RCC system for exchange of desired data. The exact IO point shall be decided during detailed engineering.
- Energy Measurement system
- DR work station/Engineering System.
- Peripheral equipment like printers, display units, key boards, Mouse etc.

The supplied SAS shall comply to Cyber security Standards as defined in the chapter 15.

1.3 It shall enable local station control via a PC by means of Human Machine Interface (HMI) and control software package, which shall contain an extensive range of Supervisory Control And Data Acquisition (SCADA) functions. The HMIs shall comply to IEC 61850-3 type test standard for Environmental and EMI/EMC standards.

1.4 It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. An architecture drawing for SAS is enclosed.

1.5 The communication gateway shall facilitate the information flow with remote control centers. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection and monitoring functions.

1.6 The Substation Automation System must have the type test reports for IEC 61850 and IEC 60870-5-104 protocol from accredited labs like NABL/CPRI/ERDA/KEMA.

## 2.0 **SYSTEM DESIGN:**

### 2.1 **General system design.**

The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions.

The system shall be of the state-of-the art suitable for operation under electrical environment present in Extra high voltage substations follow the latest engineering practice, ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The offered SAS shall support remote control and monitoring from Remote Control centers via Gateways.

The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training.

The system shall incorporate the control, monitoring and protection functions specified, self-monitoring, signaling and testing facilities, measuring as well as memory functions, event recording and evaluation of disturbance records.

Maintenance, modification or extension of components may not cause a shutdown of the whole substation automation system. Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

### 2.2 **System Architecture.**

The SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence.

Functions shall be decentralized, object-oriented and located as close as possible to the process.

The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e., in a station and a bay level.

At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands. The IEDs should be directly connected to the switchgear without any need for additional interposition or transducers.

Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.

The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fibre-optic cables, thereby guaranteeing disturbance free communication. The fibre optic cables shall be run in G.I. conduit pipes. Data exchange is to be realised using IEC-61850 Ed1 & Ed2 (Site selectable) protocol with a redundant managed switched Ethernet communication infrastructure.

The communication shall be made in 1+1 mode, excluding the links between individual bay IEDs to switch, such that failure of one set of fibre shall not affect the normal operation of the SAS. However, it shall be alarmed in SAS. Each fibre optic cable shall have four (4) spare fibres.

At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times. Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e., RCC, station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.

The station level contains the station-oriented functions, which cannot be realised at bay level, e.g. alarm list or event list related to the entire substation, gateway for the communication with remote control centres.

The GPS time synchronising signal (as specified in the section relay & protection) for the synchronization of the entire system shall be provided.

The SAS shall contain the functional parts as described in para 1.2 above.

### **2.3 Functional Requirements:**

The high-voltage apparatus within the station shall be operated from different places:

- Remote control centers.
- Station HMI.
- Local Bay controller IED

Operation shall be possible by only one operator at a time.

The operation shall depend on the conditions of other functions, such as interlocking, synchro check, etc. (see description in “Bay level control functions”).

#### **2.3.1 Select-before-execute:**

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

#### **2.3.2 Command supervision: Bay/station Interlocking and blocking.**

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accident in case of false operation does not take place. In addition to software interlocking hardwired interlocking are to be provided for:

- a) Bus Earth Switch Interlocking.
- b) Transfer Bus Interlocking (if applicable).

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.

A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

### **2.3.3 Run Time Command cancellation.**

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

### **2.3.4 Self-supervision.**

Continuous self-supervision function with self-diagnostic feature shall be included.

### **2.3.5 User configuration.**

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.

It shall also be possible to interconnect and derive input and output signals, logic functions, using built-in functions, complex voltage and currents, additional logics (AND-gates, OR gates and timers). (Multi-activation of these additional functions should be possible).

The functional requirement shall be divided into following levels:

- a) Bay (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer) Level Functions.
- b) System Level Functions.

## **3.0 BAY LEVEL FUNCTIONS:**

3.1 In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

- Bay control functions including data collection functionality.
- Bay protection functions.

### **3.1.1 Bay Control functions.**

#### **3.1.1.1 Overview.**

Functions.

- Control mode selection
- Select-before-execute principle.
- Command supervision:
  - Interlocking and blocking
  - Double command.
- Synchrocheck, voltage selection.
- Run Time Command cancellation
- Transformer tap changer control (for power transformer bays)
- Operation counters for circuit breakers and pumps
- Hydraulic pump/Air compressor control and runtime supervision /spring mechanism supervision
- Operating pressure supervision.
- Display of interlocking and blocking.
- Breaker position indication per phase
- Isolator Position Indication
- Alarm annunciation
- Measurement display
- Local HMI (local guided, emergency mode)
- Interface to the station HMI.
- Data storage for at least 200 events.
- Extension possibilities with additional I/O's inside the unit or via fiber-optic communication and process bus.

#### **3.1.1.2 Control mode selection.**

##### **Bay level operation:**

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation bay control unit allows the safe operation of all switching devices via the bay control IED.

##### **Emergency operation:**

It shall be possible to close or open the selected Circuit Breaker with ON or OFF push buttons even during the outage of bay IED.

## **REMOTE mode**

Control authority in this mode is given to a higher level (Remote Control Centre) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

### **3.1.1.3 Synchronism and energizing check.**

The synchronism and energizing check functions shall be bay-oriented and distributed to the bay control and/or protection devices. These features are:

- Settable voltage, phase angle, and frequency difference.
- Energizing for dead line – live bus, live line – dead bus or dead line – dead bus with no synchro-check function.
- Synchronizing between live line and live bus with synchro-check function.

### **Voltage selection.**

The voltages relevant for the Synchro-check functions are dependent on the station topology, i.e., on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing is derived from the auxiliary switches of the circuit breakers, the isolator, and earthing switch and shall be selected automatically by the bay control and protection IEDs.

### **3.1.1.4 Transformer tap changer control.**

Raise and lower operation of OLTC taps of transformer shall be facilitated through Bay controller IED.

## **3.1.2 Bay protection functions:**

### **3.1.2.1 General.**

The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices as detailed in Section-Relay & Protection panels.

IEDs, shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

### **Event and disturbance recording function:**

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. This shall give alarm if 70% memory is full. The disturbance recorder function shall be as per detailed in section –Relay & Protection panels.

## **3.2 System level functions:**



### 3.2.1 Status supervision:

The position of each switchgear, e.g., circuit breaker, isolator, earthing switch, transformer tap changer etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station HMI screen, recorded in the event list, and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.

The switchgear positions shall be indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

The SAS shall also monitor the status of substation auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analog values shall be monitored and recorded through this IED.

### 3.2.2 Measurements.

a) Analog inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz) and the rms values for voltage (U) and current (I) shall be calculated. The measured values shall be displayed locally on the Station HMI and in the Control Centre. The abnormal values must be discarded. The analog values shall be updated every 2 seconds.

Threshold limit values shall be selectable for alarm indications.

### 3.2.3 Event and alarm handling:

Events and alarms are generated either by the switchgear, by the control IEDs or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 ms.

### 3.2.4 Station HMI.

#### 3.2.4.1 Substation HMI Operation:

On the HMI the object has to be selected first. In case blocking or interlocking conditions are not met, the selection shall not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction and the appropriate control execution button shall be pressed in order to close or open the corresponding object.

Control operation from other places (e.g. REMOTE) shall not be possible in this operating mode.

#### 3.2.4.2 **Presentation and dialogues.**

##### **General:**

The operator station HMI shall be redundant with hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks or keyboard commands.

The HMI shall give the operator access to alarms and events displayed on the screen. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.

An acoustic alarm shall indicate abnormalities and all unacknowledged alarms shall be accessible from any screen selected by the operator.

The following standard pictures shall be available from the HMI.

- Single-line diagram showing the switchgear status and measured values.
- Control dialogues with interlocking and blocking details. This control dialogue shall tell the operator whether the device operation is permitted or blocked.
- Measurement dialogues.
- Alarm list, station / bay-oriented.
- Event list, station / bay-oriented.
- System status.

#### 3.2.4.3 **HMI design principles:**

Consistent design principles shall be adopted with the HMI concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.

The object status shall be indicated using different status colours for:

- Selected object under command
- Selected on the screen
- Not updated, obsolete values, not in use or not sampled
- Alarm or faulty state
- Warning or blocked
- Update blocked or manually updated
- Control blocked
- Normal state

#### 3.2.4.4 **Process status displays and command procedures:**

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.

In order to ensure a high degree of security against undesired operation, a “select-before-execute” command procedure shall be provided. After the “selection” of a switch, the operator shall be able to recognize the selected device on the screen and all other switchgear shall be blocked. As communication between control centre and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the “execution” of the command the operated switching symbol shall flash until the switch has reached its new position.

The operator shall be in a position to execute a command only, if the switch is not blocked and if no interlocking condition is going to be violated. The interlocking statements shall be checked by the interlocking scheme implemented at bay and station level.

After command execution the operator shall receive a confirmation that the new switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

#### **3.2.4.5 System supervision & display.**

The SAS system shall be comprehensively self-monitored such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links and printers at the station level etc.

#### **3.2.4.6 Event list.**

The event list shall contain events that are important for the control and monitoring of the substation.

The event and associated time (with 1 ms resolution) of its occurrence has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer for at least one month. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

- Position changes of circuit breakers, isolator and earthing devices.
- Indication of protective relay operations.
- Fault signals from the switchgear.
- Indication when analog measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measured.
- Loss of communication.

- Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:
  - Date and time.
  - Bay
  - Device
  - Function e.g., trips, protection operations etc.
  - Alarm class.

#### 3.2.4.7 **Alarm list:**

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control centre. The alarm list shall substitute a conventional alarm tableau and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. The date and time of occurrence shall be indicated.

The alarm list shall consist of a summary display of the present alarm situation. Each alarm shall be reported on one line that contains:

- The date and time of the alarm.
- The name of the alarming object.
- A descriptive text.
- The acknowledgement state.

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgment of the alarm, it should appear in a steady (i.e., not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition is physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, Unacknowledged and cleared, Acknowledged and persistent).

Filters for selection of a certain type or group of alarms shall be available as for events.

#### 3.2.4.8 **Object picture:**

When selecting an object such as a circuit breaker or isolator in the single-line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like

- Type of blocking
  - Authority
  - Local / remote control
  - RSCC / SAS control
  - Errors etc.,
- shall be displayed.

#### 3.2.4.9 **Control dialogues:**

The operator shall give commands to the system by means of mouse click located on the single-line diagram. It shall also be possible to use the keyboard for command activation. Data entry is performed with the keyboard. Dedicated control dialogues for controlling at least the following devices shall be available:

- Breaker and disconnecter
- Transformer tap-changer.

#### 3.2.5 **User-authority levels:**

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user authorisation group. Each user shall then be given access rights to each group of objects e.g.:

- Display only.
- Normal operation (e.g. open/close of switchgear)
- Restricted operation (e.g. by-passed interlocking)
- System administrator
- For maintenance and engineering purposes of the station HMI, the following authorisation levels shall be available:
  - No engineering allowed.
  - Engineering/configuration allowed.
  - Entire system management allowed.

The access rights shall be defined by passwords assigned during the log-in procedure. Only the system administrator shall be able to add / remove users and change access rights.

#### 3.2.6 **Reports:**

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

- **Trend reports:**
  - Day (mean, peak)
  - Month (mean, peak)
  - Semi-annual (mean, peak)
  - Year (mean, peak)
- **Historical reports of selected analog values:**
  - Day (at 15 minutes interval)

- Week
- Month
- Year

It shall be possible to select displayed values from the database in the process display on-line. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.

Following printouts shall be available from the printer and shall be printed on demand:

- i. Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.
- ii. Weekly trend curves for real and derived analog values.
- iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analog parameter for each circuit in 24 hours period.
- iv. Provision shall be made for logging information about breaker status like number of operation with date and time indications.
- v. Equipment operation details shift wise and during 24 hours.
- vi. Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap positions, temperature and status of pumps and fans for transformers.
- vii. Printout on adjustable time period as well as on demand system frequency and average frequency.
- viii. Reports in specified formats, which shall be handed over to successful bidder.

### 3.2.7 Trend display (historical data):

It shall be possible to illustrate all types of process data as trends – input and output data, binary and analog data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

### 3.2.8 Automatic disturbance file transfer:

All recorded data from the IEDs with integrated disturbance recorder as well as dedicated disturbance recording systems shall be automatically uploaded (event triggered or once per day) to a dedicated computer and be stored on the hard disc.

### 3.2.9 Disturbance analysis:

The PC-based work station shall have necessary software to evaluate all the required information for proper fault analysis.

### 3.2.10 IED parameter setting:

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters or the activation of parameter sets shall only be allowed after entering a password.

### 3.2.11 Automatic sequences:

The available automatic sequences in the system should be listed and described (e.g., sequences related to the trip transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences.

### 3.2.12 A set of following ETVM reading display and reports (ETVM Provided in Relay & Protection Panel) are required in the Station HMI.

- i) To present data read from meters.
- ii) To schedule meter reading and to select individual meters for manual reading.
- iii) To remotely program the electronic meters.
- iv) To manage the billing data and prepare it for exporting to other systems.

Other than the above parameters, those specified in the Annexure CRP-TVM shall also be provided.

The contents and format of meter reading displays shall be subject to approval by the purchaser. Energy meter integration shall be carried out using Data concentrator unit (DCU). DCU shall be capable of serving data to both SLDC and Station. Energy meter system preferably shall have web based application to view energy meter data and reports. DCU shall publish daily log, load survey & consumption of each ETVM. Energy meter system shall have the features to generate station level daily energy consumption abstract report. This report shall contain all meters consumption details.

## 3.3 Gateway:

### 3.3.1 Communication Interface:

The Substation Automation System shall have the capability to support simultaneous communications with multiple independent remote master stations. Redundant gateways shall be supplied. Each gateway shall be suitable for communicating minimum 4 numbers of remote control centres and minimum of 8 masters at a time independently.

The Substation Automation System shall have communication ports as follows:

- a) Two ports for Remote Control Centre.

- b) Two ports for SLDC.
- c) Two ports for Local Network
- d) Min. two spare ports

The communication interface to the SAS shall allow scanning and control of defined points within the substation automation system independently for each control center. The substation automation system shall simultaneously respond to independent scans and commands from employer's control centers (RCC & SLDC). The substation automation system shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each remote control center. Also, each control centres data scan and control commands may be different for different data points within the substation automation systems database.

The gateway software shall support all Type Identifiers which are defined in IEC 60870-5-104 protocol.

Gateway shall have features to save logs related to protocol communication status, data transaction and control operations with clear identification of the connected remote control centres.

If any equipment is operated from RCC/SLDC through gateway like CB, isolator operations, Tap changer operations the related alarms shall be generated in the station HMI to notify the station operator regarding the remote operations of the respective equipment along with connected remote control centre identifier. These events shall be recorded in HMI alarm list.

### **3.3.2 Remote Control Centre Communication Interface:**

Employer will supply communication channels between the Substation Automation System and the remote control centre. The communication channels provided by Employer will consist either of optical fibre, VSAT, GPRS or leased line, the details of which shall be provided during detailed Engineering.

### **3.3.3 Interface equipment:**

The Contractor shall provide interface equipment for communicating between Substation Automation System and Remote control centre and between Substation Automation System and State Load Dispatch Centre (SLDC). However, the communication channels available for this purpose will be arranged by KPTCL.

### **3.3.4 Communication Protocol:**

The communication protocol for gateway to control center must be open protocol and shall support IEC 60870-5-104 and IEC 61850 Ed1 & Ed2 (Site selectable) for all levels of communication for substation automation such as Bay to station HMI, gateway to remote station etc.

## **4.0 SYSTEM HARDWARE:**



**4.1 Redundant Station HMI, HMI View Node, Energy Measurement System workstation and Disturbance Recorder Work Station:**

The contractor shall provide redundant station HMI in hot-hot mode such that operator can visualize the SAS system from both HMI.

It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components. Processor and RAM shall be selected in such a manner that during normal operation not more than 25% capacity of processing and memory are used. Supplier shall demonstrate these features.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space.

1. Storage of all analog data (at 1 minutes interval) and digital data including alarm, event and trend data for 1 year.
2. Storage of all necessary software.

Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

The Minimum requirement of Redundant HMI, Main HMI:

General: industrial grade, fanless system

Power supply: DC supply

Processor: i7 or above

RAM: Min. of 128 GB.

SSD: RAID-1 with available 1TB

Operating System: Windows latest

The Minimum requirement of Gateways:

General: industrial grade, fanless system

Power supply: DC supply

Processor: i7 or above

RAM: Min, of 64GB.

SSD: 1TB

The Minimum requirement of Energy Measurement System and DR/Engineering System:

General: industrial grade, fanless system

Power supply: DC supply

Processor: i7 or above

RAM: Min. of 64GB.

Hard disk: 1TB

#### **4.1.1 HMI (Human Machine Interface):**

The VDU shall show overview diagrams (Single Line Diagrams) and complete details of the switchgear with a colour display. All event and alarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning

device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, decluttering etc.

#### **4.1.2 Visual Display Units:**

The contractor shall provide three display units, one for station HMI, one for redundant HMI and one for DR work station. These shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 29" diagonally in size and capable of colour graphic displays.

The display shall accommodate resolution of 1280 x 1024 pixels. The HMI shall be able to switch the key board and cursor positioning device, as unit among all the monitors at a consol vis push button or other controls.

#### **4.1.3 Printer:**

1 No. of Laser printer for A4 size shall be supplied. It shall be robust & suitable for 24\*7 operation.

The printer shall have in-built testing facility. Failure of the printer shall be indicated in the Station HMI. The printer shall have an off line mode selector switch to enable safe maintenance. The maintenance should be simple with provisions for ease of change of print head, ribbon changing, paper insertion etc.

The supplied printer shall be connected in the SAS network. Printer driver software shall be installed in all the systems supplied as part of SAS.

#### **4.1.4 Interconnection Cables & Wiring:**

The contractor shall provide all interconnecting wires, cables, connectors, terminations, local area network (LAN) cables and other wiring required by field devices and IED's including cabling required for interfacing with Marshalling Box.

#### **4.1.5 Switched Ethernet Communication Infrastructure:**

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS. The bidder shall keep provision of 50-100% spare capacity for employer use. Switch shall be provided to connect all IEDs bays of 220 KV, 110 KV/66 KV and 11kV yard to communication infrastructure.

### **4.2 Extendibility in future:**

Offered substation automation system shall be suitable for extension in future for additional bays indicated in SLD & additional 4 bays for each KV reference. During such requirement all the drawings and configurations, alarm/event list etc., displayed shall be designed in such a manner that its extension shall be easily performed by the employer. During such event,

normal operation of the existing substation shall be unaffected and system shall not require a shutdown. The contractor shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analog variable, alarm list, event list, modify interlocking logics etc., for additional bays / equipment which shall be added in future. There shall be provision for change of designation of bay as and when necessity arises.

## **5.0 Software structure:**

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance, modification or an extension of components of any feeder may not force a shutdown of the parts of the system which are not affected by the system adaptation.

### **5.1.1 Station level software**

#### **5.1.1.1 Human-machine interface (HMI)**

The base HMI software package for the operator station shall include the main SAS functions. The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and system configuration. The system shall be easy to use, to maintain and to adapt according to specific user requirements. Systems shall contain a library with standard functions and applications.

#### **5.1.2 Bay level software: System software:**

5.1.2.1 The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software along with hardware shall be capable of automatically synchronising with the remaining system. Without any manual interface. This shall be demonstrated by contractor during integrated system test.

#### **5.1.2.2 Application Software:**

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of library. The application software within the control/protection devices shall be programmed in a functional block language.

#### 5.1.2.3 **Network Management System:**

The contractor shall provide a network management system software for

following management functions:

- a. Configuration Management.
- b. Fault management.
- c. Performance Monitoring.

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR workstation and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any fault in the monitored devices. The NMS shall

- a) Maintain performance, resource usage and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.
- b) Maintain a graphical display of SAS connectivity and device status.
- c) Issue alarms when error conditions occurs.
- d) Provide facility to add and delete addresses and links.

5.1.2.4 The contractor shall provide each software in two copies in CD to load into the system in case of any problem related with Hardware communication etc.

#### 6.0 **TESTS:**

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 Ed1 & Ed2 (Site selectable) for EHV substation equipment installed in the control room and specified ambient conditions:

#### 6.1 Type Tests:

##### 6.1.1 Control IEDs and Communication Equipment:

##### 1) Power Input:

- 1. Auxiliary Voltage.
- ii. Current Circuits.
- iii. Voltage Circuits.
- iv. Indications.

**2) Accuracy Tests:**

- I. Operational Measured Values.
- II. Currents.
- III. Voltages.
- IV. Time resolution.

**3) Insulation Tests:**

- I. Dielectric Tests.
- II. Impulse Voltage withstand Test.

**4) Influencing Quantities.**

- I. Limits of operation.
- II. Permissible ripples
- III. Interruption of input voltage.

**5) Electromagnetic Compatibility Test:**

- I. 1 MHz burst disturbance test
- II. Electrostatic Discharge Test.
- III. Radiated Electromagnetic Field Disturbance Test.
- IV. Electrical Fast Transient Disturbance Test.
- V. Conducted Disturbances Tests induced by Radio Frequency Field.
- VI. Magnetic Field Test.
- VII. Emission (Radio Interference level) Test.
- VIII. Conducted Interference Test.

**6) Function Tests:**

- I. Indication
- II. Commands
- III. Measured Value Acquisition
- IV. Display Indications

**7) Environmental tests:**

- I. Cold Temperature.
- II. Dry Heat

- iii. Wet heat
- iv. Humidity (Damp Heat Cycle)
- v. Vibration
- vi. Bump.
- vii. Shock.

6.2      **Factory Acceptance Tests:**

The supplier shall submit a test specification for factory acceptance test (FAT)

and commissioning tests of the station automation system for approval. For the individual bay level IED's applicable type test certificates shall be submitted. The manufacturing phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab. If the FAT comprises only a certain portion of the system for practical reason, it has to be assured that this test configuration contains at least one unit of each and every type of equipment incorporated in the delivered system.

If the complete system consists of parts from various suppliers or some pans arc already installed on site, the F AT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT)

6.3      **Integrated Testing:**

The integrated system tests shall be performed as detailed in subsequent clauses as per the following configuration:

Redundant Station HMI, DR workstation with all IEDs & printers.

All other switches for complete substation as detailed in section project shall be simulated as needed:-

6.3.1 **Hardware Integration Tests:**

The hardware integration test shall be performed on the specified systems, to be used for Factory tests when the hardware has been installed in the Factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests.

6.3.2 **Integrated System Tests:**

Integrated System Tests shall verify the stability of the hardware and the software.

During the tests all functions shall run concurrently and all equipment shall operate a continuous 100 Hours period. The integrated system test shall ensure the SAS is free of improper interactions between software and hardware while the system is operating as a whole

6.4 **Field tests:**

The field tests shall completely verify all the features of SAS hardware and software

7.0 **SYSTEM OPERATION:**

7.1 **Substation Operation:**

7.1.1 **Normal Operation:**

Operation of the system by the operator from the remote RCC or at the substation shall take place via industry standard HMI (Human Machine Interface) subsystem consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse).

The coloured screen shall be divided into 3 fields:

1. Message field with display of present time and date.
- ii. Display field for single line diagrams.
- iii. Navigation bar with alarm/condition indication.



For display of alarm annunciation, lists of events etc., a separate HMI view mode shall be provided.

All operations shall be performed with mouse and/or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the command field (i.e., operator prompting) For control actions, the switchgear (i.e., circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys. The switching element

selected shall then appear on the background that shall be flashing in a different color. The operator prompting shall distinguish between:

Prompting of indications e.g., fault indications in the switchgear. and Prompting of operational sequences e.g., execution of switching operations.

The summary information displayed in the message field shall give a rapid display of alarm/message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described more fully.

Each operational sequence shall be divided into single operation steps, which are initiated by means of the function keys WINDOW command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicated by comments in the message field and must not be executed.

The offer shall include a comprehensive description of the system. The above operation shall also be possible via Windows based system by mouse.

## 8.0 **POWER SUPPLY:**

Power for the substation automation system shall be derived from substation 220 V DC system.

Inverter of suitable capacity shall be provided for station HMI and its peripheral devices e.g., printer etc. In the event of Power failure, necessary safeguard

software shall be built for proper shutdown and restart.

## 9.0 **DOCUMENTATION:**

The following documents shall be submitted for employer's approval during detailed engineering:

- a) System Architecture Drawing.
- b) Hardware Specification.
- c) Sizing Calculations of various components.
- d) Response Time Calculation.
- e) Functional Design Document.

Following documentation to be provided for the system in the course of the project shall be consistent, CAD supported and of similar look/feel. All CAD drawings to be provided in “dfx” format.

List of drawings.

Substation Automation System architecture.

Block Diagram.

Guaranteed Technical Parameters, Functional Design Specification and

Guaranteed availability and reliability.

Calculation for power supply dimensioning.

I/O Signal lists.

Schematic diagrams

List of Apparatus.

List of Labels.

Logic Diagram (hardware & software). -Panel

Panel layout drawing.

GA of and GTP.

Control Room Layout.

Test Specification for Factory Acceptance Test (FAT).

Product Manuals.

Assembly Drawing.

Operators Manual.

Complete documentation of implemented protocols between various elements.

Listing of software and loadable in CD ROM.

Other documents as may be required during detailed engineering.

Two sets of hard copy and Four sets of CD ROM containing all the as-built documents/drawings shall be provided to CEE (T&P) and to each of the consignee.

#### 10.0 TRAINING, SUPPORT SERVICES, MAINTENANCE AND SPARES:

##### 10.1 Training:

Contractor personnel who are, experienced instructors and who speak understandable English shall conduct training. The contractor shall arrange on his Own cost all hardware training platform required for successful training and understanding in India. The Contractor shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used to training. These materials shall be sent to Employer at least two months before the scheduled commencement of the particular training course. Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of Employer. Employer reserves the right to copy such materials, but for in-house training and use only. Hands-on training shall utilize equipment identical to that being supplied to Employer.

For all training courses, the travel (e.g., airfare) and per-diem expenses will be borne by the participants.

The Contractor shall quote training prices individually for each of the courses as indicated in Price Schedule.

Employer will have the option to cancel any or all-training courses. In the case of cancellation, the rate quoted against the respective course will not be paid to the Contractor.

The schedule, location and detailed contents of each course will be finalized

during Employer and Contractor discussions.

#### 10.2 **Computer System Hardware Course:**

A computer system hardware course shall be offered, but at the system level only.

The training course shall be designed to give Employer hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs and communicate with contract maintenance personnel. The following subjects shall be covered:

- a) System Hardware Overview: Configuration of the system hardware.
- b) Equipment Maintenance: Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, LAN's routers and printers, configuration of all the hardware equipment's.
- c) System Expansion: Techniques and procedures to expand and add equipment such as loggers, monitors and communication channels.
- d) System Maintenance: Theory of operation and maintenance of the redundant hardware configuration, fail over hardware, configuration control panels and failover switches. Maintenance of protective devices and power supplies.
- e) Subsystem Maintenance: Theory of design and operation, maintenance techniques and practices, diagnostic procedures and (where applicable) expansion techniques and procedures. Classes shall include hands-on training *for* the specific subsystems that are part of Employer's equipment or part of similarly designed and configured subsystems. Computing All interfaces to the computing equipment shall be taught in details
- f) Operational Training:: Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments.

This training shall be provided on Employer equipment or on similarly configured systems.

10.3

**Computer System Software Course:**

The Contractor shall provide a computer system software course that covers the following subjects:

- a) System Programming: Including all applicable programming languages and all stand-alone service and utility packages provided with the system. An introduction to software architecture. effect of tuning parameters (OS software, Network software, .database software etc.) on the performance of the system
- b) Operating System: Including the user aspects of the operating system, such as program loading and integrating procedures, scheduling, management, service and utility functions and system expansion techniques and procedures.
- c) System Initialization and Failover: Including design, theory of operation and practice.
- d) Diagnostics: Including the execution of diagnostic procedures and the interpretation of diagnostic outputs.
- e) Software Documentation: Orientation **in** the organization and use of system software documentation.
- f) Hands-on Training: One week with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.4

**Application Software Course:**

The Contractor shall provide comprehensive application software courses covering all applications including the database and display building course. The training shall include:

- a) Overview: Block diagrams of the application software and data flows.  
Programming standards and programme interface conventions.
- b) Application Functions: Functional capabilities, design and major algorithms.  
Associated maintenance and expansion techniques.

- c) Software Development: Techniques and conventions to be used for the preparation and integration of new software functions.
- d) Software Generation: Generation of application software from source code and associated software configuration control procedures.
- e) software Documentation: Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.
- f) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.5 **Requirement of training:**

The contractor shall provide training for two batches for two-weeks each for following courses:

| Sl. No. | Name of the Course       |
|---------|--------------------------|
| 1.      | Computer System Hardware |
| 2.      | Computer System Software |
| 3.      | Application Software     |

11.0 **MAINTENANCE RESPONSIBILITY:**

11.1

**Maintenance Responsibility during the Guaranteed Availability Period.** During Guaranteed availability period, the contractor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel spare parts, tools, test devices etc., for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational.

12.0 **RELIABILITY AND AVAILABILITY:**

The SAS shall be designed so that the failure of any single component, processor or device shall not render the system unavailable. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

- Mechanical and electrical design.
- Security against electrical interference (EMI)  
High quality components and boards.

Modular, well-tested hardware.

Thoroughly developed and tested modular software.

Easy-to-understand programming language for application programming.

Detailed graphical documentation and application software.

Built-in supervision and diagnostic functions.

Security

Experience of security requirements

Process know-how

Select before execute at operation

Process status representation as double indications

Distributed solution.

Independent units connected to the local area network Back-up functions

Panel design appropriate to the harsh electrical environment and ambient conditions.

Panel grounding immune against transient ground potential rise.

#### **Outage terms:**

##### 1) Outage:

The state in which substation automation system or a unit of SAS is unavailable for Normal Operation as defined in the clause 7.1 due to an event directly related to the SAS or unit of SAS. In the event, the owner has taken any equipment/system other than Substation Automation System for schedule-forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

2) Actual outage duration (AOD):

The time elapsed. in hours between the start and the end of an outage. The time shall be counted to the nearest 1/4th of an hour; Time less than 1/4th of an hour shall be counted as having duration of 1/4th of an hour.

3) Period Hours (PH):

The number of hours in the reporting period. In a full year the period hour are 8760h (8784h for a leap year).

4) Actual Outage hours (AOH):

The sum of actual outage duration within the reporting period

$$AOH = \sum AOD$$

5) Availability:

Each SAS shall have a total availability of 99.98% i.e., the ratio of total time duration minus the actual outage duration to total time duration.

12.1 **Guarantees Required:**

The availability for the complete SAS shall be guaranteed by the Contractor. Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total substation automation system as a Whole after commissioning of total substation automation system. The test shall verify the reliability and integrity of all sub-systems. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 1000 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test. the contractor shall rectify the problem and after rectification, the 1000 Hours period start after such rectification. If test object has not been met the test shall continue until the specified availability is achieved

The contractor has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability



criterion, the test is considered to be completed successfully. After that the system shall be taken over by the employer and then the guarantee period shall start.

13.0 SPARES :

13.1 Consumables:

All consumables such as paper, cartridges shall be supplied by the contractor till the SAS is taken over by the Owner.

13.2 **Availability Spares:**

The bidder is required to furnish the list of spares, which 'may be required for ensuring the guaranteed availability during the guaranteed availability period. The final list of spares shall form part of scope of supply and accordingly the price thereof shall be quoted by the bidder and shall be considered in the evaluation of the bids. During the guaranteed availability period. the spare parts supplied by the Contractor shall be made available to the contractor for usage subject to replenishment at the earliest. Thus, at the end of availability period the inventory of spares with the Employer shall be fully replenished by the Contractor. However, any additional spares required to meet the availability of the system (which are not a part of the above spares supplied by the contractor) would have to be supplied immediately by the Contractor free of cost to the Employer.

#### 14.0 **LIST OF EQUIPMENTS:**

Quantity of equipments shall be decided by bidder in order to achieve guaranteed reliability and availability as declared by bidder.

i. The SAS system List of equipment shall be as follows

1. Main Station HMI.
2. Redundant Station HMI (in Hot mode).
3. Engineering System.
4. Black & White Laser Printer - 1 No.
5. All interface equipment for gateway to RCC and RSCC.
6. Energy Measurement System
7. Data Concentrator Unit
8. Redundant Gateways
9. Firewall
10. Network cables and accessories

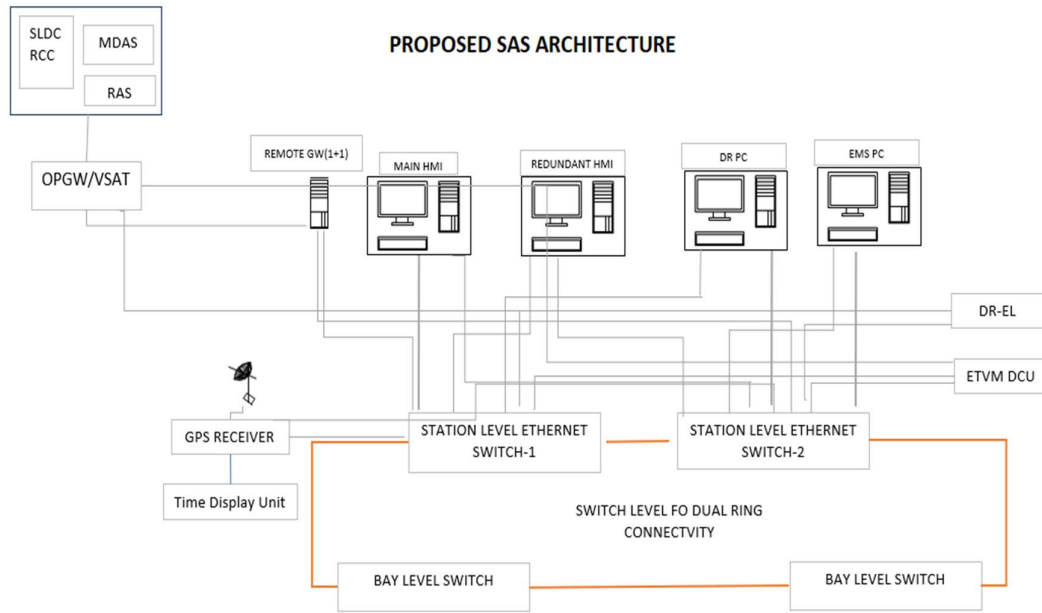
ii. Any other equipment as necessary.

**iii. Data concentrator Sync 3000** -for collection of DR from Numerical relays: The Data concentrator should collect the Disturbance Recordings from each numerical relays automatically and the data should be made available at existing RAS system (Remote DR System) of M/s Kalkitech in service at KPTCL SLDC, Bangalore. The required compatible software and hardware shall be provided including interfacing.

#### 15.0 **CYBER SECURITY COMPLIANCE:**

1. All systems in the SAS network shall have file integrity manager tool such that only whitelisted applications are allowed to run in the respective systems. This shall prevent any malicious executables in the system.
2. The offered SAS shall have comply with Applicable Global and Indian Security Standards, Guidelines, Notifications, and Regulations as listed below:
  - CEA (Cyber Security in Power Sector) Guidelines, 2021. Notification No. 12/34/2020-T&R of the Government of India / Bharat Sarkar Ministry of Power / Vidyut Mantra Laya (T&R Division) dated 8th June 2021 and 24th Dec 2021.
  - IEC 62443: Network and system security for industrial-process measurement and control.
  - IEC 62351: Power Systems Management and Associated Information Exchange - Data and Communications Security (all parts).
  - ISO 27001: Information security management.
  - IEEE 1686: IEEE standard for substation intelligent electronic Finalized devices (IEOs) cybersecurity capabilities.
  - NERC-CIP: Cybersecurity Regulation
3. The SAS architecture shall have the sufficient spare ports in the SAS EFS switch to connect the cyber security layer as depicted in proposed architecture

4. Supplier shall carry out OT Cyber audit from CERT-In empanelled cyber auditor. Any observations made during audit shall be addressed by SAS supplier before handing over the system.



**NOTES:**

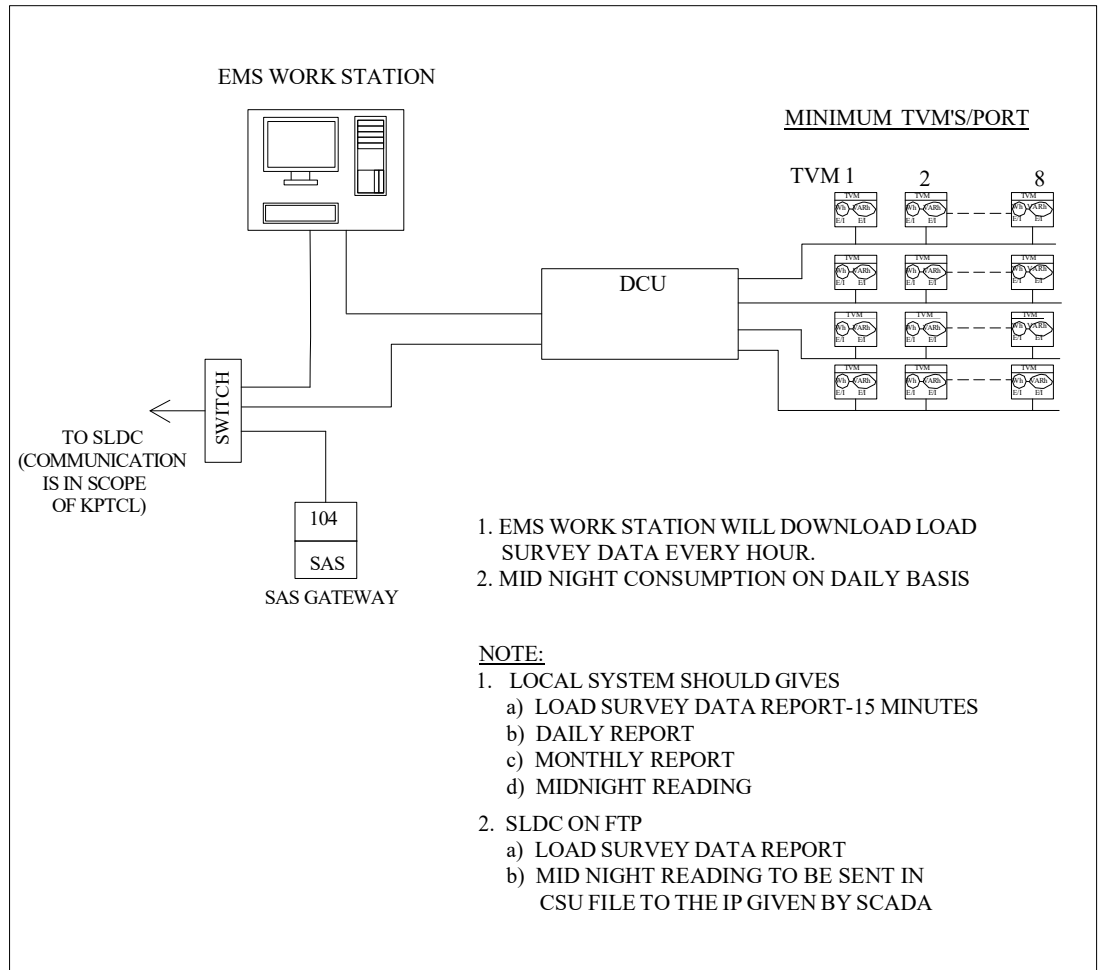
1. STATION BUS SHALL BE REALIZED BY HIGH SPEED REDUNDANT OPTICAL BUS USING INDUSTRIAL GRADE COMPONENTS AND SHALL BE AS PER IEC 61850 Ed1 & Ed2 (Site selectable).
2. IEDS FOR TWO BAYS MAY BE HOUSED IN ONE PANEL ALONG WITH ITS SWITCH.
3. ~~INSIDE THE SUB STATION, ALL CONNECTIONS SHALL BE REALIZED AS PER IEC 61850 Ed1~~
4. FOR GATEWAY, IT SHALL COMMUNICATE WITH REMOTE SUPERVISORY CONTROL CENTRE (RSCC), REMOTE CONTROL CENTRE (RCC) ON IEC 60870-5-104 PROTOCOL
5. THE ROUTER SHALL COMMUNICATE ON IEC 60870-5-104 PROTOCOL
6. THE PRINTER AS REQUIRED SHALL BE CONNECTED AT STATION BUS DIRECTLY & CAN BE MANAGED EITHER FROM STATION HMI, HMI VIEW NODE OR DISTURBANCE RECORDER WORK STATION.
7. All IEC 61850 ed1 & ed2 (Site selectable) COMPLIANT SIGNALS FROM VARIOUS MONITORING

EQUIPMENT/ACCESSORIES FROM TRANSFORMERS & REACTORS SHALL BE WIRED UPTO THE ETHERNET SWITCH.

**Note:**

1. The following Transformer and Reactors protection/control IEDs are provided, same shall be interfaced to the SAS and shall be shown in the Architecture drawing.
  - a. ITCS
  - b. On line DGA
  - c. Fiber optic temperature monitoring system.
  - d. On line drying system
2. System architecture shall be provided with dual redundant armoured fiber optic network.
3. The communication between substation to SLDC will be arranged by KPTCL. The data engineering has to be done by SAS supplier for integration into existing SLDC SCADA as per KPTCL requirements.
4. For all numerical relays confirming to IEC-61850 protocol necessary CID, ICD, PICS, MICS and PIXIT documents shall be provided in soft copy.
5. The SAS shall be suitable for extension in future for additional bays. The necessary software and hardware licenses shall be provided for additional bays. Minimum 50000 data points (tags) shall be provided.
6. Gateway shall be suitable for communicating minimum 4 numbers of remote control centers.
7. The DLMS TVM's are provided at all C&R panels. Suitable hardware and softwares shall be provided for integration to station SAS and remote SCADA.
8. The importing CID, ICD and other files from each of the IED's and interfacing with SAS is in the Bidders scope. Bidder shall import CID and ICD files from each of the IED's to the SAS. Complete programing of the SAS as per the approved scheme is to be done by the successful bidder.

## TYPICAL ARCHITECTURAL DRAWING OF ENERGY MEASUREMENT SYSTEM



**Basic Monitoring requirements are:**

- Switchgear status indication
- Measurements (U, I, P, Q, f)
- Event
- Alarm
- Winding temperature of transformers
- Ambient temperature
- Status and display of 415 V LT system, 220V & 48 VDC system.
- Status of display of Nitrogen injection Fire protection system and Air conditioning system.
- Acquisition of all counters in PLCC panels through potential free contacts from PLCC or independently by counting the receive/send commands, for 220 KV lines.
- Acquisition of alarm and fault record from protection relays
- Disturbance records for 220 KV lines.
- Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.
- Tap-position of transformer

**List of Inputs:**

The list of input for typical bays is as below:

**Analog inputs:**

- i) For line
  - Current R-phase
  - Y-phase
  - B-phase
  - Voltage R-Y phase
  - Y-B phase
  - B-R phase
- ii) For transformer
  - Current R-phase
  - Y-phase
  - B-phase
  - WTI (for transformer)

- OTI (for transformer)
- Tap position (for transformer only)
- iii) For bus coupler
  - Current R-phase
  - Y-phase
  - B-phase
- iv) Common
  - a) Voltage for Bus-I & Bus-II
    - Voltage R-Y phase
    - Y-B phase
    - B-R phase
  - b) Frequency for Bus-I & Bus-II.
  - c) Ambient temperature (switchyard).
  - d) LT system
    - i. Voltage R-Y, Y-B, B-R of Main Switchboard Section-I.
    - ii. Voltage R-Y, Y-B, B-R of Main Switchboard Section-II.
    - iii. Voltage R-Y, Y-B, B-R of Diesel Generator.
    - iv. Current from LT transformer-I.
    - v. Current from LT transformer-II.
    - vi. Current from Diesel Generator.
    - vii. Voltage of 220 V DCDB-I.
    - viii. Voltage of 220 V DCDB-II.
    - ix. Current from 220 V Battery Set-I.
    - x. Current from 220 V Battery Set-II.
    - xi. Current from 220 V Battery charger-I.
    - xii. Current from 220 V Battery charge-II.
    - xiii. Voltage of 48 V DCDB-I.
    - xiv. Voltage of 48 V DCDB-II.
    - xv. Current from 48 V Battery set-I.
    - xvi. Current from 48 V Battery set-II.
    - xvii. Current from 48 V Battery charger-I.
    - xviii. Current from 48 V Battery charger-II.

#### **Digital Inputs:**

The list of input for various bays/SYSTEM is as follows:



| Sl. No.   | Particulars                                       | 220 KV | 110/66 KV | BC |
|-----------|---|--------|-----------|----|
| <b>1.</b> | <b>Line bays:</b>                                 |        |           |    |
| i)        | Status of each pole of CB, Isolator, Earth switch |        |           |    |
| ii)       | CB trouble  |        |           |    |
| iii)      | CB operation/closing lockout                      |        |           |    |
| iv)       | Pole discrepancy optd.                            |        |           |    |
| v)        | Trip coil faulty TC1/TC2                          |        |           |    |
| vi)       | LBB optd  |        |           |    |
| vii)      | Bus bar protection trip relay optd.               |        |           |    |
| viii)     | Main bkr auto recloser operated                   |        |           |    |
| ix)       | A/R lockout                                       |        |           |    |
| x)        | Direct trip sent                                  |        |           |    |
| xi)       | Direct trip received                              |        |           |    |
| xii)      | Main-I/Backup blocking                            |        |           |    |
| xiii)     | Main-I/Backup Inter trip send                     |        |           |    |
| xiv)      | Main-I/Backup Inter trip received                 |        |           |    |
| xv)       | Fault Locator Faulty                              |        |           |    |
| xvi)      | Main VT Fuse fail                                 |        |           |    |
| xvii)     | Main Protn trip                                   |        |           |    |
| xviii)    | Back up protn trip                                |        |           |    |
| xix)      | Main PSB Alrm                                     |        |           |    |
| xx)       | Main softrip                                      |        |           |    |
| xxi)      | Main R-Phase trip                                 |        |           |    |
| xxii)     | Main Y-Phase trip                                 |        |           |    |
| xxiii)    | Main B-phase trip                                 |        |           |    |
| xxiv)     | Main Start  |        |           |    |
| xxv)      | Main Carrier aided trip                           |        |           |    |
| xxvi)     | Main fault in reverse direction                   |        |           |    |
| xxvii)    | Main Zone-2 trip                                  |        |           |    |
| xxviii)   | Main Zone-3 trip                                  |        |           |    |
| xxix)     | Main weak ends infeed                             |        |           |    |
| xxx)      | Main fault in reverse direction                   |        |           |    |
| xxxi)     | Back-up o/c optd                                  |        |           |    |
| xxxii)    | Back-up e/f optd                                  |        |           |    |
| xxxiii)   | 220 V DC-I/II source fail                         |        |           |    |
| xxxiv)    | Speech channel fail                               |        |           |    |
| xxxv)     | PLCC protection channel fail                      |        |           |    |

|                |   |               |                  |           |
|----------------|---|---------------|------------------|-----------|
| xxxvi)         | PLCC protection channel fail                      |               |                  |           |
| xxxvii)        | SF6 Gas Pressure Low                              |               |                  |           |
| <b>Sl. No.</b> | <b>Particulars</b>                                | <b>220 KV</b> | <b>110/66 KV</b> | <b>BC</b> |
| xxxvii         | Spares – 4 Nos                                    |               |                  |           |
| <b>2.</b>      | <b>Transformer bays: 100/150MVA Transformer</b>   |               |                  |           |
| i)             | Status of each pole of CB, Isolator, Earth switch |               |                  |           |
| ii)            | CB trouble  |               |                  |           |
| iii)           | CB operation/closing lockout                      |               |                  |           |
| iv)            | Pole discrepancy optd.                            |               |                  |           |
| v)             | Trip coil faulty                                  |               |                  |           |
| vi)            | LBB optd.   |               |                  |           |
| vii)           | Bus bar protn. trip relay optd                    |               |                  |           |
| viii)          | REF optd  |               |                  |           |
| ix)            | DIF optd  |               |                  |           |
| x)             | Over flux alarm (V)                               |               |                  |           |
| xi)            | Over flux trip (V)                                |               |                  |           |
| xii)           | HV Bus VT fuse (A)                                |               |                  |           |
| xiii)          | MV Bus VT Fuse (A)                                |               |                  |           |
| xiv)           | OTI Alarm/Trip                                    |               |                  |           |
| xv)            | PRD optd  |               |                  |           |
| xvi)           | Overload alarm                                    |               |                  |           |
| xvii)          | Bucholz trip                                      |               |                  |           |
| xviii)         | Bucholz Alarm                                     |               |                  |           |
| xix)           | OLTC oil surge relay alarm                        |               |                  |           |
| xx)            | OLTC oil surge relay trip                         |               |                  |           |
| xxi)           | Oil low alarm                                     |               |                  |           |
| xxii)          | Back-up o/c (HV) optd.                            |               |                  |           |
| xxiii)         | Back-up e/f (HV) optd                             |               |                  |           |
| xxiv)          | 220 V DC-I/II source fail                         |               |                  |           |
| xxv)           | Tap mismatch                                      |               |                  |           |
| xxvi)          | Back-up o/c (MV) optd                             |               |                  |           |
| xxvii)         | Back-up e/f (MV) optd                             |               |                  |           |
| xxviii)        | WTI Alaram/Trip                                   |               |                  |           |
| xxix)          | SF6 Gas Pressure low                              |               |                  |           |
| xxx)           | Spares 4 Nos.                                     |               |                  |           |
| <b>3.</b>      | Transformer bays – for others:                    |               |                  |           |
| i)             | Status of each pole of CB, Isolator, Earth switch |               |                  |           |

|         |   |        |               |    |
|---------|---|--------|---------------|----|
| ii)     | CB trouble                                      |        |               |    |
| iii)    | CB operation / closing lockout                  |        |               |    |
| iv)     | Pole discrepancy optd.                          |        |               |    |
| v)      | Trip coil faulty                                |        |               |    |
| Sl. No. | Particulars                                     | 220 KV | 110/<br>66 KV | BC |
| vi)     | LBB optd.                                       |        |               |    |
| vii)    | Bus bar protn. trip relay optd                  |        |               |    |
| viii)   | REF optd  |        |               |    |
| ix)     | DIF optd  |        |               |    |
| x)      | HV Bus VT fuse fail                             |        |               |    |
| xi)     | OTI Alarm / trip                                |        |               |    |
| xii)    | PRD optd  |        |               |    |
| xiii)   | Bucholz trip                                    |        |               |    |
| xiv)    | Bucholz alarm                                   |        |               |    |
| xv)     | Oil low alarm                                   |        |               |    |
| xvi)    | Back-up o/c HV optd                             |        |               |    |
| xvii)   | Back-up E/F HV optd                             |        |               |    |
| xviii)  | 220 V DC-I/II source fail                       |        |               |    |
| xix)    | Back up o/c LV operated                         |        |               |    |
| xx)     | Back up E/F LV operated                         |        |               |    |
| xxi)    | SF6 Gas Pressure low                            |        |               |    |
| xxii)   | Spares 4 Nos.                                   |        |               |    |
| 4.      | Bus-bar Protection:                             |        |               |    |
| i)      | Bus bar main-I trip                             |        |               |    |
| ii)     | Bus bar main-II trip                            |        |               |    |
| iii)    | Bus-bar zone-I CT open                          |        |               |    |
| iv)     | Bus-bar zone-II CT open                         |        |               |    |
| v)      | Bus protection relay fail                       |        |               |    |
| 5.      | Auxiliary system:                               |        |               |    |
| i)      | Incomer-I On/Off                                |        |               |    |
| ii)     | Incomer-II On/Off                               |        |               |    |
| iii)    | 415 V Bus-I/II U/V                              |        |               |    |
| iv)     | 415 V Bus coupler breaker on/off                |        |               |    |
| v)      | DG set bkr on/off                               |        |               |    |
| vi)     | Alarm/trip signals as listed in Section: DG Set |        |               |    |
| vii)    | PLCC exchange fail                              |        |               |    |
| viii)   | Time sync. Signal absent                        |        |               |    |

|      |  |  |  |  |
|------|--|--|--|--|
| ix)  | <b>Alarm/trip signals as listed in Section: Battery &amp; Battery charger</b>    |  |  |  |
| x)   | <b>220 V DC-I earth fault</b>  |  |  |  |
| xi)  | <b>220 V DC-II earth fault</b>   |  |  |  |
| xii) | <b>Alarm/ Nitrogen trip signals as listed in Section: Fire protection system</b> |  |  |  |

The exact number and description of digital inputs shall be as per detailed engineering requirement apart from the above mentioned digital inputs, minimum of 200 inputs shall be kept for KPTCL use in future.

## **ANNEXURE –SAS**

### **SCHEDULE OF REQUIREMENT FOR SUB-STATION AUTOMATION SYSTEM IN 220KV STATIONS**

#### **Particulars**

- 1) Station Human Machine Interface
- 2) Hot Stand by Station HMI.
- 3) Redundant managed switched Earth net Local area Network communication infrastructure including optic fibre cable etc., with hot stand by ( to RCC & RSCC)
- 4) Gate way (PC based) for remote control via industrial grade hardware through IEC 60870-5-104 protocol.
- 5) Peripheral equipment line printer display unit key Board mouse etc.,
- 6) System Software and Hardware for reliable operation of SAS in conformity with Technical specification.
- 7) Other accessories required for reliable operation of SAS as per Technical specification.
- 8) DR workstation.
- 9) EMS workstation with DLMS accessories including DCU.
- 10) Furniture's.
- 11) For all numerical relays conforming to IEC 61850 Ed1 & Ed2 (Site selectable) protocol necessary ICD, CID,PICS, MICS, PIXIT documents in soft copy.

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS OF SUB-STATION  
AUTOMATION

**GUARANTEED TECHNICAL PARTICULARS**

| <b>Sl. No.</b> | <b>Particulars</b>  |  |
|----------------|---|--|
| <b>A</b>       | <b>SUBSTATION AUTOMATION SYSTEM MASTER CONTROL UNIT OF HMI</b>  |  |
| a)             | Name and Country of Manufacture.  |  |
| b)             | Manufactures type and designation   |  |
| c)             | Memory capacity<br>i) Hard Disk<br>ii) RAM  |  |
|                | Operating system software type  |  |
| d)             | Type of drives provided   |  |
| e)             | Update time of<br>i) digital input<br>ii) Analog Input  |  |
| f)             | Response time for<br>i) Alarm Function<br>ii) Control Function  |  |
| g)             | Response time for<br>i) Alarm function<br>ii) Control function  |  |
| h)             | Whether semi of fully colour graphic type   |  |
| i)             | Total number of bay units which can be connected without effecting the response/update time of the system |  |
| j)             | Whether facility and hardware for transfer of data to remote sub-station motorized.                       |  |
| k)             | Communication protocol adopted for<br>i) Bay unit<br>ii) RSCC/LDC   |  |
| l)             | Applicable standard   |  |
| m)             | Type of auxiliary supply required   |  |
| n)             | Speed of data processing in instruction per sec.  |  |
| o)             | List of manufacture whose bay units can be connected to master unit without additional.                   |  |
| p)             | Whether equipment offered is of industrial grade  |  |
| q)             | All necessary software provided for proper functioning of the system as a whole.                          |  |
| r)             | List of all software provided   |  |
| s)             | Max. Possible distance return bay unit & master.  |  |
| t)             | Weight  |  |
| <b>Sl. No.</b> | <b>Particulars</b>  |  |
| u)             | Dimensions  |  |
| v)             | Power Consumption   |  |

|          |  |  |
|----------|--|--|
|          | aa) CPU  |  |
|          | ab) Processor speed  |  |
|          | ac) Hard disk  |  |
|          | a) Type<br>b) Capacity   |  |
|          | ad) Cache Memory<br>a) On Chip<br>b) On Board                              |  |
|          | ae) CommunicationPort  |  |
|          | af) VDU<br>a) Screen size<br>b) Resolution                                 |  |
| <b>B</b> | <b>BAY CONTROL UNIT</b>  |  |
|          | a) Name of Country of Manufacture  |  |
|          | b) Manufacturers type and designation                                      |  |
|          | c) Type of Mounting  |  |
|          | d) No. of bay control units offered  |  |
|          | e) Memory capacity   |  |
|          | f) Data Storage capacity   |  |
|          | g) Standard applicable   |  |
|          | h) Rated auxiliary voltage   |  |
|          | i) Rated frequency   |  |
|          | j) No. of binary inputs  |  |
|          | k) No. of outputs  |  |
|          | l) Language  |  |
|          | m) Type of Communication protocol  |  |
|          | n) No. & type of communication port  |  |
|          | o) Operation temperature range   |  |
|          | p) System response time  |  |
|          | q) (i) Exchange of display   |  |
|          | ii) Presentation of binary change  |  |
|          | iii) Presentation of analog change   |  |
|          | iv) Order to process output  |  |
|          | v) Order to update display   |  |
|          | vi) Report generation  |  |
|          | vii) Max. temperature<br>Max. Humidity                                     |  |
| r)       | Whether data is received on failure of unit. If yes, indicate the duration |  |

| <b>Sl. No.</b> | <b>Particulars</b>   |  |
|----------------|--|--|
| s)             | Speed of transmission between bay and Master control unit  |  |
| t)             | No. of inputs it can accommodate (specify voltage & current separately)<br>a) Digital  |  |
|                | b) Analog  |  |
| u)             | Resolution for digital inputs  |  |
| v)             | Update time of<br>a) analog inputs   |  |
|                | b) digital inputs  |  |
| w)             | Whether data processing is done in bay unit or master control unit.  |  |
| x)             | Power concentration  |  |
| y)             | Humidity   |  |
| z)             | Dimensions   |  |
| <b>C)</b>      | <b>KEYBOARD</b>  |  |
|                | i) Name & county of Manufacture<br>ii) Manufactures type & designation<br>a) Operation<br>b) Engineers.                        |  |
|                | iii) Whether standard or the numerical keyboard included in the programming terminal.  |  |
| <b>D)</b>      | Local Area Network LAN<br>1) Standard<br>2) Protocol<br>3) Communication Medium<br>4) Speed<br>5) Maximum distance             |  |
| <b>E)</b>      | Network Operating system   |  |
| <b>F)</b>      | SCADA Software<br>1) Supplies<br>2) Operating system<br>3) Facilities Provided (Full details to be enclosed in separate sheet) |  |



| <b>Sl. No.</b> | <b>Particulars</b>  |  |
|----------------|---|--|
| G)             | Printer <ul style="list-style-type: none"> <li>1) Colour Printer</li> <li>2) Manufacturer name</li> <li>3) Country of Manufacture</li> <li>4) Model type</li> <li>5) A3 and A4 size paper supplied</li> <li>6) Throughput rate</li> <li>7) Resolution</li> <li>8) Available data interface</li> <li>9) Print colour</li> <li>10) Max. Temperature</li> <li>11) Max. Humidity.</li> </ul>      |  |
| G(b)           | Alarm/Event Printer   |  |
|                | <ul style="list-style-type: none"> <li>1) Manufacturer name</li> <li>2) Country of Manufacture</li> <li>3) Model type</li> <li>4) Paper Size</li> <li>5) Paper Loading Facility</li> <li>6) Print head</li> <li>7) Throughput</li> <li>8) Resolution</li> <li>9) Available Data Interface</li> <li>10) Print Colour</li> <li>11) Max. temperature</li> <li>12) Max. Humidity (Rh.)</li> </ul> |  |

| Sl. No.     | Particulars  |               |
|-------------|--|---------------|
| <b>G(c)</b> | <b>SCANNER</b>   |               |
|             | 1) Manufacturer name<br>2) Country of Manufacture<br>3) Model type<br>4) Paper Size<br>5) Resolution<br>6) Available Data interface  |               |
| H           | Following information is attached separately with the bid<br>a) Type, Make and Model No. for each item/sub-item with relevant catalogues / descriptive information   | <b>Yes/No</b> |
|             | b) List of installation of similar Equipment now in service with contact   | <b>Yes/No</b> |
|             | Persons name and address   | <b>Yes/No</b> |
|             | Detailed drawing with dimensions of each equipment panel and interfaces  | <b>Yes/No</b> |
|             | Full functional description specific to project along with proposed Architecture/scheme enclosed   | <b>Yes/No</b> |
| I           | <b>SYSTEM SOFTWARE</b><br>1) Multitasking operating system<br>2) Background executive<br>3) File handling utility<br>4) Magnetic tape/disk data transfer utility<br>5) Online debugger<br>6) Object Module library utility<br>7) Report generator utility for display & Print<br>8) Communication utility<br>9) Graphic display generation utility<br>10) Online system backup capability<br>11) Test and Maintenance Programs (Diagnostic software)<br>12) System generation at site<br>13) Data base utility<br>14) Data acquisition, processing and alarm monitoring/reporting<br>15) Communication<br>16) Operator interface (MMI)<br>17) Network Operating system<br>18) Utilities like debugging and software downloading<br>19) Mathematical and logic function |               |

| Sl. No. | Particulars   |         |
|---------|---|---------|
| II      | PROCESS SOFTWARE  |         |
|         | 1) Plant data base<br>2) Control software<br>3) Graphic display with points assignment<br>4) Logs or reports with points assignment<br>5) Software for communication with external computer system<br>6) Relay setting software<br>7) Any other software. |         |
|         | Note: Bidder shall supplement information in this Data Sheet with a write up on each topic  |         |
|         | CPU<br>Processing capacity<br>Word Length<br>Programmable real time clock   | Yes/No. |
|         | Watch dog timer   | Yes/No. |
|         | Auto Restart  | Yes/No  |
|         | Time synchronization  | Yes/No  |
|         | PROCESS INPUT SYSTEM  |         |
|         | No. of high resolution inputs   |         |

#### Cyber security:

- All systems in the SAS network must have file integrity manager tool such that only whitelisted applications are allowed to run in the respective systems. This shall prevent any malicious executables in the system.
- The offered SAS shall have comply with Applicable Global and Indian Security Standards, Guidelines, Notifications, and Regulations as listed below:
  - CEA (Cyber Security in Power Sector) Guidelines, 2021. Notification No. 12/34/2020-T&R of the Government of India / Bharat Sarkar Ministry of Power / Vidyut Mantra Laya (T&R Division) dated 8th June 2021 and 24th Dec 2021.
  - IEC 62443: Network and system security for industrial-process measurement and control.
  - IEC 62351: Power Systems Management and Associated Information Exchange - Data and Communications Security (all parts).
  - ISO 27001: Information security management.
  - IEEE 1686: IEEE standard for substation intelligent electronic Finalized devices (IEOs) cybersecurity capabilities.
  - NERC-CIP: Cybersecurity Regulation
- Supplier shall carry out OT Cyber audit from CERT-In empanelled cyber auditor. Any observations made during audit shall be addressed by SAS supplier before handing over the system.