

PART 2: EMPLOYER'S REQUIREMENTS

CHAPTER 12B: SCADA-TECHNICAL SPECIFICATIONS

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12. SCADA (CONTROL AND MONITORING)

12.1 Technical Requirements of SCADA System

12.1.1 Generals

- 12.1.1.1 The SCADA system shall be constructed with modern techniques in accordance with internationally recognized standards and designed for safe and efficient operation. All materials and equipment to be supplied shall be of a proven design and shall have reference installation in India or Abroad specifically in railway traction power control applications.
- 12.1.1.2 The SCADA software architecture should be modular, and it should be possible to upgrade it to the newer versions of Windows/LINUX as operating systems.
- 12.1.1.3 The SCADA system at control centres shall supervise, control and acquire the various specified data from the 'Controlled Stations' along the Line, such as Receiving Substations (incl. Auxiliary Main Substation & Traction Substation), Auxiliary Substations, 25 kV Traction Network and 33 kV Auxiliary Network, Stations, 25 kV Traction Switching Stations (SP, SS, SSP, FP, etc.) along the Line, Depot etc.
- 12.1.1.4 All the RTU's and RSS Gateway in the corridors 2 and corridor 4 shall communicate with SCADA Servers at OCC and BCC over SCADA dedicated/ dark FO network on IEC 60870-5-104 protocol through OFC backbone network to be provided by designated Telecom contractor.

12.2 SCADA SOFTWARE REQUIREMENT

Proposed SCADA software shall be completely tested and verified and as approved by Engineer in charge prior installation at site.

All software media shall be clearly labelled with the programmer's name, date of issue and issue status. All software details and information shall be contained and listed in the equipment operating and maintenance manuals.

The SCADA software shall be supplied on a non-volatile removable storage medium such as optical disk, etc. (magnetic discs or any other type of exposed media shall not be used). Three Copies of the SCADA software, including all the supporting documentation, manuals etc. shall be provided to the Employer in accordance with the General Conditions of Contract. Further copies shall be retained and archived to support the software maintenance.

SCADA software shall be written and presented in accordance with the latest issue of an internationally recognized standard. The SCADA software shall be written and documented to ensure that changes to any SCADA facilities and operating procedures shall be easily implemented by the operating personnel once they have successfully completed the software training course.

The technical features of the SCADA software shall meet the following minimum technical features:

12.2.1 Acquisition of measurands

- a) The SCADA system shall be capable of acquiring measurands i.e. analogue inputs from the RTUs including transients.
- b) Software shall have capability for Analogue value scaling, processing and conversion to engineering values, limit settings of parameters.
- c) Software shall be fully configurable to analyse the analogue data received from RTU e.g. energy parameters (active, reactive and apparent power & energy), voltage, current and power factor in the form of displays (graphs as well as tabular), trends, alarms to operator in case of set limit violations and historical interpretations.
- d) Software shall also be able to analyse the transient analogue data for detection of faults and their corrective measures
- e) There shall be facility to transfer the data to spreadsheet applications like MS- Excel in .xml

formats.

12.2.2 Acquisition of tele signals

- a) The software shall support the acquisition of tele-signals (bi-state devices) for each RTU.
- b) There shall be dependent and independent points in the power supply system. For example, if a feeder Circuit Breaker Trips, there shall be associated tele- signals for catenary and 230 V AC fail. All such events shall be reported by RTU to OCC/BCC with time stamp.

12.2.3 Execution of tele-commands

- a) The Software shall be capable of issuing tele-commands to open or close a switching device. All the commands shall follow select – check – execute and report back execution procedure.
- b) Operator shall be able to cut off power to a sub-sector by selecting it and giving the command. The system shall open all the associated switching devices automatically in appropriate order with confirmation for each device as an event.
- c) Option to abort a command shall be available with the operator before giving the confirmation.
- d) All the operator commands shall be logged as events (along with operator ID and device ID indicating the identity of power controller and workstation/server from which the operator has executed the command) after a control command is issued by the operator, and if the command is not executed, then a message shall be displayed indicating reason(s) for it.
- e) The tele-command once selected, if not sent to RTU due to communication failure or otherwise, shall be aborted after a predefined period and shall not remain in queue.

12.2.4 Process Displays

- a) The SCADA software shall support flexible process displays for continuous & effective monitoring at OCC & BCC for the RSS, Depot, Traction & Auxiliary Power equipment on the power supply network of the BI-RIDE Rail Project.
- b) The process display feature shall facilitate depiction of Single Line Diagrams with flexible choice of colors for the process objects and backgrounds. The Process Displays shall support zooming & panning facility. The process display features shall be flexible enough to build the complete Traction network and the auxiliary network as a single Display with facility to navigate using mouse from one end of the network to the other. It shall also be possible to zoom portions for picture for getting a magnified view of the Single Line Diagram.

12.2.5 Alarm Management

- 12.2.5.1 Alarm Management System to alert Power Controllers & maintenance staff during equipment malfunctions or any other system alarms likely to cause disruption to operation of the railways. The alarm management function shall support:

- a) Two types of Alarm List templates
- b) User friendly filters, Alarm List setting tool for colors and text layout
- c) Updating / frozen presentation modes
- d) Alarm acknowledgement, Alarm reset function
- e) Authorization support
- f) Help in all dialogs
- g) Visible Alarm Class
- h) Locate Object
- i) Column sort, Find, Fields indicating the number of active and unacknowledged alarms
- j) Field indicating the use of filters
- k) Field indicating the current presentation mode
- l) Current / total page number indication on both lists
- m) Export of selected alarms or all rows available in the online alarm database or only visible

rows in the view to excel or csv file for reporting function.

12.2.6 Event Logging System

12.2.6.1 Event Logging System for displaying and logging sequence of event recording with 1 millisecond resolution for the various field inputs configured at the RTU. The Event List contains the following features and options:

- a) Historical storage of events with facility to retrieve the same later
- b) Configurable layout: columns, fonts, toolbars, colouring and so on
- c) Configurable colouring of events
- d) Configurable scrolling behaviour
- e) Configurable presentation modes: log / event order, latest at top / bottom
- f) Updating / frozen presentation modes
- g) Easy navigation through scrolling, go to date, time filters and so on
- h) Extensive filtering that can be stored and easily called up later
- i) Multiple station/device/bay filtering to filter out more than one location/feeder simultaneously
- j) Find, sorting by column, copy / paste of events to other windows applications
- k) Printouts
- l) Commenting of events by Power Controllers
- m) Events logged in SCADA shall neither editable nor erasable.
- n) Event text shall be configurable as per requirement and not fixed/system defined.
- o) Export of selected event logs or all rows available in the online event database or only visible rows in the view to excel or csv file for reporting function.
- p) All events shall be accessible to operator. The deletion of events shall not be random in case of exhaustion of system capacity. It shall be First In First Out (FIFO) to retain latest events. However, all the events of SCADA shall be available in archive and backup system.

12.2.7 SCADA Software configuration

12.2.7.1 The software shall provide menu driven and user-friendly configuration. The configuration shall define the various devices, their attributes and the traction system specific details. The configuration of the software shall be carried out to cover all details/address/nodes of traction supply operation e.g. Interlocking, locked out signals, protection relays & elements, alarms with attributes, power blocks, parameter settings and display/picture screen properties etc.

12.2.8 Test Procedure & Diagnostics

- a) The software shall support basic test procedure and diagnostic checks for RTU as per IEC 60870-5-104 & basic standards of IEC 60870-5 series. As in IEC 60870-5-104, there is no periodic polling for Class1/Class2 event from the master and all events shall be reported by exception from the RTU. The only periodic poll from the master shall be the general interrogation, at intervals not exceeding 10 minutes. Apart from this, master shall send a TESTFR packet 10- 15 seconds, to check the health of the RTU and communication media.
- b) SCADA application software shall have minimum following inherent features to check its own sub functions and report status to the operator:
 - Operating Status & Online (Hot /standby /offline state) of SCADA server/communication front ends.
 - State of all RTUs.
 - State of printers.
 - Connection & Operating status of all the operator workstations.
 - Diagnostics shall use standard OS tools to be provided as part of the administrator tools.

12.2.9 Communication Failures

- 12.2.9.1 Time out of the RTU and the cyclic redundancy check (CRC) errors shall be progressively counted and displayed in a tabular report as "Communication failures" for each RTU. The tabular report shall be generated at 04:00hrs every day for the preceding calendar day of 24 hours.

12.2.10 Hot-Standby Redundancy**12.2.10.1 Switch over to hot-standby systems**

- Hot standby systems shall be designed to improve the reliability of SCADA system by having back-up machines that automatically takes over when the primary fails.
- The standby systems for the main server shall ensure that there will be no loss of data, alarms, event etc. due to the failure of primary server and data shall be updated normally after the failure occurs.
- In the event of failure of primary server, the system shall ensure that the standby server computer system automatically takes over including the data acquisition and the communication with RTUs over the existing channels. In any case the changeover from main to standby computer shall not take more than 30 secs from the point of view of SCADA system working. The failure of primary server shall be displayed on all HMI's along with suitable alarm indication.
- The system shall be configured on dual Ethernet LAN wherein each computer and server shall have two LAN interfaces. From each computer, one LAN interface shall be connected to first network switch and the second interface to the other switch. After achieving this connectivity, it shall be ensured that any failure of one LAN interface of computer, any one LAN wire, any one LAN switch shall not cause permanent break in LAN connection between any two machines. In any such condition, the system shall be able to restore alternate LAN route within 30 seconds. None of the equipment shall be declared offline/disconnected during LAN failure. Server hot standby switch over shall not be initiated due to a single LAN card failure.

12.2.11 Data logging and Reports generation:

- a) All alarms and events shall be logged by the system. Average, minimum & maximum values of selected analogue parameters shall be stored. The duration of this logging shall be settable and logged data shall be stored automatically with date and time stamp in a file. The software shall be capable of generating different types of reports.
- b) Some of the reports which may be required are: -
 - Summary of circuit breaker's tripping during a specified period including the relay(s) which caused the tripping
 - Power block availed report
 - Event and their durations during the month when the voltage went beyond permissible levels at the RSS, ASS and Traction system respectively, & parameters of excesses. Duration during the month when the current exceeded nominal full load capacity of the transformer
 - Energy data interpretation, MD violation.
 - Morning reports of all the abnormal incidences in the last 24 hours.

12.2.12 Tabular displays, Current & Historical trends diagrams/ graphs:

- a) The software shall be capable of providing tabular display of data of a controlled station e.g. equipment status, alarms and measurands.
- b) The time versus value plot of measurands in a separate colour including the arithmetic values on

the measurands such as multiplication shall be displayed in a trend diagram. The trending shall include both historical trending and dynamic trending of current data.

- c) The dynamic (current values) trending shall update at an interval of 2-10 seconds and shall be logged for 24 hours. For historical trend, average value of data shall be logged at the interval of 5 min duration.
- d) It shall be possible to store historical data for a period of 1 year.
- e) However, all data shall be accessible from the main screen of operator workstation.

12.2.13 Measurement Reports

The SCADA software shall support configuration of time related measurement reports as detailed in Chapter 12A Clause 12.12.9.3.

12.2.14 Printers

The SCADA software shall support a minimum of four data-logging laser printers connected on SCADA LAN. It shall be possible to display status of each printer in SCADA.

12.2.15 Help functions

On-line help and tutoring guide shall be provided for all major functions in the HMI using the HELP option. The help option shall guide the operator for any specific help for carrying out certain tasks.

12.2.16 Safety Tagging

- a) Tagging facility with addition of note marker shall be provided on each item / equipment for operator to put his comment and inhibit the command for that equipment.
- b) Note marker shall be possible for any alarms, equipment status including manually operated isolators, measurands and limit-settings, through keyboard.
- c) This note shall be saved even on the condition of change over and change of operator.
- d) The operator shall be able to give some specific instructions to the shift operator using this functionality.
- e) This shall be logged in the event list with date & time, operator Id who is putting or deleting the note and that particular equipment Id.
- f) After this note has been enabled, issuing of command shall not be possible from any operator or other control rooms until this note has been over-ridden by the chief SCADA operator.
- g) The note shall not be lost on system restart or any such scenario.
- h) Tag can appear near to any breaker/device symbol. Tagging facility should be configurable for multiple states of an equipment such as L/R Status, MTR Status etc. Upon resetting of the status tag should automatically disappear.

12.2.17 Breaker Operation Counter

The system shall monitor operation counter of the breakers. The operation counter shall segregate normal operations and fault tripping after analysing the associated trip relay data. It shall generate alarms after a predefined limit of normal & fault operations is reached.

12.2.18 Block/Un-block control for devices

Facility shall be provided to block / un-block a control point (circuit breaker, interrupter and other controllable equipment or a set of controlled equipment at the controlled station). The block or unblock command shall disable/enable control operations from the OCC. The blocked condition of any equipment or a set of equipment shall be suitably indicated on the monitor. It shall also be possible to block/ un-block the control/update/event/alarm of an individual signal or I/O point of any controlled equipment of the installation or complete device.

12.2.19 Blocking List

The SCADA software shall support feature of Blocking List which shall depict the prevailing blocking status of update, Control, Alarm and event for the various data base points along with the name of the Signal text used in the SCADA system.

12.2.20 Screen Design & Real Time Display

- a) The MMI screen shall generally comprise of title bar, menu bar, tool bars, status bars etc. for real time depiction & control of traction power system. This interface shall provide for all interactions between the operator and the SCADA system.
- b) The MMI shall have features for alerting the operator with audio/visual supports on occurrence of critical alarms and events.
- c) Full graphic, coloured displays of controlled stations shall be provided by the software. The display shall include ON/OFF status of equipment, (such as feeder CB trip, AC and DC voltage fail/low, RTU fail, communication fail, machine down etc.), alarms, measurands and names of the controlled stations.
- d) There shall be facility for viewing display of full section, suitably condensed to fit screen size. This condensed picture shall be displayed on the MMI when called by the operator. Condensed diagram shall have fewer details as compared to the normal display but operator shall be able to control any of the devices and accept / acknowledge any alarm. The display shall support decluttering, zooming and panning through mouse.

12.2.21 Bus Bar Colouring

- a) The SCADA software proposed shall support necessary busbar colouring feature by which the dynamic status of the busbar can be depicted during charged and dead (discharged) conditions.
- b) The bus bar colouring shall be provided for the overall feeding scheme, 33kV distribution scheme, ASS overview diagram, 25 kV Traction Overview Diagram, RSS, depot etc.
- c) Earthed equipment, blocked equipment, faulty equipment, faulty status, communication failures shall be displayed in separate colors.
- d) The colouring shall be provided on all screens (overview / individual or sub- picture) at all the times.
- e) It shall be possible to give a specific colour to any section based on an intelligent rule.

12.2.22 User interface and Data Engineering Tool

The user interface and data engineering tool shall provide minimum of following functions:

- a) Easy linking of station and network pictures with the SCADA data as a part of data engineering function.
- b) Drag and drop support for linking to database and pictures.
- c) Easy addition or deletion of any equipment, signals or complete station RTU etc. in the user interface SCADA views without upgrading the software by employer's maintenance staff or OEM personnel.

12.2.23 Playback Option

The SCADA Software shall have a feature of playback option which can be used to check the sequence of operations performed, if required.

Playback function shall involve recording of data into the history and play it back, starting from some given time and advancing at various speeds. In the playback mode the user sees the system in the same manner that the normal "live" operator can see it: they can look at any screen and they will appear as they would if viewed at the same time in history. The only difference is an annotation on the screen showing that it is operating in playback mode. It shall be possible to playback the stored data of last one week.

This permit post-mortem analysis of the information that was available to the operators (and their responses). It is also useful for capturing "scenarios" for training and analysis purposes.

12.3 Remote Terminal Unit (RTU)

12.3.1 Hardware Requirement

The RTU at each elevated, underground station ASS and Depot shall have as a minimum following configuration:

- 12.3.1.1 The Central processing unit shall have 32-bit microprocessor and shall have a dedicated peripheral bus controller for handling the IO functions. The CPU should have minimum 256 MB of RAM and SD Flash Memory to store RTU parameterization data & events storage (minimum 2000 events) in the event of a SCADA communication failure to store archived data. RTU shall have an internal clock with ≤ 50 ppm accuracy. The CPU module shall have non-volatile memory.
- 12.3.1.2 Dual redundant CPU modules shall be provided with hot-standby configuration. Operating status and Hot-standby status of each CPU module shall be monitored at OCC/BCC.
- 12.3.1.3 RTU shall communicate with various peripherals. The RTUs shall support the following serial & ethernet ports requirements:
 - a) It shall have necessary communication ports for communication with at least 4 (four) control centres over IEC 60870-5-104 protocol.
 - b) It shall have min. 4 nos. of 10/100 Base T Ethernet Ports (each CPU module with 2 nos. of 10/100 Base T Ethernet Ports) for communication with OCC/BCC over IEC 60870-5-104 protocol.
 - c) It shall have necessary communication ports for communication with numerical relays/IEDs on IEC 61850 protocol with provision of redundant ports and redundant communication modules. Redundancy in relay communication port and relay communication module shall ensure that the failure of single relay communication port or single relay communication module shall not affect the transmission of relay signals to OCC/BCC.

- d) It shall support data acquisition from Energy meters on MODBUS protocol.
- e) The RTU shall have one HMI port which can be used for local configuration purpose.
- f) The RTU shall be provided with necessary Ethernet Port for interfacing with the SCADA Ethernet Switches & Telecom equipment which will be installed at Telecom Equipment Room (TER) at each station by the Telecom Contractor. Necessary communication interface and connection equipment between TER and the SCADA RTU shall be under the Scope of the SCADA Contractor.
- g) The OFC cables, converter or any other equipment required for terminating at the Telecom equipment would be in the Scope of the SCADA Contractor.

12.3.1.4 There shall be three types of I/O Modules connected to CPU:

12.3.1.4.1 Digital Input Modules: It shall have 16 optically isolated channels per modules and shall support time stamping with time resolution of 1 ms with buffering up to 3 changes. The digital input module shall support configuration of inputs for the Single Indications, Double Indications & Digital Measurements. The digital input module shall support the programmable parameters like

- a) Bounce Filter (Suppression Time),
- b) settling time for reliable digital measurand value,
- c) chatter suppression,
- d) suppression of intermediate position,
- e) Configurable with / without time tagging and configurability of message transmission priority.
- f) The digital input module shall also have the feature of indication processing of
 - group or common alarms shall be configurable from individual alarms by Boolean operations,
 - acquisition of events in chronological order with a time resolution of 1 msec and
 - buffering up to 3 changes per input.

12.3.1.4.2 Analogue Input Modules: Analogue input modules shall have 8 channels per modules and shall support 16-bit A/D conversion. It shall support unipolar and bipolar measured values with accuracy $\leq 0.1\%$ of full scale. Input shall be 4 to 20 mA bipolar or live zero. They shall also support programmable parameters like

- a) live zero conversion coefficient,
- b) cyclic transmission or threshold value,
- c) forced zero point conversion coefficient,
- d) limit values,
- e) smoothing factor,
- f) threshold values,
- g) cyclic duration and
- h) Priority of transmission.

12.3.1.4.3 Digital Output Modules: The Digital Output module shall support a minimum of 16 digital output channels per module. The output module shall support features like

- a) select before execute,
- b) priority of transmission,

- c) cyclic duration,
- d) release disconnection delay time at response indications and
- e) Duration of output pulse.

- 12.3.1.5 The Power supply unit (PSU) shall have suitable EMI filters capable of filtering all switching surges, electrical noise and high frequency transients. The power supply unit/DC-DC convertor of RTU shall have internal protections against voltage overload and short circuits in addition to adequate protection against surges. The Power supply unit (PSU) shall accept universal input supply (i.e. both AC/DC supply as input voltage).
- 12.3.1.6 There shall be a facility of remote programming for remote download of database for configuration or any modification purposes at OCC/BCC (under password control).
- 12.3.1.7 The critical components of RTU's like CPU card, Power Supply card, Communication card, Power Supply Converter, networking switch, Communication Interface module for I/O racks/extension racks etc. shall be provided with dual redundant configuration. In case of failure of any modules like PSU/CPU/Communication module the redundant module will immediately take over without interrupting full functionality of SCADA and alarm of the failed module shall be generated in the OCC/BCC and logged as event also. Only one set of I/O modules shall be provided. The I/O modules shall be Hot-swappable.
- 12.3.1.8 One overview picture shall be developed in SCADA to show the status of CPU module, Communication module, Power supply modules and each I/O module at OCC/BCC. Failure of any module shall be communicated to OCC/BCC so that timely rectification can be done. An alarm of the failed module shall be generated in the OCC and logged as event also.
- 12.3.1.9 RTU panel door status (open/close) shall also be communicated to OCC SCADA system. An alarm shall be generated in the OCC if panel door is opened and logged as event also.
- 12.3.1.10 Status of Relay communication shall be provided at OCC/BCC. All local reset provisions of relay shall be provided in OCC/BCC also for rapid restoration during tripping. The sequence of relay events logged in SCADA should be as per the actual sequence of relay operation. Status of relay signals should remain updated on CPU changeover.
- 12.3.1.11 RTU modules like CPU module, Communication module, I/O modules, Power supply modules, Diode coupler, Ethernet Switch etc. shall be provided with inbuilt LED indicators to monitor at RTU level the healthiness status, any fault status, error status, communication fault status, hot-standby status of respective module, signal status on individual channel of each I/O module, individual communication port/link status of respective networking switches etc. The RTU shall have self-diagnostic feature for fault conditions.
- 12.3.1.12 All cards/modules of RTU shall be conformal coated and tested as per IEC 61086- 1,2,3. Class-2 conformal coating shall be provided for high reliability.

12.3.2 Communication Requirement

- 12.3.2.1 All the RTUs shall be linked to the OCC as well as to the BCC. The RTUs shall have provision for direct communication over 10/100Mbps LAN and RTUs shall support minimum four (4) communication ports. Connectivity to a third control centre in future shall be possible.
- 12.3.2.2 All the RTUs shall have dual – redundant managed ethernet switches for communicating to OCC/BCC over SCADA dedicated/ dark FO network through redundant FO communication backbone system.
- 12.3.2.3 RTU shall support communication over following protocols:
- a) IEC 60870-5-104 for communication with Control Centre.
 - b) IEC 61850 for communication with Relays/IEDs.
 - c) MODBUS for communication with Energy Meters.
 - d) Proposed RTU shall also support IEC 60870-5-103 Protocol for communication with Relays/IEDs if required.

12.3.3 Functional Requirement

- 12.3.3.1 RTUs shall be intelligent, fully autonomous in operation and modular in construction. Remote terminal units shall be configured to suit the input/output requirements of the selected equipment they are connected to.
- 12.3.3.2 RTUs shall be suitable for floor mounting and shall be suitably robust. Remote terminal units shall be, as far as possible, of the same make and type and individual components shall be interchangeable between remote terminal units.
- 12.3.3.3 Remote terminal units shall be capable of being fully interrogated or reconfigured from portable test equipment.
- 12.3.3.4 It shall be possible to disable a RTU locally to allow maintenance or reconfiguring of the remote terminal unit without affecting other parts of the SCADA system. When disabled or enabled, a change of status condition shall be recorded as an event in SCADA system.
- 12.3.3.5 RTUs shall operate correctly in conjunction with independent safety systems, such as hardwired safety circuits for over temperature trips, over pressure trips, electrical interlocks on equipment, etc. Neither normal operation nor failure of the SCADA equipment connected to such systems shall prevent the correct and timely operation of such systems.
- 12.3.3.6 The memory of the RTUs shall be sized, in addition to holding all necessary programs and data, to store up to 2000 data points/events in the event of a SCADA communications failure. Operation of the remote terminal units or any other part of the SCADA system shall not be adversely affected as memory utilization increases to the maximum. These events could be retrieved locally at RTU level whenever required for analysis. Provision of software required for retrieving is included in the scope of SCADA contractor. These events shall be transferred to OCC automatically upon restoration of SCADA communication.
- 12.3.3.7 All recorded events shall be tagged with the date, real time, in hours, minutes and seconds, and milliseconds for high resolution events, and location of the event. The data shall be stored on non-volatile read-write memory, in a first in first out (FIFO) manner, such that the data shall overwrite the earlier recorded data. Access to stored data in a RTU shall be restricted by means of security codes/password. Portable computer based plug-in devices shall be provided to read and evaluate

stored data. Such reading process shall not erase or corrupt stored data.

- 12.3.3.8 RTUs shall be provided with a clock which shall support time synchronization from SCADA servers via periodically initiated synchronization messages over IEC 60870- 5-104 communication protocol. The SCADA system shall also initiate time synchronization messages when the communication with the RTU is restored after a communication failure. RTUs shall be provided with dedicated back-up power for the clock, so that in the event of a RTU suffering a power failure, the clock shall keep updating the time.
- 12.3.3.9 The RTU has to program for several logic functions which are required for the rail power supply distribution application. Hence the RTUs offered shall support PLC programming facility as per IEC 61131-3 standards. Necessary programming tool shall be offered.
- 12.3.3.10 RTUs shall be compatible with the input/output signals from selected equipment. Power supplies contained within the remote terminal unit shall be available for the interrogation of volt-free contacts of the selected equipment.
- 12.3.3.11 Each RTU shall be supplied complete with 20% spare I/O signals capacity or min. 1 spare card of each type complete with RTU internal wiring and termination for handling additional input, output and analogue signals. Expansion by at least 50% of the initial capacity shall be possible simply by adding more input/output modules and reconfiguring the software.

12.3.4 Environment Condition

- 12.3.4.1 The RTU hardware shall specifically meet the environmental condition of Bangalore region and in general follow environmental requirements:
 - a) EMC Immunity: As per IEC 60870-2-1 Level 3 or 4
 - b) EMC Emission: As per IEC 60870-2-1 Class A
 - c) Temperature: -10 to 55 deg C as per IEC 60870-2-2
 - d) Humidity: 5 to 95% as per IEC 60870-2-2

12.3.5 RTU Panel

- 12.3.5.1 The RTU panel shall be of IP54 protections class and shall comply with EMC Immunity and emission as per IEC 60870-2-1.
- 12.3.5.2 The RTU panel which houses RTU hardware mainly consisting of the CPU & IO racks and power supplies, switches, interface converters etc. All panels shall provide enough space to house main and redundant components and shall be of IP54 protection class or higher for indoor panels and of IP65 protection class or higher for outdoor ones with a canopy on the top. For outdoor applications, the RTU exterior shall be epoxy based polyester powder coated or of SS-304 stainless steel grade.
- 12.3.5.3 RTU panels shall be having dual access i.e. front and rear access. All the CPU cards, I/O racks, I/O modules, power supply cards, converters, switches, LIU box etc. shall be mounted and installed on the front side of the RTU. All the terminal blocks, AC/DC cables, field interface C&M cables and wiring shall be located on the rear side of the RTU panel.
- 12.3.5.4 RTUs shall be provided with enclosure/space heater to avoid moisture inside the panel. It shall also be provided with LED light interlinked with panel door limit switch for proper illumination inside the panel.

12.3.5.5 The designated station contractor will provide an earth terminal for the RTU's. RTU's will be connected by the SCADA contractor to this Earth. SCADA contractor will interface with station contractor for earthing requirement of RTUs. Kindly refer Chapter 3 of Tender Specifications for detailed SCADA interface requirements.

12.3.5.6 Earthing link from MET & communication with TER shall be provided by SCADA contractor.

12.3.6 Terminal Block

12.3.6.1 Disconnecter type screw less push-in type terminal block and push-in type Fuse terminal block with LED indicator should be used for ease in trouble shooting.

12.3.6.2 Terminal block (TB) for receiving control & monitoring cables and AC, DC supply cables laid by other contractors from their equipment's to RTU shall be in the RTU in such a manner that the other contractor can terminate & connect the cables in the TB without unlocking / opening the main door of RTU. TB shall have a separate lockable door with cable runways for laying the incoming / outgoing cables neatly inside the RTU and suitable provisions for cable entry inside the enclosure.

12.3.7 Transducer for Analogue Measurement

12.3.7.1 The RTUs will acquire analogue signals like voltages and currents from the transducers, if required, via 4 to 20 mA analogue. The transducers at RTU end would be supplied by the SCADA contractor, if required. There shall be dead band of

0.5 kV for voltage measure of PT to reduce data traffic & loading of server, if required.

12.3.7.2 Surge protection device for 4-20 mA circuits and analog signals from field shall be provided in RTU panel

12.3.8 Test Sheet of RTU

12.3.8.1 The test sheets include Type Test, Routine Test, Acceptance Test and Integrated Test. The test shall be performed in accordance with the IEC standards mentioned in test sheet.

12.3.8.2 The tests defined in the sheet are indicative. The Contractor shall carry out all the tests and checks required for guaranteeing the engineer in charge of the satisfactory construction and the satisfactory operation.

12.3.8.3 The Contractor shall put in place a full testing program to demonstrate that all the requirements of the specification are met.

12.3.8.4 The Contractor shall develop Type Test, Routine Test, Acceptance Test and Integrated Test plan including details of all testing activities as specified, to verify the system in all modes of operation and with all necessary interfacing requirements. Test programs, methods and results shall be documented and submitted to the Engineer in charge for necessary approval.

INDICATIONS	TYPE of TEST			
	Type	Routine	Acceptance	Integrated Testing
Dry Heat Test as per IEC 60068-2-2	X			

Damp Heat Test as per IEC 60068-2-30	X			
Cold Test as per IEC 60068- 2-1	X			
Temperature Change Test as per IEC 60068-2-14/ IEC60870-2-2 for Environmental conditions	X			
Vibration Test as per IEC 60068-2-6	X			
Series of Electromagnetic Compatibility Tests as per IEC 61000-4	X			
Series of Operating Conditions – Power Supply And Electromagnetic Compatibility Tests as per	X			

INDICATIONS	TYPE of TEST			
	Type	Routine	Acceptance	Integrated Testing
IEC 60870-2				
Degree of protection provided by enclosures (IP Code) as per IEC 60529	X			
Visual / Physical Inspection as per approved drawing		X	X	
Panel Paint shade and Thickness		X		
General Arrangement, Bill of material and Layout check as per approved drawing		X	X	
Electrical wiring check as per approved drawing		X	X	
System start-up and Power Supply Test		X	X	
Modules Redundancy check		X	X	
I/O and Functionality Test through simulator software		X		
Communication Test through Protocol simulator software		X		
Panel Earthing Test			X	
Power Supply Test			X	
RTU Communication Link Test			X	
I/O Signal Local Testing with power supply equipment			X	
I/O signal and functionality Test Integrated with SCADA and power supply equipment				X

12.4 SCADA DEDICATED/ DARK FIBRE OPTIC NETWORK

12.4.1 Description

- 12.4.1.1 The communication between control centre and RTU at controlled stations shall be achieved through dedicated and managed communication network over dark fibre optic cables. It shall also be used for transferring Disturbance Records, internal fault logs to OCC and BCC from each relay/IED installed at controlled stations for achieving Disturbance Recording functionality at OCC and BCC. SCADA contractor shall design and install the dedicated and managed SCADA communication network and communication up to control centres shall be achieved through OFC backbone network to be provided by designated Telecom contractor.
- 12.4.1.2 Telecom contractor shall lay the redundant optical fibre backbone network along the entire rail lines and shall provide/reserve dark fibre or dedicated fibre cores to SCADA contractor for SCADA communication only.
- 12.4.1.3 SCADA contractor shall connect all the RTUs installed at elevated ASS, Depot and Gateway at RSS of corridor 2 and corridor 4 to these dark fibre cores through direct ODF (Optical Distribution Frame) interface at TER.
- 12.4.1.4 SCADA contractor shall design the dedicated FO ring network for SCADA communication as per telecom fiber optic backbone and shall configure it in accordance to the technical characteristics and requirements of the managed switches/routers installed in the SCADA communication network. The network design and its configuration shall be validated from the OEM or manufacturer of the communication switches/routers which shall be involved during network design, installation and commissioning phase.

12.4.2 Transmission Network

- 12.4.2.1 The OCC/BCC shall communicate with the RTUs over IEC 60870-5-104 protocol.
- 12.4.2.2 Control & monitoring information shall be exchanged in between control centre and RTUs over 100 Mbps dual Ethernet link to be design by SCADA contractor.
- 12.4.2.3 Telecom contractor shall provide communication backbone network and shall lay redundant optical fiber cables for UP track and Down track along the corridor 2 & corridor 4 connecting all stations, RSS, depot and OCC/BCC.
- 12.4.2.4 4 Nos. dark/dedicated fibre cores from UP track and 4 Nos. dark/dedicated fibre cores Down track backbone FO cable shall be provided by Telecom contractor to SCADA contractor connecting all stations, depot, RSS and direct connectivity up to OCC/BCC.
- 12.4.2.5 A dual direct link of 100Mbps connecting both OCC & BCC shall also be provided by designated telecom contractor. SCADA contractor shall carry out interface for the same.

- 12.4.2.6 RTU provided with dual redundant managed ethernet Switches shall be connected to these dedicated fibre cores through direct ODF interface. Optical Distribution Frame (ODF) for UP track FO cable and Down track FO cable shall be provided & installed by Telecom contractor inside the Telecom rack in TER at all stations, depot and OCC/BCC.
- 12.4.2.7 Telecom contractor shall provide a minimum of 8 nos. ports (depending upon the total no. of dedicated fibre cores provided) each in UP track ODF and Down track ODF to SCADA contractor at each station, depot & OCC/BCC TER and shall allow SCADA contractor to do necessary patching/termination of FO patch chords (to be provided by SCADA contractor) in these ports for data transmission through designated dark fibre cores up to control centres.
- 12.4.2.8 Telecom contractor shall also provide space inside its Telecom rack for mounting of SCADA LIU box/ FO Junction box (to be provided by SCADA contractor) at each station, depot & OCC/BCC TER and shall allow the termination of SCADA FO cable (to be provided by SCADA contractor) in this LIU box.
- 12.4.2.9 SCADA contractor shall interface with Telecom contractor during project implementation stage for all the requirements as per SCADA Dedicated FO network design. Telecom contractor shall provide needful support during SCADA network integration testing/ interface test support during commissioning of dedicated FO network.
- 12.4.2.10 OFC backbone medium is outside the supply scope of SCADA contractor. However necessary Ethernet switches, media converter, network router, FO termination box, FO patch cables, FO cables up to TER and other equipment required for connection to Telecom ODF rack in TER at each station, depot & OCC/BCC shall be under the scope of SCADA contractor. LIU (Light Interface Unit) boxes at both ends shall be provided by SCADA contractor who will interface with Telecom contractor for placement of LIU inside telecom rack at each TER.

12.4.3 Communication with Control Centre

- 12.4.3.1 The RTU shall be provided with necessary Ethernet Ports for interfacing with the Station/depot Telecom ODF Rack installed at respective TER. The dual redundant fibre optic cables required for connection of RTU to ODF at TER and dual redundant fibre optic cables required for connection of SCADA communication equipments (at OCC/BCC SCADA server room) to ODF at TER will be under the scope of SCADA contractor.
- 12.4.3.2 Each cable shall be single/mono mode, armoured FO cable with minimum 2 nos. of the fiber cores will be spare. FO cable shall be of FRLS type for all elevated stations and FRLS-0H type for all underground station and within OCC/BCC.
- 12.4.3.3 The RTU installed at controlled stations shall be provided with dual redundant L-2 managed ethernet switches. However, RTU installed at nodal stations (Stations with direct connectivity to OCC/BCC) can be provided with dual redundant L-3 managed ethernet switches. Each ethernet switch shall consist of single mode FO ports with minimum 2 nos. spare FO ports and sufficient no. of RJ45 ports with minimum 2 nos. spare RJ45 ports.
- 12.4.3.4 The minimum technical specifications of ethernet switch and other communication equipments required for data transmission from field RTUs to OCC/BCC over dark fiber are as follows.
- 12.4.3.5 RTU Ethernet Switch

Sr. No	Characteristics	Description
1	Type	L-2, Managed Ethernet Switch, Industrial Grade Hardware
2	Power supply provision	Dual redundant input DC power supply
3	Fast ethernet port details	Min. 6x 10/100 Base Tx RJ45 ports
4	Optical ethernet port details	Min. 4x 100/1000 Base X single/mono mode FO port, 20 KM (Typical distance (KM) can be increase as per network design requirements for all/particular location switches if required)
5	Optical Wavelength (nm)	1310
6	Configurable properties	Fully configurable as per network design, network security and for monitoring the switch status, ports status, network traffic and other required network properties. Security Features – Cyber security compliant (NERC, CIP, CERT-In, IEC 62443) switch with Multi level user passwords, SSH/SSL (128-bit encryption), Enable/Disable ports, MAC based port security, 802.1x-Port based network access control, SNMPv3, RADIUS Supports SNMP, VLAN, RSTP for network loop prevention and port prioritization, SNTP, http, Port configuration and status, Port statistics and remote monitoring, Events logging and alarms, HTML web browser, Command Line Interface and TELNET user services, Configuration backup and restoration. Complying to IEEE 802 series standards 802.3-10BaseT, 802.3u-100Base TX and 100Base FX, 803.3x- Flow Control, 802.1D-Spanning Tree Protocol, 802.1w for RSTP, 802.1Q- VLAN, 802.3ad for Link Aggregation control
7	EMI Immunity and EMC Compliance	IEC 61850-3, IEC 61000-4 (Series of standards – Electromagnetic compatibility – Generic standards – Testing and Measurement Techniques) IEC 61000-6-2 for EMC, Immunity for Industrial environments Shall withstand Vibrations and Shock as per IEC/equivalent standards
8	Operating Temperature	-10° C to 70° C (Fanless)

12.4.3.6 FO Patch Chords

Sr. No.	Characteristics	Description
1	Type	Single/mono mode, Duplex
2	Optical wavelength (nm)	1310

12.4.3.7 Light Interface Unit (LIU) Box

S. No.	Characteristics	Description
1	Type	LIU box with sufficient nos. Of ports with connectors andwith single/mono mode pigtails for FO cable splicing and patching.

12.4.3.8 Fibre Optic Cable

S. No.	Characteristics	Description
1	Fibre Type	Single/mono mode as per ITU-T G.652.D
2	Cable type	Armoured, FRLS/FRLS-OH
3	No. Of core/fibre	Min. 6 core cable (2 nos. Spare fibre cores shall be considered in each cable)
4	FO cable construction parameters	Peripheral strength member (Steel wire/steel rod) with moisture barrier water blocking tape over the tube
5	Tensile Strength – Installation/ Operating	2000 N / 1000 N
6	Crush Resistance	1500 N/10 cm

12.4.3.8.1 Factory Acceptance Test (FAT) of Fibre Optic cable shall be done at manufacturer's place prior to dispatch for review by employer's engineer. The Contractor shall develop a FAT Plan including details of all testing activities to verify the system in all modes of operation. Test programs, methods and results shall be documented and submitted to the Engineer in charge for necessary approval.

12.4.4 Control Centre Network

12.4.4.1 The SCADA Servers, Workstations and Video Control Panel at control centres shall be connected over dual LAN to be setup by SCADA contractor. The required LAN switch/ routers and firewalls to achieve this shall be in scope of SCADA contractor. All the ethernet switches at OCC/BCC shall be managed ethernet switches. In case of loss of any workstation, server, printer or any OCC/BCC SCADA equipment, an alarm shall be generated.

12.4.4.2 SCADA contractor shall supply and lay dual redundant mono mode, armoured fibre optic cable from SCADA communication equipments installed in SCADA server rack at SCADA server room up to the ODF rack in TER at OCC/BCC. FO cable splicing, jointing and patching up to the designated ports in UP

& Down track ODF inside Telecom rack shall be under the scope of SCADA contractor.

12.4.4.3 Dual redundant mono mode, armoured fibre optic cable from SCADA server room to OCC/BCC theatre room for communication in between SCADA servers and operator workstations shall be provided by SCADA contractor.

12.4.4.4 LIU (Light Interface Unit) boxes at both ends shall be provided by SCADA contractor who will interface with Telecom contractor for placement of LIU inside telecom rack at OCC/BCC TER. SCADA contractor shall provide and install dual redundant L-2, managed ethernet switches inside SCADA server rack at SCADA server room with spare ports of each type.

12.4.4.5 The minimum technical specifications of the switch at OCC/BCC are as follows.

S. No.	Characteristics	Description
1	Type	L-2, Managed Ethernet Switch, Industrial Grade Hardware
2	Power supply provision	Dual redundant with two separate & Isolated Power supply units (AC power supply)
3	Fast ethernet port details	Min. 24x 10/100/1000 Tx RJ45 ports
4	Optical ethernet port details	Min. 4x 100/1000 Base X single/mono mode FO port, 20 KM (No. of FO ports shall be increased if required as per network design requirement) (Typical distance (KM) can be increase as per network design requirements if required)
5	Optical Wavelength (nm)	1310
6	Configurable properties	Fully configurable as per network design, network security and for monitoring the switch status, ports status, network traffic and other required network properties. Security Features – Cyber security compliant (NERC, CIP, CERT-In, IEC 62443) switch with Multi level user passwords, SSH/SSL (128-bit encryption), Enable/Disable ports, MAC based port security, 802.1x-Port based network access control, SNMPv3, RADIUS Supports SNMP, VLAN, RSTP for network loop prevention and port prioritization, SNTP, http, Port configuration and status, Port statistics and remote monitoring, Events logging and alarms, HTML web browser, Command Line Interface and TELNET user services, Configuration backup and restoration.

		Complying to IEEE 802 series standards 802.3-10BaseT, 802.3u-100Base TX and 100Base FX, 803.3x-Flow Control, 802.1D- Spanning Tree Protocol, 802.1w for RSTP, 802.1Q-VLAN, 802.3ad for Link Aggregation control
7	EMI Immunity and EMC Compliance	IEC 61850-3, IEC 61000-4 (Series of standards – Electromagnetic compatibility – Generic standards – Testing and Measurement Techniques) IEC 61000-6-2 for EMC, Immunity for Industrial environments Shall withstand Vibrations and Shock as per IEC/equivalent standards
8	Operating Temperature	-10° C to 70° C (Fanless)

12.4.5 Network Management System

- 12.4.5.1 A Network Management System (NMS) shall also be provided at OCC by SCADA contractor for monitoring the status, performance, statistics, errors and alarms of all switches, routers and all other active nodes of SCADA dedicated FO network system for corridor 1, corridor 2, corridor 3 and corridor 4.
- 12.4.5.2 NMS shall be a set of dedicated server or workstation and a network management software. The NMS shall have simple browser-based user interface to provide all the required information of SCADA dedicated network nodes (with additional 20% spare capacity). The NMS shall not impact the availability and performance of SCADA system.
- 12.4.5.3 The NMS software shall perform but not limited to the following features.
- 12.4.5.3.1 Centralized web-based management of all network nodes and IP networks
- 12.4.5.3.2 Auto discovery of device links and services and representation on a network map. NMS shall have the polling system by which devices shall be discovered using ICMP pings. Logs can be received, status can be detected, and a topology map shall be created. Performance data shall be regularly polled by NMS of all discovered devices.
- 12.4.5.3.3 Real time monitoring and notification of events, alarms and thresholds. NMS shall continuously monitor the network and reports or trigger events for any changes and abnormal traffic conditions it detects. It shall allow the users to define their own customized threshold rules.
- 12.4.5.3.4 Continuous collection of traffic statistics for analyses and reporting. Reports allow a network operator to assess the current and historical health of a network. These reports provide the tools needed to pro-actively detect issues and correct them before an outage or unacceptable network latency occurs. Statistics shall be available for printout.
- 12.4.5.3.5 NMS shall support remote monitoring of the network and shall monitor network traffic for abnormal

behaviour such as a rapid rise or fall in throughput.

12.4.5.3.6 NMS shall provide flexible, browser-based mapping of network entities. It can automatically map and lay out a selected set of devices, save and restore custom map views, perform live map updates, display map updates in real time and more.

- a) Icon specific to each device type
- b) Hierarchical views of devices
- c) Grouping of multiple objects under a single icon
- d) Color coded representation of each node and link status
- e) Graphical representation of bandwidth used between ports.
- f) Network monitor gage (for overall usage of network bandwidth)
- g) Capability for getting detailed information by clicking on desired device icon

12.4.6 Time Synchronization

12.4.6.1 The SCADA servers will be synchronized with BI-RIDE Rail Master Clock which in turn will synchronize all the RTUs and RSS Gateways with the required periodicity.

12.4.6.2 The accuracy and resolution of the time stamping is very critical for analysing the events that occurs across various stations. To achieve this RTU should be provided with clock which shall support time synchronization from master station via periodically initiated synchronization messages over IEC 60870-5-104 communication protocol.

12.4.6.3 Apart from periodically synchronizing the RTUs, the SCADA servers will synchronize the RTU during start-up or after recovering from communication failure. The SCADA system shall also initiate Time Synchronization messages when the communication with the RTU is restored after a communication failure. If RTU loses time synchronization, event should be generated for loss of synchronization at OCC/BCC.

12.4.6.4 The SCADA servers will acquire the time synch messages over NTP protocol via TCP/IP link at OCC/BCC through the ports provided by telecom contractor.

12.4.6.5 RTU shall be provided with dedicated back-up power for clock, so that in the event of RTU getting off due to power failure, the clock shall be updating the time. When communication with an RTU is interrupted, all data from that RTU shall be marked with invalid time till the time synchronization with the RTU is established again.

12.4.6.6 All relays shall be synchronized by RTU using IEC 61850 communication protocol.

12.4.6.7 Manual and automatic time synch shall be possible from SCADA software at OCC/BCC.

12.5 MASTER STATION EQUIPMENT & SAS**12.5.1 Description**

12.5.1.1 The Master Station Equipments shall be installed in OCC, BCC and Local RSS.

12.5.1.2 The SCADA contractor shall assess the requirement of the Master Station Equipment (including the networking & communication cabling) for achieving the desired functional & performance characteristic of SCADA system and submit the Engineer for approval.

12.5.1.3 The SCADA contractor shall offer servers, workstations & other SCADA IT equipment's of latest technology prevailing in similar industry.

12.5.2 Hardware Configuration

The minimum configuration for various data processing equipment are as follows.

12.5.2.1 Server

S. No.	Item	Description
1	Processor	Dual Processor, Intel Xeon Octa Core, 3.2 GHz or higher
2	Main Memory (RAM)	32 GB (2x16GB) upgradable up to 64 GB
3	Hard Disk	Total storage of 1 TB (3x 1 TB with RAID 5 controller), min. 7200 rpm
4	Input Output Device	KVM Switch (8-Port KVM switch with all connectors and accessories)
5	Ethernet Ports (LAN)	10/100/1000 Mbps Dual Ethernet Ports expandable upto four Also 1 On-board Ethernet port
6	DVD-R Drive	16x DVD +/-RW ROM, with double layer write capability
7	USB Ports	Min. 4 nos. USB ports and 1 no. On-board USB port for installing hard license (if required)
8	Operating System	LINUX / MS Windows Server 2019 or Latest
9	Power Supply	Dual Redundant Power Supply
10	Server Type	Rack Mountable
11	Form Factor	1U or 2U
12	EMI immunity	As per IEC 801

12.5.2.2 Workstation

S. No.	Item	Description
1	Processor	Single Processor Quad Core Intel Processor 3.6 GHz or higher
2	Main Memory (RAM)	16 GB (2x8GB)
3	Hard Disk	Minimum 1 TB, SATA, 7200 rpm
4	DVD-R Drive	Inbuilt DVD R/W (Latest Model)
5	Graphics Card	ATI/NVIDIA graphics controller 2 GB Dual Output
6	Ethernet Ports (LAN)	10/100/1000 Mbps Dual Ethernet Ports Also 1 On-board Ethernet port
7	Keyboard	Standard Wireless QWERTY Keyboard
8	Mouse	Wireless Optical Scroll Mouse
9	Monitor	Dual 24-inch LED display for all Operator Workstation & Training Workstation Native Resolution: 1920 x 1080 at 60 Hz Viewing Angle: 178° h; 178° v Aspect Ratio: Widescreen – 16:9 Colour Support: 16.7 Million colors Brightness: min. 250 cd/m ² (typical) Screen Coating: 2H/3H hard coating, Anti-glare Input Connection: Min. 1 x HDMI, 1 x VGA, 1 x USB 3.0, 1 x DVI, 1 x DP View Adjustment: Tilt -5° to + 30° vertical Height Adjustable up to 4.72 in (12.0 cm) Pivot Rotation 90° to portrait
10	USB Ports	Min. 4 nos. USB ports and 1 no. On-board USB port for installing hard license (if required)
11	Interface	2 x DVI, 2 x VGA, 2 x DP or mini-DP
12	Operating System	MS Windows 10 Professional (64 bit) or latest
13	Form Factor	Tower Type
14	EMI immunity	As per IEC 801

12.5.2.3 Disturbance Recorder Workstation

The PC-based workstation with 24" LED display shall be provided at OCC and BCC with Disturbance Recording (DR) functionality and relay/IED configuration software. The system shall retrieve the event list, internal fault logs and download the disturbance records and SCD (Substation Configuration Description) file from each relay/IED.

Each relay/IED at field locations shall be provided with unique IP address and information & fault records shall be transmit to OCC and BCC through SCADA dedicated fiber optic network link over Ethernet TCP/IP. IP address scheme of relays/IEDs shall be designed in conjunction to the IP address scheme of SCADA field equipments of a location for communication up to OCC and BCC.

The system shall be provided with status/fault data analysis software for analysing COMTRADE (Common Format for Transient Data Exchange for Power Systems) files generated by IEDs. It shall also be provided configuration software to manage/change settings or online configuration of relays from a centralized location.

12.5.2.4 Ethernet Switch

Servers and peripheral devices shall be connected to each other on a dual local area network (LAN). Industrial Grade, Managed Ethernet Switches shall be provided at OCC/BCC for this purpose and shall have the following characteristics:

- a) Shall preclude LAN failure if a server, device, or their LAN interface fails.
- b) Shall allow reconfiguration of the LAN and the attached devices without disrupting operations.
- c) Shall support VLAN.
- d) Shall have sufficient no. of ports of 10/100/1000 Tx and 100/1000 Base X FO ports with spare ports of each type for respective switch as per detail design requirement.
- e) Ethernet switch provided at SCADA server room shall be Industrial Grade, Layer- 2, managed switch with min. 24x 10/100/1000 Tx RJ45 ports and 4x 100/1000 Base X single/mono mode FO ports.
- f) Ethernet switch provided at OCC theatre room shall be Industrial Grade, Layer-2, managed switch with min. 10x 10/100/1000 Tx RJ45 ports and 2x 100/1000 Base X single/mono mode FO ports.
- g) Shall have Dual redundant two separate & Isolated Power supply units.
- h) As or when required in compliance to latest network security guideline for SCADA system.

Kindly refer clause 12.4.4.5 for detailed technical specification of Ethernet Switch at OCC/BCC.
Firewall/L-3 Router

12.5.2.4.1 The SCADA LAN shall be provided with redundant hardware firewalls/L-3 routers in order to deploy different security settings for access control in SCADA LAN. One set of redundant industrial Grade hardware firewalls cum L-3 Routers shall be provided each at OCC & BCC, between SCADA dual LAN and external system interface. Each Firewall shall be a Layer-3 switch with security feature.

12.5.2.4.2 The SCADA FO network cables from TER at OCC/BCC shall be directly connected to these redundant Firewall/L3 Switch in order to ensure fully secured data communication of SCADA servers with field RTUs. Any external system interface or data exchange such as Master clock interface with Telecom contractor shall be through firewall only.

12.5.2.4.3 The Firewall settings and network configuration shall be validated from the OEM or manufacturer of the Firewall/L3 Router which shall be involved during design, configuration and commissioning phase.

12.5.2.4.4 Each Firewall/L3 Switch shall be rack mount Firewall system with following features.

- a) Data encryption supported DES (56 BITS) 3des (168 bits) and hashing algorithm like MD5 and SHA-1.
- b) Shall have NERC, CIP, CERT-In compliance.
- c) It should have minimum 8x 10/100/1000 Tx RJ45 Ports and minimum 6x 100/1000 Base X single/mono mode FO Ports (20 KM) with spare ports of each type. Number of ports shall be increased if required as per network design requirements. Typical distance (KM) can be increase as per network design requirements if required.
- d) Shall support Layer-3 routing.
- e) Support NAT and PAT
- f) Filtering of packets based on Source address, Destination address, Protocol type, User, Port number
- g) Denial of service prevention
- h) Stateful packet inspection
- i) Detailed system logging and accounting feature
- j) No. of concurrent TCP Session supported should be more than 5000
- k) Capability of working in Hot-standby mode, VRRP
- l) Radius Integration
- m) Assigning zones to virtual and physical interfaces
- n) Assigning firewall policies between zones, physical interfaces and virtual interfaces
- o) Web based management interface
- p) Definition updates for software patches up to DLP period.
- q) Shall have Dual redundant two separate & Isolated Power supply units
- r) Operating Temperature: -10° C to 70° C (Fanless)
- s) Shall follow IEC 61850-3, IEC 61000-4 (Series of standards – Electromagnetic compatibility – Generic standards – Testing and Measurement Techniques), IEC 61000-6-2 for EMC, Immunity for Industrial environments
- t) Shall withstand Vibrations and Shock as per IEC/equivalent standards

12.5.2.5 Colour Printer

S. No.	Item	Description
1	Resolution	600 X 600 dots per inch
2	Print Speed Mono/Colour	A4 Mono 20 PPM / Color 20 PPM A3 Mono 15 PPM / Color 15 PPM
3	First Page Out	Less than 30 Secs
4	Duty Cycle	10000 per month
5	Interface	USB 2.0, 10 Base-T/100-Base-TX

6	Network Port Feature	SNMP enabled with network interface, security features and remote monitoring function
7	Paper Size	A3, A4
8	Paper Weight	80 to 160gsm
9	Duplex Printing	Built-in Duplex Printing
10	Input Tray	250 sheets
11	Output Tray	250 sheets
12	Output Tray Page Orientation	Landscape and Portrait

12.5.2.6 Large Video Display Screen (LVDS)

12.5.2.6.1 The supply, installation, testing & commissioning of Large Video Display Screen (LVDS) shall be in the scope of SCADA contractor. SCADA contractor shall be responsible to coordinate with the OEM or manufacturer of the LVDS for any upgradation or modification works if required during DLP & AMC period.

12.5.2.7 Factory Acceptance Test (FAT) shall be done prior to dispatch and actual graphics shall be shown at the time of FAT. Contractor shall provide and organize display wall mock-up demonstration at manufacturer's place for review by employer's engineer before implementation. The Contractor shall develop a FAT Plan including details of all testing activities to verify the system in all modes of operation. Test programs, methods and results shall be documented and submitted to the Engineer in charge for necessary approval.

12.5.2.7.1 The LVDS shall be installed in OCC only. It shall be made up of 6 cubes of 70" Rear Projection Unit fitted in 6 columns wide and 2 rows high.

12.5.2.7.2 The LVDS in the control room shall be used for the display of important graphics from the pc, workstation. It should have the functionality to pre-configure and save various display layouts to be accessed at any given point of time with a simple mouse click.

12.5.2.7.3 It should provide real-time clear luminous view to share information between operators and decision makers. The operators whose systems are on the same Ethernet should be able to work on the large screen sitting at their own position.

12.5.2.7.4 It should be able to show the images of the monitor, which is connected on the LAN and the windows should be freely resizable, scalable and repositionable on any part of the large video screen.

12.5.2.7.5 It shall be consisting of multiple rear projection modules in multiple rows and columns behaving as a single logical screen.

12.5.2.7.6 It should be compatible to work with Windows as well as LINUX/UNIX based system.

12.5.2.7.7 The display wall should be rugged and industrial nature and should be able to work in 24/7 environments.

12.5.2.7.8 The LVDS should consist of the Visual Display Unit, Display Controller and the Wall Management

Software, which should be supplied from a single manufacturer with the following specifications:

- a) The Visual Display Unit / Rear Projection Module must be based on Single Chip DLP-based Rear Projection Technology with Laser Light source.
- b) Should have the scalability and upgradeability to be made up of multiple rear projection modules stacked up in rows and columns to achieve a display wall for better viewing ability in linear or curved configuration.
- c) The Diagonal Size of each Visual Display Unit / Rear Projection Module should be 70" nominal with a native resolution of 1920 X 1080 pixels (Full HD) and should offer 16.7 million colors.
- d) The optical engine should have a light output of minimum 2000 lumens or better and the optical engine should be IP6X certifies from a third party to prevent dust ingress thus maintaining long life of components as well as no drop in light output due to dust accumulation. It shall comply to IEC 60529 and Test certificate should be submit to employer along with technical design submission.
- e) The Visual Display Unit / Rear Projection Modules should have in-built redundancy in Laser and ensures redundancy at the light source level without any mechanical movement. The engine should have multiple Laser banks with multiple Laser diodes. Failure of any Laser diode in the engine should not affect the functioning of other diodes.
- f) The MTBF of the entire engine should be minimum 50,000 hrs and the life of the Laser in eco mode should be minimum 100,000 hrs.
- g) The brightness uniformity should be minimum 98%.
- h) The dynamic contrast shall be 700,000:1 or higher.
- i) Contrast ratio shall be 1500:1 or better.
- j) The Aspect Ratio of each of projection module should be 16:9.
- k) The luminance on each rear projection module is 275 cd/m² (typical) with wide viewing angle screens.
- l) The screen should have adjustable low inter screen gap to give seamless viewing experience. The inter-screen gap should be adjustable upto 0.5 mm measured at 25°C. The screen surface should not be reflective.
- m) The Projection engine shall have DP/DVI/HDMI input and HDMI/DVI output as standard.
- n) The pixel clock shall be > 160 MHz on the inputs or higher.
- o) Each cube shall have its own IP address to have the access from a standard web page from any PC over the Ethernet and shall communicate to a viewer via Ethernet and its IP address to prevent communication loss. It shall have its own IP address with status, health and configuration.
- p) Cubes shall be controlled both by IP based control or IR remote based control which should be supplied as standard with each cube.
- q) Screen should not be expanding or shrinking due to variations in humidity and temperature or any other climatic conditions. Screen should be minimum 3 layers with a hard backing.
- r) Cooling inside cube should be done by means of heat pipe.
- s) Power consumption for each Visual Display Unit / Rear Projection Modules should be maximum 350 watts.
- t) Base stands shall be cover from all sides and shall be vermin proof. Rear covers shall be openable and screwless with key lock.

12.5.2.7.9 Display Controller

The Display Controller should have the following specifications:

- a) The display controller shall be provided in dual redundant configuration.

- b) The Controller should be in an industrial 19" rack mounted casing based on Intel Quad Core Xeon Processor
- c) The min. memory of 32 GB (2x 16GB) expandable up to 64 GB.
- d) The unit should be equipped with a DVD ROM Drive.
- e) The system should be equipped with minimum 1 TB HDD in RAID 1 Configuration.
- f) The display controller should have dual redundant hot swappable power supply. Should have 10/100/1000 Mbps Redundant Ethernet port for dual LAN connection.
- g) Supplied with a Keyboard and mouse with 20 m cable extension.
- h) The display controller should be based on LINUX/UNIX/Windows 10 Pro (64 bit) or latest.
- i) The display controllers shall be provided with the Antivirus software with min. 5 years of license subscription from the date of commissioning.
- j) There should be possibility of connecting the various type of analog and digital sources which can be shown in freely scalable and moveable windows on the graphics wall. It should support 2 DVI/VGA/HDMI Inputs and 8 Composite video inputs.

12.5.2.7.10 Wall Management Software

The Wall Management Software should have the following specifications:

- a) The software should be able pre-configure various display layouts and access them at any time with a simple mouse click or based on the timer.
- b) The software should enable the users to see the desktop of the graphics display wall remotely on the any PC connected with the Display Controller over the Ethernet and change the size and position of the various windows being shown.
- c) The software should enable various operators to access the display wall from the local keyboard and mouse of their workstation connected with the Display Controller on the Ethernet.
- d) The software should copy the screen content of the workstation connected on the Ethernet with the Display Controller to be shown on the Display wall in scalable and moveable windows in real time environment.
- e) The wall management software should support open APIs to enable system integrators to integrate it with their Software.
- f) The Diagnostic software shall perform health monitoring that allows timely detection of faults.
 - Wall health
 - Cube health
 - Cube IP-address
 - Brightness and colour adjustments.
- g) Diagnostic Software shall allow commands on wall level or cube level or a selection of cubes:
 - Switching the entire display wall on or off.
 - Setting all projection modules to a common brightness target, which can be either static (fixed) or dynamic to always achieve maximum (or minimum) common brightness between projection modules.
 - Fine tune colour of each cube
- h) The integrated view shall provide a database that

- records all events
- can record full status at given time intervals
- can be exported to excel/html
- Show internal patterns

12.6 UPS & BATTERIES

12.6.1 General

12.6.1.1 A reliable on-line UPS system of 2x20 KVA rating along with the batteries and associated equipment shall be supplied by Traction SCADA contractor for SCADA equipment's at OCC/BCC.

12.6.1.2 EPC contractor shall provide dual feeders in their UPS according to SCADA Load (approximately 9 KVA) in RSS. Cable laying from UPS room to RSS control room, Distribution Board (in RSS control room) and Power supply distribution for SCADA equipment's shall be done by SCADA contractor.

12.6.1.3 The details of 2x20 kVA UPS system at OCC/BCC shall be as under.

Item	Description
Rating	Each UPS shall be continuously rated for 20 kVA at 0.8 PF, Input: 3-Phase 415 V + 10% & -15% Vac, Frequency 50Hz $\pm$ 3% Hz Output: Stabilized 3-Phase, Ph-N: 240Vac $\pm$ 0.5%, 50 Hz. Harmonic content of output voltage: $\leq$ 3% System Efficiency > 90%
Arrangement type	One UPS of 20 kVA rating shall be sufficient to cater for the entire load of OCC. The UPS system shall operate in dual redundant mode where another 20 kVA UPS shall provide 100% redundancy to the system. The malfunction of online UPS shall cause it to automatically isolate from the system and the other UPS shall take up the load without any interruption. Each UPS shall be designed to operate as a true on-line, double conversion system where the UPS output is independent of input supply voltage & frequency variations. The UPS system shall comprise: • Two AC/DC converter (Battery Charger) • One common battery bank (Ni-Cd Battery) • Two Inverter • Two static bypass switch • Two emergency switch • Two AC output protection circuit breakers / isolators In normal operating mode load shall be feed through inverter and Static switch. In case of main supply failure, the thyristors switches automatically, without breaking, on the stand by supply made by battery and inverter. At the time of failure of both UPS, load shall be feed through bypass and Static switch. For maintenance purpose or in case of one UPS system failure, another UPS system shall ensure the supply of the connected equipment.

	In case of load transfer operation, transfer shall be made with a maximum delay of 20 ms and restoration shall be only manual without breaking. The UPS shall have Cold start facility.
Battery	Battery sets of maintenance free Ni-Cd batteries of sufficient Ah capacity to cater the full load for minimum 3 hours shall be provided. The batteries shall be suitable for UPS applications.

12.6.2 UPS Test Requirement

- 12.6.2.1 Factory Acceptance Test (FAT) of UPS System and Battery Set shall be done at manufacturer's place prior to dispatch for review by employer's engineer. The Contractor shall develop a FAT Plan including details of all testing activities to verify the system in all modes of operation. Test programs, methods and results shall be documented and submitted to the Engineer in charge for necessary approval.

12.7 SCADA SYSTEM SECURITY

12.7.1 Description

The SCADA system shall support following security provisions

- Identification and Authentication
- Role Based Access Control
- Media Control
- Security from Malicious Code

12.7.1.1 Identification and Authentication

- 12.7.1.1.1 The workstations shall have a restricted access to data and system.

- 12.7.1.1.2 To restrict access the SCADA system, each person accessing the system shall be required to initially log-in using some form of security access code. All login activities shall be recorded including time of action, terminal and user.

12.7.1.2 Role Based Access Control

- 12.7.1.2.1 Besides access codes the system's 'Area of Responsibility' function shall govern the limits of access for each individual user. The access codes shall be assigned to individual persons based upon, as a minimum, the following access levels:

- Read all data: - All views shall be available, but controls are not allowed.
- Read all data and equipment control facilities. All views along with control and monitoring shall be available.
- Facilities as in (b) above, with access to modify certain (non-critical) SCADA parameters
- Full SCADA system access: -Shall be the authorized person/administrator with full access including maintenance and software upgrade.
- Maintenance: -Can access any of the maintenance functions but not operational functions.
- Training: - Can access any of training related functions

- 12.7.1.2.2 Separate user groups and their passwords for corridor 1, corridor 2, corridor 3 and corridor 4 traction power operators shall be defined within the system based on these access levels.

- 12.7.1.2.3 Operator responsible for control & monitoring of corridor 2 shall not be able to access, view, acknowledge, control & monitor the corridor 4. And Operator responsible for control & monitoring of corridor 4 shall not be able to access, view, acknowledge, control & monitor the corridor 2. However, in emergency situations, for smooth operation and ease in extending power supply from one corridor to another on requirement, access/view/acknowledge/control & monitor rights of both the RSS and interlinking feeders/junction points of both the corridors shall be available with the Operators of both corridors.
- 12.7.1.2.4 It shall be possible to modify the access security features and user rights only from the highest access level i.e. administrator level only. In the event that no activity at a particular workstation has been detected by the SCADA system following a pre-defined period, access to the SCADA system from such a workstation shall be denied and the Power Controller shall be required to again log-in using the normal procedure.
- 12.7.1.2.5 The Power Controller shall log off to end a working session on a workstation. After the current operator has logged off and with no other Power Controller logged on, no supervisory, control, monitoring or other action on the SCADA system shall be possible from the workstation.
- 12.7.1.2.6 Any workstation shall not permit log on of more than 1 user at a time.
- 12.7.1.2.7 The action of all log-in and log-out operations of the SCADA system, as well as any configuration changes to the system, shall be recorded by date, time and the user's security access code as an event record.
- 12.7.1.3 Media Control
- 12.7.1.3.1 Use of External Media on any of system component (server, workstations etc.) shall not be allowed on SCADA system
- 12.7.1.3.2 There shall be means to indicate & give alarm in case an intrusion event occurs either through a connection or a peripheral device.
- 12.7.1.4 Security from Malicious Code
- 12.7.1.4.1 The Servers, Workstations etc. shall be provided with proper application (Anti-virus, Intrusion Detection system etc.) to prevent propagation of malicious code by any Media or on Network.
- 12.7.1.4.2 There shall be no remote/email/internet access in the master station software and hardware so that any possibility of a cyber-intrusion or attacks is eliminated. Reasonable precaution, by way of installing firewall, and blocking ports for connecting external devices like pen drives, CD drives etc. shall be ensured.
- 12.7.2 Firewall in Network Architecture**
- 12.7.2.1 The SCADA network shall be separate from the corporate network. The nature of network traffic on these two networks is different: Internet access, FTP, e-mail, and remote access will typically be permitted on the corporate network but should not be allowed on the SCADA network. Rigorous change control procedures for network equipment, configuration, and software changes may not be in place on the corporate network. By having separate networks, security and performance problems on the corporate network should not be able to affect the SCADA network.

12.8 INSTALLATION REQUIREMENT

12.8.1 Description

- 12.8.1.1 The SCADA equipment shall be of modular in construction to facilitate maintenance, repair and replacement of parts.
- 12.8.1.2 Cabinets and racks when fully assembled shall not be filled to greater than 80% of their capacity at the completion of the Works.
- 12.8.1.3 Outdoor equipment shall be sealed against the ingress of dust, moisture and vermin to a minimum rating of IP65 or higher in accordance with EN 60529. The Indoor Panels shall have rating of IP54 or higher.

12.8.2 RTU Manufacturing

- 12.8.2.1 All components used shall be purchased from suppliers complying with internationally authorize quality assurance and reliability certification procedures.
- 12.8.2.2 All components shall be identified either by carrying a manufacturer's designation or part reference number or unique value in a standard format.
- 12.8.2.3 Adjustable controls shall be provided with locking devices to prevent inadvertent movement. Test points shall be clearly labelled as such in English and any test points involving Safety Critical functions shall be protected against unauthorized access.
- 12.8.2.4 Plugs and sockets shall incorporate mechanical locking features to hold both parts together and protect against vibration and shock. Mechanical coding or barriers shall be provided to prevent a plug or socket being incorrectly connected.
- 12.8.2.5 Each wire shall be labelled, consistent with the circuit or handbook/drawing designation, such that it may be uniquely identified.
- 12.8.2.6 Each wire connecting the remote terminal units to the selected equipment shall carry a unique identification, which shall also be clearly shown on the interface drawings.

12.8.3 Server Rack Specification

- 12.8.3.1 Rack should be of All Steel Construction and powder coated finish.
- 12.8.3.2 All SCADA servers or any communication equipments will be installed in a 42U standard 19" rack complying to IEC 60297-3 at SCADA server room with redundant power supply system and protection from UPS distribution board.
- 12.8.3.3 Rack shall be designed with redundant power strips with applicable electrical protection, inbuilt protection MCBs arrangements to safeguard different IT equipments.
- 12.8.3.4 Rack design should enable shipping of the rack in (CKD) Completely Knock Down condition. Typically, the frame and other structural members are bolted together to offer such flexibility of the product. Design should permit an easy assembly of the racks at site as per the requirement at site. Complete flexibility should be available with regards to the internal mountings in every rack.

- 12.8.3.5 Front and rear frame should be rigidly fastened together with the help of side mounting channels or depth sections to ensure perfect square-ness of the internal mounting space. Furthermore, the said structure comprising of frames and mounting channels should rest positively fastened onto the Plinth of box like Configuration. Thus, ensuring the higher level of Rigidity of the Basic rack skeleton while effectively distributing and transferring the entire load to integrated Plinth.
- 12.8.3.6 Mounting rails (for Standard 19" mounting) should be made up of steel. (Minimum 2.0mm thickness) Recessing of these Front & Rear 19" mounting rails should be completely flexible within the entire depth of the rack. These mounting rails should also have an extra internal web for increasing rigidity and to facilitate mounting of the shelves and other required accessories conveniently.
- 12.8.3.7 Integral Plinth should have provision for Cable Entry on rear and two sides along with cable entry gland plate on the top face of the Plinth. Minimum opening of this top gland plate on the plinth should be at least 300mm x 300mm with separate opening for electrical / power cables entry. Solid bottom panel with provision of front and rear cable entries through bottom cable entry removable gland plate.
- 12.8.3.8 The rack should have provision to mount castors (4 Nos.) and Levelling Feet – (4 Nos.) simultaneously. This is required for the facility of moving the rack while installation process and then resting the same rigidly at the final location. When the rack is resting on the levelling feet, castors should not touch the ground surface.
- 12.8.3.9 Side Panels should be easily removable type along with the provision for locking. Ideally, the panels should have latching arrangement to facilitate easy removal and putting back the panel along with locks for the security purpose.
- 12.8.3.10 It should also be possible to open the front and rear door by 180 Degrees to ensure proper approach to front of rack. It should have the provision of unique key lock for restricted access control.
- 12.8.3.11 Rear door should be completely perforated to facilitate the air circulation at the maximum without offering any resistance to the same. Ideally, it should be possible to remove it easily and should have unique key lock for the security purpose and restricted access control.
- 12.8.3.12 Top roof should be well ventilated, especially with ventilation provided on the vertical side of the roof. This will greatly enhance the hot air outflow while in operation. Roof should also have provision to mount the cooling fan trays. It should be possible to mount at least 4 nos. of 90 CFM cooling fans on this roof.
- 12.8.3.13 Two vertical cable managers to be provided at the rear of the rack in the form of Cable Trays. These trays should offer the maximum flexibility by way of the cable dressing and routing provision.
- 12.8.3.14 Panel lighting provision with LED light connected with door limit switch mounted on the top to provide indoor working LUX level.
- 12.8.3.15 All panel entries should be blockable with metallic covering plates and it should be vermin proof.
- 12.8.3.16 Contractor shall ensure the provision of free space inside the rack and shall submit the general arrangement drawing to Engineer in charge for approval.

12.8.4 Installation & Control Cabling of RTU

- 12.8.4.1 Traction contractor shall finalize the space requirement for SCADA equipment in

RSS/ASS/Depot/Trackside. It shall interface with RSS contractor to ensure the provision of RSS gateway integration with Dark fiber optic communication network for RSS data transmission up to OCC & BCC.

- 12.8.4.2 Traction contractor shall interface with Station E&M contractor to ensure the provision of necessary I/O contacts for SCADA RTU interface for control & monitoring of 415 V LV Breakers in MDB from OCC/BCC for elevated station only.
- 12.8.4.3 The Traction contractor will ensure that all Energy Meters are provided with RS485 or TCP/IP port for communication with SCADA over MODBUS Protocol.
- 12.8.4.4 Kindly refer Chapter 3 of Tender Specifications for detailed interface requirements.
- 12.8.4.5 All SCADA cables, except power supply cables, shall be terminated in order of their core number on combined terminal/disconnection or terminal/fuse links. Each wire shall be capable of being disconnected and isolated without removing the wire itself. Such terminations shall be easily accessible for inspection and test and shall be identified with the designation of the circuit it carries.
- 12.8.4.6 All multi-core SCADA cables shall have 20% of their cores (with a minimum of 2 cores), as spares.
- 12.8.4.7 Cable terminals and busbars carrying voltages exceeding 50 volts shall be uniquely identified and protected against accidental contact by persons, test equipment or other unintended physical contact.
- 12.8.4.8 All C&M cables in elevated section shall be FRLS type and in underground section shall be FRLS-0H type.
- 12.8.4.9 RTUs installed at Elevated ASSs shall have Top cable entry provision and RTUs installed at Underground ASSs, and Depot shall have Bottom cable entry provision.

12.8.5 Furniture

- 12.8.5.1 The SCADA Contractor shall consider suitable and aesthetically designed furniture at OCC and BCC Server room and Training simulator room for all SCADA servers display console, server room printer and for Training Simulator setup. The contractor shall supply furniture tables each of dimensions 1500 x 800 mm with attached Drawer and Keyboard Tray.
- 12.8.5.2 Each table shall be equipped with min. 4 nos. electrical 5-pin switch socket and 2 nos. communication port (for phone and data). It shall be provided with cable raceway and applicable cut outs for cable entry. Front partition of each table shall be Pin-up type & 18 inch above the tabletop. Attached Drawer with each table shall have partitions for both material and document storage with key lock arrangement.
- 12.8.5.3 Swivel chair shall be provided for each table with armrests, height adjustment and back support adjustment provision.
- 12.8.5.4 The servers shall be housed in separate cabinets to prevent dust and they should have easy access for the cables.
- 12.8.5.5 The furniture for Traction power controller and operator workstations at OCC theatre room shall be provided by control centre contractor. The SCADA contractor shall interface with control centre contractor and shall submit the requirement of necessary power supply switch sockets & cooling fans

along with the provision of cut out on bottom plate for cable entry inside the furniture.

12.8.5.6 The Contractor shall submit proposal for furniture type and design to Engineer for approval.

12.8.6 Power Supply

12.8.6.1 The designated contractor will install DCDB, ACDB, Inverter, battery and battery charges of appropriate capacity and will provide connections at DCDB, ACDB for SCADA RTU at each location. Traction contractor shall ensure the provision at DCDB for dual feeders of 110 V DC supply and single feeder of 230 V AC supply from ACDB for SCADA RTU power supply.

12.8.7 Interconnection with OCC/BCC

12.8.7.1 SCADA contractor shall coordinate with station/depot building contractor for requirement of cable route and support (cable tray etc.) for laying of RTU communication cable up to Telecom Equipment Room (TER) at stations and depot. The designated station / E&M contractor shall provide cable route and install support (metallic cable tray, conduit etc.) for RTU communication cable to Telecom Equipment Room at all stations and depot.

12.8.7.2 SCADA contractor shall interface with E&M contractor for the requirement of cable route and cable tray connectivity inside OCC/BCC building for laying of SCADA power and communication cables. Kindly refer Chapter 3 of Tender Specifications for detailed interface requirements.

12.8.8 Power supply distribution in OCC/BCC

12.8.8.1 Equipment contained within the OCC/BCC shall be fed from the UPS distribution board, installed complete with protective devices and earth terminal. There shall be separate AC power distribution boards for SCADA equipments in SCADA server room, Training Simulator room and Theatre room at OCC/BCC. Power distribution to the various items of ancillary equipment and desks shall be by means of several ring main circuits. Each circuit contains a dedicated protective conductor (separate conductor or cable armouring) connected to the protective earth terminal at the distribution switchboard. All items of control and communication equipment shall have a direct connection between the equipment earth terminal and the circuit protective conductor.

12.8.8.2 The distribution board shall comply with the relevant Indian Standards and shall comply to the I.E. Rules with ingress protection rating of IP 41.

12.8.8.3 The Distribution Board (DB) shall comprise of the following accessories of suitable rating, but not limited to:

- a) MCB/ MCCBs.
- b) Bus bar chamber with copper bus of adequate size.
- c) Ammeters, Voltmeter
- d) Double Pole MCBs for distribution (with min. 2 nos. spare MCBs of each type)
- e) Power supply Indication lamps.
- f) Outgoing feeders as per requirement

12.8.8.4 The distribution boards shall be of heavy sheet steel construction and shall be completely dust, moisture and vermin proof. These shall be supplied complete with framework, fixing bolts, barriers enclosure, internal wiring cable end boxes, labels etc.

12.8.8.5 The distribution boards shall be suitable for wall mounting.

- 12.8.8.6 Bus bars of the DB shall be electrolytic copper with heat shrinking sleeves. Internal cabling/wiring shall be FRLS-0H wiring of suitable sizing shall be selected to carry the full load current. MCBs shall be selected for providing discrimination between incoming and outgoing feeders.
- 12.8.8.7 All units of the distribution boards including supporting frames shall be made rust proof.
- 12.8.8.8 The busbars shall be supported on LT porcelain insulators. Busbar chambers shall be made of heavy sheet and should be provided with detachable covers at both ends and suitable opening on top as well as at the bottom to enable installation of incoming and outgoing feeders.
- 12.8.8.9 The circuit breaker, changeover switch shall be arranged neatly and mounted on the panel which shall be of standard design and provided within a hinged cover to facilitate inspection.
- 12.8.8.10 The various items constituting the distribution board shall be neat and secured on a channel from framework designed for wall mounting. The indicating lamps shall be of the low watt consumption and which shall be interchangeable and replaceable on front of the panel.
- 12.8.8.11 Suitable markings for identification of circuits shall be provided on the distribution panels. Suitable name plates shall also be provided.

12.8.9 Earthing of SCADA Equipment

- 12.8.9.1 The SCADA contractor is required to interface with the designated station/depot E&M contractor for earthing requirement of SCADA equipments at field and OCC/BCC.
- 12.8.9.2 The Traction contractor shall ensure dual Earthing arrangement and shall connect SCADA equipment RTU, Server rack, ACDB, LVDS, Wall mount cubicles etc. with MET as per approved schematic. The cable required for this connection shall be under the scope of Traction contractor. Kindly refer Chapter 3 of Tender Specifications for detailed interface requirements.

12.8.10 WIND SPEED SENSOR

The objective of Wind speed sensor is to generate pulse input received from the cup generator and to give output in the form of changeover of contacts when wind speed goes above the set speed.

The wind speed sensing system will be provided at three different locations along the corridor 2 and at three different locations along the corridor 4. The exact location shall be finalized during detailed design stage upon approval of Engineer in charge.

These wind speed sensors will be installed and it will give the two-stage speed indication in OCC, BCC and Station Control Room (SCR) where it has been installed. It is to be integrated to SCR and OCC/BCC for giving alarm of the wind speed so that train operation can be regulated upto a particular speed and if wind speed exceeds another higher set limit, then train operation can be stopped.

Output	4-20mA
Range	0-110 MPH
Accuracy	0.2 MPH over the range 11 to 55 MPH
Operating Voltage	10-36 VDC
Current Draw	Same as sensor output
Warm up time	3 seconds minimum
Operating Temperature	- 40°C to +55°C
Size of Probe	7" diameter x 8.5" long
Weight	1 lb

Wind speed sensor or Anemometer is a fast response Opto electronic anemometer. It shall be a 3-cup anemometer with each cup mounted at equal angles to each other on a friction free vertical shaft and coupled to a chopper.

The sensor is a two-wire sensor using the red wire for power and the black wire for the output signal. The sensor should be connected with the power turned off.

The sensor comes with a stainless-steel elbow that can be mounted on a 1" diameter tube. The sensor is mounted parallel to the ground surface.

The wind speed sensor or anemometer produces a sine wave voltage signal with a frequency that changes linearly with the wind speed. The frequency is transformed into a 4-20 mA sensor signal output.

The signals of wind speed sensor should be integrated in OCC/BCC through RTU via the SCADA System. Each wind speed sensor shall be provided with the necessary auxiliary contacts and internal wiring to permit remote control and indication.

A digital processing display unit and an alarm/buzzer shall be installed in Station Control Room (SCR) of the station where wind speed sensor will be installed. It is required for displaying the wind speed on the display unit which will give relay contact output when wind speed exceeds the set point and will generate an alarm and raise the buzzer.

The SCADA contractor shall submit the detail design of the selected wind speed sensor device with all accessories to the Rail for approval. It shall also interface for the installation of wind speed sensor, display unit and buzzer unit at a location.

12.9 Earthquake Sensor

Earthquake sensor shall be installed for both corridor 2 and corridor 4 of BI-RIDE Rail. The requirement of earthquake sensor is to detect even feeble earthquake and generate an alarm on the OCC. The objective is that the earthquake can be detected and alarm to be generated on the OCC SCADA system to take a decision to stop the train operation.

12.9.1 Earthquake Warning System Specifications

1	No of proposed nodes	Five (initially) (Four at corner, One at Centre)
2	Connectivity	SCADA LAN Network
3	Individual Nodes	Seismic Warning System (SWS) (Accelerometer + Seismic Data Acquisition System) with LAN Connectivity
4	Alarm Generation	On thresholding (Programmed PGA Value, resolution 0.05g)
5	Data Packet	Containing timing and data values
6	Central Recording System	Recording and alert packet generation at OCC

12.9.2 Specifications of Seismic Warning System (SWS)**12.9.2.1 Sensor**

1	Type	Force Balance Accelerometer
2	Component	Three (Tri-Axial)
3	Full Scale Range	± 1g (Capability to adjust ± 2g also)
4	Frequency Response	DC to 100 Hz
5	Operating temperature	-10°C to 50°C
6	Cross-Axis sensitivity	<1%
7	Dynamic Range	> 130 dB
8	Connection	Military style metal connector

12.9.2.2 Seismic Data Processing Unit

1	No. of Channel	Three (Programmable)
2	Recording Mode	User Selectable Continuous and Triggering mode
3	Sampling Mode	Programmable
4	Timing	GPS timing unit
5	System Triggering	Amplitude Triggering, STA/LTA Triggering Alarm
6	Alarm Logic	Programmable up to 3 (One for each channel) Alert
7	Alarm Signal	On exceeding Peak Ground Acceleration (PGA) (Minor and Major alarm as per PGA)
8	Connectivity	Ethernet
9	Data Storage	Internal in GB
10	Software	Data viewing software
11	Date Downloading	Using IP address Over Ethernet connectivity
12	Pre-event memory	Programmable up to 100 sec
13	Post-event memory	Programmable upto filling of internal memory

The signals of earthquake sensor should be integrated in OCC through RTU via SCADA system. Earthquake sensor shall be provided with the necessary auxiliary contacts and internal wiring to permit remote control and monitoring.