BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION PROJECTS ENGINEERING MANAGEMENT

NEW DELHI

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CONTROL & RELAYS PANELS WITH SUBSTATION AUTOMATION SYSTEM				GROUP	TBEM		
				W.O. No	83009		
CUSTOMER	BIHAR STATE POWER GENERATION COMPANY LIMITED						
PROJECT	2 * 250 MW BARAUNI THERMAL POWER STATION EXTENSION UNIT # 8 & 9						

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SECTION 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITES

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of 220kV and 132kV Protection panels with substation automation system and Energy Metering System. In case of any discrepancies between the requirements mentioned in this section and those specified in the following sections of this specification, the specifications given herein shall prevail and shall be treated as binding requirements.

The fitment and equipments offered shall be of approved make of BSEB **(BSPGCL)** / BHEL or its subsequent approval from BSEB **(BSPGCL)** shall be bidder's responsibility with no commercial implications to BHEL. If any of the make offered by the bidder is not acceptable to M/s BSEB **(BSPGCL)**, the bidder has to supply alternate BSEB **(BSPGCL)** approved make, meeting the specification, with no commercial implications to BHEL.

All auxiliary relays, timers, counters, aux CTs, switches etc required for completeness of the scheme and good engineering are deemed to be included in the offer and no claim whatsoever shall be entertained at contract stage.

The specification comprise of following sections:

Section-1: Scope, Specific Technical Requirements and Bill of Quantities.
Section-2: Equipment Specification.
Section-3: General Technical Requirements.
Section-4: Guaranteed Technical particulars (GTP)
Section-5: Enclosures to Specification

In case of any conflict between various sections, order of precedence shall be in the same order as listed above.

1.1 THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT.

Name of the Customer : M/s Bihar State Power Generation Company Limited

Name of the Project : 2 x 250MW Barauni Thermal Power Station Extension

1.2 SPECIFIC TECHNICAL PARAMETERS

As per Single Line Diagram and Section- 2 of the specification

In addition, following points to be noted by the bidder:

i) The scope for relay setting shall be as follows:

a) Conducting the relay setting calculations and determination of the recommended relay settings shall be in bidder's scope. The relay settings shall be submitted in the OEM's format along with supporting calculations for approval of BSEB **(BSPGCL)** during contract stage.

b) Co-ordination with the customer for all the inputs pertaining to protection relay settings shall be in BHEL scope.

ii) Wherever bidder offers any spare/ item/ fitment in lieu of the same being "Built-in feature" of any relay/ fitment or the same being "Not applicable" is subject to approval by BSEB **(BSPGCL)**. No price implication will be entertained by BHEL at contract stage if any separate item is insisted by BSEB **(BSPGCL)** to meet the contract requirement.

iii) Bidder to note that the GTP, Make & type of fitments, Bill of material of the offered Control & Relay Panels and their mandatory spares are subject to BSEB **(BSPGCL)** approval at the contract stage. No price implications will be entertained by BHEL at contract stage.

iv) Bidder to provide CRP with SAS and Energy Metering system for 4 nos. 220kV Line Bays and 6 nos. 132 kV Bays in the present scope. Bidder to note that 220kV Switchyard in Barauni is existing and IEC 61850 based SAS is already provided by M/s Alstom T & D, India Ltd.

v) Bus bar protection for 4 nos. 220kV Bays in present scope shall be augmented with the Alstom Make P741 Busbar Protection System (Single, Distributed). Only Peripheral units for 4 nos. bays are to be provided. The central unit (CU) is already capable to take the present scope addition. Peripheral Unit shall be provided in the respective protection panels.

vi) New Bus bar protection (Single, decentralized) shall be provided for 132 kV Switchyard.

vii) Existing Energy Meters (ABT compliant) are of Elster (ALPHA) Make. New Energy Meters (Make and Check) to be provided for present scope shall be integrated with the existing Energy Metering System.

viii) Main-1 & Main-2 Numerical Distance relay is considered for 4 Nos. 220kV Line Bays. The make of relays shall be different.

ix) Main Line differential relay along with Back up standalone over current & E/F relay is considered for 2 Nos. 132kV interconnecting line bays.
Line Differential Relays for remote end (Panel mounted) to be supplied in loose.

For balance 132kV line, Main Numerical Distance Protection & Backup Directional over current & E/F Protection Relay shall be considered.

x) 220kV Bays (4 nos.) and 132 kV Bays (6 Nos.) in present scope shall be augmented and integrated with the existing Alstom Make IEC 61850 based Substation Automation System. (Architecture of existing SAS and Metering System is enclosed)

1.3 BILL OF QUANTITIES

S. No.	Description	Unit	Quantity
1	220kV Line Protection Panel along with BCU	Sets	4
2	132 KV Side 220/132kV ICT Protection Panel along with BCU	Sets	2
3	132kV Interconnecting Line-1/2 Protection Panel along with BCU	Sets	2
4	132kV Line Differential relay for Interconnecting Line-1/2 Protection (Panel mounted) (to be supplied in loose for remote end)	Sets	2
5	132kV Line Protection Panel for Line-3 along with BCU	Sets	1
6	132kV Bus Transfer Protection Panel along with BCU	Sets	1
7	Augmentation of 220kV Bus Bar Protection (4 bays to be augmented)	Lot	1
8	132kV Bus Bar Protection (Single, decentralized, 6 bays)	Lot	1
9	Bay Control Unit for Substation Auxiliary system (with 64 Digital Inputs, 24 Digital outputs and 16 Analog Inputs (110V/1A/ 4-20 mA)	Lot	1
10	Augmentation of SAS for 4 nos. 220kV Bays and 6 nos. Bays (present scope) with the existing Alstom Make IEC 61850 based Substation Automation System	Lot	1
11	Communication infrastructure including Ethernet switch , patch-cords, connectors, optical cables etc for completeness of data communication network for redundant bus configuration	Lot	1
12	Armored FO cable for SAS and Bus bar Protection	m	2000
13	Energy Meters, ABT compliant 0.2S Accuracy class (For 220kV Line bays – 8 Nos., 132kV Line Bays-6 Nos. and 132kV ICT Bays – 2Nos. (Panel mounted)	Lot	1
14	Integration of ABT Meters with the existing Energy Metering System including any hardware and software etc.	Lot	1
15	Relevant manuals as per SA (Substation Automation) specification.	Lot	1
16	Testing & commissioning of complete SAS for 220kV and 132 KV SS (Comprising 10 Electrical bays)	Bays	10

	Services include the following: a) Testing & commissioning of main protection relays including configuration and protection relay setting calculations. b) Testing, commissioning & relay setting of 132kV bus-bar protection & SAS including termination of network / optical cables (complete with supply of end connectors, tees etc. as required). Augmentation of 220kV Busbar Protection system. c) Testing, commissioning & parameter setting of ABT Meters and integration with existing ABT Metering System including termination of network / optical cables (complete with supply of end connectors, tees etc. as required). d) Arranging all necessary tools & tackles including 3-phase automatic relay test kit and equipment for testing of BCU, Protection relays, communication infrastructure shall be bidder's responsibility. e) Splicing & termination of FO cables (armored & patch-cord)		
17	Training for SAS as per Clause 10.0 of section-2 of Technical specification document **(for 5 Nos. Engineers for 5 days =25 Man-days)**	Lot	1

Note:

1. If any additional item as per the specification for Substation Automation System is required to be supplied for completion of the system over and above the items indicated above, the same shall be indicated clearly in the offer. Otherwise, the same shall be deemed to be included in the offer.

2. Relay setting to be furnished in OEM's format.

3. 10 Electrical bays comprises: 4 x 220kV Line Feeders, 3 x 132 KV Line Feeders, 2 x 132 kV ICT Bays and 1 nos. 132kV Bus Transfer Bay.

4. All relay panels shall have BCU mounted on it. Prices of BCU to be considered in the main Relay panel supply.

5. Bidder to estimate the actual lengths of the Fiber optic cable and GI Conduits. Payment for Fiber optic cable shall be made on pro-rata basis.

6. The commissioning of Switchyard shall be in stages. Bidder to quote accordingly. Total value of item S. No. 16 shall be minimum 5% of the sum total of the value of items from S. No. 1 to 15 together.

7. Main-I & Main-II distance protection shall be of different make.

8. The auto reclose & synchronizing shall be made part of BCU.

9. Over fluxing relay (Numerical) to be provided on both side of ICT.

10. 220kV and 132kV Bay panels shall be placed in AC kiosk supplied by BHEL. One AC Kiosk shall be provided for 2 bays.

11. The necessary training for 5 Nos. Engineers for 5days =25mandays) to be provided to the customer i.e. M/s BSEB shall be arranged well before supply of material and the program shall be intimated well in advance

12. Main & Check meters is to be provided for all outgoing feeders as per CEA guidelines.

13. The recording for Parameter in decimal point for Energy meter is to be in accordance with CEA guidelines/applicable standard.

14. The addition/ deletion to the scope shall be as per the breakup unit rates for all the Protection, SAS and Energy Meter panel fitments furnished with the offer.

15. Item at S. No. 4 of the BOQ is optional and shall be ordered only after obtaining the necessary clearance from customer.

1.4 TYPE TESTS

All the tests as per relevant IS/IEC shall be carried out and reports shall be submitted.
The Type Test for offered equipments/materials used for this project should have been conducted in any approved Government/Govt. recognized laboratories conforming to latest IS/IEC. The above type test certificates should accompany the drawings of the materials equipments, duly signed under seal by the Institution, who have issued the type test certificate.

The above type test should have been conducted not earlier than five (5) years as on the date of technical bid opening, which is **24.09.2013**

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The original type test certificates shall be furnished for verification.

1.5 DRAWINGS and SCHEME

a. The documentation requirements detailed under Section-2 & 3 shall be submitted to BHEL at various stages of contract. Softcopy of the drawings and schemes are to be submitted at contract stage.
b. Protection Key and Metering SLD shall be the first document for submission.
c. Preparation of AS- BUILT drawings is also in the scope of the bidder.

1.6 DOCUMENTS REQUIRED WITH OFFER

a) Clause wise confirmation/ comments.
b) Bill of Material.

c) Un priced schedule of Unit Prices
d) Filled up Guaranteed Technical Particulars
e) Catalogue and Technical Leaflets for the offered Equipments

1.7 INSPECTION AND TESTING

Factory acceptance tests (FAT), Inspection, routine tests & Quality assurance shall be as per approved Quality Plan by BSEB **(BPGCL)** /BHEL

1.8 QUALITY PLAN

Bidder to follow valid **BSEB** (BPGCL) / **BHEL** approved Quality Plan as per **BSEB** (BPGCL) procedure. In case the bidder doesn't have approved QP, it will be the bidder's responsibility to get its QP approved directly from the ultimate customer.

SECTION 2

EQUIPMENT SPECIFICATION

As per BSEB/BHEL SPECIFICATION ENCLOSED HERE IN

SECTION-2A

SUBSTATION AUTOMATION SYSTEM

1.0 GENERAL

1.1. This specification is based on the requirement that a complete integrated Substation Automation System (SAS) is required for the 220kV & 132kV Switchyard that provides a central station from where the complete Switchyard can be controlled.

1.2. The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipment from remote control centre (RLDC) as well as from local control centre.

The SAS shall contain the following main functional parts:

- Bay control Intelligence Electronic Devices (IED s) for control and monitoring.
- Station Human Machine Interface (HMI)
- Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- Gateway for remote control via industrial grade hardware (to RLDC) through IEC60870-5-101 protocol.

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- Peripheral equipment like printers, display units, key boards, Mouse etc.

1.3. It shall enable local station control via a PC by means of human machine interface (HMI) and control software package, which shall contain an extensive range of supervisory control and data acquisition (SCADA) functions.

1.4. It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure.

1.5. The communication gateway shall facilitate the information flow with remote control centres. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the

switchgear without the need of interposing components and perform control, protection, and monitoring functions.

2. System design

2.1 General system design

The Substation Automation System (SAS) shall be suitable for operation and monitoring of the 220KV substation.

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

The offered SAS shall support remote control and monitoring from Remote Control centres via gateways.

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

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

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

One AC Kiosk shall be provided for two bays in 220kV Level.

And one AC Kiosk shall be provided for two bays in 132kV Level

2.2 System architecture

The SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence. Functions shall be decentralized, object-oriented and located as close as possible to the process.

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

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

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

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

The communication shall be made in fault tolerant ring in redundant mode, excluding the links between individual bay IEDs to switch wherein the redundant connections are not envisaged, such that failure of one set of fiber shall not affect the normal operation of the SAS. However failure of fiber shall be alarmed in SAS. Each fiber optic cable shall have four (4) spare fibers

At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.

Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e. RCC, station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.

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

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

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

2.3 FUNCTIONAL REQUIREMENTS

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

- Remote control centres
- Station HMI.
- Local Bay controller IED (in the bays)

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

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

2.3.1 Select-before-execute

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

2.3.2 Command supervision

Bay/station interlocking and blocking

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

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

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

2.3.3 Run Time Command cancellation

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

2.3.4 Self-supervision

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

2.3.5 User configuration

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

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

The Functional requirement shall be divided into following levels:

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

b. System Level Functions

3.1. Bay level functions

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

- Bay control functions including data collection functionality in bay control/protection unit.
- Bay protection functions

Separate IEDs shall be provided for bay control function and bay protection function.

3.1.1. Bay control functions

3.1.1.1. Overview

Functions

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

3.1.1.2. Control mode selection

Bay level Operation:

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal

operation bay control unit allows the safe operation of all switching devices via the bay control IED.

EMERGENCY Operation

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

REMOTE mode

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

3.1.1.3. Synchronism and energizing check

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

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

Voltage selection

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

3.1.1.4. Facility for Transformer tap changer control

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

3.1.2. Bay protection functions

3.1.2.1. General

The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices as per section Relay & Protection.

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

Event and disturbance recording function

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. The disturbance recorder function shall be as per detailed in section C&R

3.1.2.2. **Bay Monitoring Function:**

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz), and the rms values for voltage (U) and current (I) shall be calculated in the Bay control/protection unit.

3.2. System level functions

3.2.1. Status supervision

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

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

The SAS shall also monitor the status of sub-station auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analogue values shall be monitored and recoded through this IED.

3.2.2. Measurements

The analogue values acquired/calculated in bay control/protection unit shall be displayed locally on the station HMI and in the control centre. The abnormal values must be discarded. The analogue values shall be updated every 2 seconds.

Threshold limit values shall be selectable for alarm indications.

3.2.3. Event and alarm handling

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

3.2.4. Station HMI

3.2.4.1. Substation HMI Operation:

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

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

3.2.4.2. Presentation and dialogues

General

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

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

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

The following standard pictures shall be available from the HMI:

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

3.2.4.3. HMI design principles

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

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

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

- Update blocked or manually updated
- Control blocked
- Normal state

3.2.4.4. Process status displays and command procedures

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

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

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

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

3.2.4.5. System supervision & display

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

3.2.4.6. Event list

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

The event and associated time (with1 ms resolution) of its occurrence has to be displayed for each event.

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

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

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible

to store all events in the computer for at least one month. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

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

Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

- Date and time
- Bay
- Device
- Function e.g. trips, protection operations etc.
- Alarm class

3.2.4.7. Alarm list

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

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

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

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

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

3.2.4.8. Object picture

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

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

shall be displayed.

3.2.4.9. Control dialogues

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

- Breaker and disconnector
- Transformer tap-changer

3.2.5. User-authority levels

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

- Display only
- Normal operation (e.g. open/close of switchgear)
- Restricted operation (e.g. by-passed interlocking)
- System administrator

For maintenance and engineering purposes of the station HMI, the following authorisation levels shall be available:

- No engineering allowed
- Engineering/configuration allowed
- Entire system management allowed

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

3.2.6. Reports

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

- Trend reports:
  - Day (mean, peak)
  - Month (mean, peak)
  - Semi-annual (mean, peak)
  - Year (mean, peak)
- Historical reports of selected analogue Values:
  - Day (at 15 minutes interval)
  - Week
  - Month
  - Year

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

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

i. Daily voltage and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.

ii. Weekly trend curves for real and derived analogue values.

iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.

iv. Provision shall be made for logging information about breaker status like number of operation with date and time indications along with the current vale it interrupts (in both condition i.e. manual opening and fault tripping)

v. Equipment operation details shift wise and during 24 hours.

vi. Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Positions, temperature and status of pumps and fans for transformers.

vii. Printout on adjustable time period as well as on demand system frequency and average frequency.

viii. Reports in specified formats which shall be handed over to successful bidder. The bidder has to develop these reports. The

reports are limited to the formats for which data is available in the SAS database.

3.2.7. Trend display (historical data)

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

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

3.2.8. Automatic disturbance file transfer

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

3.2.9. Disturbance analysis

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

3.2.10. IED parameter setting

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

3.2.11. Automatic sequences

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

3.3. Gateway

3.3.1 Communication Interface

The Substation Automation System shall have the capability to support simultaneous communications with multiple independent remote master stations,

The Substation Automation System shall have communication ports as follows:
(a) Two ports for RLDC shall arrange to ALDC/SLDC/RLDC.
(b) Two ports for DCS

The communication interface to the SAS shall allow scanning and control

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

3.3.2 Remote Control Centre Communication Interface

Communication channels between the Substation Automation System and RLDC is not part of SAS system.

3.3.3 **Interface equipment:**

The PLCC Modem will be provided for communicating between Substation Automation system and Remote control centre.

Modem supplied shall not require manual equalization and shall include self-test features such as manual mark/space keying, analogue loop-back, and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. The modem should be stand alone complete in all respects including power supply to interface the SAS with communication channel. The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem. All necessary hardware and software shall also be in the scope of bidder except the communication link along with communication equipment between substation control room and Remote Control Centre.

3.3.4 Communication Protocol

The communication protocol for gateway to control centre must be open protocol and shall support IEC 60870-5-101 and IEC 61850 for all levels of communication for sub-station automation such as Bay to station HMI, gateway to remote station etc..

4.0 System hardware:

4.1 Redundant Station HMI, and Engineering cum Disturbance Recorder Work station:

The contractor shall provide redundant station HMI in hot standby mode. The servers used in these work stations shall be of industrial grade.

The SAS system shall be latest type either i5 or i7 with quad processor 640GB hard disk, 5GB RAM, DVD writer,multishot card reader in built,1GB graphic card.It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components. Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features.
The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space:

1. Storage of all analogue data (at 15 Minutes interval)and digital data including alarm , event and trend data for thirty(30) days,
2. Storage of all necessary software,
3. 20GB space for OWNER'S use.

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

4.1.1 **HMI (Human Machine Interface)**

The VDU shall show overview diagrams (Single Line Diagrams) and complete details of the switchgear with a colour display. All event and alarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, decluttering etc.

4.1.2 Visual Display Units/TFT's (Thin Film Technology)

The display units shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 27" diagonally in size and capable of colour graphic displays.

The display shall accommodate resolution of 1280 X 1024 pixels.

4.1.3 Printer

The Printer shall of multi functional.It shall be robust & suitable for operation with a minimum of 132 characters per line. The printing operation shall be quiet with a noise level of less than 45 dB suitable for location in the control room. Printer shall accept and print all ASCII characters via master control computer unit interface.

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

All reports and graphics prints shall be printed on laser printer. One dot

matrix printer shall be exclusively used for hourly log printing.

All printers shall be continuously online.

4.1.4 Mass Storage Unit

The mass storage unit shall be built-in to the Station HMI. All operational measured values, and indications shall be stored in a mass-storage unit **in form** of **DVD RW** The unit should support at least Read (48X), Write(24X), and Re-Write (10X) operations, with Multi-Session capability. It should support ISO9660, Rockridge and Joliet Filesystems. It should support formatting and use under the operating system provided for Station HMI. The monthly back up of data shall be taken on disc. The facility of back up of data shall be inherent in the software.

4.1.5 Switched Ethernet Communication Infrastructure

Redundant switched optical Ethernet communication infrastructure for SAS shall be provided.

Each switch shall have at least 20 percent spare ports for connecting bay level IEDs and one spare port for connecting station bus.

4.2 Bay level unit

The bay unit shall use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select-before-operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation commands from station HMI and control centre. The bay unit shall have the capability to store all the data for at least 24 hours.

One no. Bay level unit shall be provided for supervision and control of each 220 kV (a bay comprises of one circuit breaker
and associated disconnector, earth switches and instrument transformer). The Bay level unit shall be equipped with analogue and binary inputs/outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.

The Bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

4.2.1 Input/Output (I/O) modules

The I/O modules shall form a part of the bay level unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear. The measured values of voltage and current shall be from the secondaries of instrument transformers. The digital inputs shall be acquired by exception with 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state

4.3 Switchyard Panel Room:

The **switchyard panel room shall be constructed to house** Bay level units, bay mimic, relay and protection panels, PLCC panels etc. one each for two bays
In case of incomplete diameter the switchyard panel room shall have necessary space for accommodating the future bay IEDs. The layout of equipment/panel shall be subject to Owner's approval. The switchyard panel room shall be provided with necessray illuminations, fire alarm system with at least two detectors **with necessary power supply if required** and it shall be wired to SAS.

4.4 Extendibility in future

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

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

5.0 Software structure

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

5.1.1 Station level software

5.1.1.1 Human-machine interface (HMI)

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

5.1.2 Bay level software

5.1.1.1 System software

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

5.1.1.2 Application software

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

5.1.1.3 Network Management System:

The contractor shall provide a network management system software for following management functions:

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

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

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

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

6.0 TESTS

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV sub-station equipment installed in sheltered area in the outdoor switchyard and specified ambient conditions:

6.1 Type Tests:

6.1.1 Control IEDs and Communication Equipment:

a. Power Input:
   i. Auxiliary Voltage
   ii. Current Circuits
   iii. Voltage Circuits
   iv. Indications

b. Accuracy Tests:
   i. Operational Measurd Values
   ii. Currents
   iii. Voltages
   iv. Time resolution

c. Insulation Tests:
   i. Dielectric Tests
   ii. Impulse Voltage withstand Test

d. Influencing Quantities

i. Limits of operation
ii. Permissible ripples
iii. Interruption of input voltage

e. Electromagnetic Compatibility Test:

i. 1 MHZ. burst disturbance test
ii. Electrostatic Discharge Test
iii. Radiated Electromagnetic Field Disturbance Test
iv. Electrical Fast transient Disturbance Test
v. Conducted Disturbances Tests induced by Radio Frequency Field
vi. Magnetic Field Test
vii. Emission (Radio interference level) Test.
viii. Conducted Interference Test

f. Function Tests:

i. Indication
ii. Commands
iii. Measured value Acquisition
iv. Display Indications

g. Environmental tests:

i. Cold Temperature
ii. Dry Heat
iii. Wet heat
iv. Humidity (Damp heat Cycle)
v. Vibration
vi. Bump
vii. Shock

6.2 Factory Acceptance Tests:

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IED's applicable type test certificates shall be submitted.

The manufacturing and configuration phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab. During FAT the entire Sub-station Automation System including complete control and protection system to be supplied under present scope shall be tested for complete functionality and configuration in factory itself. The extensive testing shall be carried out during FAT. The purpose of Factory Acceptance Testing is to ensure trouble free installation at site. No major configuration setting of system is envisaged at site.

If the complete system consists of parts from various suppliers or some parts are already installed on site, the FAT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site

together with the site acceptance test (SAT).

6.2.1 Hardware Integration Tests:

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests. The vendor specifically demonstrates how to add a device in future in SAS during FAT. The device shall be from a different manufacturer than the SAS supplier.

6.2.2 Integrated System Tests:

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

6.3 Site Acceptance Tests:

The site acceptance tests (SAT) shall completely verify all the features of SAS hardware and software. The bidder shall submit the detailed SAT procedure and SAT procedure shall be read in conjunction with the specification.

7.0 SYSTEM OPERATION

7.1 Substation Operation

7.1.1 NORMAL OPERATION

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

The coloured screen shall be divided into 3 fields :

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

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

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

- Prompting of indications e.g. fault indications in the switchgear, and

- prompting of operational sequences e.g. execution of switching operations

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

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

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

8.0 POWER SUPPLY

Power for the substation automation system shall be derived from substation 220V DC system.
Inverter of suitable capacity shall be provided for station HMI **disturbance recorder evaluation unit** and its peripheral devices e.g. printer etc. In the event of Power failure, necessary safeguard software shall be built for proper shutdown.

9.0 DOCUMENTATION

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

(a) System Architecture Drawing
(b) Hardware Specification
(c) Functional Design Document

(d) Clear procedure describing how to add an IED/bay/diameter in future covering all major supplier

The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported, and of similar look/feel. All CAD drawings to be provide in "dxf" format.

- List of Drawings
- Substation automation system architecture
- Block Diagram
- Guaranteed technical parameters, Functional Design Specification and Guaranteed availability and reliability
- Calculation for power supply dimensioning
- I/O Signal lists
- Schematic diagrams
- List of Apparatus
- List of Labels
- Logic Diagram (hardware & software)
- **Switchyard Panel Room** layout drawing
- Control Room Lay-out
- Test Specification for Factory Acceptance Test (FAT)
- Product Manuals
- Assembly Drawing
- Operator's Manual
- Complete documentation of implemented protocols between various elements
- Listing of software and loadable in CD ROM
- Other documents as may be required during detailed engineering

Two sets of hard copy and Four sets of CD ROM containing all the as built documents/drawings shall be provided.

10.0 TRAINING AND SUPPORT SERVICES

10.1 Training

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

that being supplied to Employer.

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

The Contractor shall quote training prices as indicated in BPS.

The schedule, location, and detailed contents of each course will be finalized during Employer and Contractor discussions.

10.2 Computer System Hardware Course

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

(a) System Hardware Overview: Configuration of the system hardware.

(b) Equipment Maintenance: Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, LANs, routers and printers. Configuration of all the hardware equipments.

(c) System Expansion: Techniques and procedures to expand and add equipment such as loggers, monitors, and communication channels.

(d) System Maintenance: Theory of operation and maintenance of the redundant hardware configuration, failover hardware, configuration control panels, and failover switches. Maintenance of protective devices and power supplies.

(e) Subsystem Maintenance: Theory of design and operation, maintenance techniques and practices, diagnostic procedures, and (where applicable) expansion techniques and procedures. Classes shall include hands-on training for the specific subsystems that are part of Employer's equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be taught in detail.

(f) Operational Training: Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments. This training shall be provided on Employer equipment, or on similarly configured systems.

10.3 Computer System Software Course

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

(a) System Programming: Including all applicable programming languages and all stand-alone service and utility packages provided

with the system. An introduction to software architecture, Effect of tuning parameters (OS software, Network software, database software etc.) on the performance of the system.

(b) Operating System: Including the user aspects of the operating system, such as program loading and integrating procedures; scheduling, management, service, and utility functions; and system expansion techniques and procedures

(c) System Initialization and Failover: Including design, theory of operation, and practice

(d) Diagnostics: Including the execution of diagnostic procedures and the interpretation of diagnostic outputs,

(e) Software Documentation: Orientation in the organization and use of system software documentation.

(f) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.4 Application Software Course

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

(a) Overview: Block diagrams of the application software and data flows. Programming standards and program interface conventions.

(b) Application Functions: Functional capabilities, design, and major algorithms. Associated maintenance and expansion techniques.

(c) Software Development: Techniques and conventions to be used for the preparation and integration of new software functions.

(d) Software Generation: Generation of application software from source code and associated software configuration control procedures.

(e) Software Documentation: Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.

(f) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.5 Requirement of training:

The contractor shall provide training for personnel comprehensively covering following courses.

S. No.	Name of Course
1	Computer System Hardware
2	Computer System Software
3	Application Software

11.0 RELIABILITY AND AVAILABILITY

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

- Mechanical and electrical design
- Security against electrical interference (EMI)
- High quality components and boards
- Modular, well-tested hardware
- Thoroughly developed and tested modular software
- Easy-to-understand programming language for application programming
- Detailed graphical documentation and application software
- Built-in supervision and diagnostic functions
- Security
  - Experience of security requirements
  - Process know-how
  - Select before execute at operation
  - Process status representation as double indications
- Distributed solution
- Independent units connected to the local area network
- Back-up functions
- Panel design appropriate to the harsh electrical environment and ambient conditions
- Panel grounding immune against transient ground potential rise

Outage terms

1) **Outage**

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

2) **Actual outage duration (AOD)**

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

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

4) **Actual Outage hours (AOH)**
The sum of actual outage duration within the reporting period

$AOH = \sum AOD$

5) **Availability:**
Each SAS shall have a total availability of 99.98 % i.e. the ratio of total time duration minus the actual outage duration to total time duration.

11.1 Guarantees Required

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

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

After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability criterion, the test is considered to be completed successfully. After that the system shall be taken over by the employer and then the guarantee period shall start.

SECTION-2B

PROTECTION REQUIREMENTS

The general protection requirements for the system are indicated

The total critical fault clearing time, including the circuit breaker operating time, from fault initiation in any part of the system under all conditions shall not be more than 80 ms for faults within zone-I reach (i.e. up to 80% of line length) and 100 ms for end zone faults including carrier transmission time of 20ms.

The SIR values to be considered for the operating time of relays for the SWYD feeders shall be between 4 and 15. The rated break time for the EHV circuit-breaker, as offered, shall be considered for the purpose of circuit-breaker operating time. The Bidder shall furnish the operating time curves at various SIR values for all types of faults.

2.1 EHV Line Protection

Each line shall be provided with the following protection scheme. The protection scheme shall be complete and necessary trip relays flag relays, aux relays, CVT selection relays etc are to be provided as per scheme requirements.

i) **Main-I**: Numerical Distance protection scheme suitable for carrier aided protection.

ii) **Main-II**: Numerical Distance protection scheme suitable for carrier aided protection of a make different from that of Main-I Protection. (Main -II Relay is not Applicable for 132kV)

ii) Backup Numerical directional overcurrent and earth fault protection (For 132kV Line feeder protection)

The Main-I and Main-II distance protection shall be of equal performance capability.

The Main-I and Main–II distance protection relays shall be connected to two different protection groups to meet the requirements of relevant clause above.

iii) **Local Over voltage Function**: The over voltage function shall have adjustable voltage and time settings. It shall monitor all phases and be tuned to power system frequency. The over voltage function shall have two independent voltage and time stages. It is also acceptable for the local over voltage function to be a built-in feature of the Main-I and Main-II Distance Protection relays.

iv) Back-up IDMT Earth fault Function: A back-up IDMT Directional earth fault protection function shall be provided in each Main protection system. The function shall measure zero sequence current and have suitable current/timer setting range.

v) Open Jumper Protection: The open jumper protection function shall operate upon detecting negative sequence current and shall provide an alarm. The open jumper protection function, as a built-in feature of the Main-I and Main-II protection is also acceptable.

The protective relays shall be suitable for use with capacitor voltage transformers (CVTs) having non-electronic damping and transient response as per IEC.

Back-up over-current Protection: Distance protection gets disabled, in case of its connected VT fuse, failure. Consequent to this, a back-up over-current function shall get activated in the respective distance relays.

Numerical Distance Protection Scheme

i) The numerical distance relays shall be the latest version meeting the in-service criteria specified elsewhere.

ii) The distance protection schemes shall be such as to facilitate compatibility with the protection at the remote ends of the 400kV transmission lines.

iii) The reaches of relay for zones 1, 2 & 3 should be able to cover line lengths associated with this contract.

iv) The distance protection shall be of the non-switched type with separate measurements for all phase-to-phase and phase-to-ground fault types.

v) The protection shall have two, independent, continuously variable, time settings each with a range of 0 to 5 s for zone-2 and zone-3.

vi) The characteristics shall have adjustable characteristic angle setting ranges of 45° to 85°.

vii) Tripping characteristics shall be polygonal and mho circle with adjustable offset and with independently adjustable reactive and resistive reaches (for polygonal characteristics) separately settable for each zone. The type of tripping characteristics shall be user selectable.

viii) The protection shall operate correctly for close-up three-phase faults and other adverse conditions. It shall operate instantaneously when the circuit-breaker is closed onto a zero-volt 3-phase fault.

ix) The protection shall provide Phase segregated tripping i.e. single phase as well as three-phase tripping.

x) The protection shall have a maximum resetting time of 60 milliseconds.

xi) Zone 3 shall have a reverse offset capability adjustable to 10 to 20% of zone-3 setting. Their should be only an an independent reverse zone 4 shall be provided.

xii) The earth fault measurements shall have zero sequence compensation variables from 0.5 to 5 (scalar Z0/Z1).

xiii) The setting / reach should not be affected by mutual coupling effects

xiv) It shall have a continuous current rating of 2 times rated current. The relay shall also be capable of carrying a high short time current of 100 times the rated current without damage for a period of 1.0 s. The voltage circuit shall be capable of continuously withstanding 1.2 times the rated voltage and 1.7 times for 3 s.

xv) The protection shall include **Power Swing Blocking** protection. The power swing blocking feature shall:

- be of three pole type
- Block/unblock tripping during power swing conditions, separately for each zone.
- Have a continuously adjustable time delay on pick up of 0 to 5s.
- Be in service during the dead time of a single pole Reclosing cycle.
- Have user configurable unblocking criteria in the case of fault detection during a power swing.

xvi) Shall include **Fuse Failure Protection**, which shall

a) Monitor all the three fuses of the CVT and associated cabling against open circuit

b) Inhibit trip circuits on operation and initiate annunciation

c) Have an operating time of less than 7.0 ms

d) Remain inoperative for system earth faults

xvii) It shall have user configurable scheme logic such as permissive under-reach (PUTT), Permissive over-reach (POTT), Direct Transfer Trip, Blocking scheme etc. using communication channels. The scheme shall be complete so that the user can select any option on site without any modification. Non-carrier aided

schemes such as Zone-1 extension, Loss of Load etc. shall be provided to ensure high-speed clearance during channel failure.

xviii) The protection shall be able to distinguish between short circuit and heavy load conditions.

xix) It shall have supplementary over current and earth fault protection functions.

xx) The dead line charging feature shall have adjustable minimum and maximum voltages.

xxi) The protection shall have a multiple settings group feature. It shall be possible to switch between the various available setting groups when the relay is in service without compromising the protection during the switch-over.

xxii) The protection shall include the following additional functions:

- Weak-in feed tripping
- Echo function
- Current reversal guard
- Switch onto fault logic
- It shall be suitable for series compensated lines.

2.2 Digital Fault Recording

A Digital Fault Recorder shall be provided for each line. The Digital Fault Recorder shall meet the following requirements:

a) Shall be used to record the graphic form of the instantaneous values of analog inputs such as voltages and currents in all the three phases, open delta voltage and neutral current in the primary circuits in the case of a short circuit (fault) and a disturbance in the Power System, as per the required technical parameters.

b) Shall be provided with a self-monitoring facility.

c) Fault / disturbance logs shall be clearly identified by Fault ID, Fault date and time (hour, minutes, seconds and ms). Time stampings on fault records shall be synchronized with a GPS clock.

d) The disturbance recorder shall comprise distributed individual acquisition units, one for each feeder and an evaluation unit which is common for the entire substation. The acquisition units shall acquire the disturbance data for the pre-fault, fault and post-fault periods and transfer them to the evaluation unit automatically for storage on a mass storage device.

The acquisition unit shall be suitable for inputs from current transformers with 1 A rated secondary and capacitive voltage transformers with 63.5 V (phase-to-neutral voltage) rated secondary.

e) Shall have Scan rate of 1000 Hz or better for sampling each of the analog channels having a fundamental frequency of 50 HZ. The frequency response for these channels shall be DC on the lower side to 50 HZ or better on the upper side. Any interposing devices provided with the DFR system shall not compromise this frequency response.

f) Shall be provided with sensors based on threshold values of voltage, current and frequency and rate of change of system frequency. External signals if required can also be used for triggering the DR. The starting sensors of the DFR, and pick-up, shall preserve the disturbance/fault data on the non-volatile solid state memory of the acquisition unit. The setting of the starting sensors shall be flexible, and shall have reasonable range/steps. The settings of the starting sensors shall be field programmable.

g) The fault data from the Digital Fault Recording feature shall be available in IEEE / COMTRADE format. The data format shall be compatible for dynamic protection relay testing with the relay test kit to be supplied by the Bidder. The necessary equipment for interfacing and transfer of data shall also be supplied by the Bidder.

h) All the fault records shall be transferred to the Protection / DR Station at the Substation Level automatically or on request for further detailed analysis. The software for analyzing the fault data shall be available at the Substation Level. The software shall be capable of the complete analysis of fault data, including the display of RMS/Peak envelop of any voltage / current, fundamental power frequency deviation, display of instantaneous values of Real Power (computed value), Reactive Power (computed value), power factor angle etc. A facility to edit the fault data shall also be provided.

i) Following analog values shall be recorded –

Currents (R-phase, Y-phase, B-phase and Neutral), Voltages (V_{RY}, V_{YB}, V_{RB}, Open Delta).

The pre-fault recording time shall be at least 200 ms and the post-fault recording time shall be at least 5.0secs.8 Analogue channels (IR, IY, IB, IN, VRY, VYB, VBR AND OPEN DELTA)

16 Nos. Digital Channels

Amplitude Resolution of Analogue channels (minimum): 16 bit

Event Resolution of Digital Channel (minimum): 1 milli sec

Aux. voltage: 220VDC (+10%,-20%)

DFR system offered shall also have a built-in Distance-to-Fault Locator Function.

This function shall be an on-line function and shall be suitable for circuit-breaker operating times of 2 cycles. The computed distance-to-fault shall be available as a percentage of line length or kilometers without requiring any further calculations. It shall have a provision for mutual zero sequence compensation. It shall have an accuracy of 3% or better for all types of faults and fault levels. This accuracy shall not be impaired under following conditions:

- Presence of remote end in-feed
- Predominant DC component in fault current
- High fault arc resistance
- Severe CVT transients
- Mutual zero sequence coupling between adjacent lines

Digital Fault Recorder, having specified technical Parameters, as a built in feature in Main Numerical Distance Relay is also acceptable.

Necessary hardware and software, for automatic up-loading the data captured by disturbance recorder to the DR workstation available in the substation, shall be included in the scope.

2.3 Transformer Protection (For ICT only)

The following protection scheme shall be provided for each of the transformer. The protection scheme functions may be grouped into Group-

Current in all three windings in nine analogue channels in case of 400 kv class and above transformers or 6 analogue channels for lower voltage transformers and voltage in one channel

The disturbance recorder shall have the facility to record the following external digital channel signal apart from the digital signal pertaining to differential relay:

a) REF protection operated

b) HV breaker status (Main and Tie)

c) IV Breaker status

d) Bucholz / OLTC Buckolz alarm / trip etc.

e) WTI/OTI/PRD alarm / trip of transformer etc.

Necessary hardware and software, for automatic up-loading the data captured by disturbance recorder to the DR workstation available in the substation, shall be included in the scope.

2.3.2 Over fluxing Protection Relays (both HV & LV side) shall

a) operate on the principle of voltage to frequency ratio and shall be phase to phase connected and to be provided on both sides of ICT.

b) have inverse time characteristics, matching with transformer over fluxing withstand capability curve

c) provide an independent 'alarm' with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of 'v/f' between 100% to 130% of rated values

d) tripping time shall be governed by 'v/f' time characteristics of the relay

e) have a set of characteristics for various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at 'v/f' values of 1.4 and 1.5 times, the rated values, respectively.

f) have an accuracy of operating time, better than $\pm$ 10%

g) have a resetting ratio of 95% or better

h) be acceptable as a built in feature of other protection IEDs provided for transformer protection

2.3.3 Restricted Earth Fault Protection shall

a) be single pole type.

b) be of current/voltage operated type

c) have a current setting range of 10-40% of 1 Amp./ have a suitable voltage setting range

d) be tuned to the system frequency.

2.3.4 Back up directional over current and earth fault protection scheme (On HV as well as LV side)

a) shall have three over current and one earth fault elements which shall be either independent or composite units

b) shall include necessary VT fuse failure relays for alarm purposes

c) **over current** elements shall

- Have directional IDMT characteristics with a definite minimum time of 3 seconds at 10 times setting
- Have a variable setting range of 50-200% of rated current
- Have low transients,over reach high set instantaneous unit of continuously variable setting range 500-2000% of rated current
- Have a characteristic angle of 30/45 degree lead
- Include hand reset flag indicators or LEDs

d) **Earth fault** relay shall

- Have directional IDMT characteristics with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current
- Have low transient, over reach high set instantaneous unit of continuously variable setting range 200-800% of rated current

- Have a characteristic angle of 45/60 degree lag
- Include hand reset flag indicators or LEDs
- Include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay

2.3.5 **Transformer overload Protection Relay** shall

a) Be of single pole type

b) Be of definite time over current type

c) Have one set of over-current relay element, with continuously adjustable setting range of 50-200% of rated current

d) Have one adjustable time delay relay for alarm having setting range of 0.1-10.0 seconds, continuously.

e) Have a drop-off/pick-up ratio greater than 95%.

f) Be acceptable as built in feature of numerical transformer differential relay

2.3.6 Further, transformer auxiliary protections contacts (Buchholz, , Oil Temperature, winding Temperature, OLTC Buchholz etc.) can be wired suitably in above protections or provide separate flag relays/ auxiliary relays as per scheme requirements.

2.4 EHV Circuit-breaker Protection

Each circuit breaker in the Switchyard shall be provided with following protection functions:

i) **Local Breaker Back up Protection Function**: LBB protection function shall be provided for each circuit breaker in 220 kV & 132kV switchyard. The LBB protection function for each circuit-breaker shall be interfaced with the Bus bar protection at the Bay Level over the communication LAN as well as by hard-wired signals between the Bay Protection Unit and the Bus bar protection panels. The intent of providing the hard-wired logic as a back up to the software logic is to ensure that in the event of failure of Substation LAN, the bay level functionality is not hampered. The LBB function as a built-in function of busbar Protection Unit is

I and Group-II protections and it shall be complete. Necessary trip relays flag relays, aux relays, CVT selection relays etc are to be provided as per scheme requirements.

a) Transformer Differential protection

b) Restricted Earth Fault Protection

c) Over fluxing Protection – for both HV & LV side

d) Back up directional over current and earth fault protection - for both HV & LV side

e) Transformer overload Protection

2.3.1 Transformer Differential Protection

Transformer Differential protection scheme shall

1) Be triple pole type, with faulty phase identification / indication

2) Have an operating time not greater than 30 milli seconds at 5 times the rated current

3) Have three instantaneous high set over current units

4) Have an adjustable bias setting range of 20-50%

5) Be suitable for rated current of 1 amp

6) Have second harmonic or other inrush proof features and also should be stable under normal over fluxing conditions. Magnetizing inrush

   proof feature shall not be achieved through any intentional time delay e.g. use of timers to block relay operation or using disc operated relays

7) Have an operating current setting of 15% or less

8) Include necessary separate interposing current transformers for angle and ratio correction or have internal feature in the relay to take care of the angle & ratio correction

9) Have a fault recording feature to record graphic form of instantaneous values of following analogue channels during faults and disturbances for the pre fault and post fault period:

acceptable provided it meets all the requirements specified for the LBB function. In addition, the LBB protection function shall meet following criteria:

- Be three pole type having three single phase units
- Shall operate for stuck breaker conditions
- Have an operating/resetting time each of less than 15 ms.
- The LBB function shall be initiated by external trip contacts from the Bay Protection Units and after a set time delay shall energize the trip bus in the bus bar protection scheme on which the stuck breaker is connected for tripping of all breakers connected to the particular bus. In addition, for all 220 kV CBs other than that of Line breakers, an instantaneous repeat trip command from LBB shall be given to the primary breaker through a separate self reset trip relay. The interlocking between
- Have a setting range of 5 to 80% of rated current
- Have a continuous thermal withstand of 2 times rated current irrespective of the setting.
- Have time delay feature with a continuously adjustable setting range of 0.1 to 1 s.
- Shall be an individual phase comprehensive scheme.
- Shall not operate during the single-phase auto-reclosing period.
- Shall provide end-fault protection that initiates a direct transfer trip to the remote end upon the detection of a loss of SF6.

ii) **Trip Coil Supervision:** A Trip Coil supervision function shall be provided for each lockout trip relay and each of the circuit-breaker trip coils. It shall incorporate both the pre-close and post-close supervision of trip coils and associated trip circuits. An audible alarm shall be given in the event of operation of trip coil supervision function. It shall have a time delay on drop-off of not less than 200ms. Trip coil supervision function as a built-in feature of the BCUs / Bay Protection Units is also acceptable, provided it meets all other requirements specified here, including loss of DC supply.

2.6 Bus bar Protection

a) Each bus bar shall be covered with segregated low impedance, distributed high-speed single bus bar protection scheme. Single Busbar protection scheme shall be provided for each main bus and transfer bus for 220kV voltage levels. The LBB shall be made part of bubar protection

scheme provided it meets all the requirements specified for the LBB function.

Each bus bar protection scheme shall:

- Be numerical having modular construction and three pole type.
- Have a maximum operating time for all types of faults of 20ms at five times the setting value.
- Operate selectively for each bus bar.
- Give 100% security up to a **40kA** fault level.
- Incorporate continuous supervision for the CT secondary against any possible open circuit and if it occurs, shall render the relevant zone of protection in-operative. The zone protection contact shall be bypassed automatically and the affected zone shall be protected by the appropriate healthy zone only.
- Not give any false operation during normal load flow in bus bars.
- Shall not mal-operate for an out-of-zone fault, particularly with current transformer saturation under maximum through fault current with maximum DC offset
- Shall provide independent zones of protection and incorporate clear zone indication.
- Include individual high speed tripping relays for each feeder, including future ones, as identified in single line diagram.
- Be transient free in operation.
- Incorporate protection "In-Out" switches for each zone.
- Be a biased differential type, have operate and restraint characteristics and self monitoring facilities.
- Shall be of phase segregated type with three-pole tripping
- Shall include individual high speed hand reset tripping relays & modules for each bay including future bays as per SLD.
- Shall include continuous DC supply supervision
- Shall be provided with " End fault Protection feature"

- not cause tripping for the differential current below the load current of heaviest loaded feeder. Contractor shall submit application check for the same.

- shall include necessary C.T switching relays wherever C.T. switching is involved and have CT selection incomplete-alarm.

- shall include trip relays, CT switching relays (if applicable), auxiliary CTs (if applicable) as well as additional power supply modules, input modules etc. as may be required to provide a Bus-bar protection scheme for the complete bus arrangement i.e. for all the bays or breakers as per the single line diagram for new substations.

2.7 TRIPPING RELAY

High Speed Tripping Relay shall

(a) Be instantaneous (operating time not to exceed 10 milli-seconds).

(b) Reset within 20 milli seconds

(c) Be D.C. operated

(d) Have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, disturbance recorder, fault locator etc.

(e) Be provided with operation indicators for each elemet/coil.

2.8 DC SUPPLY SUPERVISION RELAY

(a) The relay shall be cpable of monitoring the failure of D.C supply to which, it is connected.

(b) It shall have adequate potential free contacts to meet the scheme requirement.

(c) the relay shall have a time delay on drop off of not less than 100 milli seconds & be provided with operation indicator/flag.

The Bus bar protection relay shall be connected to the Inter bay communication bus. Use of external CT-switching relays and CT ratio correction relays is not acceptable. The bus bar relay settings and

analysis of bus bar fault data shall be possible from the Substation Level.

2.9 TIME SYNCHRONIZATION EQUIPMENT

i) Time Synchronization equipments shall be provided to receive Coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite (GPS) for time synchronization of all components of the SAS/ generator relay panel.

ii) Shall be complete in all respects including antenna, all cables, processing equipment, etc.

iii) All auxiliary systems and special cables required for synchronization of the equipment shall be supplied and commissioned by the Contractor.

iv) Shall work from DC supplies only and the Bidder to clarify if any built-in battery back -up is provided, in which case, same shall be of long life lithium batteries.

v) Shall be immune to hostile electrical environment. Suitable protections are to be provided against lightning surges and over-voltages in power supply systems and antenna feeders.

vi) The system shall be fully tested to the relevant international standards such as IEC: 801 and IEC: 255. One copy of all the test reports shall be enclosed with the bid.

vii) All components of the SWYD SAS, including Substation Controllers, Workstations, Bay Control Units (BCU) and Bay Protection units (BPU) and all numeric protection relays shall be synchronized with an accuracy of 1ms.

viii) The system should be able to track more than 1 satellite at a time to ensure no interruptions of synchronization signals.

ix) The system shall have provisions for any of the following output signals

- NTP (network time protocol) 100Mbits Ethernet port
- IRIG-B00x (TTL, pulse width modulated signal)

- 2 x Pulse per half-hour/ Pulse per minute/ Pulse per second outputs via potential free contacts
- Any other output port as may be required for the offered system.
- Alarm status contact indicating healthy status of system

The actual port requirements (no/type) in line with the system offered shall be finalized during detail engineering.

x) These output ports shall be compatible with the requirement of the equipment to be synchronized i.e. BCUs and BPUs. The master clock in control room shall also be synchronized with the time synchronization system.

xi) The equipment should have a periodic time correction facility of one-sec. periodicity. The equipment shall also have real time display in hour, minute, second (24 hour mode) and have a separate time display unit to be mounted on top of the MIMIC panel, having display size of approx. 144mm height.

2.10 TYPE TESTS

The reports for following type tests shall be submitted by the bidder for the Protective relays, Fault locator 7 disturbance recorder.

a) Insulation tests as per IEC 60255-5

b) DC Voltage dips & interruptions/variation as per IEC 6100-4-29.

c) High frequency disturbance test as per IEC 61000-4 16, Class IV (Not applicable for electromechanical relays)

d) Electrostatic discharges as per IEC 61000-4-2, level; 4 (not applicable for Electromechanical relays)

e) Fast transient test as per IEC 61000-4-4, Level IV (Not applicable for electromechanical relays)

f) Relay characteristics, performance & accuracy test as per IEC 60255.

- Steady state characteristics & operating time.

- Dynamic characteristics & operating time for distance protection relays & current differential protection relays.

- For disturbance recorder, only performance tests are intended under this item.

- Conformance test as per IEC 61850-10

g) Tests for thermal & mechanical requirements as per IEC 60255-6.

h) Tests for rated burden as per IEC 60255-6.

i) Contact performance test as per IEC 60255-0-20 (not applicable for Distance to fault locator & Disturbance recorder.

In case there is a change either in version or in model (Except firmware) of the relay, the contractor has to submit the type test reports for the offered revision/model.

SECTION-2C

ENERGY METERING REQUIREMENTS

The following shall be provided for the metering system for 220 kV Extn and 132kV Switchyard

i) Energy meter suitable for ABT requirement as specified below shall be provided for following bays:

a) 220 kV Line bay, 132kV Line Bay (Main and Check)

b) 220 kV GT bay,

c) 220 kV ST bay,

d) 220 kV ICT bay 132kV Side of 220/132kV ICT (Main)

ii) This metering system shall have following feature:

a) Meters shall be microprocessor-based MWH meters having an accuracy class of 0.2S . MVARH meters shall have accuracy class of 0.5 or better.

b) These meters shall have provision for downloading of data through an optical port and /or through RS 232 / 485 port.

c) Even under absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meters.

d) All these meters shall be networked and connected to the Metering Master Station (MMS), provided for the ABT meters.

e) It shall be possible to download the energy meter data into the MMS.

Technical Requirements of Energy Meters for ABT Requirement

Bidder shall supply energy meters along with metering station, MRI as per the technical specification given below:

a) Shall be microprocessor-based conforming to IEC 60687 /IEC 62052-11/IEC 62053-22 / IS 14697

b) Shall carry out measurement of active energy (both import and export) and reactive energy (both import and export) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load.

c) Shall have an accuracy of energy measurement of at least Class 0.2 for active energy and at least Class 0.5 for reactive energy according to IEC 60687, and shall be connected to Class 0.2S CT cores and Class 0.2 VT windings.

d) The active and reactive energy shall be directly computed in CT & VT primary ratings.

e) The reactive energy shall be recorded for each metering interval in four different registers as MVARh (lag) when active export, MVARh (Lag) when active import, MVARh (lead) when active export, MVARh (Lead) when active import.

f) Two separate registers shall be provided to record MVARH when system voltage is >103% and when system voltage is < 97%.

g) Shall compute the net MWh and MVARh during each successive 15-minute block metering interval along with a plus/minus sign, instantaneous net MWh, instantaneous net MVARh, average frequency of each 15 minutes, net active energy at midnight, net reactive energy for voltage low and high conditions at each midnight.

h) Each energy meter shall have a display unit with a seven digit display unit. It shall display the net MWh and MVARh with a plus/minus sign and average frequency during the previous metering interval; peak MWh demand since the last demand reset; accumulated total (instantaneous) MWh and MVARh with a plus/minus sign, date and time; and instantaneous current and voltage on each–phases.

i) All the registers shall be stored in a non-volatile memory. Meter registers for each metering interval, as well as accumulated totals, shall be downloadable. All the net active/reactive energy values displayed or stored shall be with a plus /minus sign for export/import.

j) At least the following data shall be stored before being over-written for the following parameters.

	Parameters details		Min No of days
1.	Net MW	15 min block	40 days in meter
2.	Aver Freq	15 min block	40days in meter
3.	Net MVARH for V > 103%	15min block	40days in meter
4.	Net MVARH for V < 97%	15min block	40days in meter
5.	Cumulative Net MWH at every midnight		10 days in meter/ 40 days in PC
6.	Cumulative Net MVARH for V> 103%		10 days in Meter/ 40 days in PC

at every midnight

7. Cumulative Net MVARH for V < 97% At every midnight — 10 days in Meter / 40 days in PC

8. Date and time blocks of VT failure on any phase.

k) Shall have a built in clock and calendar with an accuracy of less than 15 seconds per month drift without assistance of external time synchronizing pulse.

l) Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment being supplied by the bidder.

m) The voltage monitoring of all the three voltages shall be provided and alarm contacts provided to signal failures to the Substation Automation System, as well as alarm contact to indicate meter healthy status. The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be less than 2 VA.

n) The power supply to the meter shall be healthy even with a single-phase VT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be provided by a built in long life battery and shall not need replacement for at least 10 years with a continuous VT interruption of at least 2 years. Date and time of VT interruption and restoration shall be automatically stored in a non-volatile memory.

o) Shall have an optical port on the front of the meter for data collection from either a hand held meter reading instrument (MRI) having a display for energy readings or from a notebook computer with suitable software . The bidder shall supply the MRI and/or notebook complete with all optical interface unit required.

p) A dedicated Metering Master Station (MMS), hardwired to all the energy meters in bidder's scope shall be provided. The MMS shall be complete to offer the following functionality:

- To automatically downloaded the meter data from each meter point at scheduled daily intervals
- To create calculated metering points by addition, subtraction, and applying multiplication factors to meter points
- To present the demand of each meter point and calculated meter points in graphical format over specified intervals.

- To calculate the total energy exchanged on meter points or calculated meter points for different time-of-use periods over specified intervals.
- To export meter data to Excel format for external analysis.
- To calculate the Unscheduled interchanges (UI) and the corresponding commercial parameters to suit the ABT requirements. The exact requirements shall be worked out during detail engineering stage , in coordination with site.

q) The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same.

r) Each meter shall have a unique identification code provided by the Employer and shall be permanently marked on the front of the meter and stored in the non volatile memory of the meter.

s) The MMS shall be connected to substation LAN so as to facilitate display of Energy data at other locations of the LAN. However, this may be treated as optional.

SECTION-2D

CONSTRUCTIONAL FEATURES OF PANELS

1. TYPE OF PANEL

1.1 Simplex panel shall consist of a vertical front panel with equipment mounted thereon and having wiring access from rear for control panels & either front or rear for relay panels. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built-in locking facility or will be provided with pad-lock.

2. CONSTRUCTIONAL FEATURES

2.1. Control and Relay Board shall be of panels of simplex or duplex type design as indicated in bill of quantity. It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes be properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions. No price increase at a later date on this account shall be allowed . However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

2.2. Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IS: 2147.

2.3. Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and

2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

2.4. All doors, removable covers and panels shall be gasketed all around with synthetic rubber gaskets Neoprene/EPDM generally conforming with provision of IS 11149. However, XLPE gaskets can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

2.5. Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent from outside, with all exterior surfaces tune and smooth.

2.6. Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti vibration strips made of shock absorbing materials that shall be supplied by the contractor, shall be placed between panel & base frame.

2.7. Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly.

2.8. Relay panels of modern modular construction would also be acceptable.

3. MOUNTING

3.1. All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush.

3.2. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and

are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

3.3. The Contractor shall carry out cut out, mounting and wiring of the free issue items supplied by others which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

3.4. The centre lines of switches, push buttons and indicating lamps shall be not less
than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel.

3.5. The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.

3.6. No equipment shall be mounted on the doors.

3.7. At existing station, panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement of equipment (centre lines of switches, push buttons and other equipment) on the front of the panel.

4. PANEL INTERNAL WIRING

4.1. Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally.

4.2 All wiring shall be carried out with 650V grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

1) All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 1.5mm sq. per lead.
2) All current transformer circuits one 2.5 sq.mm lead.
3) Voltage transformer circuit (for energy meters): Two 2.5 mm sq.per lead.

4.3. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.

4.4. Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panels running throughout the entire length of the panels.

4.5. Wire termination shall be made with solderless crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.

4.6. Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

4.7. Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments

5. TERMINAL BLOCKS

5.1. All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 650 V grade and have 10 Amps. continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

5.2. Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

5.3. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.

5.4. Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side

- All CT & PT circuits: minimum of two of 2.5mm Sq. copper.
- AC/DC Power Supply Circuits : One of 6mm Sq. Aluminium.
- All other circuits: minimum of one of 2.5mm Sq. Copper.

5.5. There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the

clearance between two rows of terminal blocks edges shall be minimum of 150mm.

5.6. Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the Owner's external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

5.7. The number and sizes of the Owner's multi core incoming external cables will be furnished to the Contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included the scope of supply.

6. MISCELLANEOUS ACCESSORIES

6.1. **Plug Point** : 240V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

6.2. **Interior Lighting** : Each panel shall be provided with a fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

6.3. **Switches and Fuses** : Each panel shall be provided with necessary arrange ments for receiving, distributing and isolating of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-

circuits shall be separately provided with miniature circuit breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. MCBs shall confirm to IS :13947 . Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. However voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS:13703 mounted on plug-in type fuse bases. . Fuse carrier base as well as MCBs shall have imprints of the fuse 'rating' and 'voltage'.

6.4. **Space Heater** : Each panel shall be provided with a space heater rated for 240V , single phase , 50 Hz Ac supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit

7. EARTHING

7.1. All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq.mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

7.2. Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.

7.3. All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The colour code of earthing wires shall be green.

7.4. Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

7 .5. VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

SECTION - 3
GENERAL TECHNICAL REQUIREMENTS

3.0 GENERAL

This section stipulates the General Technical Requirements under the Contract and will form an integral part of the Technical Specification.

a) The provisions under this section are intended to supplement general requirements for the materials, equipment and services covered under other sections and; is not exclusive. However in case of conflict between the requirements specified in this section and requirements specified under other sections, the requirements specified under respective sections shall hold good.

3.1 SITE INFORMATION

	Particulars	
a)	Customer/ Purchaser/ Owner	BSEB/BHEL/BSEB
b)	Engineer/ Consultant	STEAG Energy Services (India) Pvt Ltd, Noida, India
c)	Project Title	220/ 132 kV Switchyard at Barauni TPS
d)	Location	Barauni / Bihar
e)	Postal Address	Shall be furnished to successful bidder
SITE CONDITIONS		
a)	Max. ambient air temp.	42.4° C
b)	Min. ambient air temp.	8.4° C
c)	Max. design ambient temp.	50° C
d)	Min. design ambient temp.	5° C
e)	Max. RH	100 %
f)	Min. RH	---
g)	Height above MSL	Less than 1000 m
h)	Pollution Severity	Shall be furnished to successful bidder
i)	Seismic Zone	Zone – IV as per IS 1893
WIND DATA		
b)	Site Wind Pressure	50 m / sec
c)	Average Annual Rainfall	1119.1mm (Max. rain fall in 24 hrs is 352.8 mm)

3.2 INSTRUCTION TO BIDDERS

The bidders shall submit the technical requirements, data and information as per the technical data sheets, provided in Section-4.

The bidders shall furnish catalogues, engineering data, technical information, design documents, drawings etc fully in conformity with the technical specification.

It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different than those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to the Purchaser. Unless brought out clearly, the Bidder shall be deemed to conform to this specification scrupulously. All deviations from the specification shall be clearly brought out in the respective schedule of deviations. Any discrepancy between the specification and the catalogues or the bid, if not clearly brought out in the schedule, will not be considered as valid deviation.

Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.

Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/ or needed for erection, completion and safe operation of the equipment as required by applicable codes, though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components not specifically stated in the specification but which are necessary for commissioning and satisfactory operation of the switchyard unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment under supply shall be inter-changeable with one another.

The Contractor shall supply type tested (including special tests as per tech. specification) equipment and materials. The test reports shall be furnished by the Contractor, along with equipment/ material drawings. In the event of any discrepancy in the test reports, (i.e., if any test report is not acceptable due to any design/ manufacturing changes or due to non-compliance with the Technical Specification and/ or applicable standard), the tests shall be carried out without any additional cost implication to the PURCHASER. The PURCHASER reserves the right to get any or all type/tests conducted/repeated.

3.3 STANDARDS

The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

The equipment to be furnished under this specification shall conform to latest issue (with all amendments) of specified standards.

In addition to meeting the specific requirement called for in Sections 1 and 2 of the Technical Specification, the equipment shall also conform to the general requirement of the applicable standards, which shall form an integral part of the specification.
The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other.

When the specific requirements stipulated in the specifications exceed or differ from those required by the applicable standards, the stipulation of the specification shall take precedence.

Other internationally accepted standards, which ensure equivalent or better performance than that specified in the standards referred, shall also be accepted. The bidder shall submit copies of such standards.

In case governing standard for the equipment is different from IS or IEC,, the salient points of difference shall be clearly brought out in the offer along with English language version of standard or relevant extract of the same. The equipment conforming to standards other than IS/IEC shall be subject to Purchaser's / owner's approval.

The bidder shall clearly indicate in his bid the specific standards in accordance with which the works will be carried out.

3.4 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment. The equipment shall also comply to the following:

a) All outdoor EHV equipment except marshalling kiosks shall be suitable for hot line washing.
b) To facilitate erection of equipment, all items to be assembled at site shall be "match marked"'.
c) Piping, if any, between equipment control cabinet and operating mechanism to marshalling box of the equipment shall bear proper identification to facilitate the connection at site.

3.5 ENGINEERING DATA

3.5.1 Drawings

All drawings submitted by the Contractor including those submitted at the time of bid shall be in sufficient detail to indicate the type, size, arrangement, material description,

Bill of Materials, weight of each component, break-up for packing and shipment, the external connections, fixing arrangement required. the dimensions required for installation and interconnections with other equipment and materials, clearances and spaces required for installation and interconnections between various portions of equipment and any other information specifically requested in the specifications.

Each drawing submitted by the Contractor shall be clearly marked with the name of the Purchaser, the unit designation, the specifications title, the specification number and the name of the Project. If standard catalogue pages are submitted, the applicable items shall be indicated therein. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in metric units.

Further work by the Contractor shall be in strict accordance with these drawings and no deviation shall be permitted without the written approval of the Purchaser, if so required.

The review of these data by the Owner will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. Owner may not indicate a thorough review of all dimensions, quantities and details of the equipment, material, any devices or items indicated or the accuracy of the information submitted. This review and /or approval by the Owner shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.

All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Purchaser. Approval of Contractor’s drawing or work by the Purchaser shall not relieve the contractor of any of his responsibilities and liabilities under the Contract

All engineering data submitted by the Contractor after final process including review and approval by the Owner shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Owner in Writing.

3.5.2 Approval Procedure

The scheduled dates for the submission of these as well as for, any data/ information to be furnished by the Purchaser would be discussed and finalised at the time of award. The following schedule shall be followed generally for approval.

	Stage	No. of copies	Submission Schedule /Remarks
i)	Initial Submission Drawings, Data sheets, Type test Reports and O & M	5	As per agreed schedule

	Instructions (in case of standard products)		
ii)	Resubmission, if required	5	Within 3 (three) weeks from date of comments including both ways postal time
iii)	Approval or comments		Within 3(three) weeks of receipt of resubmission.
iv)	Furnishing of distribution copies of drawings in bound volume	See remark	2 Weeks from the date of final approval Five (5) copies for each substation plus two (2) copies for corporate centre.
v)	Furnishing of distribution copies of type test reports in bound volumes	See remark	2 Weeks from the date of final approval One (1) copies for each substation plus two (2) copies for corporate centre.
vi)	Furnishing of distribution copies of Routine test reports	See remark	2 Weeks from the date of final approval One (2) copies for each substation
vii)	Furnishing of instruction/ operation manuals	See remark	As per agreed schedule Four (4) copies for each substation plus three (3) copies for corporate centre.
viii)	Video Cassette (VHS-PAL) highlighting installation and maintenance techniques/ requirements of circuit breaker & Isolators	See remark	As per agreed schedule One (1) copy for each substation plus two (2) copies for corporate centre.
ix)	RTFs of as-built drawings	See remark	As per agreed schedule Two (2) copies for each substation plus two (2) copies for corporate centre.
x)	As-built drawings	See remark	After completion of works Two (2) copies for each substation plus two (2) copies for corporate centre.
xi)	CD-ROM/ Optical Disc of all 'As - built drawings/ design documents	See remark	on completion of works one (1) set for each substation plus two (2) set for corporate centre.

NOTES:

a) The contractor may note that all re-submissions must incorporate all comments given in the prior submission by the Purchaser. Adequate justification for not incorporating the same must be submitted, failing which the submitted documents may be returned.

b) The drawings, which are required to be frequently referred during execution, should be submitted on cloth lined paper. The list of such drawings shall be finalised with the Contractor at the time of Award.

c) All major drawings shall be submitted in Auto Card Version 12 or better.

d) The instruction Manuals shall contain full detailed drawings of all equipment being supplied under this contract, their exploded views with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.

e) If after the commissioning and initial operation of the installation, the instruction manuals require any modifications/ additions/ changes, the same shall be incorporated and the Contractor shall submit the updated final instruction manuals to the Purchaser.

f) The Contractor shall furnish to the Purchaser, spare parts catalogues also

3.6 COLOUR SCHEME

All steel structures, plates, etc. shall be painted with non-corrosive paint on a suitable primer. It may be noted that normally all Purchaser's electrical equipment in Purchaser's switchyard are painted with shade 697 of IS 5. All the indoor cubicles shall be of same colour scheme. For other miscellaneous items, the Purchaser will approve colour scheme.

3.7 PROVISIONS FOR EXPOSURE TO HOT AND HUMID CLIMATE

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity' heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipment located in non-air-conditioned areas shall also be of same type.

One or more adequately rated thermostatically controlled heaters, suitable for continuous operation at 240-V supply, shall be provided to maintain temperature so as to prevent condensation in any compartment. On-off switch and fuse shall also be provided. The surface temperature of the heater assembly shall be restricted to a value which will not shorten the life of the heater sheaths or the wire insulation or other components in the compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from the heaters to minimize deterioration of supply wire insulation. The heaters shall be designed to prevent any contact between the heater wire and air. The design and construction of the heater shall be to approval.

Besides the space heaters, special moisture and fungus resistant varnish may be applied to parts, which may be subjected to or predisposed to the formation of fungi due to presence or deposit of nutrient substances. The varnish shall not be applied to any surface or part where the treatment will interfere with the operation or the performance of the equipment.
The compartments may be provided with ventilation openings, if required. These openings shall be covered with fine wire mesh of brass to prevent ingress of insects and minimise the entry of dirt and dust. Openings in outdoor equipment shall be provided with shutter type blinds.

The degree of protection shall be in accordance with IS 13947 (Part-1) / IEC-947 (Part-1). Type test report for degree of protection test, on each type of the box shall be submitted for approval.

The minimum requirements for panels are as follows :

a) Installed out door: IP- 55
b) Installed indoors in air-conditioned area: IP-31
c) Installed in covered area: IP-52
d) Installed indoors in non air-conditioned area where possibility of entry of water is limited: IP-41.
e) For LT Switchgear (AC & DC distribution Boards): IP-52.

3.8 RATING PLATES, NAME PLATES AND LABELS

Each main and auxiliary item of substation shall have, permanently attached to it in a conspicuous position, a rating plate of non-corrosive material. Upon this plate, shall be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate shall be according to IEC recommendations.

All such nameplates, instruction plates, rating plates shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates, one with Hindi and the other with English inscription, may be provided.

3.9 QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Contractor's Works or at his Sub-contractor's premises or at the Purchaser's site or at any other place of Work, are in accordance with the specifications, the Contractor shall adopt a suitable quality assurance programme to control such activities at all points, as necessary. Such programme shall be outlined by the Contractor and shall be finally accepted by the Purchaser after discussions before the award of Contract. A quality assurance programme of the contractor shall generally cover the following:

(a) Contractor's organisation structure for the management and implementation of the proposed quality assurance programme :
(b) Documentation control system;
(c) Qualification data of bidder's key personnel;
(d) The procedure for purchases of materials, parts components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
(e) System for shop manufacturing and site erection controls including process controls and fabrication and assembly control;
(f) Control of non-conforming items and system for corrective actions;
(g) Inspection and test procedure both for manufacture and field activities;
(h) Control of calibration and testing of measuring instruments and field activities;
(i) System for indication and appraisal of inspection status;
(j) System for quality audits;
(k) System for authorising release of manufactured product to the Purchaser
(1) System for maintenance of records;
(m) System for handling storage and delivery; and

(n) A quality plan detailing out the specific quality control measures and Procedures adopted for controlling the quality characteristics relevant to each item of equipment furnished and/or services rendered.

The Purchaser or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and Procedure of the Contractor/'his vendors quality management and control activities.

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Purchaser and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed shall be included in the Contractor's quality assurance programme.

3.10 Quality Assurance Documents

The Contractor shall be required to submit the following Quality Assurance Documents within three weeks after despatch of the equipment.

All Non - Destructive Examination Procedures, stress relief and weld repair. Procedure actually used during fabrication and reports including radiography interpretation reports.
Welder and welding operator qualification certificates Welder's identification list, listing welder's qualification procedure and welding identification symbols.
Raw material test reports on components as specified by the specification and/or agreed to in the quality plan.

Stress relief time temperature charts/oil impregnation time temperature charts
Factory test results for testing required as per applicable codes/mutually agreed quality plan/standards referred in the technical specification.
The quality plan with verification of various customer inspection points (CIP) as mutually agreed and methods used to verify the inspection and testing points in the quality pain were performed satisfactorily.

3.11 INSPECTION, TESTING & INSPECTION CERTIFICATE

The Purchaser, his duly authorised representative and/or outside inspection agency acting on behalf of the Purchaser shall have at all reasonable times free access to the Contractoes premises or Works and shall have the power ,at all reasonable times to inspect and examine the materials and workmanship of the Works during its manufacture or erection if pert of the Works is being manufactured or assembled at other premises or works, the Contractor shall obtain for the Engineer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor’s own premises or works.inspection may be made at any stage of manufacture, despatch or at site at the option of the Purchaser and the equipment if found unsatisfactory due to bad workmanship or quality, material is liable to be rejected.

The reports for all type tests and additional type tests as per technical specification and shall be furnished by the Contractor along with equipment/material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO/IEC Guide 25/17025 or EN 45001 by the national accredition body of the country where laboratory is located) or witnessed by the representative(s) of BSPGCL or Utility. The test-reports submitted shall be of the tests conducted within last 5 (five) years prior to the date of LOA i.e. 24.09.2013. In case the test reports are of the test conducted earlier than 5 (five) years prior to the date of LOA, the contractor shall repeat these test(s) at no extra cost to the purchaser.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the technical specification or any/all additional type tests not carried out without any additional cost implication to the Purchaser.

The purchaser intends to repeat the type tests and additional type tests on transformers, reactors, cables and battery chargers for which test charges shall be payable as per provision of contract. The price of conducting type tests and additional type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal sheets. These type tests charges would be considered in bid evaluation. In case the bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected.

All equipment being supplied shall conform to type tests and shall be subject to routine tests in accordance with requirements stipulated under respective sections. Purchaser reserves the right to witness any or all the type tests. The Contractor shall intimate the Purchaser the detailed programme about the tests at least three (3) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies. Purchaser reserves the option for getting any or all the type tests repeated on the equipment. The Contractor shall also submit type test procedure for approval of the Purchaser.

The Contractor shall give the Purchaser/inspector thirty (30) days written notice of any material being ready for testing. Such tests shall be to the Contractor's account except for the expenses of the inspector. Unless witnessing of the tests is virtually waived, the Purchaser/ inspector will attend such tests within thirty (30) days of the date of which the equipment is notified as being ready for test/ inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and the Contractor shall forthwith forward duly certified copies of test reports in triplicate to the Inspector.

The Purchaser or Inspector shall, within fifteen (15) days from the date of inspection as defined herein, give notice in writing to the Contractor, of any objection to any

drawings and all or any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Purchaser/ inspector giving reasons therein, that no modifications are necessary to comply with the Contract.

When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Purchaser/ inspector shall issue a certificate to this effect within fifteen (15) days after completion of tests but if the tests are not witnessed by the Purchaser/inspector, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Engineer/ Inspector. Failure of the Purchaser/inspector to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Purchaser to accept the equipment should it, on further tests/ after erection, be found not to comply with the Contract. The equipment shall be dispatched to site only after approval of test reports and issuance of MICC by the Purchaser.

In all cases where the Contract provides for tests whether at the premises or at the works of the Contractor or of any Sub-Contractor, the Contractor except where otherwise specified shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Purchaser /Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Purchaser Inspector or to his authorised representative to accomplish testing.

The inspection by Purchaser and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract.

The Purchaser will have the right of having at his own expenses any other test(s) of reasonable nature carded out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

The Purchaser reserves the right for getting any field tests not specified in respective sections of the technical specification conducted on the completely assembled equipment at site. The testing equipment for these tests shall be provided by the Purchaser

3.12 FINISHING OF METAL SURFACES

All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. High tensile steel nuts & bolts and spring washers shall be electro-galvanized to service condition 4. All steel conductors including those used for earthing/ grounding (above ground level) shall also be galvanized according to IS: 2629.

3.12.1 HOT DIP GALVANISING

The minimum weight of the zinc coating shall be 610 g/ m2 and minimum thickness of coating shall be 85 microns for all items thicker than 6mm. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall not be less than 610 g/ m2.

The galvanised surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

After galvanizing no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate treatment shall be provided to avoid formation of white rust after hot dip galvanisation. The galvanized steel shall be subjected to six one-minute dips in copper sulphate solution as per IS-2633.

Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions.

Following galvanizing tests shall essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of zinc rich paint at site shall not be allowed.

3.12.2 PAINTING

All sheet steelwork shall be degreased, pickled, phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with atleast two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving-type zinc chromate primer. The first coat may be 'flash dried" while the second coat shall be stoved.

After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.

The exterior colour of the paint shall be as per shade no. 697 of IS -5 and inside shall be glossy white. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipment.

In case the Bidder proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted along with the Bids for Purchaser's review & approval.

3. 13 AUXILIARY SUPPLY

The sub-station auxiliary supply is normally met through a system indicated under section-5 having the following parameters. The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform to the parameters as indicated in the following.

Normal Voltage	Variation in Voltage	Frequency in HZ	Phases	Neutral connection
415V	+/- 1 0%	50 +/- 5%	3/4-Wire	Solidly
240 V	+/- 1 0%	50 +/- 5%	1 /2-wire	Earthed.
220V	240-190 V	DC	2-wire	Isolated
50 V	53- 41.5 V	DC	2-wire	+ve -earthed

Combined variation of voltage and frequency shall be limited to +/- 10%.

3.15 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

3.15.1 All power clamps and connectors shall conform to IS:5561 & NEMA CC1 and shall be made of materials listed below-

a)	For connecting ACSR conductors	Aluminium alloy casting, conforming to designation A6 of IS:617 and shall be tested for all test as per IS:617
b)	For connecting bimetallic equipment terminals made of copper/ brass with ACSR conductors	Connectors made from Al alloy casting, conforming to designation A6 of IS 617 with 2-mm thick bimetallic liner and shall be tested as per IS 617. Copper alloy liner shall be cast integral with Al body.
c)	For connecting G.I. Shield wire	Galvanised mild steel

d)	i) Bolts, nuts & Plain washers	Electro-galvanised for sizes below M12, for others hot dip galvanized
	ii) Spring washers for items 'a' to 'c'	Electro-galvanised mild steel suitable for at least service conditions as per IS 1573

Each equipment shall be supplied with the necessary terminals and connectors, as required by the ultimate design for the particular installation. The conductor terminations of equipment shall be either expansion, sliding or rigid type suitable for 4" IPS (O.D. : 114.2 mm, ID: 97.18 mm) aluminium tube or suitable for Quad/Twin Moose ACSR Conductor (450 mm sub-conductor spacing and 250 mm Sub-Conductor spacing for 400 kV & 220 kV respectively). The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings and the equipment shall be factory tested with the connectors in position. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

Where copper to aluminium connections are required, bimetallic clamps shall be used, which shall be properly designed to ensure that any deterioration of -the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress. The design details of the joints shall be furnished to the Purchaser by the Contractor.

Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.

No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner of minimum 2 mm thickness shall be cast integral with aluminium body for Bimetallic clamps.

All casting shall be free blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/ sliding) type connection of 4" IPS Al tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

Clamp shall be designed to carry the same current as the conductor and the temperature rise shall be equal or less than that of the conductor at the specified ambient temperature. The rated current for which the clamp/connector is designed with respect to the specified reference ambient temperature, shall also be indelibly marked on each component of the clamp/connector, except on the hardware.

All current carrying parts shall be designed and manufactured to have minimum contact resistance.

Clamps and connectors shall be designed to be corona controlled. Corona extinction voltage for 400kV class clamps shall not be less than 320KV (rms) and R.I.V. level shall not be more than 1000 micro volts at the test voltage specified in respective sections.

3.15.2 Tests

Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Type tests/special tests shall be carried out on three samples.

The following is the list of type tests:

i) Temperature rise test (max. temp. rise allowed is 35°C over 50°C ambient)
ii) Short time current test
ii) Corona (dry) and RIV (dry) test (for 220 kV and higher voltage level)
iv) Resistance test and tensile test

3.16 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT

All types of boxes, cabinets, etc. shall generally conform to & be tested in accordance with IS-5039/ IS 8623, IEC: 439, as applicable, and the clauses given below:

Control cabinets, junction boxes, Marshalling boxes and terminal boxes shall be made of sheet steel or aluminium enclosure and shall be dust, water and vermin proof. Sheet steel used shall be at least 2.0-mm thick cold rolled or 2.5 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. In case of aluminium enclosed box the thickness of aluminium shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

Cabinet/boxes shall be free-standing, floor-mounting type, wall mounting type or pedestal mounting type as per requirements. Cabinet/boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of the gasket shall be such that it does not get damaged/cracked during the operation of the equipment.

All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged/cracked during the ten years of operation of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth straight and reinforced if necessary to minimise distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting at least 150 mm above the base of the marshalling kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland plate. The gland shall

project at least 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel- plated glands shall be dust-proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS: 6121.

A 240-V, single phase, 50 Hz, 15-A AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade. For illumination, 20-W fluorescent tube or a 15-W CFL shall be provided. The switching of the fittings shall be controlled by a door switch.

All control switches shall be of rotary switch type and Toggle/piano switches shall not be accepted.

Positive earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self- etching washer. Earthing of hinged door shall be done by using a separate earth wire.

The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/ferruling by pasting the same on the inside of the door.

Tests

a) In addition to routine tests as per IS 5039, following routine tests shall also be conducted:
   i) Check for wiring
   ii) Visual and dimension check
b) The enclosure of bay marshalling kiosk, junction box, terminal box shall be type tested for IP-55 as per IS: 13947. After IP-55 test, 2.5 kV rms for 1 (one) minute, insulation resistance and functional tests shall be carried out.

A canopy and sealing arrangements for operating rods shall be provided in Marshalling Boxes control cubicles to prevent ingress of rain water.

3.17 AUXILIARY SWITCHES

The auxiliary switches shall conform to following type tests:

(a) Electrical endurance test - A minimum of 2000 operations for 2 A DC with a time constant greater than or equal to 20 millisecond with a subsequent examination of mV drop/visual defects/temperature rise test.
(b) Mechanical endurance test. A minimum of 1,00,000 operations with a subsequent checking of contact pressure test/ visual examination.
(c) Heat run test on contacts.

Insulation Resistance Test / HV test (2.5 kV for one minute)

3. 18 TERMINAL BLOCKS AND WIRING

Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All inter-phase and external connections to equipment or to control cubicles will be made through terminal blocks.

Terminal blocks shall be 1100-V grade and have continuous rating to carry the maximum expected current on the terminals. Those shall be of moulded piece, complete with insulated barriers stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted 'terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CATM4, Phoenix, cage-clamp-type of Wago or equivalent.
Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short-circuiting and earthing facilities.

The terminal shall be such that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally.
The conducting part in contact with cable shall preferably be tinned or silver-plated. However, nickel-plated copper or zinc-plated steel shall also be acceptable.

The terminal blocks shall be of extensible design.

The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non-deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live.

At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminal rows.

Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors on each side.

a)	All circuits except CT circuits	Min. of two of 2.5 mm2 of copper flexible.
b)	All CT circuits	Min. of 4 nos. of 2.5 mm2 copper flexible

There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm.

The Contractor shall furnish all wire, conduits and terminals for the necessary inter-phase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. For equipment rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge over voltages either transferred through the equipment or due to transients induced from the EHV circuits.

All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The Contractor shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment

3.19 LAMPS AND SOCKETS

3.19.1 Lamps:

All incandescent lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

3.19.2 Sockets

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

3.19.3 Hand Lamp:

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

3.19.4 Switches and Fuses:

Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signalling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with switch-fuse units. Selection of the main and sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

All fuses shall be of HRC cartridge type conforming to IS 9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal Protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

3.20 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into

successful Operation, shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

3.21 PACKAGING & PROTECTION

All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Owner / Purchaser, the supplier shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Purchaser to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The supplier shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharf age and other such charges claimed by the transporters, railways etc. shall be to the account of the supplier.

All coated surfaces shall be protected against abrasion, impact, discolouration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves and piping's and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

3.22 Bushings, Hollow Column Insulators, Support Insulators:

Bushings shall be manufactured and tested in accordance with IS: 2099 & IEC: 137 while hollow column insulators shall be manufactured and tested in accordance with IEC 233/IS 5621. The support insulators shall be manufactured and tested as per IS 2544/IEC 168 and IEC 273. The insulators shall also conform to IEC 815 as applicable.

The bidder may also offer composite silicon insulator, conforming to IEC-1109.

Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.
Supports insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the

strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

3.23 MOTORS

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall conform to type tests and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP 55 as per IS: 4691. For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP 44 as per IS: 4691.

Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing

Motors weighing more than 25Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.

Motors shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particular as given in Clause 15.0 of this section.

All induction motors shall be suitable for full voltage direct-on-line starting and accelerating to the rated speed along with the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

Motors shall be capable of withstanding the electro-dynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.

The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS: 325.
Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding

at least two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.

The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS: 325 (for 3 phase induction motors) after adjustment due to increased ambient temperature specified.

The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.

All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

TESTING AND COMMISSIONING

An indicative list of tests is given below. Supplier shall perform any additional test based on specialities of the items as per the field O.P./Instructions of the driven equipment supplier or Owner / purchaser without any extra cost to the owner / Purchaser. The supplier shall arrange all instruments required for conducting these tests along with calibration certificates and shall furnish the list of instruments to the Owner / Purchaser for approval.

Insulation resistance.

Phase sequence and proper direction of rotation.

Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

ANNEXURE - A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

General:

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona both by observing the voltage level for the extinction of visible corona under failing power frequency voltage and by measurement of radio interference voltage (RIV).

Test Levels:

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

3.0 Test Methods for RIV:

3.1 RIV tests shall be made according to measuring circuit as per CISPR Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency within 10% of 0.5 MHz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in micro-volts.

3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

3.3 Temporary additional external corona shielding may be provided in measurement of RIV. Only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, 115% and 130% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 400 kV and 220 kV is listed in Section -1/ Section -2 of the specification together with maximum permissible RIV level in micro-volts.

3.5 The measuring instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noises meter.

4.0 Test Methods Visible Corona

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a

search technique shall be used near the onset and extinction voltages, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 130% of RIV test voltage and maintained for five minutes. The voltage will then be decreased slowly until visible corona disappears. The procedure shall be repeated at least 4 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purpose of determining compliance with the specification shall be the lowest of the four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, 115% and 130%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

The test shall be recorded on each photograph. Additional photographs shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

In addition to photographs of the test object, at least four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by that energisation of test object at a voltage which results in corona.

The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

However, both tests shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Purchaser's inspector if, in his opinion, it will not prejudice other test.

Test Records:

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

a) Background noise before and after test.
b) Detailed procedure of application of test voltage.
c) Measurements of RIV levels expressed in micro-volts at each level.
d) Results and observations with regard to location and type of interference sources detected at each step.

e) Test voltage shall be recorded when measured RIV passes through 100 micro-volts in each direction.

f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

ANNEXURE - B

SEISMIC WITHSTAND TEST PROCEDURE

The seismic withstanding test if required to be conducted on the complete equipment shall be carried out along with supporting structure.

The supplier shall arrange to transport the structure from his premises/POWERGRID sites for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Purchaser / owner. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the Purchaser / owner.

SECTION-4		
GUARANTEED TECHNICAL PARTICULARS (GTP)		
1.00.00	**General Technical Details and Drawings**	
1.01.00	SAS Manufacturer's Name	
1.02.00	Make/Model No	
1.06.00	Bidder to state any constraints imposed by proposed system as regards to expansion	
	a) Addition of BCUs	
	b) Addition of OWSs and peripherals (like CRT/Keyboard, printers)	
	c) Addition of discreet numerical relays	
	d) Increase in communication through put	
	e) Memory addition	
1.07.00	On-line removal/replacement of BCUs/BPUs possible without switching off power supply to the corresponding rack & without affecting SAS operation	
1.08.00	Guaranteed annual system availability (refer to 2.02.00 of section-2 of specification)	
1.11.01	Overall display response time (alarms, status, analogues)	
1.11.02	Expected LAN loading	
1.11.03	Expected CPU usage of workstations and controllers	
1.11.05	Power Fail Auto Restart (PFAR) facility provided	
1.12.00	Accuracy in terms of time for all devices within substation with time synchronization (in line with Clause 1.09.00 of section-2 of Specification)	
1.13.00	Bidder to confirm strict compliance to specification requirements	
2.00.00	**Human-Machine Interface (HMI) for SAS**	
2.01.00	Bidder to confirm the compliance of HMI to specification requirements	
3.00.00	**Communication Network**	
3.01.00	Data communication speed for Substation LAN	
3.02.00	Provide drawing of data communication bus for :	
	a) Substation network	
	b) Interbay (BCU/BPU) bus including details of cable type, armouring, etc	
3.03.00	Data cable for substation network as well as Interbay (BCU/BPU) bus is armoured as per 8.02.00 & 8.03.00 of section-2 of specification	
3.04.00	Communication protocol used for :	
	a) Devices at Control Level 1 as per specification (i.e. BCU & BPU)	
	b) Substation Level LAN at Control Level 2 as per specification	
3.05.00	Data communication speed for Substation Network & Interbay Bus	
3.06.00	Interface with Owner's OPC-compliant DCS provided in line with the requirements of technical specification	

3.07.00	**Gateways (Each type)**	
3.07.01	Protocols supported by each type	
3.07.02	No. of communication Ports	
3.07.03	Details of communication Ports	
4.00.00	**Bay Control Units (BCU)**	
4.01.00	Make and type of BCU offered for	
4.02.00	No of BCU offered for each bay	
4.03.00	No of analog inputs in each BCU	
4.04.00	No of digital inputs in each BCU	
4.05.00	No of digital outputs in each BCU	
4.06.00	Accuracy of analog measurements in BCU :	
	a) Voltage	
	b) Current	
	c) Frequency	
	d) Power	
4.07.00	Bay mimic provided on BCU display	
4.08.00	Time resolution, in ms, for events/alarms acquired by BCU	
4.09.00	Built-in functions provided (if any) (list out)	
4.10.00	Detailed Technical Catalogue for offered BCU enclosed	
4.11.00	Synchronization	
	i) Angle range	
	ii) Frequency (slip) range	
	iii) Voltage range	
	iv) Synchronization source (Line/Phase)	
5.00.00	**Bay Protection Unit (BPU)**	
a)	Make and type of Main I/Main II Numerical Distance Relay offered	
b)	Country of manufacture	
c)	Hardware version number	
d)	Firmware version number	
e)	Mean-time between failures	
f)	Rated Voltage Vn (phase-to-neutral)	
g)	Rated Current In	
h)	Rated Frequency	
i)	Overvoltage capability - continuous	
j)	Overvoltage capability – 3s	

k)	Burden on voltage transformers (VA per phase)	
l)	Overcurrent capability - continuous	
m)	Overcurrent capability – 1s	
n)	Burden on current transformers (VA per phase)	
o)	Reference standards	
p)	Operating principle	
q)	Is it a full scheme design i.e. six measuring systems for each zone	
r)	Operation indicator provided separately for phase & zone of operation, power swing block/trip, SOTF, A/R Block, etc	
	s) Maximum operating time for a source to line impedance ratio equal to 15 and fault at Zone 1 reach setting	
	t) Setting range (Ohmic, time & angular) :	
	- Zone 1	
	- Zone 2	
	- Zone 3	
	- Additional Zones, if available	
	u) Maximum resetting time	
	v) Setting range of offset feature	
	w) Suitable for single and three phase trip?	
	x) Shape of characteristics for :	
	- Earth faults	
	- Phase faults	
	y) Required minimum voltage at relay terminals	
	z) Fault resistance coverage	
	aa) Zero sequence compensation range (Z0/Z1)	
	bb) Whether mutual compensation module for double circuit lines included?	
	cc) Available compensation setting range	
	dd) Self monitoring and cyclical test facilities available?	
	ee) Display on demand of various measured parameters, alarms, clock, settings, etc available?	
	ff) Facility for synchronization of internal clock with GPS, in line with specification requirement provided	
	gg) Built-in functions provided :	
	-Local overvoltage function	
	- Voltage setting range	
	- Drop off/pick up ratio	
	- Timer setting range	
	Open jumper protection	
	Power swing blocking	
	Weak infeed tripping logic	
	Echo function	
	CVT fuse failure function	

	Switch onto fault function	
	Current reversal guard	
	Digital fault recording function	
	Trip coil supervision function	
	Distance to fault locator function	
	hh) List out the user-configurable carrier-aided scheme logics (such as PUTT, POTT, Direct Transfer Trip, etc) and non-carrier aided schemes such as Zone 1 extension etc, provided	
	ii) Multiple settings group feature available (indicate the number of available setting groups)	
	jj) Back-up earth fault protection functions provided	
	kk) Dead Line Charging feature provided	
	ll) Communication ports – number and type	
	mm) Relay operating and analysis software	
	nn) Built-in sequence of event recording	
	- Resolution	
	- Number of stored events	
	oo) Built-in oscillography	
	pp) Self supervision	
5.02.00	a) Make and type of Transformer Differential Relay	
	b) Country of manufacture	
	c) Hardware version number	
	d) Firmware version number	
	e) Mean-time between failures	
	f) Rated Voltage Vn (phase-to-neutral)	
	g) Rated Current In	
	h) Rated Frequency	
	i) Overvoltage capability - continuous	
	j) Overvoltage capability – 3s .	
	k)Burden on voltage transformers (VA per phase)	
	l) Overcurrent capability - continuous	
	m)Overcurrent capability – 1s	
	n)Burden on current transformers (VA per phase)	
	o)Reference standards	
	p)Operating principle	
	q) Is each phase current separately evaluated at both end for both amplitude and phase?	
	r)Is the measurement stabilized phase by phase for CT saturation & be compensated for line CT ratio mismatches?	
	s)Is phase selectivity without compromise on resistive fault sensitivity available?	
	t) Suitable for single phase tripping?	
	u)Suitable for auto-reclosing?	
	v)Type of communication port for remote monitoring, programming and control.	
	w) Information transmitted by the relay to other end via message (Currents, supervision information, CT saturation detection, synchronization of terminals etc.)	

	x)Is direct inter-trip signal also transmitted as part of communicated information?	
	y)Is the communication delay continuously measured and automatically compensated for the differential measurement	
	z)Are error detection and correction feature available for communicated message?	
	aa)Availability of suitable programmable evaluation algorithm to ensure proper security and dependability of the message?	
	bb)Is an optional electrical or optical port provided to directly connect the signal to auxiliary channel of OLTE (optical line terminal equipment) by passing the	
	multiplexer for redundancy purpose?	
	cc) Minimum sampling frequency for analog signals (kHz).	
	dd) Is filtering and measuring techniques used with sampling frequency to ensure correct performance during all operating and transient conditions?	
	ee) Availability of self diagnostic features?	
	ff) Availability of GPS time synchronization facility?	
	gg) Availability of Programmable Scheme Logic to customize the device to meet the exact protection and control scheme requirements of the bay.	
	hh) The protection shall include the following additional functions:	
	ii) Shape of characteristics for :	
	Earth faults	
	Phase faults	
	jj) Required minimum voltage at relay terminals	
	kk) Fault resistance coverage	
	ll) Display on demand of various measured parameters, alarms, clock, settings, etc available?	
	mm) Multiple settings group feature available (indicate the number of available setting groups)	
	nn) Relay operating and analysis software	
	oo) Built-in sequence of event recording	
	Resolution	
	Number of stored events	
	Built-in oscillography	
	Self supervision	
5.03.00	a) Make and type of Restricted E/F Relay	
	b) Country of manufacture	
	c) Hardware version number	
	d) Firmware version number	
	e) Mean-time between failures	
	f) Rated voltage	
	g) Setting ranges	
	h) Drop off/pick up ratio	
	i) Timer setting range	
	j) Numerical	

5.04.00	Back up Directional OverCurrent & earth Fault Relay (67/67N)	
	a) Manufacturer & country of manufacturer	
	b) Type designation	
	c) Hardware version number	
	d) Firmware version number	
	e) Mean-time between failures	
	f) Rated voltage	
	g) Setting ranges	
	h) Drop off/pick up ratio	
	i) Timer setting range	
	j) Numerical	
5.05.00	Overfluxing Relay	
	a) Manufacturer's name, type and designation	
	b) Country of manufacture	
	c) Hardware version number	
	d) Firmware version number	
	e) Whether inverse time operating characteristic	
	provided?	
	f) Maximum operating time	
	g) Accuracy operating time	
	h) Resetting time	
	I) Numerical	
5.06.00	Stand by Earth Fault Relay	
	a) Manufacturer & country of manufacturer	
	b) Type designation	
	c) Hardware version number	
	d) Firmware version number	
	e) Mean-time between failures	
	f) Rated voltage	
	g) Setting ranges	
	h) Drop off/pick up ratio	
	i) Timer setting range	
	j) Numerical	
5.07.00	Stand alone/Built-in Digital Fault Recorder for 400 kV Lines	
a)	Manufacturer's name, type and designation	
b)	Country of manufacture	
c)	Hardware version number	
d)	Firmware version number	
e)	Mean-time between failures	
f)	Rated Voltage Vn (phase-to-neutral)	
g)	Rated Current In	
h)	Rated Frequency	
i)	Overvoltage capability - continuous	
j)	Overvoltage capability – 3s	

k)	Burden on voltage transformers (VA per phase)	
l)	Overcurrent capability - continuous	
m)	Overcurrent capability – 1s	
n)	Burden on current transformers (VA per phase)	
o)	Reference standards	
p)	Operating principle	
q)	Bidder to confirm compliance to requirements of technical specification	
r)	Scan rate range	
	i) Selectable dual scan rate	
s)	No of analog channels offered	
t)	No of digital channels offered	
u)	By how many numbers can the channels be expanded :	
	- Analog channels	
	- Digital channels	
v)	Following starting sensors provided :	
	- Threshold (voltage, current & frequency)	
	Rate of change of voltage & frequency	
w)	Pre-fault memory (in milliseconds)	
x)	Post-fault memory (in milliseconds)	
y)	Frequency response	
z)	Resolution of digital channels (in ms)	
aa)	Amplitude resolution	
bb)	Memory capacity in solid state non-volatile memory	
cc)	Provision for time synchronization of internal clock with GPS, in line with the specification requirement provided	
dd)	Whether fault data is available in IEEE/COMTRADE format at Substation Level for analysis as per the requirements of technical specification	
ee)	Whether alarm output contacts provided for power supply fail, processor fail, memory fail, printer fail, etc provided	
ff)	Whether software for analysis of fault data provided	
gg)	Detailed technical literature enclosed	
hh)	Communication ports – number and type	
ii)	Self supervision	
6.00.00	RELAYS COMMON TO 220kV Line, 220KV ST & ICT BAY	
6.01.00	Local Breaker Back-up Protection (50 LBB)	
a)	Manufacturer's name, type and designation	
b)	Country of manufacture	
c)	Hardware version number	
d)	Firmware version number	
e)	Mean-time between failures	
f)	Duplicated	
g)	Build specify location	
h)	Rated Voltage Vn (phase-to-neutral)	
i)	Rated Current In	
j)	Rated Frequency	

k)	Overcurrent capability - continuous	
l)	Overcurrent capability – 1s	
m)	Burden on current transformers (VA per phase)	
n)	Reference standards	
o)	Operating principle	
p)	Operation indicator provided	
q)	Setting ranges :	
	i) Current	
	ii) Time	
r)	Operating time	
s)	Resetting time	
u)	Communication ports – number and types	
v)	Relay operating and analysis software	
w)	No of binary outputs	
x)	No of binary inputs	
y)	Self supervision	
6.02.00	Bus bar Protection for 132kV Busbar	
	a) Manufacturer's name, type and designation of busbar protection relay	
	b) Is it complete numerical protection?	
	c) Operating principle	
	d) Rated current/voltage	
	e) Setting ranges	
	f) Operating time at 5* setting value	
	i) Does the relay give 100% security and reliability under all operating conditions and up to 40kA fault level?	
	j) CT secondary supervision and protection against CT secondary open provided	
	k) Does it require auxiliary CTs for ratio correction?	
	l) Does it require external CT switching relays?	
	m) Self-monitoring diagnostic provided	
	n) Country of manufacture	
	s) Selectable Internal or External breaker failure per bay	
	t) Overall Check Zone	
	u) Bay Out of Service switches for each bay	
	v) Overcurrent capability - continuous	
	w) Overcurrent capability – 1s	
	x) Burden on current transformers (VA per phase)	
	y) Reference standards	
	z) Bidder to confirm compliance to requirements of technical specification	
	aa) Communication ports (number and type)	
	bb) Relay operating and analysis software	
	cc) Built-in sequence of event recording	
	- Resolution	

	- Number of stored events	
	dd) Self supervision	
	ee) Built-in oscillography	
	ff) Device status and operation indications	
7.00.00	Time Synchronisation Equipment	
	a) Manufacturer's name and country of manufacture	
	b) Type designation	
	c) Tested to all relevant standards and one copy of test reports enclosed in the bid?	
	d) Accuracy	
	e) All auxiliary systems and special cables, etc required to meet the specification provided?	
	f) Suitable protections provided against lightning surges and over voltages?	
	g) Details of output ports provided for time synchronization and their specification (such as pps,ppm,pph etc,soft configurable,hard configurable etc)	
	h) Is output signal programmable at site?	

SECTION 5

ENCLOSURES TO SPECIFICATIONS

ANNEXURE 1	**CHECK LIST FOR INFORMATION TO BE FURNISHED WITH THE OFFER**
ANNEXURE 2	**SCHEDULE OF DEVIATION**
ANNEXURE 3	**SINGLE LINE DIAGRAM DRG. NO. TB2-374-510-001 REV.00**
ANNEXURE 4	**ARCHITECTURE OF EXISTING IEC 61850 BASED SAS (ALSTOM MAKE)**

ANNEXURE-1

CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER

BIDDER SHALL PUT A TICK **'✓' IF THE INFORMATION IS ENCLOSED** WITH THE OFFER, PUT A CROSS **'X' IF THE INFORMATION IS NOT ENCLOSED** OR WRITE **'NOT APPLICABLE' IF THE QUERY/ SCHEDULE IS NOT RELEVANT** AND **RETURN THIS CHECKLIST AS PART OF THE OFFER DULY SIGNED**

The offer may not be considered if the following information and this Checklist are not enclosed with the Offer.

BIDDER:
OFFER REFERENCE:

1.	Technical offer with detailed schedules of equipment/ material and spares	_____
2.	Guaranteed Technical Particulars as per Section - 4	_____
3.	Schedule of Deviations listing deviations, if any, clause-wise with respect to technical specification	_____
4.	List of past supplies complete with Purchase Order & Project name, quantity, order reference, etc., where identical equipment have been supplied.	_____
5.	Manufacturer's Quality Plans for approval	_____
6.	Field Quality Plan for approval	_____
7.	General Arrangement drawings with dimensions and weights and foundation/ fixing details	_____
8.	Drawing/ data submission Schedule	_____
9.	Type test reports. The type test reports shall be accompanied with a list listing all the relevant clauses of the applicable standard and the corresponding type test report. The manufacturer shall also furnish a certificate certifying that the test reports have been carried out on equipment identical in all respects to the one offered. In case the reports are for a different equipment and the applicability of the report is permitted as per applicable standards, the justification shall be enclosed to the list of type test reports.	_____

10. Bar Chart showing time schedule showing time required for design, manufacture, test and inspection, transport, erection, site testing and commissioning _____

11. Makes of all important components, like motors, operating switches, fuses, etc. _____

12. Any additional information called for in any part of the technical specification. _____

Date: **Signature of the authorized representative of Bidder**

Company Seal

ANNEXURE-2

SCHEDULE OF DEVIATIONS

Certified that the following are only deviations from the specification (for the equipment and systems being offered)

S. No.	Page No.	Clause No.	Deviation	Reason / Justification

Date:

Signature:

Name:

Designation:

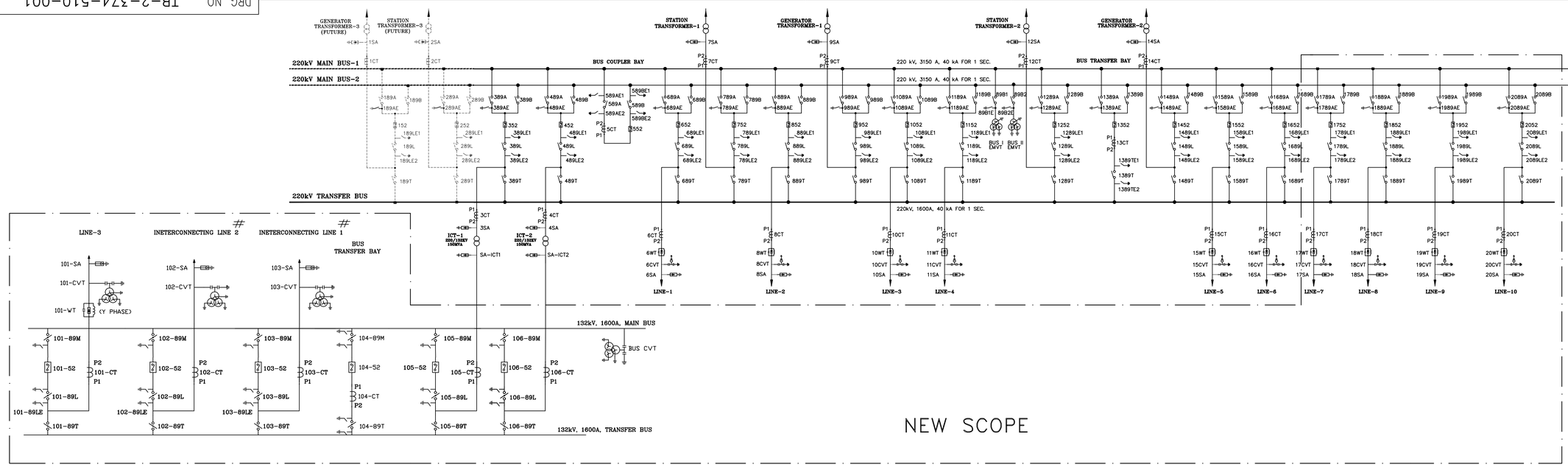
COMPUTER DRG. PATH NAME :

SIGN & DATE

INVENTORY NO.

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

DRG. NO. TB-2-374-510-001



NEW SCOPE

BILL OF QUANTITY

S.N.	EQUIPMENT DESCRIPTION	KV	SYMBOL	OLD SCOPE (QTY.)	NEW SCOPE (QTY.)
1a.	SF6 CIRCUIT BREAKER (3–PH), 1600A	245		13	04
1b.	SF6 CIRCUIT BREAKER (3–PH), 3150A – (552)	245		01	--
2a.	HCB ISOLATOR WITH 2 E/S 3ø, 1600A (MECHANICALLY GANGED)	245		13	04
2b.	HCB ISOLATOR WITH 2 E/S 3ø, 3150A (MECHANICALLY GANGED) (589A, 589AE1, 589AE2, 589B, 589BE1, 589BE2)	245		02	--
3.	HCB ISOLATOR WITH 1 E/S 3ø, 1600A (MECHANICALLY GANGED)	245		15	04
4.	HCB ISOLATOR WITHOUT E/S 3ø, 1600A, TANDEM TYPE (MECHANICALLY GANGED)	245		25	08
5a.	CURRENT TRANSFORMER,1600A (1–PH), 5 CORE (EXTENDED CURRENT RATING 120%)	245		39	12
5b.	CURRENT TRANSFORMER, 2400 (1–PH), 5 CORE (EXTENDED CURRENT RATING 120%) – (5CT)	245		03	--
6.	198kV SURGE ARRESTOR (1–PH)	198		36	12
7.	WAVE TRAP (1–PH), 1600A, 0.5 mH	245		12	08
8.	4400pF CAPACITOR VOLTAGE TRANSFORMER (1–PH)	245		18	12
9.	EMVT (1–PH)	245		06	--
10.	220/132 kV, 150 MVA ICT	220/132		02	--
11.	120 kV SURGE ARRESTER (1–PH)	120		06	09
12.	145kV, 1250A 3–PHASE, SPRING OPERATED SF6 CIRCUIT BREAKERS SUITABLE FOR 3–PHASE OPERATION.	145		--	06
13.	145kV, 1250A 3–PHASE, DOUBLE BREAK ISOLATOR (MECHANICALLY GANGED MOTOR OPERATED) WITH TWO E/S (MANUALLY OPERATED)	145		--	07
14.	145kV, 1250A 3–PHASE, DOUBLE BREAK ISOLATOR (MECHANICALLY GANGED MOTOR OPERATED) WITH ONE E/S (MANUALLY OPERATED)	145		--	05
15.	145kV, 1250A 3–PHASE, DOUBLE BREAK ISOLATOR (MECHANICALLY GANGED MOTOR OPERATED) W/O E/S	145		--	05
16.	145kV, 1–PHASE 5 CORE CURRENT TRANSFORMER	145		--	18
17.	145kV, 8800 pF, $\frac{132}{\sqrt{3}}/\frac{0.110}{\sqrt{3}}/\frac{0.110}{\sqrt{3}}/\frac{0.110}{\sqrt{3}}$kV, 1–PHASE CAPACITOR VOLTAGE TRANSFORMER	145		--	12
18.	145kV, 1250A, 0.5mH, 1–PHASE WAVE TRAP	145		--	01

220KV CT DETAILS FOR LINE BAY, GT BAY, ST BAY & TBC BAY (EXTENDED CURRENT RATING 120%)

CORE	RATIO	OUTPUT BURDEN	ISF	ACCURACY CLASS	MIN. KNEE POINT VOLTAGE(Vk)	MAX. EXCITING CURRENT at Vk/2	Rct (ohm) (max)
01	1600–800–400/1			PS	1600/800	30 mA at Vk/2 at 1600/1 TAP	8/4/2
02	1600–800–400/1			PS	1600/800	30 mA at Vk/2 at 1600/1 TAP	8/4/2
03	1600–800–400/1	20 VA	≤ 5	0.2S			
04	1600–800–400/1			PS	1600/800/400	30 mA at Vk/2 at 1600/1 TAP	8/4/2
05	1600–800–400/1			PS	1600/800/400	30 mA at Vk/2 at 1600/1 TAP	8/4/2

220KV CT DETAILS FOR BUS COUPLER CT (EXTENDED CURRENT RATING 120%)

CORE	RATIO	OUTPUT BURDEN	ISF	ACCURACY CLASS	MIN. KNEE POINT VOLTAGE	MAX. EXCITING CURRENT at Vk/2	Rct (ohm) (max)
01	2400–1600/1			PS	2400–1600/1	30 mA at Vk/2 at 2400/1 TAP	12/8
02	2400–1600/1			PS	2400–1600/1	30 mA at Vk/2 at 2400/1 TAP	12/8
03	2400–1600/1	20 VA	≤ 5	0.2	2400–1600/1		
04	2400–1600/1			PS	2400–1600/1	30 mA at Vk/2 at 2400/1 TAP	12/8
05	2400–1600/1			PS	2400–1600/1	30 mA at Vk/2 at 2400/1 TAP	12/8

132kV CURRENT TRANSFORMER DETAILS (EXTENDED CURRENT RATING 120%)

CORE	RATIO	OUTPUT BURDEN	ISF	ACCURACY CLASS	MIN. KNEE POINT VOLTAGE	MAX. EXCITING CURRENT at Vk/2	Rct (ohm) (max)
01	800–400/1			PS	800/400	25 mA at 800/1 TAP 50 mA at 400/1 TAP	8/4
02	800–400/1			PS	800/400	25 mA at 800/1 TAP 50 mA at 400/1 TAP	8/4
03	800–400/1	20 VA	≤ 5	0.2			
04	800–400/1			PS	800/400	25 mA at 800/1 TAP 50 mA at 400/1 TAP	8/4
05	800–400/1			PS	800/400	25 mA at 800/1 TAP 50 mA at 400/1 TAP	8/4

220KV LINE CVT DETAILS (4400 pF)

CORE	220/√3KV/ 110/√3V/110/√3V/110/√3V
SEC I	CLASS 3P 100 VA
SEC II	CLASS 3P 100 VA
SEC–III	0.2 50 VA

220KV BUS EMVT DETAILS

CORE	220/√3KV/ 110/√3V/110/√3V/110/√3V
SEC I	CLASS 3P 100 VA
SEC II	CLASS 3P 100 VA
SEC–III	0.2 100 VA

132kV CVT DETAILS (8800 pF)

CORE	220/√3KV/ 110/√3V/110/√3V/110/√3V
SEC I	CLASS 3P 50 VA
SEC II	CLASS 3P 50 VA
SEC–III	0.2 50 VA

NOTE:–

I. ELECTRICAL SYSTEM PARAMETERS	245kV	145kV
01. NOMINAL SYATEM VOLTAGE.	220kV	132kV
02. HIGHEST SYATEM VOLTAGE.	245kV	145kV
03. CURRENT RATING (BUS BAR)	3150A	1600A
04. SHORT CIRCUIT CURRENT RATING	40 kA FOR 1 SEC.	31.5 kA FOR 1 SEC.
05. BASIC INSULATION LEVEL	1050kVp	650kVp
06. POWER FREQUENCY WITHSTAND VOLTAGE	460 kV	275 kV
07. CREEPAGE	25mm/kV	25mm/kV
08. SYSTEM EARTHING	EFFECTIVELY EARTHED	EFFECTIVELY EARTHED

II. PHASES ON WHICH WAVE TRAP TO BE MOUNTED TO BE CONFIRMED BY BSPGCL.

III. SCOPE:

A. NEW SCOPE : INSIDE CHAIN DOTTED LINE
B. OLD SCOPE : OUTSIDE CHAIN DOTTED LINE

REV.	DATE	ALTD.	CHD.	APPD.	REV.	DATE	ALTD.	CHD.	APPD.

	NAME	SIGN.	DATE
DRAWN	PR		
CHECKED	PR/VK		
APPROVED	MK		

DISTRIBUTION OF PRINTS

DEPT.	CODE
TBEM	422

CUSTOMER	BIHAR STATE POWER GENERATION COMPANY LTD
CONSULTANT	STEAG ENERGY SERVICES (INDIA) PVT. LTD.
PROJECT	2 X 250 MW BARAUNI THERMAL POWER STATION

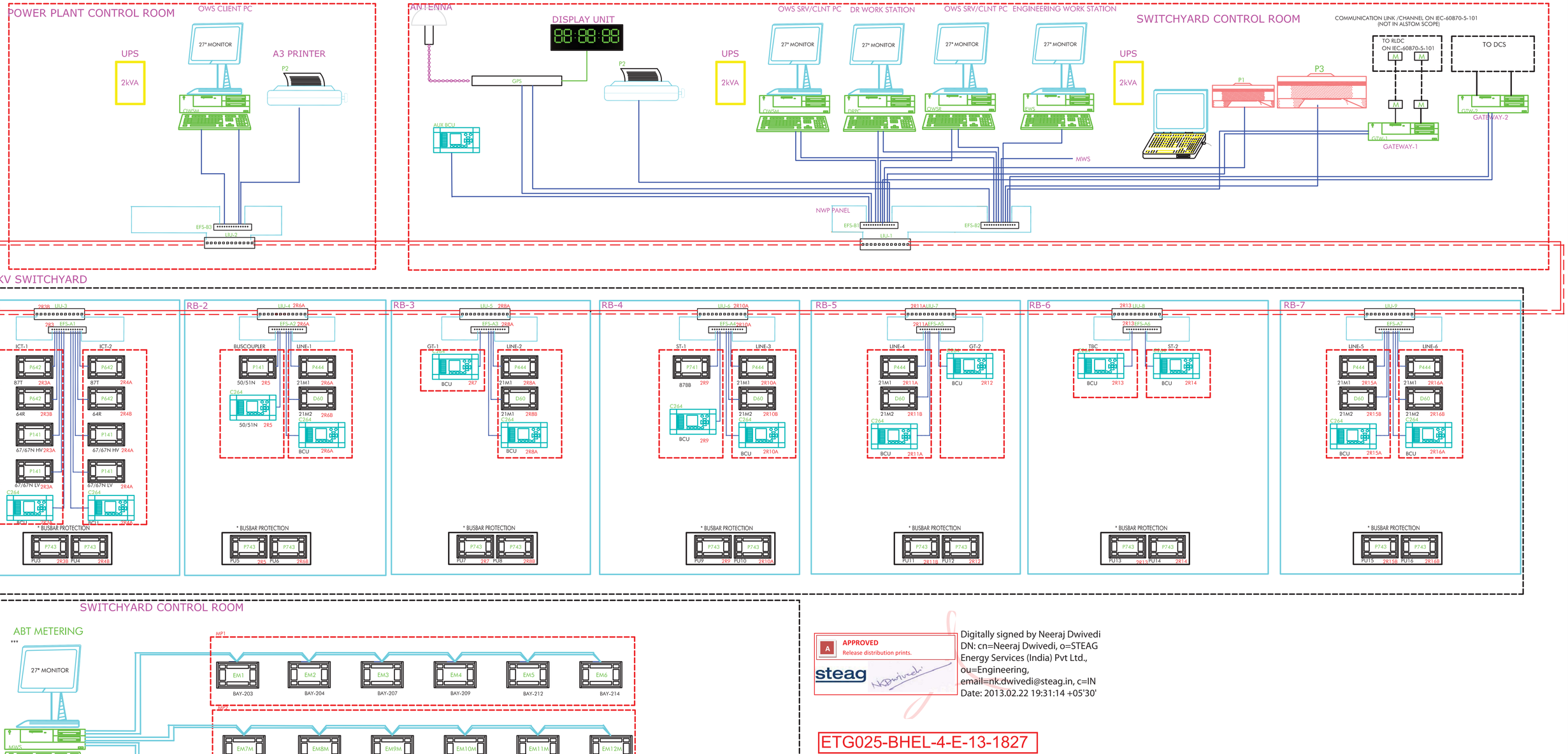
BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP

CARD CODE

TITLE
SINGLE LINE DIAGRAM OF 220/132KV SWITCHYARD

NEXT SHEET: --
SHEET No.: 01

SCALE | W.O. No. 83009ABJU | DRG. No. TB-2-374-510-001 | REV. 00



S.NO.	DESCRIPTION	QTY.	HARDWARE/SOFTWARE SPECIFICATION
1	OWS SERVER/CLIENT PC	2	AS PER APPROVED GTP
2	ENGINEERING WORK STATION	1	AS PER APPROVED GTP
3	GATEWAY PC	2	AS PER APPROVED GTP
4	OWS CLIENT PC	1	AS PER APPROVED GTP
5	DR WORK STATION PC	1	AS PER APPROVED GTP
6	PLCC MODEM	4	AS PER APPROVED GTP
7	DOT MATRIXPRINTER (P2)	2	AS PER APPROVED GTP
8	BCU	15	AS PER APPROVED GTP
9	GPS	1	AS PER APPROVED GTP
10	DISPLAY UNIT	1	AS PER APPROVED GTP
11	EFS	10	AS PER APPROVED GTP
12	LIU(12 PORT)	10	AS PER APPROVED GTP
13	MEETRING WORK STATION	1	AS PER APPROVED GTP
14	UPS (2KVA)	3	AS PER APPROVED GTP
15	LASER PRINTER-A3 (P3)	1	AS PER APPROVED GTP
16	LASER JETPRINTER-A4 (P1)	1	AS PER APPROVED GTP
16	LAPTOP	1	AS PER APPROVED GTP

A APPROVED
Release distribution prints.

steag

Digitally signed by Neeraj Dwivedi
DN: cn=Neeraj Dwivedi, o=STEAG Energy Services (India) Pvt Ltd., ou=Engineering, email=nk.dwivedi@steag.in, c=IN
Date: 2013.02.22 19:31:14 +05'30'

ETG025-BHEL-4-E-13-1827

* FOR BUSBAR PROTECTION CENTRAL UNIT WILL COMMUNICATE TO PERIPHERAL UNIT.
** LOCATION & EFS CONNECTION OF BB CU RELAYS TO BE CONFIRMED BY THE CUSTOMER
*** LOCATION OF METERING PANEL TO BE CONFIRMED BY THE CUSTOMER

LEGEND:–

- 100 MBPS ARMOUR FIBER OPTIC TCP/IP RING (MULTI MODE) - MAIN
- RJ45 ETHERNET CABLE
- 100 MBPS MULTI MODE FIBER OPTIC PATCH CABLE
- COAXIAL CABLE (GPS LINK)
- SERIAL LINK CABLE
- MODBUS CABLE

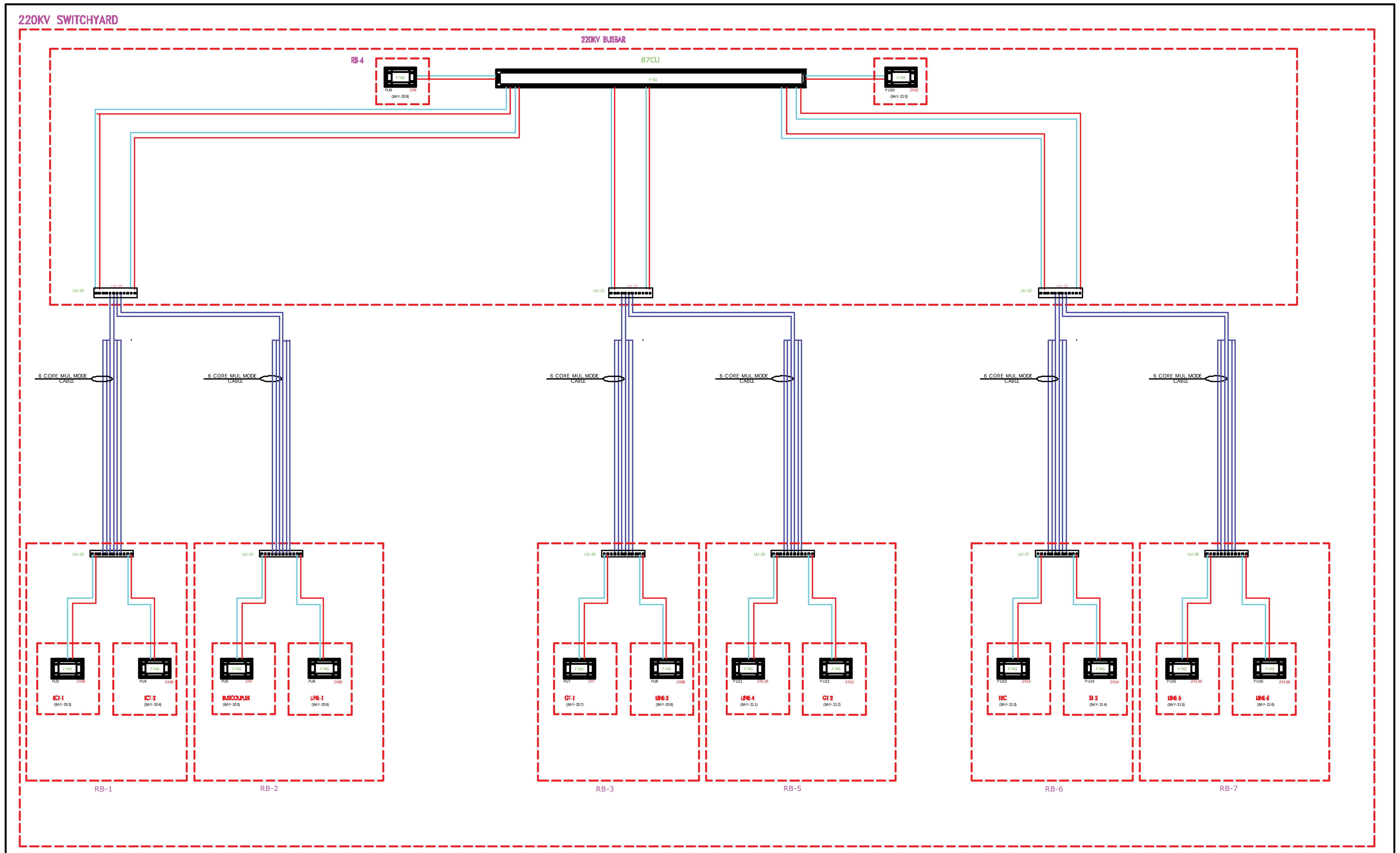
CUSTOMER : BHARAT HEAVY ELECTRICALS LIMITED
CONTRACTOR : .
PROJECT : 2*250 MW BARAUNI THERMAL POWER STATION
PO . NO. : 172P290
DATED : 30.11.2012

REV	DESCRIPTION	DATE
B	SECOND ISSUE	20.02.2013
A	FIRST ISSUE	06.02.2013

SYSTEM ARCHITECTURE DRAWING
TITLE : SYSTEM ARCHITECTURE

ALSTOM T&D INDIA LIMITED - AUTOMATION SAS
PALLAVARAM CHENNAI 600043

ENGG.REF.NO. : KU21
PNL. TYPE : -
SCH REF. : -
SALES ORDER NO : 3269024721
FILE : KU21-SA1
PREPARED BY : SRK
CHECKED BY : PTG
APPROVED BY: PTG
SCALE: -
DRG. REF.: KU21-SA1
(F) SHT 1 OF 1
DATE: 20.02.2013
REV: B



LEGEND:-

(blue line)	100 MBPS ARMOUR FIBER OPTIC TCP/IP RING (MULTIMODE)
(cyan/red lines)	100 MBPS FIBER OPTIC PATCH CHORD (MULTIMODE)

SNO	EQPT	QTY	HARDWARE DES.
1.	LIU-20,21,22	3	LIU WITH 12 ST PORTS
2.	LIU-23,24,25,26,27,28	6	LIU WITH 6 ST PORTS

NOTE:

(cyan line)	RX
(red line)	TX

APPROVED

steag

Digitally signed by Neeraj Dwivedi
DN: cn=Neeraj Dwivedi, o=STEAG Energy Services (India) Pvt Ltd., ou=Engineering, email=nk.dwivedi@steag.in, c=IN
Date: 2013.02.22 19:31:36 +05'30'

REV	DESCRIPTION	DATE
A	FIRST ISSUE	06.02.2013

CUSTOMER : BHARAT HEAVY ELECTRICALS LIMITED
CONSULTANT : -
CONTRACTOR : -
PROJECT : 2*250 MW BARAUNI THERMAL POWER STATION
SUB-STATION :
PO. NO. : 172P290
DATED : 30.11.2012

SYSTEM ARCHITECTURE DRAWING
TITLE : 220KV BUSBAR SYSTEM ARCHITECTURE

A B C D ALSTOM T&D INDIA LIMITED - AUTOMATION SAS
PALLAVARAM CHENNAI 600043

PNL. TYPE: -
ENGG.REF.NO. : KU21
SCH REF. : -
SALES ORDER NO : **3269024721**
FILE : KU21SA2
PREPARED BY: SRK
CHECKED BY : PTG
APPROVED BY: PTG
SCALE: -
(F) SHT 1 OF 1
DRG. REF.: KU21SA2 (F)
DATE: 06.02.2013
REV: A