TECHNICAL SPECIFICATION

SCADA RTU/ DCU & NETWORK AUTOMATION SYSTEM FOR 66/33/11kV NEW GRID STATION (IEC 61850 PROTOCOL)

PREPARED BY	APPROVED BY	REV	2
		DATE	13th July 2022
RAJEEV V	ANIL V	PAGE	1 of 51

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Sr. No.	Topic	Description
1	**Scope of the Document**	BYPL already has SCADA Control Centre implementation consisting of MCC (Master Control Centre) and (BCC) Business Continuity Centre (commissioned by M/s ABB Ltd. with Network Manager Ver 5.5) through which currently 55 grid stations and approx 400 DMS stations are being controlled and monitored. The present SCADA RTU/ DCU & Network system enable remote monitoring and controlling of all equipment's of the unmanned grid stations. This document states that the new RTU/ DCU & Network automation system supplied will integrate with the existing SCADA infrastructure enabling remote monitoring and controlling of grid equipment's, facilitating unmanned station provision. The scope of this specification covers all the Technical requirements of the RTU/ DCU & Network Automation system including System Architecture design, Manufacturing, Quality, Testing facility at manufacturer's works, packing, forwarding with loading/ unloading at site/ stores. It also states the installation, commissioning and testing of all the equipment's supplied or required for efficient and trouble free SCADA RTU/ DCU & Network Automation system. The scope also covers supply of spares, trainings, configuration tools and documents. This document describes the automation requirement for C&R/ switchgear panels, IEDs, and all other items required for SCADA controlled 66/33/11 kV power system supplied in grid. The specific requirements are covered under technical requirements (Ref.3)
2.	**Climate conditions for system**	The atmosphere of Delhi/National Capital Region (NCR) is generally laden with mild acid and dust suspended during dry months and subjected to fog in cold months. The design of the equipment's and accessories shall be suitable to withstand seismic forces corresponding to an acceleration of 0.1g • Max. Ambient Temperature (Working): 50°C • Min. Ambient Temperature: 0°C • Max. Humidity: 95% non-condensing • Min. Humidity: 10% • Avg. no. of Thunderstorm days per annum: 50 • Avg. Annual Rainfall: 750mm

		The supplier/ BA is required to submit climate compliance test certificate for supplied SCADA RTU/ DCU & network Automation system.
3	**Technical Requirements**	
3.a	General requirements for Supplier/ Business Associates (BA)	The supplier/ BA should have at least 10 years of experience in design, manufacturing and supply of SCADA RTU/ DCU & Network Automation system integrated with the protection system for controlling and monitoring of the electricity transmission and distribution network. The supplier/ BA needs to submit the proof of completing minimum 5 such projects with other Indian utilities/ concerns as its experience certificate. The supplier/BA should have direct business office at Delhi/NCR. In case of support through business partners details of customers supported by the service partners to be submitted to BYPL. The supplier/ BA should have experience of SCADA RTU/ DCU and Network system integration with numerical relays/ IEDs on standard international protocols (Ref 3.d). The supplier/ BA shall produce a well- structured project plan constituting of timelines for installation, commissioning and testing of the SCADA RTU/ DCU and Network Automation system to which he will have strictly abide. The supplier/ BA can offer an innovative and advanced system and the ways and cost to integrate the same in the existing infrastructure. The offer is subjected to an approval from BYPL after a thorough discussion between the supplier/BA and BYPL. In case, an approval is not awarded to the supplier/BA's offered innovative system, BYPLs existing/ desired infrastructure prevails and the supplier/BA shall provide the system accordingly. The supplier/ BA should optimize on the cost of software products offered to BYPL considering already available licenses with BYPL. The supplier/BA should clearly indicate licensing policy for the software tools offered. The supplier/ BA should be technically capable to provide necessary training to the personnel recommended by BYPL to maintain the system and troubleshooting reports (Ref. 10)

3.b	General System Design	The SCADA RTU/ DCU & Network Automation system shall be modular and suitable for remote operation and monitoring of the complete substation including future expansions. The systems shall be state of the art, suitable for operation under electrical environment present in high voltage substations (66/33/11kV), follow the latest engineering practice, and ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff. The housing of the SCADA RTU/ DCU & Network Automation system hardware should be IP class protected suitable for both indoor and outdoor installations. The offered SCADA RTU/ DCU & Network Automation system shall support remote control and monitoring from existing remote SCADA control centers (MCC/ BCC) via gateways. The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator Interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training. The system shall incorporate the control, monitoring and protection functions specified, self-monitoring, signaling and testing facilities, measuring as well as memory functions, event recording and evaluation of disturbance records. Maintenance, modification, diagnosis or extension of components shall not cause a shutdown of the whole SCADA RTU/ DCU & Network 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. The SCADA RTU/ DCU and Network Automation system should be processor, co-processor, power supply, rack and media redundant. The SCADA RTU/ DCU & Network Automation system should be web accessible with facility to upload/ download the system configuration files and controlling & monitoring of equipment's. The SCADA RTU/ DCU & Network Automation system should be cyber secured with user based configured password protection.

3.c	System Architecture	The SCADA RTU/ DCU & Network Automation system shall be based on decentralized architecture and on 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 SCADA RTU/ DCU & Network Automation system architecture shall be structured in two levels, i.e. station and bay level. At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection information, inputs for status indications, outputs for commands and measurand/ analog data. The IEDs should be directly connected to the switchgear without any needs for additional interposition or transducers. Each bay control IED shall be independent from each other and its SCADA 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. Data exchange is to be realized on PRP using IEC 61850 protocol with a redundant managed layer 2 switched Ethernet communication infrastructure. The Ethernet switch must be IEC 61850 compliant and KEMA, CE and FCC certified. The communication shall be made in 1+1 mode (PRP) for IEC 61850 protocol, including the fiber link between the individual bay IEDs to bay switch and Ethernet link between the bay switch to RTU/ DCU, such that failure of one link shall not affect the normal operation of the SCADA RTU/DCU & Network Automation system. However it shall be alarmed in SCADA RTU/ DCU & Network Automation system. Communication shall be on serial link between IEDs (serial communicable devices) like MFMs, DCDBs and the processor with SPD. 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. MCC/ BCC, bay level or apparatus level. The priority shall always be on the lowest enabled control level.

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<td>3.d</td>
<td>Communication Interface and Protocol</td>
<td>The communication protocol for gateway to control centers must be on IEC 60870-5-104 protocol. While the communication for sub-station IEDs of Bay level and station level must be on IEC 61850 protocol. In addition the RTU/ DCU should have RTU/ DCU serial Modbus RS485 protocol for communication to MFMs and DCDBs. DCDB, NIDS, NIFPS (8 No. DI signals for integration) and APFC should also interfaced with RTU through hard-wiring.

Different protocols to integrate the SCADA RTU/ DCU & Network Automation system are as given in Table 3.d [1]:

<table>
<tr><th colspan="2">Table 3.d [1]</th></tr>
<tr><td>RTU/ DCU to SCADA Control Centers (MCC/ BCC)</td><td>IEC 104</td></tr>
<tr><td>RTU/ DCU to Transformer Monitoring Unit/ NIDS/ APFC</td><td>IEC 61850</td></tr>
<tr><td>RTU/ DCU to Bay Control Units/ Relays</td><td>IEC 61850</td></tr>
<tr><td>RTU/ DCU to MFMs and Other serial communicable devices</td><td>RTU/ DCU serial Modbus RS485</td></tr>
</table>

NOTE: Converters (protocol/ media/ power supply) of any sort will not be permitted for RTU/ DCU and Network Automation system.</td>
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<td>3.e</td>
<td>IEC 61850 compliant Managed Ethernet switch & network</td>
<td>The IEC 61850 compliant Managed Ethernet switch shall meet the demand of power system automation systems (IEC 61850-3, IEEE 1613 compliance).

• Ethernet switch shall be layer 2 industrial grade.
• Ethernet switch shall be modular with SFP for copper and fiber port.
• Ethernet switch port shall be approve by engineering in charge of SCADA.
• Ethernet switch shall be 19” rack mounted.
• Ethernet switch shall operate at 36 to 72 VDC power supply.
• Operating Temperature: -40°C to +85°C.
• All port shall be user configurable with minimum configuration of 100Mbps.
• Communication type: Fiber Optics media and ST/LC Connector compatible with IEDs supplied with CRP, As Per Site and Ethernet - copper CAT6/ above cable. Further approval at the time of final</td>
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		engineering approval. • LED indicators on all ports shall be blinking with data transfer. • The switch should have a diagnostic/ error/ warning LED. • It should support remote user setting configuration. • It should own separate maintenance/ console port. • Latency shall be not more than 10ms. • Should be KEMA, CE and FCC Certified. • Switch should be extendable for future expansion. • Minimum 20% spares of utilized hardware and accessories to be provided by the supplier/ BA. • On-site warranty for the switch must be 5 years. The warranty certificate is required to be submitted by the supplier/ BA to BYPL at the time of SAT. • Shall be suitably mounted in CRP/switchgear panel. • Ethernet Switch shall have required nos. of ports (having RJ45 Ports / FO Ports).Minimum 20% spare ports shall be provided. Final approval at the time of detail engineering. • Power Supply of EFS shall be Dual redundant with pluggable terminal block. • Shall have Environmental conditions compliance as per IEC60068-2-1 COLD TEMPERATURE IEC60068-2-2 DRY HEAT IEC60068-2-30 HUMIDITY IEC60068-21-1 VIBRATION IEC60068-21-2 SHOCK • Shall have Features: Management through Web-based, Telnet, CLI SNMP supported Remote Monitoring Diagnostics with logging and alarms Console ports • Shall have Product conformity acc. to IEEE 802.3-10BaseT Yes acc. to IEEE 802.3u-100BaseTX Yes acc. to IEEE 802.3u-100BaseFX Yes acc. to IEEE 802.3ab-1000BaseT Yes acc. to IEEE 802.3ad-Link Aggregation Yes acc. to IEEE 802.3x-Flow Control Yes acc. to IEEE 802.1d-MAC Bridges Yes acc. to IEEE 802.1d-STP Yes acc. to IEEE 802.1p-class of service Yes acc. to IEEE 802.1Q-VLAN tagging Yes

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acc. to IEEE 802.1Q-2005 (formerly IEEE 802.1s) MSTP Yes
acc. to IEEE 802.1w-RRST Yes
acc. to IEEE 802.1x-port based Network Access Control

• Shall have Mode Store and Forward
• Shall have Protection class IP4X,Conformal Coating,IPV6
• Shall have Authorized Repair center of original Ethernet switch manufacture in India.
• Shall have Uplink Rate 1 GBPS and Downlink Rate 100 MBPS

<table>
<tr><th colspan="2">Table 3.e [1] BYPL approved Makes</th></tr>
<tr><th>S.No.</th><th>Make</th></tr>
<tr><td>1</td><td>Ruggedcom</td></tr>
<tr><td>2</td><td>Hirschmann</td></tr>
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The specified makes are to be strictly adhered to and no change will be considered hereto.
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<td>3.f</td>
<td>RTU/ DCU Enclosure</td>
<td>
RTU/ DCU enclosure should be suitably sized minimum 800mm to accommodate all RTU/ DCU and network accessories, self-standing, fabricated 14 gauge, CRC sheet, duly powder coated paint (RAL 7035 Siemens Grey Structure Shade) with black color plinth and IP class IP5X protected suitable for both indoor and outdoor installations.

Enclosure Details:

• Panel should have a front toughened glass door behind which the RTU/ DCU racks should be mounted on a swing door frame. Doors should have Ergoform- S lock system with key.
• The whole RTU/ DCU hardware should be housed in an energy-efficient Air Conditioned cabinet with temperature and humidity controller.
• Enclosure should have GI mounting plate fitted on its rear wall. Rear wall shall be fixed.
• It should have gland plates suitably sized, fabricated with 3mm CRC sheet, duly powder coated paint (RAL 7035 Siemens Grey Structure Shade).
• Enclosure should have sufficient illumination system with door interlocks, crankcase heaters, Rat/ Rodents repellent system, drawing pocket etc.
• It should have fan and louvers ,both with filters to dissipate heat.
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- Copper earth strip of suitable size to be provided for both power and electronics, separately.
- A minimum 30% free space should be provided for spares for future expansion.

<table>
<tr><th colspan="2">Table 3.f [1] BYPL approved Makes</th></tr>
<tr><th>S.No.</th><th>Make</th></tr>
<tr><td>1</td><td>Rittal and equivalent</td></tr>
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<tr><td>3.g</td><td>RTU/ DCU System</td><td>

In general the RTU/ DCU system design should aim to minimize power consumption and heat generation. The RTU/ DCU shall be modular type, housed in a 19” rack consisting of processor, co-processor, Digital Input/ Output and Analog Input/ Output modules, power supply and communication interface module, Ethernet switches etc. The auxiliary supply of RTU/ DCU and network system should be 48VDC nominal range: 36-72 VDC with copper wire of suitable size.

RTU/ DCU system should be completely wired up with all the required accessories like MCB, heavy duty CMRs (miniature contactors), rack mounted DC-DC converters, contactors, screw terminals, PVC duct, galvanized GI mounting channels etc. and should be enclosed in an air-conditioned self- standing enclosure.

RTU/ DCU system:

- RTU/ DCU shall be modular and expandable.
- RTU/DCU shall have temperature range from -25°C to +70°C.
- RTU/DCU processer shall have 800Mhz clock frequency.
- RTU/ DCU system should have redundant processor, co-processor, power supply, rack, Ethernet switch, bay and station network level.
- It should have a under voltage and earth leakage detection system.
- RTU/ DCU processor should communicate to MCC and BCC on IEC 60870-5-104 protocol on a single IP address.
- Processor and co-processor should be capable to communicate with IEDs (Protection Relays, Digital RTCC relay, bay controller etc.) on IEC 61850 protocol and MFMs, DCDBs etc to communicate on RS485 RTU/ DCU Modbus slave. DCDB, NIDS and APFC should also interface with RTU through hard-wiring.
- RTU/ DCU system should have programmable logic capabilities supported by easy to use editing facilities. These capabilities shall

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enable the RTU/ DCU to perform functions using ladder, FBD and statement language as per IEC standard.

- Internal battery backup to hold data in SOE buffer memory & also Maintain the time & date.
- RTU shall have Integrated HMI/Web based HMI feature.
- RTU shall have security log and event archive feature.
- All digital and analog input-output modules should be housed in a separate rack.
- Digital input and output modules should be 16 channels, 48VDC and potential free contact respectively.
- Analog input should be 8/ 16 channel, 16-bit resolution, and universal type, configurable for all ranges between ±10VDC and ±20mA.
- RTU/ DCU system should have minimum 20% spares of utilized RTU/DCU & Network hardware and accessories, completely wired up to the last terminal.
- RTU shall have DC voltage supply monitoring through transducer and AI module.
- RTU shall have IEC60870-5, IEC61850, MODBUS, PLC,Advance cyber security, integrated HMI, Archive license.
- RTU shall have 3 Nos 16 channel DI, 2 Nos 16 Channels DO, 1 Nos 8 channel AI modules for future hard wiring.

Bidders who are OEM of RTU and Numerical Relays are only acceptable & Pilot with successful test results are main criteria for induction of any new models in BYPL.

Note : System shall be approved if they are agree to fulfil the following terms & Conditions,

It is applicable for all OEM products.

- AMC period should be given 3 years along with this proposal.
- AMC period should be started after handing over the system to BYPL.
- During AMC period all the issues pertaining to RTU/Gateway/BCU should be handled by OEM at site(this included unlimited site visit)
- 5 Year replacement warranty is applicable for all OEM for Electronic cards & Gateway Units…If any hardware (or) Software fails during this period will be rectified by OEM.

Table 3.g [1] BYPL approved Makes with Type

S.No.	Make	Type
1	ABB Ltd.	RTU560
2	Schneider	Saitel DP
4	Siemens	A8000

The specified makes are to be strictly adhered to and no change will

		be considered hereto.
3.h	Control Wiring, Name Plate and Marking System	**Panel Control Wiring** Suitable size and color control and power wiring to be used for the connection of RTU/ DCU equipment and accessories along with proper and suitable lugs and ferrules. Control wire used inside the panels should be as per international color standards, approved by BYPL. **Field Control Wiring** • All control and power cables used in the RTU/ DCU and Network Automation system should be multi-core, FRLS, armored with copper multi-strand. • All communication cables used in the RTU/ DCU and Network Automation system should be tinned copper high density shielded or armored with PVC FRLS. All Optical Fiber Cables (OFC) used in the RTU/ DCU and Network Automation system should be of proper size, armored and suitable for multi/ single mode operations. • Laying of control cable from field to RTU/ DCU should be in separate cable trays and armored conduit/ duct of suitable size. • Laying of communication cable is in wall mounted PVC pipe of suitable size. • The field wiring material and laying plan is to be submitted by the supplier/ BA and should be duly approved by the engineering staff of SCADA, BYPL before the commencement of work. • During execution if any replacement/ changes (due to site constraint) are required in the material/ field wiring and laying that shall be duly made by the supplier/ BA without any additional costs within the committed time (maximum one (1) week). • All field wiring make and model should be approve by SCADA engineering in-charge at the time of detail engineering. **Table 3.h [2] Field Control Wiring** **Description** | **Approved Make** RS485 Wire | Belden or equivalent Ethernet | D-link, Belden or equivalent

		<table><tr><td>Fiber optic cord</td><td>Preston or equivalent</td></tr></table> **Equipment Name Plate** • All equipment's either in RTU/ DCU panel or field should have proper name plate. • The name plate material, size, and text font and size are to be submitted by the supplier/ BA and should be duly approved by the engineering staff of SCADA, BYPL before the commencement of work. • Sample name plates are to submit for approval before field installations, any changes suggested by BYPL shall be duly incorporated. • During the execution any change in name plate size, text font or size suggested by BYPL shall be duly incorporated without any additional costs within the committed time (maximum one (1) week). **Marking System** • The panel and field control wiring Marking System should be proper for the system. The name plates should be properly engraved and all wires should have proper size ferrule nos. and printing life for both should be of minimum 10 years.
3.i	RTU/ DCU Commissioning	• The supplier/ BA will install all network, control and RTU system as per BYPL approved network system architecture. • The supplier/BA will configure existing equipment to RTU if any. • The supplier/ BA will configure, validate and submit the network as per system requirement which will be verified and approved by SCADA engineering in-charge. • The supplier/ BA will be responsible for commissioning of RTU/ DCU with all IEDs as per Annexure 12.b provided. • RTU/ DCU network commissioning engineer (supplier/ BA) will be responsible for IEC 61850 protocol files. • During the local testing, only and only if the punch points are thorough then only final testing will be done. • Final point-to-point testing from SCADA Center is to be necessarily cleared before SAT.

3.j	Time synchronization and SOE	A dedicated GPS signal from the SCADA MCC & BCC (FEP) will be provided for the synchronization of the entire system. This GPS signal would be available to the RTU/ DCU at regular specified intervals and the RTU/ DCU in turn should synchronize all devices via the inter bay bus using SNTP protocol as defined in IEC 61850 standard. RTU shall have capability to sync with PTP. To analyze the chronology or sequence of events occurring in the power system, time tagging of data is required which shall be achieved through SOE feature of RTU. The RTU shall have an internal clock with the stability of 10ppm or better. The RTU time shall be set from time synchronization messages received from master station using IEC 60870-5- 104 protocol. In addition, the message can be transmitted using NTP/SNTP. SOE time resolution shall be 1ms or better. The RTU shall maintain a clock and shall time-stamp the digital status data. Any digital status input data point in the RTU shall be assignable as an SOE point. Each time a SOE status indication point changes the state, the RTU shall time-tag the change and store in SOE buffer within the RTU. A minimum of 10000 events shall be stored in the SOE buffer. SOE shall be transferred to Master Station as per IEC 60870-5-104 protocol. SOE buffer & time shall be maintained by RTU on power supply interruption.
3.k	Response Times and I/O Capacities	The total I/O count in a major substation will become large and it must be ensured that the hardware and communication links have sufficient performance to ensure prompt processing of data, Ref. Tables 3.k [1] Processor shall have minimum 5000 DP capability. As I/O at the bay level, both digital and analog will typically be handled by intelligent relays or specialized IEDs, it is therefore important to ensure that these devices have sufficient I/O capacity and dual communication ports for PRP protocol. **Table 3.k [1] Minimum system response times for a substation** Digital Input — 1s Analog Input — 1s Digital Output — 0.75s Disturbance Record File — 3s

<table>
<tr><td></td><td></td><td>The above are the minimum capacity which may change during detailed engineering of RTU/ DCU. The RTU/ DCU should have the capability of I/Os expansion.</td></tr>
<tr><td>3.l</td><td>Multi Function Meters (MFM)</td><td>A single network loop of MFMs should not have more than eight (8) MFMs. MFM communication network on RTU/ DCU serial Modbus RS485 should be protected against surges and electrical leakages therefore, it is necessary to install Surge Protection Devices placed in between the RTU/ DCU & MFM serial network loop.

The inter-looping of MFMs to be made by 22 guage Belden 8761 non-screened cable while the extension of the communication network from MFM to RTU/ DCU to be made by 22 guage Belden 8761 Belden screened cable. The typical diagram for this connection is mentioned in the System Architecture diagram, Annexure 12.a.

Minimum two (2) spare links from CRP to RTU/DCU to be provided by supplier/ BA for future extension.

All hardware of the RTU/ DCU and Network Automation system and CT & PT wirings to MFMs and its configurations fall in supplier/ BAs scope.

The integration of MFM to be done as per the technical document and parameter configuration as per Annexure 12.b.

Table 3.i [1] Field Control Wiring
Description | Approved Make
MFM | Delta energy, Conserv 6400NG
SPD | San-tele quip, Phoenix</td></tr>
<tr><td>3.m</td><td>Transformer Monitoring cum Automatic Voltage Regulator (AVR) Unit</td><td>A digital transformer monitoring cum automatic voltage regulator unit is to be provided as per the tender document for each transformer and it should fulfill the following requirements for SCADA integration and configuration:

• As the name suggests, it should have the functionality of automatic voltage control.
• A digital transformer monitoring cum automatic voltage regulator unit should have the facility to measure CT, PT, Oil</td></tr>
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		temperature, winding temperature and tap position etc. further these parameters shall be telemetered to SCADA RTU/ DCU on IEC 61850 protocol. • It should have facility to control tap position, fan control etc. further these parameters shall be telemetered to SCADA RTU/ DCU on IEC 61850 protocol for monitoring and controlling. • It shall have Microprocessor based Numerical relay having LCD display along with the software to make the parameters settings of the device and it shall be possible to do the parameter setting through keyboard unit. • It should have the feature to set the parameters related to voltage regulation and fan control from MCC & BCC. • The unit shall have suitable interface to communicate with higher level SCADA system as per the protocol proposed in the integrated package solution. • The unit should be capable of taking tap position, oil temperature inputs directly without any transducers. • The parameters configuration should be as per Annexure 12.b.
3.n	Maintenance, Diagnostics and Reliability	**Maintenance:** It is a requirement that all RTU/ DCUs require no routine or planned maintenance. Therefore, no fans or moving parts shall be used in the RTU/ DCU to avoid any need for maintenance. To ensure this, the RTU/ DCU should be constructed to resist the entry of dust. A single technician shall be able to remove and replace for repair purposes, without special tools and test equipment's involved in the operation of RTU/ DCU. Restoration of equipment to full operational use shall be possible within 15 minutes (nominally) of repairs being completed. It should not be necessary to dismantle (remove multiple pieces of) the RTU/ DCU in order to replace a module. **Diagnostics:** The vendor should provide remote maintenance and monitoring diagnostic and configuration tools (Laptop) which should be able to access the RTU/ DCU and all other IEDs using BYPLs TCP/ IP WAN network. The station should use RTU/ DCUs pass through access capability to monitor the station devices and carry out parameterization of the IEDs, Protection Relays and network devices in the station. • The supplier is required to provide diagnostic and licensed configuration software to run in the supplied tools and access the RTU/ DCU. This software tool shall allow building of new configuration file,

modification and configuration of RTU/ DCU configuration file along with the below listed facilities:

- Monitoring of all inputs, control of all outputs and testing of calculation logic. Monitoring of all inputs and logic at card level, logic level and protocol level.
- Display of communication statistics and eavesdropping of communications channels, including Ethernet, IP, IEC103, IEC 104, IEC 61850 and Modbus.
- Download & upload of RTU/ DCU software, database configuration and calculations, upload the complete configuration from RTU/ DCU to modify and then download to RTU/ DCU.
- On-line help.
- Display time, date, current firmware, software and configuration running in the RTU/ DCU.
- Configuration and diagnostic software must run on latest Microsoft Windows version.

- The diagnostic and configuration utility software shall be provided on a pen drive which is compatible with laptop/ PC. The current version number of such software shall be provided.

Reliability:

The RTU/ DCU and Network Automation system will normally remain in continuous service, 24X7, to provide SCADA facilities. A high level of reliability is required as failure can result in the interruption of the operation and monitoring of the Power System Control.

Predicted availability of equipment supplied should exceed the following:

Table 3.n [1]

System Function	System Availability
Control and monitoring of any one breaker/ equipment	99.99%
Monitoring of any one status & measurand data indication	99.99%
Monitoring of any one status/ measurand/analog input	99.99%

3.o	Interchangeability & Future Extendibility	**Interchangeability:** RTU/ DCU parts like processors, co-processors and interface modules and network hardware shall be interchangeable individually, and as a whole RTU/ DCU without the need of re-configuration with pre-programmed flash memory. Any such change or replacement shall not reduce the capability of the equipment to conform to requirements of this specification. Each module and switch links of the RTU/ DCU and Network Automation system should have Hot Swap feature i.e., at the time of removal/ insertion of modules and switch links, the system should not become faulty and automatically recognize the new module and switch link without any need of system reboot. **Future Extendibility:** Offered SCADA RTU/ DCU & Network Automation system shall be suitable for extension in future for additional bays. During such requirements, all the drawings and configurations, alarms/ events list etc displayed shall be designed in such a manner that its extension shall be easily performed by the BYPL user. During such event, normal operation of the existing substation shall be unaffected and system shall not require a shutdown. The BA shall provide all the necessary software tools along with the source codes to perform addition of bays in future and complete integration with RTU/ DCU & Network Automation system by the user. These software tools shall be able to configure IEDs, add additional analog variables, alarm list, event list, modify interlocking logics etc. for additional bays/ equipment which shall be added in future. Offered RTU/ DCU & Network Automation System including switches shall have minimum 20% spare of utilized RTU/DCU & Network Automation system hardware and accessories, completely wired up to the last terminal.
3.p	Service life, Warranty and Replacement Support	**Service Life:** BYPL prefers that the major equipment's of RTU/ DCU and Network Automation system shall be capable of complying with this standard, including performing its intended purpose, for a minimum of 10 years from the date of supply.

		The supplier/BA shall provide a service support letter containing: • The date at which the product was released for sale. • The anticipated date at which the product will be withdrawn from sale, but support will continue to be supplied. • The anticipated date of when the product support will be withdrawn i.e. spares will no longer be available and technical support will no longer be provided. **Warranty and Replacement Support:** During the guaranteed availability period, the spare parts supplied by the supplier/ BA shall be made available to the supplier/ BA for usage subject to replenishment within the committed time (maximum eight (8) weeks). Thus, after the system is revived the inventory of spares with BYPL shall be fully replenished by the supplier/ BA. However, any additional spares required to meet the availability of the system (which is not a part of the above spares supplied by the supplier/ BA) would have to be supplied immediately by the supplier/ BA free of cost to BYPL. • RTU/ DCU and Network Automation System Hardware: Minimum 5 years • RTU/ DCU and Network Automation System Accessories: 2 years • Managed Ethernet Switch: 5 years At the time of failure or non-availability of the system, during the warranty period, the supplier/ BA is required to visit the site on BYPLs call within 24hrs, free of cost to revive the system. The supplier/ BA should submit a liability warranty support certificate to BYPL. 5 years warranty is mandatory for all SCADA/RTU products(Electronic cards,GPS,Switches,HMI,etc…).If any cards fails/burnt due to surges from CT,PT via RS485/serial, Surges through cables then replacement will be in your scope up to 5 years.So suitable SPD to be incorporate in the system according to site requirements for avoid card failures.
3.q	RTU/ DCU & Network Earthing System	Two types of earthing should be provided by the supplier/ BA: power and electronics. Both should be of copper, isolated and suitably sized (as per BYPLs approval). Power earthing should be connected to the RTU/ DCU Enclosure, light, fan, AC while the electronic earthing will be connected to the inside modules of the RTU/ DCU.

<table>
<tr><td></td><td></td><td>Color of earthing wire: Green and Yellow/ Green

In the receiving station, grid earthing will be used for RTU earthing.</td></tr>
<tr><td>3.r</td><td>DR Download</td><td>The proposed SCADA network should be configured for remote downloading of DR over WAN from any one (1) location falling under BYPL jurisdiction.

All the required configuration settings of the supplied network are to be made by the supplier/ BA.</td></tr>
<tr><td>3.s</td><td>RTU Auxiliary Power supply system</td><td>Power for the RTU/ DCU & Network Automation system shall be derived from substation 48/ 220V DC system. The power supply system will have a wide range, 48 VDC nominal : 36- 72 V. The supplier/ BA may use DC- DC converter to convert grid control voltage 220VDC to 48VDC with wide operating range. The power supply system should be redundant and distributed through MCB of suitable ratings. Power supply should also be equipped with surge protection device.
<table>
<tr><th colspan="2">Table 3.s [1] Field Control Wiring</th></tr>
<tr><th>Description</th><th>Approved Make</th></tr>
<tr><td>DC DC converter</td><td>Meanwell or equivalent</td></tr>
</table></td></tr>
<tr><td>3.t</td><td>Cyber security</td><td>Offered system shall have advance cyber security feature which comply below mentioned standards and certificate shall be provided during detail engineering
IEC 62443-4-2
IEC 62443-3-3
IEEE 1686
IEC 62351-3
IEC TS-62351-5
IEC 60870-5-7 security extension</td></tr>
<tr><td>4</td><td>SCADA Commands, Indications & Measurands Data</td><td>As per Annexure 12.b.</td></tr>
<tr><td>5</td><td>Quality Control and Checklist</td><td>The supplier/ BA is required to submit a plan of different stages of manufacturing and testing based on which subsequent reports and certificates shall be submitted. If during this period the manufacturing and quality is found unsatisfactory as to workmanship or material, the same is liable for rejection and the supplier/ BA will be obliged to provide standardized equipment as per BYPLs specifications.</td></tr>
</table>

		Checklist: 1. Space required for future expansion 2. Component layout 3. Wiring termination details 4. Equipment/ component make used in the panel with their specifications
6	**Pre- Dispatch Inspection (FAT) & Minimum Testing Facility**	**Pre-Dispatch Inspection (FAT):** After submitting and on BYPLs acceptance of the Test certificate and Quality Report, the supplier/ BA is required to call BYPL for Pre-Dispatch Inspection. The supplier/ BA should ensure the completion of manufacturing and set-up for Pre-Dispatch Inspection. Pre-Dispatch Inspection will be treated as FAT, which will only be carried on if the minimum testing facility has been arranged by the supplier/ BA. Travel, boarding, lodging and local conveyance etc shall be under vendors scope. In case FAT is waived off, all the below mentioned points will be tested during SAT. The following tests are to be carried out under FAT: 1) Visual inspection of dimensions, workmanship, quality and specifications of the equipments as per the approved drawing and tender document. 2) Test certificate and Quality Report verification as submitted 3) Simulation of RTU/ DCU & SCADA Network connectivity, data acquisition from IEDs/ MFMs and functionalities like: • Indications, Commands and Measurands data • Time synchronization • Sequence of Events • Redundancy, diagnostic feature • Interchangeability • Hot Swapping • Any other functionality as per the tender document 4) During the Pre-dispatch inspection period if the vendor fails to simulate any of the functionality mentioned above and as per the tender document then BYPL has the rights to scrap the inspection and another FAT will be arranged for which the supplier/ BA will bear the travel expenses including both side airfares, cab rent, food and lodging.

		Minimum Testing Facility: The minimum testing facility should include: 1) Minimum number of each type of relays being supplied by the supplier/ BA for SCADA RTU/ DCU and Network Automation system. 2) Complete SCADA RTU/ DCU and Network Automation system with redundancy connecting to each type of IED, at least two (2), being supplied by the supplier/ BA for the aforementioned system.
7	**Packing & Forwarding**	The supplier/ BA shall ensure that all equipment covered by this specification shall be prepared for rail/ road transport (local equipment) and be packed in such a manner so as to protect it from damage in transit. All equipment/ material are to be transported with proper packing and markings. Any damage to the equipment(s) during the transit will be borne by the supplier/ BA and the replaced damaged equipment(s) will be made available to BYPL within the committed time (maximum eight (8) weeks).
8	**System Spares, Tools & Software Tools with Licenses**	The bidder is required to list the spares, which may be required for ensuring the availability during the guaranteed availability period. The final list of spares shall form part of scope and accordingly the price thereof shall be quoted by the bidder and shall be considered in the evaluation of the bids. The list shall include the following: • Item identification • Recommended spares quantities (minimum 20% of utilized Hardware of SCADA/ DCU and Network Automation System) • Base price of proposed spares. • Procurement lead time probability of returning the replaced/ repaired spare parts • Procurement lead time probability of the spare material BYPL may need to procure apart from this Tender • Quantity of item held in local office by supplier/ BA as emergency spare parts. All spare parts shall be fully tested, however BYPL has the right to return the tested spare part on being found faulty for which the BA/ supplier shall

provide with replacement within the committed time (maximum eight (8) weeks).

Table 8 [1] Mandatory loose Spares material

S.No.	Item	Qty	UOM
1.	RTU/ DCU & Network Hardware		
1.1	Rack redundant	1	No. each type
1.2	Rack I/O	1	No. each type
1.3	DI module with cable	1	No. each type
1.4	DO module with cable	1	No. each type
1.5	AI module with cable	1	No. each type
1.6	Managed Ethernet switch	1	No. each type
1.7	OFC patch cord	5	No. each type
1.8	Power Supply SMPS	2	No. each type
1.9	MCB	2	No. each type
1.10	Main Processor	1	No. each type
1.11	Co-processor connecting IEC 61850 protocol devices	1	No. each type
1.12	Co-processor connecting serial devices	1	No. each type
1.13	Power supply for RTU rack	1	No. each type
2.	RTU/ DCU Panel Accessories (Converters, Power Supplies etc.)	Minimum 20% of Utilized Hardware of SCADA/ DCU and Network Automation System	No. each type
3.	Communication Cable- RS485, LAN		
4.	Control Cable		

Table 8 [2] Software Configuration Tools

S.No.	Item	Qty
1	RTU/ DCU configuration tools with licensed software and cables	2 Nos.
2	Network configuration tools with licensed software and cables	1 Nos.

		Network configuration tool: 10th Generation Intel Core TM i5-10210UProcessor(4Cores/8Threads, 1.60-GHZ up to 2.10 GHZ with Turbo Boost, 6MB Casche),Windows 10 Pro 64, 35.56cms(14.0)FHD (1366x768)TN220nts Anti-glare, 16GB RAM DDR4 5Years Onsite Warranty,Stereo,Dolby@AudioTM 65W Adaptor,Carry Bag & Wired Mouse,Integrated Intel@UHD Graphics HDMI Port,2xUSB 3.2Gen1, 1xUSB 32 Type-C Gen 1.1xUSB3.2 Type-C Gen2 Laptop Battery 3 Cell,45Wh,CAM 720p HD Intel Wi-FI & Blue tooth 5.1,mini 250GB SSD,1TB HDD
9	**Drawings & Documents, Configuration Backup and Certificates**	**Drawings & Documents:** Following drawings and documents shall be prepared on BYPLs specifications and statutory requirements and shall be submitted before the starting of manufacturing: 1. Completely filled in Technical Particulars 2. General description of the equipment and all components including brochures 3. Bill of material 4. Type test certificates 5. System Design Architecture Drawing 6. Layout drawings of Control cable, communication cable and cable tray linking RTU/ DCU panel, communication panels/ hardware 7. Hardware Specification 8. Sizing Calculations of various components 9. Response Time Calculations 10. Functional Design Document 11. Power Distribution Schematic Diagrams for each RTU 12. Standard documentation per IED, according to IEC 61850 13. MICS document (Model Implementation Conformance Statement) 14. PICS document (Protocol Implementation Conformance Statement) 15. Conformance Test certificate 16. ICD File (IED Capability Description file) 17. SCD file (Substation Configuration Description) After the award of the contract four (4) copies of drawings, drawn to scale, describing the equipments in detail shall be forwarded for approval and the supplier/ BA shall subsequently provide four (4) complete sets of final drawings, one of which shall be auto-positive suitable for reproduction, before the dispatch of the equipments. Soft copy (Pen drive) of the drawings, GTP, Test certificates shall be submitted after the final approval

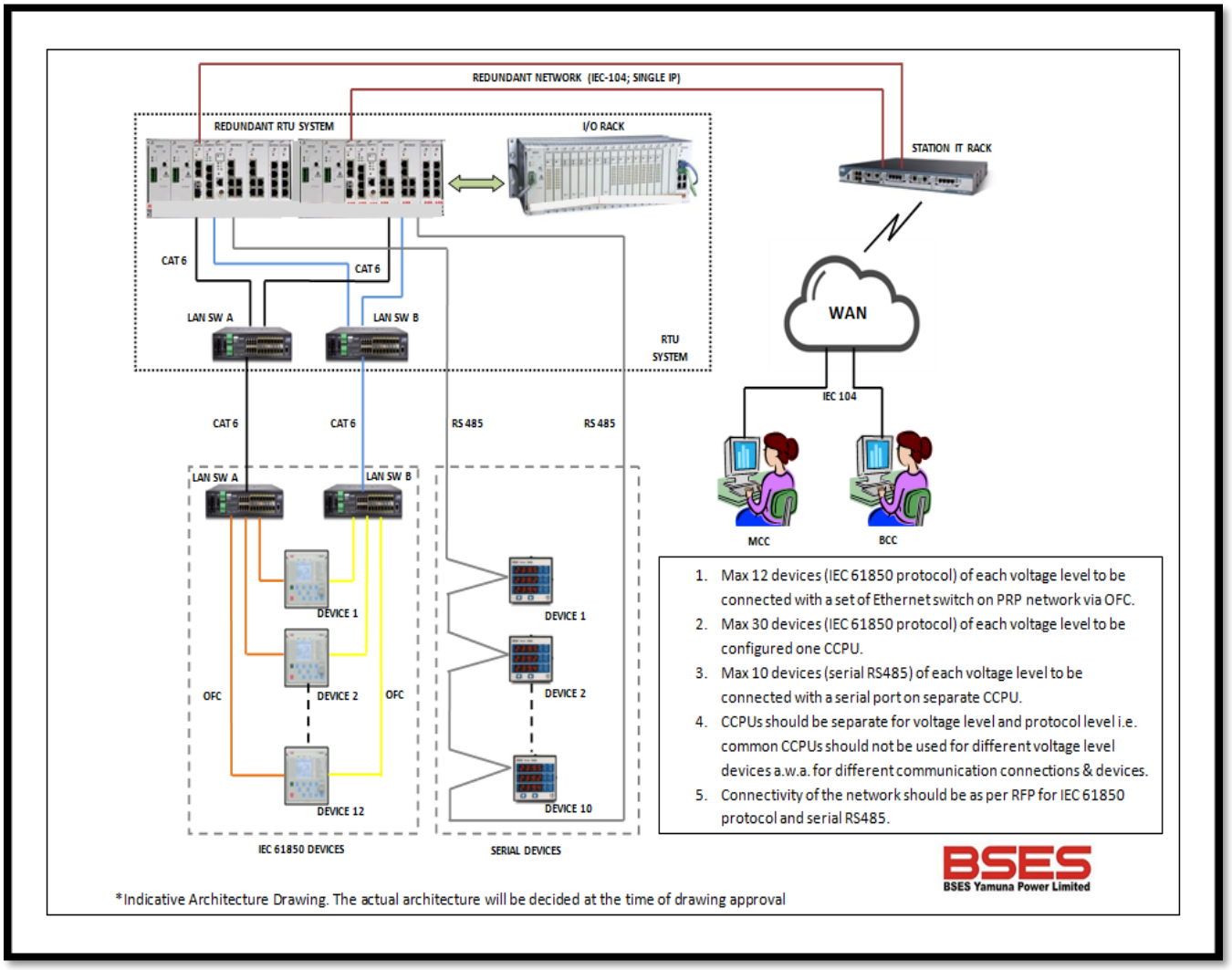
		of the same to BYPL. All the documents and drawings shall be in English language. After execution any minor/ major change(s) made at the site to be incorporated in the documents and As build drawings and duly submitted to BYPL in the form of hard and soft copy. **Instruction Manuals:** Bidder shall furnish two (2) soft copies (Pendrive) and four (4)hard copies of nicely bound manuals (in English language) covering erection and maintenance instructions and all relevant information and drawings pertaining to the main equipments as well as the auxiliary devices. **Configuration Backup:** All Configuration files for RTU/ DCU and network automation system should be provided to BYPL. Data Backup along with software shall be handed over to BYPL in Pen drive at the time of project hand over. **Certificates:** 1. Test certificates of all the tests required and conducted by the supplier/ BA. 2. System and equipments warranty certificates 3. Maintenance and Service Agreement Certificates The supplier/ BA shall ensure that all the certificates mentioned in this document along with SAT document are submitted to BYPL at the time of SAT.
10	**Trainings and Hands-on**	The supplier/ BA personnel who are experienced instructors and who speak understandable English shall conduct training. The supplier/ BA shall arrange on its own cost all hardware training platform required for successful training and understanding at BYPLs works. The supplier/BA 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 BYPL at least two (2) 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 BYPL. BYPL

		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 BYPL. The schedule, location, and detailed contents of each course will be finalized during BYPL and supplier/ BAs discussions. If the supplier/ BA have utilized 3rd party equipment or outsourced work to a 3rd party then experienced instructors of the 3rd party are required to be part of the training sessions. **System Hardware Course** A computer system hardware course shall be offered, but at the system level. The training course shall be designed to give BYPL 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 shall be covered: • System hardware design architecture overview: Configuration of the system hardware. • Equipment Maintenance: Basic theory of operation, maintenance techniques and diagnostic procedures for each element of the computer system, e.g., processors, auxiliary memories, Ethernet, routers and printers. Configuration of all the hardware equipment. • System Expansion: Techniques and procedures to expand and add equipment such as loggers, monitors and communication channels. • System Maintenance: Theory of 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 BYPLs equipment or part of similarly designed and configured subsystems. All interfaces to the computing equipment shall be taught in detail. • 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 BYPLs equipment or on similarly configured systems. **System Software Course** The contractor shall provide a computer system software course that covers the following subjects:

		• 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. • 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. • System Initialization and Failover: Including design, theory of operation and practice • Diagnostics: Including the execution of diagnostic procedure and the interpretation of diagnostic outputs. • Software Documentation: Orientation in the organization and use of system software documentation. • 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. **Application Software Course** The supplier/ BA shall provide comprehensive application software courses covering all applications including the database and display building course. The training shall include: • Overview: Block diagrams of the application software and data flows. Programming standards and program Interface conventions. • Application Functions: Functional capabilities, design and major algorithm. Associated maintenance and expansion techniques. • Software Development: Techniques and conventions to be used for the preparation and integration of new software functions. • Software Generation: Generation of application software from source code and associated software configuration control procedures. • Software Documentation: Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals. • 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. **Requirement of Training**

		The supplier/ BA shall provide training for a batch (maximum of 5 people) for five (5) days in two slots (Time of which will be decided by BYPL and supplier/ BA) on the following courses. Travel, boarding, lodging and local conveyance etc shall be under vendors scope. Name of Course: • System Hardware • System Software • Application Software
11.	**SAT**	This document exclusively covers the SAT for SCADA RTU/ DCU and Network Automation system. After the successful commissioning and testing of the SCADA RTU/ DCU & Network Automation system and liquidation of all punch points, the system will be put on continuous running mode for a cycle of minimum thirty (30) days after clearance on punch-points. During this period, if the RTU/ DCUs performance due to configuration and/ or hardware does not meet the criteria as per points 3.k and 3.n, the cycle will be reset. During the cycle, availability and operational efficacy of the system will be checked and after successful validation SAT will be concluded. SAT will include the validation of the following: 1. Communication Network 2. SCADA RTU/ DCU and Network redundancy 3. Validation of SOE 4. All approved Indication, Command and Measurand data. BYPL reserves the right to financially penalize the supplier/ BA on failure of SAT as per the technical and tender document.

Annexure 12.a (RTU/ DCU System Architecture Drawing)



Annexure 12.b (Signal List- 11/33/66kV)

A. 11kV Outgoing feeders- IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through N.Relay/ BCU	DO soft through N.Relay/ BCU	Signal Type
1.	Breaker ON	✓		DPI
2.	Breaker OFF			SPI
3.	Trip Ckt Healthy 1	✓		SPI
4.	Trip Ckt Healthy 2	✓		SPI
5.	Spring Charge	✓		SPI
6.	Breaker in Service	✓		SPI
7.	Breaker in Test	✓		SPI
8.	Auto Trip (86) Operated	✓		SPI
9.	Panel DC Fail	✓		SPI
10.	Panel AC Fail	✓		SPI
11.	L/R switch in SCADA	✓		SPI
12.	Relay Int Fault	✓		SPI
13.	Over Current Operated(ALL STAGES)	✓		SPI
14.	Earth Fault Operated(ALL STAGES)	✓		SPI
15.	BKR Close COMMAND		✓	DCO
16.	BKR Open COMMAND			
17.	Auto Trip (86) relay reset from Remote		✓	SCO
18.	3Phase R, Y, B- Current & Voltage, Active Power, Reactive Power, Power factor, Max. Demand, Neu. Current	✓		AI/ MV
19.	Fault current and phase indication of faulty phase viz. R, Y, B, Earth, Unbalance (O/C & E/F Relay), Disturbance Records, Fault Graphs for Remote diagnosis purpose	✓		AI/MV

Note:
1.Signals like Panel DC Fail and Relay Int Fault to be taken from adjacent panel.
2.Final signals list will be approved with CRP/Switchgear panel drawing.

B. 11kV Incomers: IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through N.Relay/ BCU	DO soft through N.Relay/ BCU	Signal Type
1.	Breaker On	✓		DPI
2.	Breaker OFF			
3.	Trip Ckt Healthy 1	✓		SPI
4.	Trip Ckt Healthy 2	✓		SPI
5.	Panel AC Fail	✓		SPI
6.	Spring Charge	✓		SPI
7.	Breaker in Service	✓		SPI
8.	Breaker in Test	✓		SPI
9.	Auto trip (86) Operated	✓		SPI
10.	VT fuse Blown- Metering	✓		SPI
11.	VT fuse Blown- Protection	✓		SPI
12.	Panel DC Fail			SPI
13.	L/R Switch in SCADA	✓		SPI
14.	Relay Int Fault	✓		SPI
15.	Over Current Operated (All Stages)	✓		SPI
16.	Earth Fault Operated (All Stages)	✓		SPI
17.	Under Voltage Prot. Operated	✓		SPI
18.	Over Voltage Prot. Operated	✓		
19.	REF Operated	✓		SPI
20.	BKR Close COMMAND		✓	DCO
21.	BKR Open COMMAND			
22.	Auto trip (86) relay reset from Remote		✓	SCO
23.	3Phase R, Y, B- Current & Voltage, Active Power, Reactive Power, Power factor, Max. Demand, Neu. Current	✓		AI/ MV
24.	Fault current and phase indication of faulty phase viz. R, Y, B, Earth, Unbalance (O/C & E/F Relay), Disturbance Records, Fault Graphs for Remote diagnosis purpose	✓		AI/MV

Note:
1. Signals like Panel DC Fail and Relay Int Fault to be taken from adjacent panel
2. Final signals list will be approved with CRP/Switchgear panel drawing.

C. 11kV Bus Coupler: IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through N.Relay/ BCU	DO soft through N.Relay/ BCU	Signal Type
1.	Breaker On	✓		**DPI**
2.	Breaker OFF			
3.	Trip Ckt Healthy 1	✓		**SPI**
4.	Trip Ckt Healthy 2	✓		SPI
5.	Panel AC Fail	✓		SPI
6.	Spring Charge	✓		**SPI**
7.	Breaker in Service	✓		**SPI**
8.	Breaker in Test			**SPI**
9.	Auto trip (86) Operated	✓		**SPI**
10.	Panel DC Fail	✓		**SPI**
11.	L/R Switch in SCADA	✓		**SPI**
12.	Relay Int. Fault	✓		**SPI**
13.	PT MCB- Metering operated	✓		**SPI**
14.	PT MCB- Protection operated	✓		**SPI**
15.	Over Current Operated	✓		**SPI**
16.	Earth Fault Operated	✓		**SPI**
17.	BKR Close COMMAND		✓	**DCO**
18.	BKR Open COMMAND			
19.	Auto trip (86) relay reset from Remote		✓	SCO
20.	3Phase R, Y, B- Current & Voltage, Active Power, Reactive Power, Power factor, Max. Demand, Neu. Current	✓		AI/ MV
21.	Fault current and phase indication of faulty phase viz. R, Y, B, Earth, Unbalance (O/C & E/F Relay), Disturbance Records, Fault Graphs for Remote diagnosis purpose	✓		**AI/MV**

Note:
1. Signals like Panel DC Fail and Relay Int Fault to be taken from adjacent panel
2. Final signals list will be approved with CRP/Switchgear panel drawing.

D. 11Kv Capacitors: IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through N.Relay/ BCU	DO soft through N.Relay/ BCU	Signal Type
1.	Breaker On	✓		**DPI**
2.	Breaker OFF			
3.	Bank ISO ON	✓		**DPI**
4.	Bank ISO OFF			
5.	Trip Ckt Healthy 1	✓		**SPI**
6.	Trip Ckt Healthy 2	✓		SPI
7.	Panel AC Fail	✓		SPI
8.	Spring Charge	✓		**SPI**
9.	Breaker in Service	✓		**SPI**
10.	Breaker in Test	✓		**SPI**
11.	Master Trip (86) Operated	✓		**SPI**
12.	Bus PT fuse Blown- Metering	✓		**SPI**
13.	Bus PT fuse Blown- Protection	✓		**SPI**
14.	Panel DC Fail	✓		**SPI**
15.	L/R Switch in SCADA	✓		**SPI**
16.	Over Current Operated	✓		**SPI**
17.	Earth Fault Operated	✓		**SPI**
18.	Under Volt. Prot. Operated	✓		**SPI**
19.	Over Volt. Prot. Operated	✓		**SPI**
20.	Neg. Phase sequence Operated	✓		**SPI**
21.	Timer Relay operated/ Normal	✓		**DPI**
22.	Relay Int. Fault	✓		**SPI**
23.	BKR Close COMMAND		✓	**DCO**
24.	BKR Open COMMAND			
25.	BANK ISO OPN		✓	**DCO**
26.	BANK ISO CLS			
27.	Master trip (86) reset from remote		✓	**SCO**

28.	3phase R, Y, B- Curr & Volt, React. Pow, Neu. Curr	✓		**AI/ MV**
29.	Fault current and phase indication of faulty phase viz. R, Y, B, Earth, Unbalance (O/C & E/F Relay), Disturbance Records, Fault Graphs for Remote diagnosis purpose	✓		**AI/MV**

Note:
1. Signals like Panel DC Fail and Relay Int Fault to be taken from adjacent panel
2. Final signals list will be approved with CRP/Switchgear panel drawing.

E. 33 & 66 kV Incomers/ Outgoing- IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through N.Relay/ BCU	DO soft through N.Relay/ BCU	Signal Type
1.	Breaker On	✓		**DPI**
2.	Breaker OFF			
3.	Bus ISO (89A) ISO ON	✓		**DPI**
4.	Bus ISO (89A) ISO OFF			
5.	Bus ISO (89B) ISO ON	✓		**DPI**
6.	Bus ISO (89B) ISO OFF			
7.	LINE ISO (89L) ON	✓		**DPI**
8.	LINE ISO (89L) OFF			
9.	EARTH SWITCH (89LE) CLOSE	✓		**SPI**
11.	EARTH SWITCH (89AE) CLOSE	✓		**SPI**
13.	Breaker in Service (In-case of I/D BKR)	✓		**SPI**
14.	Breaker in Test (In-case of I/D BKR)	✓		**SPI**
15.	Trip Ckt Healthy	✓		**SPI**
16.	Spring Charge	✓		**SPI**
17.	Master Trip (86) Operated	✓		**SPI**
18.	SF6 Pressure Low & SF6 Lock Out	✓		**SPI**
19.	VT fuse Fail	✓		

20.	L/R Switch in Remote	✓		**SPI**
21.	LBB Operated	✓		**SPI**
22.	Panel DC Fail	✓		**SPI**
23.	Relay Int. Fault	✓		**SPI**
24.	Over Current Operated (All Stages)	✓		**SPI**
25.	Earth Fault Operated (All Stages)	✓		**SPI**
26.	DIFF. Prot Operated	✓		**SPI**
27.	DIST. Prot Operated	✓		**SPI**
28.	BKR Close COMMAND		✓	**DCO**
29.	BKR Open COMMAND			
30.	Bus ISO (89A) ISO ON CMD		✓	**DCO**
31.	Bus ISO (89A) ISO OFF CMD			
32.	Bus ISO (89B) ISO ON CMD		✓	**DCO**
33.	Bus ISO (89B) ISO OFF CMD			
34.	LINE ISO (89L) ON CMD		✓	**DCO**
35.	LINE ISO (89L) OFF CMD			
36.	Master trip (86) relay reset from remote		✓	**SCO**
37.	3phase R, Y, B- Curr & Volt,Active & React. Pow, Pow Factor, Max Demand, Neu. Curr etc.	✓		**AI/ MV**
38.	Fault current and phase indication of faulty phase viz. R, Y, B, Earth, Unbalance (O/C & E/F Relay), Disturbance Records, Fault Graphs for Remote diagnosis purpose	✓		**AI/MV**

Note:

1. Signals like Panel DC Fail and Relay Int Fault to be taken from adjacent panel

2. Final signals list will be approved with CRP/Switchgear panel drawing.

F. 33 & 66 kV Transformer- IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through N.Relay/ BCU	DO soft through N.Relay/ BCU	Signal Type
1.	Breaker On	✓		DPI
2.	Breaker OFF			
3.	Bus ISO (89A) ISO ON	✓		DPI
4.	Bus ISO (89A) ISO OFF			
5.	Bus ISO (89B) ISO ON	✓		DPI
6.	Bus ISO (89B) ISO OFF			
7.	LINE ISO (89T) ON	✓		DPI
8.	LINE ISO (89T) OFF			
9.	EARTH SWITCH (89TE) CLOSE	✓		SPI
10.	EARTH SWITCH (89AE) CLOSE	✓		SPI
13.	Breaker in Service (In-case of I/D BKR)	✓		SPI
14.	Breaker in Test (In-case of I/D BKR)	✓		SPI
15.	Trip Ckt Healthy- 1	✓		SPI
16.	Trip Ckt Healthy- 2	✓		SPI
17.	Panel AC Fail	✓		SPI
18.	Spring Charge	✓		SPI
19.	Auto Trip (86) Operated	✓		SPI
20.	Differential Operated	✓		SPI
21.	LBB Operated	✓		SPI
22.	REF/SEF Prot Operated	✓		SPI
23.	SF6 Pressure Low & SF6 Lock Out	✓		SPI
24.	Panel DC Fail	✓		SPI
25.	L/R Switch in Remote	✓		SPI
26.	LBB Operated	✓		SPI
27.	Relay Int. Fault	✓		SPI
28.	Over Current Operated	✓		SPI
29.	Earth Fault Operated	✓		SPI
30.	BKR CLS COMMAND		✓	DCO
31.	BKR OPN COMMAND			
32.	Bus ISO (89A) ISO ON CMD		✓	DCO
33.	Bus ISO (89A) ISO OFF CMD			

34.	Bus ISO (89B) ISO ON CMD		✓	**DCO**
35.	Bus ISO (89B) ISO OFF CMD			
36.	LINE ISO (89T) ON CMD		✓	**DCO**
37.	LINE ISO (89T) OFF CMD			
38.	Master trip (86) relay reset from remote		✓	**SCO**
39.	3phase R, Y, B- Curr & Volt,Active & React. Pow, Pow Factor, Max Demand, Neu. Curr etc.	✓		**AI/ MV**
40.	Fault current and phase indication of faulty phase viz. R, Y, B, Earth, Unbalance (O/C & E/F Relay). Fault voltage and phase indication of faulty phase viz. R,Y,B (Voltage Protection Relay). Fault Differential and Bias current in Line and T/F Differential Relay, Fault distance (in distance relay), Disturbance Records, Fault graphs for remote diagnosis purpose.	✓		**AI/MV**

Note:
1. Signals like Panel DC Fail and Relay Int Fault to be taken from adjacent panel
2. Final signals list will be approved with CRP/Switchgear panel drawing.

G. Signals Related with CRP

Sr. No.	Signal Detail	Type of Signal on IEC61850
1	**Signals of Differential Relay**	
	Digital Input Signals	
1	Differential Trip Bph	Single Point Information
2	Differential Trip Rph	Single Point Information
3	Differential Trip Yph	Single Point Information
4	Differential Highset Trip	Single Point Information
5	Differential Trip	Single Point Information
6	Inrush detected	Single Point Information
7	REF Trip	Single Point Information
8	Trafo. Differential lockout operated	Single Point Information

9	Trafo. Differential watchdog operated	Single Point Information
10	Trafo. Differential communication fail	Single Point Information
11	Trafo Trouble Trip	Single Point Information
	Measurement Signals	
1	Current Bph	Measured Float
2	Current Rph	Measured Float
3	Current Yph	Measured Float
4	Fault Current Bph	Measured Float
5	Fault Current Rph	Measured Float
6	Fault Current Yph	Measured Float
7	Fault Current Nph	Measured Float
8	Fault locator in some relays	Measured Float
9	Sigma kA square	Measured Float
2	**Signals of Distance Relay**	
	Digital Input Signals	
1	Distance Relay Lockout Operated	Single Point Information
2	Distance Trip	Single Point Information
3	Distance Zone-1 operated	Single Point Information
4	Distance Zone-2 operated	Single Point Information
5	Distance Zone-3 operated	Single Point Information
6	Line Distance Relay Communication Fail	Single Point Information
7	Line Distance Relay watchdog operated	Single Point Information
3	**Signals of Line Differential Relay**	
	Digital Input Signals	
1	Conductor Broken	Single Point Information
2	Differential Trip	Single Point Information
3	Rph Differential Trip	Single Point Information
4	Yph Differential Trip	Single Point Information
5	Bph Differential Trip	Single Point Information
6	Distance Trip	Single Point Information
7	Distance Zone-1 operated	Single Point Information
8	Distance Zone-2 operated	Single Point Information
9	Distance Zone-3 operated	Single Point Information
10	Earth Fault high set trip	Single Point Information
11	Earth Fault IDMT trip	Single Point Information
12	General Trip	Single Point Information
13	Inter-trip	Single Point Information
14	Line differential block	Single Point Information
15	Line differential Channel-1 fail	Single Point Information
16	Line differential Channel-2 fail	Single Point Information
17	Line differential operated	Single Point Information

18	Line differential relay watchdog operated	Single Point Information
19	Phase fault high set trip	Single Point Information
20	Phase fault IDMT trip	Single Point Information
21	PT Fuse Fail	Single Point Information
22	Sync fail	Single Point Information
	Digital Output Signals	
1	General trip	Single Command Output
2	Line Diff. Operated	Single Command Output
	Measurement Signals	
1	Active Power	Measured Float
2	Current Bph	Measured Float
3	Current Rph	Measured Float
4	Current Yph	Measured Float
5	Fault Current Bph	Measured Float
6	Fault Current Rph	Measured Float
7	Fault Current Yph	Measured Float
8	Fault Current Nph	Measured Float
9	Fault Locator in some relays	Measured Float
10	Frequency	Measured Float
11	Power Factor	Measured Float
12	Reactive Power	Measured Float
13	Sigma kA square	Measured Float
14	Voltage BR	Measured Float
15	Voltage RY	Measured Float
16	Voltage YB	Measured Float
4	**Signals of Overcurrent Earthfault Relay**	
	Digital Input Signals	
1	50BF/LBB Operated	Single Point Information
2	86 Supervision	Single Point Information
3	Relay Communication fail	Single Point Information
4	Relay watchdog operated	Single Point Information
5	Isolator A status	Double Point Information
6	Isolator B status	Double Point Information
7	Cable door open	Single Point Information
8	CB in Remote	Single Point Information
9	CB Status	Double Point Information
10	Earth Fault General Trip	Single Point Information
11	Earth Fault High set Trip	Single Point Information
12	Earth Fault IDMT Trip	Single Point Information
13	Earth Switch AE status	Double Point Information
14	Earth Switch BE status	Double Point Information

15	Earth Switch LE status	Double Point Information
16	Line Isolator status	Double Point Information
17	Breaker L/R switch	Single Point Information
18	Negative Phase Sequence	Single Point Information
19	Phase Fault General Trip	Single Point Information
20	Phase Fault Highset Trip	Single Point Information
21	Phase Fault IDMT Trip	Single Point Information
22	Phase Fault Overload Trip	Single Point Information
23	PT Fuse Failure	Single Point Information
24	Relay Reset	Single Point Information
25	SF6 Gas Pressure Low	Single Point Information
26	SF6 Lockout Operated	Single Point Information
27	Spring Charged	Single Point Information
28	TCS Alarm-1	Single Point Information
29	TCS Alarm-2	Single Point Information
	Digital Output Signals	
1	CB Command	Double Command Output
2	Relay Reset	Single Command Output
	Spare Output	
	Measurement Signals	
1	Active Power	Measured Float
2	Current Bph	Measured Float
3	Current Rph	Measured Float
4	Current Yph	Measured Float
5	Fault Current Bph	Measured Float
6	Fault Current Rph	Measured Float
7	Fault Current Yph	Measured Float
8	Fault Current Nph	Measured Float
9	Fault Locator in some relays	Measured Float
10	Frequency	Measured Float
11	Power Factor	Measured Float
12	Reactive Power	Measured Float
13	Sigma kA square	Measured Float
14	Voltage BR	Measured Float
15	Voltage RY	Measured Float
16	Voltage YB	Measured Float

H. Transformer- TM cum AVR relay Signals- IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through TM cum AVR	DO soft through TM cum AVR	Signal Type
1.	DC Fail	✓		**SPI**
2.	Oil Temp Alarm	✓		**SPI**
	Relay Int Fault	✓		**SPI**
3.	Oil Temp Trip	✓		**SPI**
4.	Winding Temp Alarm	✓		**SPI**
5.	Winding Temp Trip	✓		**SPI**
6.	Buchholz Alarm	✓		**SPI**
7.	Buchholz Trip	✓		**SPI**
8.	PRV Trip	✓		**SPI**
9.	OLTC OSR	✓		**SPI**
10.	MOG/LOW Oil Level Alarm	✓		**SPI**
11.	SPR Trip	✓		**SPI**
12.	OSR Main Tank	✓		**SPI**
13.	L/R Switch in Local	✓		**DPI**
14.	L/R Switch in Remote	✓		
15.	Auto Mode	✓		**DPI**
16.	Manual Mode	✓		
17.	Fan Fail	✓		**SPI**
18.	Tap Changer Fail	✓		**SPI**
19.	OLTC Out of Step/ Stuck up/ Motor trip	✓		**SPI**
20.	Tap Rise/ Low Command		✓	**RCO**
21.	Oil Temp	✓		**AI**
22.	Winding Temp	✓		**AI**
23.	Tap Position	✓		**AI**

Note:
1. Signals like Panel DC Fail and Relay Int Fault to be taken from adjacent panel
2. Final signals list will be approved with CRP/Switchgear panel drawing.

I. 33 & 66kV Bus Coupler- IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through N.Relay/ BCU	DO soft through N.Relay/ BCU	Signal Type
1.	Breaker On	✓		DPI
2.	Breaker OFF			
3.	Bus ISO (89A) ISO ON	✓		DPI
4.	Bus ISO (89A) ISO OFF			
5.	Bus ISO (89B) ISO ON	✓		DPI
6.	Bus ISO (89B) ISO OFF			
7.	EARTH SWITCH (89AE) CLOSE	✓		SPI
8.	EARTH SWITCH (89BE) CLOSE	✓		SPI
9.	Breaker in Service (In-case of I/D BKR)	✓		SPI
10.	Breaker in Test (In-case of I/D BKR)	✓		SPI
11.	Trip Ckt Healthy- 1	✓		SPI
12.	Trip Ckt Healthy- 2	✓		SPI
13.	Panel AC Fail	✓		SPI
18.	Spring Charge	✓		SPI
19.	Auto Trip (86) Operated	✓		SPI
20.	SF6 Pressure Low	✓		SPI
21.	SF6 Lock Out	✓		SPI
22.	VT fuse-1 Blown	✓		SPI
23.	VT fuse-2 Blown	✓		SPI
24.	Panel DC Fail	✓		SPI
25.	L/R Switch in Remote	✓		SPI
26.	LBB Operated	✓		SPI
27.	Relay Int. Fault	✓		SPI
28.	Over Current Operated (All Stages)	✓		SPI
29.	Earth Fault Operated (All Stages)	✓		SPI
30.	BKR Close COMMAND		✓	DCO
31.	BKR Open COMMAND			
32.	BUS (89A) ISO OPN COMMAND		✓	DCO
33.	Bus (89A) ISO CLS COMMAND			
34.	Bus (89B) ISO OPN		✓	DCO

	COMMAND			
35.	Bus (89B) ISO CLS COMMAND			
36.	Auto trip (86) relay reset from remote		✓	**SCO**
37.	3phase R, Y, B- Curr, BUS PT-01 & BUS PT-02 3 phase voltages	✓		**AI/ MV**
38.	Fault current and phase indication of faulty phase viz. R, Y, B, Earth, Unbaethernetce (O/C & E/F Relay). Fault voltage and phase indication of faulty phase viz. R,Y,B (Voltage Protection Realy). Fault Differential and Bias current in line and T/F Diff Relay, Fault distance (in Distance Relay), Disturbance Records, Fault Graphs for Remote diagnosis purpose	✓		**AI/ MV**

Note:
1. Signals like Panel DC Fail and Relay Int Fault to be taken from adjacent panel
2. Final signals list will be approved with CRP/Switchgear panel drawing.

J. 33 & 66kV CAP Bank- IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through N.Relay/ BCU	DO soft through N.Relay/ BCU	Signal Type
1.	Breaker On	✓		**DPI**
2.	Breaker OFF			
3.	Bus ISO (89A) ISO ON	✓		**DPI**
4.	Bus ISO (89A) ISO OFF			
5.	Bus ISO (89B) ISO ON	✓		**DPI**
6.	Bus ISO (89B) ISO OFF			
7.	LINE ISO (89C) ON	✓		**DPI**
8.	LINE ISO (89C) OFF			

9.	EARTH SWITCH (89CE) CLOSE	✓		**SPI**
10.	EARTH SWITCH (89AE) CLOSE	✓		**SPI**
11.	Trip coil Ckt Healthy- 1	✓		**SPI**
12.	Trip coil Ckt Healthy- 2	✓		**SPI**
13.	Panel AC Fail	✓		**SPI**
12.	Spring Charge	✓		**SPI**
13.	Auto Trip (86) Operated	✓		**SPI**
14.	SF6 Pressure Low & SF6 Lock Out	✓		**SPI**
15.	VT fuse Blown	✓		**SPI**
16.	Cap Discharge Time	✓		**SPI**
17.	Neutral Displacement	✓		**SPI**
18.	Panel DC Fail	✓		**SPI**
19.	L/R Switch in Remote	✓		**SPI**
20.	LBB Operated	✓		**SPI**
21.	Relay Int. Fault	✓		**SPI**
22.	Over Current Operated	✓		**SPI**
23.	Earth Fault Operated	✓		**SPI**
24.	Under Voltage Prot. Operated	✓		**SPI**
25.	Over Voltage Prot. Operated	✓		**SPI**
26.	BKR Close COMMAND		✓	**DCO**
27.	BKR Open COMMAND			
28.	Bus (89A) ISO OPN COMMAND		✓	**DCO**
29.	Bus (89A) ISO CLS COMMAND			
30.	Bus (89B) ISO OPN COMMAND		✓	**DCO**
31.	Bus (89B) ISO CLS COMMAND			
32.	CAP Bank ISO OPN Command		✓	**DCO**
33.	CAP Bank ISO CLS Command			
34.	3phase R, Y, B- Curr & voltage, Reactive Pow, Neu Curr	✓		**AI/ MV**

35.	Fault current and phase indication of faulty phase viz. R, Y, B, Earth, Unbaethernetce (O/C & E/F Relay). Fault voltage and phase indication of faulty phase viz. R,Y,B (Voltage Protection Realy). Fault Differential and Bias current in line and T/F Diff Relay, Fault distance (in Distance Relay), Disturbance Records, Fault Graphs for Remote diagnosis purpose	✓		**AI**

Note:
1. Signals like Panel DC Fail and Relay Int Fault to be taken from adjacent panel
2. Final signals list will be approved with CRP/Switchgear panel drawing.

K. BUS PT-1 & 2- IEC 61850 Protocol

S.No.	Signal List	DI/ AI soft through N.Relay/ BCU	DO soft through N.Relay/ BCU	Signal Type
1.	BUS A (89A) ON	✓		**DPI**
2.	BUS A (89A) OFF			
3.	BUS B (89B) ON	✓		**DPI**
4.	BUS B (89B) ON			
5.	Earth Switch (89LE)-1 ON	✓		**DPI**
6.	Earth Switch (89LE)-1 OFF			
7.	Earth Switch (89LE)-2 ON	✓		**DPI**
8.	Earth Switch (89LE)-2 OFF			
9.	BUS-A ISO OPN COMMAND		✓	**DCO**
10.	BUS-A ISO CLS COMMAND			
11.	BUS-B ISO OPN COMMAND		✓	**DCO**
12.	BUS-B ISO CLS COMMAND		✓	**DCO**

L. Smoke Detector- ALL sensors, Manual Call Points- Modbus Protocol

S.No.	Signal List	Soft Signals	Signal Type
1.	All Sensors Alarm operated Signalsll Sensors Alarm operated Signals (10 to 20 Sensors)	✓	**SPI**
2.	All Manual Call Points- MCP- 1, MCP- 2, etc.	✓	

M. Battery Charger- Modbus Protocol

S.No.	Signal List	DI/ AI soft through RTU	Signal Type
1.	Battery CHG Mains AC Fail	✓	**SPI**
2.	Charger A AC MCCB Trip	✓	**SPI**
3.	Charger A DC MCCB Trip	✓	**SPI**
4.	Charger B AC MCCB Trip	✓	**SPI**
5.	Charger B DC MCCB Trip	✓	**SPI**
6.	Charger A/B in boost	✓	**SPI**
7.	Charger A/B rectifier Capacitor Fuse Blown	✓	**SPI**
8.	Battery MCCB Trip	✓	**SPI**
9.	DC system Earth	✓	**SPI**
10.	Insulation Fault	✓	**SPI**
11.	Charger A Current	✓	**AI**
12.	Charger A Voltage	✓	**AI**
13.	Charger B Current	✓	**AI**
14.	Charger B Voltage	✓	**AI**
15.	Battery Current	✓	**AI**
16.	Battery Voltage	✓	**AI**

N. LT Board

S.No.	Signal List	DI Hard Wire to RTU	Signal Type
1.	LT AC Fail	✓	SPI
2.	R,Y,B Phase Current		AI/ MV/ MFI

O. Fire Fighting (All T/Fs)

S.No.	Signal List	DI Hard Wire to RTU	Signal Type
1.	SYSTEM OPERATED	✓	SPI
2.	SYSTEM OUT OF SERVICE	✓	SPI
3.	TCIV CLOSED	✓	SPI
4.	FIRE DETECTOR TRIP	✓	SPI
5.	N2 CYLINDER PRESSURE LOW	✓	SPI
6.	FIRE SYSTEM ALARM	✓	SPI
7.	DC SUPPLY FAIL	✓	SPI

P. MFM- BUS PT- 1, 2 Signals (Front & Rear Bus)- Modbus Protocol

S.No.	Signal List	Data Type
1.	R-Ph Current	MV/ MFI
2.	Y-Ph Current	MV/ MFI
3.	B-Ph Current	MV/ MFI
4.	Neutral Current	MV/ MFI
5.	R-Y Ph Voltage	MV/ MFI
6.	Y-B Ph Voltage	MV/ MFI
7.	B-R Ph Voltage	MV/ MFI

Q. MFM- Signals- All Feeders (Including Bus Section/ Coupler)- Modbus Protocol

S.No.	Signal List	Data Type
1.	R-Ph Current	MV/ MFI
2.	Y-Ph Current	MV/ MFI

3.	B-Ph Current	MV/ MFI
4.	Neutral Current	MV/ MFI
5.	R-Y Ph Voltage	MV/ MFI
6.	Y-B Ph Voltage	MV/ MFI
7.	B-R Ph Voltage	MV/ MFI
8.	Active Power	MV/ MFI
9.	Active Energy	MV/ MFI
10.	Reactive Power	MV/ MFI
11.	Power Factor	MV/ MFI
12.	Max Demand	MV/ MFI
13.	Phase angle 1	MV/ MFI
14.	Phase angle 2	MV/ MFI
15.	Phase angle 3	MV/ MFI
16.	THD Mean Current	MV/ MFI
17.	THD Mean Voltage	MV/ MFI

Annexure 12.c (List of Abbreviations)

1. SCADA: Supervisory Control and Data Acquisition
2. RTU: Remote Terminal Unit
3. DCU: Data Concentrator Unit
4. C&R: Control and Relay
5. BA: Business Associates
6. I/O: Input/ Output
7. MFM: Multi Function Meter
8. TM: Transformer Monitoring
9. BYPL: BSES Yamuna Power Ltd.
10. MCC: Master Control Center
11. BCC: Business Continuity Center
12. IED: Intelligent Electronic Devices
13. NCR: National Capital Region
14. IEC: International Electrotechnical Commisssion
15. KEMA: Keuring van Elektrotechnische Materialen te Arnhem
16. CE: Conformité Européene
17. FCC: Federal Communications Commission
18. PRP: Parallel Redundancy Protocol
19. LAN: Local Area Network
20. NIDS: Network Intrusion Detection System
21. NIFPS: Nitrogen Injection Fire Protection System
22. DCDB: DC Distribution Board
23. APFC: Automatic Power factor Controller
24. HMI: Human Machine Interface
25. TCP/ IP: Transmission Control Protocol/ Internet Protocol
26. GPS: Global Positioning System
27. FEP: Front-End processor
28. SNTP: Simple Network Time Protocol
29. CRC: Cold Rolled Close
30. MCB: Miniature Circuit Breakers
31. CMR: Contact Multiplying Relay
32. PVC: Polyvinyl Chloride
33. GI: Galvanized Iron
34. RTCC: Remote Tap Changer Control
35. CT: Current Transformer
36. PT: Potential Transformer
37. WAN: Wide Area Network
38. DI: Digital Input
39. DO: Digital Output
40. AI: Analog Input
41. FRLS: Fire Retardant Low Smoke

42. OFC: Optical Fiber Cable
43. GTP: Guaranteed Technical Particulars
44. DCO: Double Command Input
45. DPI: Double Point Indication
46. MV: Measured Value
47. SCO: Single Command Input
48. SPI: Single Point Indication
49. BCU: Bay Control Unit
50. SAT: Site Acceptance Test
51. AVR: Automatic Voltage Regulator
52. SPD: Surge Protection Device