

	BHARAT HEAVY ELECTRICALS LIMITED TRANSMISSION PROJECTS ENGINEERING MANAGEMENT										
	DOCUMENT No.	TB-393-510-015		Rev. No.	00		Prepared	Checked	Approved		
	TYPE OF DOC.	TECHNICAL SPECIFICATION				NAME	VSG	VK	VK		
	TITLE PMU(PHASOR MEASUREMENT UNIT)					SIGN	-SD-	-SD-	-SD-		
						DATE	12-09-17	12-09-17	12-09-17		
						GROUP	TBEM	W.O. No			
	CUSTOMER	Power Grid Corporation of India Ltd.									
	PROJECTS	400/220kV Mysore (Extn) S/s						Project code : 393			
	CONTENTS										
	Section	Description								No. of Sheets	
1.	SCOPE, SPECIFIC TECHNICAL REQUIREMENTS & BILL OF QUANTITIES								3		
2.	EQUIPMENT SPECIFICATION(PMU)								17		
3.	PROJECT DETAILS AND GENERAL SPECIFICATION								37		
4.	GTR (GENERAL TECHNICAL REQUIREMENT)								5		
5.	CHECKLIST								2		
	01		VSG	VK	VK						
	Rev No.	Date	Altered	Checked	Approved	REVISION DETAILS					
						Distribution	TBMM	TBQM	TBCM	TBTS	
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SECTION 1 SCOPE AND QUANTITIES

1.0 GENERAL SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing, dispatch, site testing and commissioning of the PMU equipments/items, complete in all respect for 400/220kV Mysore (Extn.) S/s by bidder. The detailed technical specification is enclosed under Section II of this specification.

This section covers the specific technical requirements of PMU Equipment System. This constitutes minimum technical parameters for the PMU system as specified by the customer (POWERGRID). The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification.

The specification comprise of following sections:

Section-1: Scope & Bill of Quantities

Section-2: Equipment Specification

Section-3: General Technical Requirements

Section 4 : GTR

Section 5 : Checklist

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

1.1 A) THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT

The equipment is required for the following Projects.

Name of Customer : Power Grid Corporation of India Ltd.

Name of the Project : 400/220kV Mysore (Extn) S/s

Refer Section - 3 for Project Details and General Specifications

1.1 B) SCOPE

The scope shall include equipment's supply, installation, testing and commissioning. To fulfil complete system commissioning any item Hardware/software/service support/site –survey related to these equipment's installation and commissioning is in the scope of bidder.

For the completeness of the system all items/ materials/services are deemed to be included in the offer and no claim whatsoever shall be entertained at later stage.

If any of the item supplied by bidder is found not meeting the technical specification requirement, the item shall be replaced without any price implication to BHEL and the technical requirement shall be met.

The offered PMUs shall be complete in all respect including GPS receiver and can communicate with Phasor Data Concentrators (PDCs) installed at control centres of RLDC/NLDC as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standards.

The PMU and associated equipment's/items as per specification at bay level shall be offered in separate panels for two 400kV lines a) Mysore- Hiriyur line and b) Mysore- Tumkur line .

1.2 BILL OF QUANTITIES

for 400/220kV Mysore (Extn) S/s .

The BOQ mentioned below.

SN	DESCRIPTION	UNIT	QTY
1.	PMU	Nos.	2
2.	Time System (GPS Receiver)	Nos.	2
3.	Substation Grade Layer -3 LAN Switches with minimum 4x10/100 Mbps Ethernet ports and 2x1 Gbps Ethernet ports	Nos.	3
4.	Armored Fibre Optic Cable and associated termination	LOT	1
5.	Services: Integration of PMU at S/s end for data transmission to PDC at respective RLDC	LOT	1

NOTE:

- Qty variation shall be +/- 50% .
- Any additional item required for completion of PMU system as per tech specification {Please refer fig 1.2 , section 2 of technical specification for typical architecture of PMU system } shall be deemed to be included in the above BOQ. No additional price implication shall be entertained during contract stage in this regard.
- Bay Level : - The PMU and associated items (bay level LIU, bay ethernet switch etc) , shall be mounted on separate dedicated PMU panel for each line. The price and quantity of panel (2 Nos) shall be included in quoted price and above mentioned BOQ.
- Station Level (Control room):- LIU and ethernet switch which are supplied under present scope by bidder shall be mounted in existing SAS panel/communication panel placed in control room.
- Tentative quantity of armoured F.O Cable (S.N 4) above shall be 1500 m . Laying of the supplied cable shall be in scope of BHEL. The termination and splicing of the F.O cable shall be in bidders scope.

1.3 APPROVAL CRITERION

- The contract drawings shall preferably be POWERGRID standard approved drawings or shall be approved by POWERGRID in some of their previous project. The approval extension of standard drawings for this project or obtaining fresh approval from POWERGRID Engg shall be the sole responsibility of the bidder without any price and delivery implications to BHEL.
- The items offered shall be of approved make and model from POWERGRID and is working satisfactorily in their projects.
- In case, the offered item is not POWERGRID approved then it is the sole responsibility of the bidder to get it approved without any price & Delivery implication to BHEL.

1.4 TYPE TEST REQUIRMENTS

As per Technical Specification Section -2.

1.5 INSPECTION, TESTING AND ACCEPTANCE

Bidder has to follow Technical specification and POWERGRID approved Manufacturing Quality Plan of Power Grid Corporation of India Ltd.

1.6 DEVIATION

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

1.7 DOCUMENTATION

Final Documentation (after approval) shall be separate for each Substation. List of documents to be submitted is mentioned in section-2 of specification.

1.8 DOCUMENTS REQUIRED DURING TENDER STAGE

Following documents are required during tender stage:

- a) Clause wise compliance to the specification
- b) Available catalogs of offered items
- c) Filled checklist
- d) Un-priced Bill of Quantity

Note: It may be noted that word “contractor “wherever is referred in section-2 &4 shall be read as bidder and word “employer “wherever is referred in section – 2 & 4 shall be read as “Powergrid”.

1.9 Technical Qualification Requirement of Communication Equipment shall be as follows:

The broad Scope of the procurement of Communication Equipment and PMU shall include planning, designing, engineering, supply, transportation, insurance, delivery at site, unloading handling, storage, installation, termination, testing, training and demonstration for acceptance, commissioning and documentation for :

- i. SDH Equipment along with suitable interfaces and line cards.**(not in scope)**
- ii. PMU Equipment along with interfaces.
- iii. All cabling, wiring, Digital Distribution frame patch facilities and interconnection to the supplied equipment at the defined interfaces.
- iv. System integration of all supplied subsystem **(if applicable)**
- v. Integration with the existing communication system based on SDH and PDH of employer
- vi. Integration of supplied subsystem with SCADA system, PLCC equipment, PABX of RLDC/NLDC **(if applicable)**

(SECTION-II)

Technical Specifications for Phasor Measurement Unit (PMU)

Technical Specifications for Phasor Measurement Unit



SECTION 1:	PHASOR MEASUREMENT UNIT (PMU) REQUIREMENTS	3
1.0	GENERAL REQUIREMENTS.....	3
1.1	PMU REQUIREMENTS	3
<i>1.1.1</i>	<i>PMU Functional Requirements</i>	3
1.2	GPS BASED TIME FACILITY	6
1.3	INDUSTRIAL GRADE LAYER-3 LAN SWITCH.....	7
1.4	PMU TESTING	7

Section 1: Phasor Measurement Unit (PMU) Requirements

1.0 General requirements

The offered PMUs shall be complete in all respect including GPS receiver. The PMU shall be integrated with Phasor Data Concentrators (PDCs) installed at Control centers of SLDC/RLDC and NTAMC (National Transmission Asset Management Center) /NLDC as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard. The scope of Integration shall be upto the supplied PMUs and associated substation switches only.

The supplied PMUs shall be mounted in the C&R/SAS panels being supplied by the Contractor for respective substation package and interface cabling requirements shall be as applicable for relay.

1.1 PMU Requirements

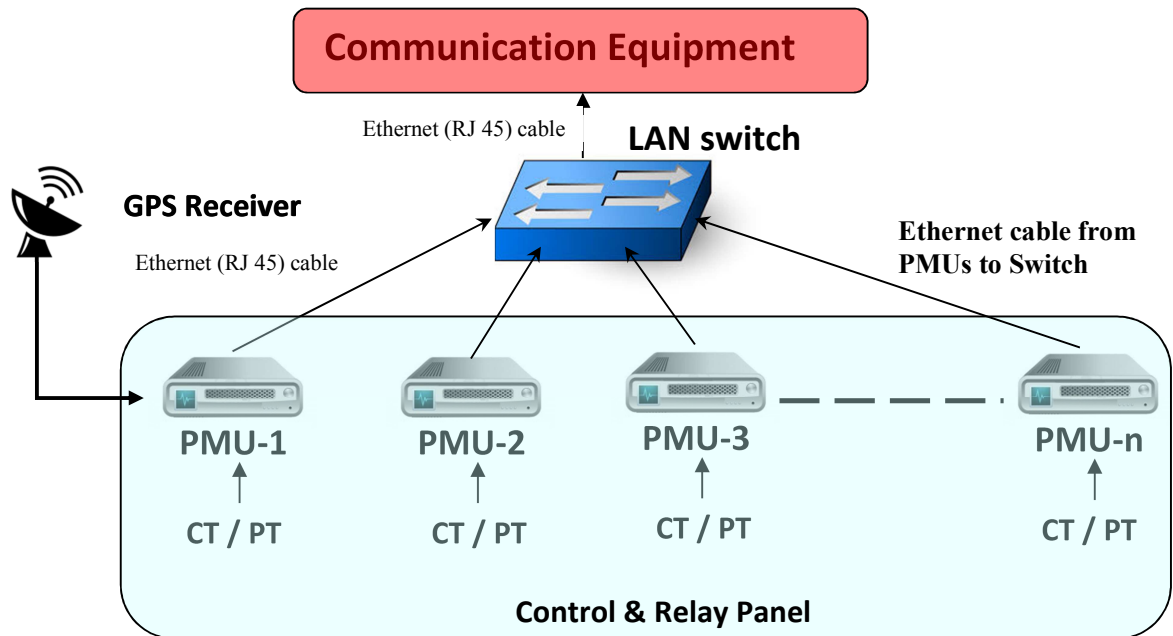
1.1.1 PMU Functional Requirements

The supplied PMUs shall be compliant to M class requirements of IEEE C37.118 Standards (latest version released in 2014).

The PMUs shall communicate with PDC at Control center over the communication link provided by the Employer. For this, PMU shall be provided with One Ethernet port of 10/100 Base Tx and one optical fiber port of 100 Mbps for streaming the data in UDP/IP multicast in IEEE C37.118 format. The supplied PMUs shall be suitable to operate on unearthed 220 V DC or 110V DC or 48V DC (+10%, -15%) power supply as available in the substation.

The PMU shall support data 'Reporting Rates' of 25, and 50 frames per seconds for 50 Hz System. The actual rate to be used shall be user selectable. All the PMU hardware and software shall be sized considering 50 frames per second. The typical network architecture of PMUs at substation is given at Fig 1.1 & Fig 1.2 below. The Data Requirement Sheets (DRS) of PMUs and associated items are mentioned at **Annexure-I**.

At Sub Station Control Room



**PMU installed at Sub-Station Control Room
(with Centralized C&R Panels)**

Fig 1.1: Typical Network Architecture at Sub Station Control Room

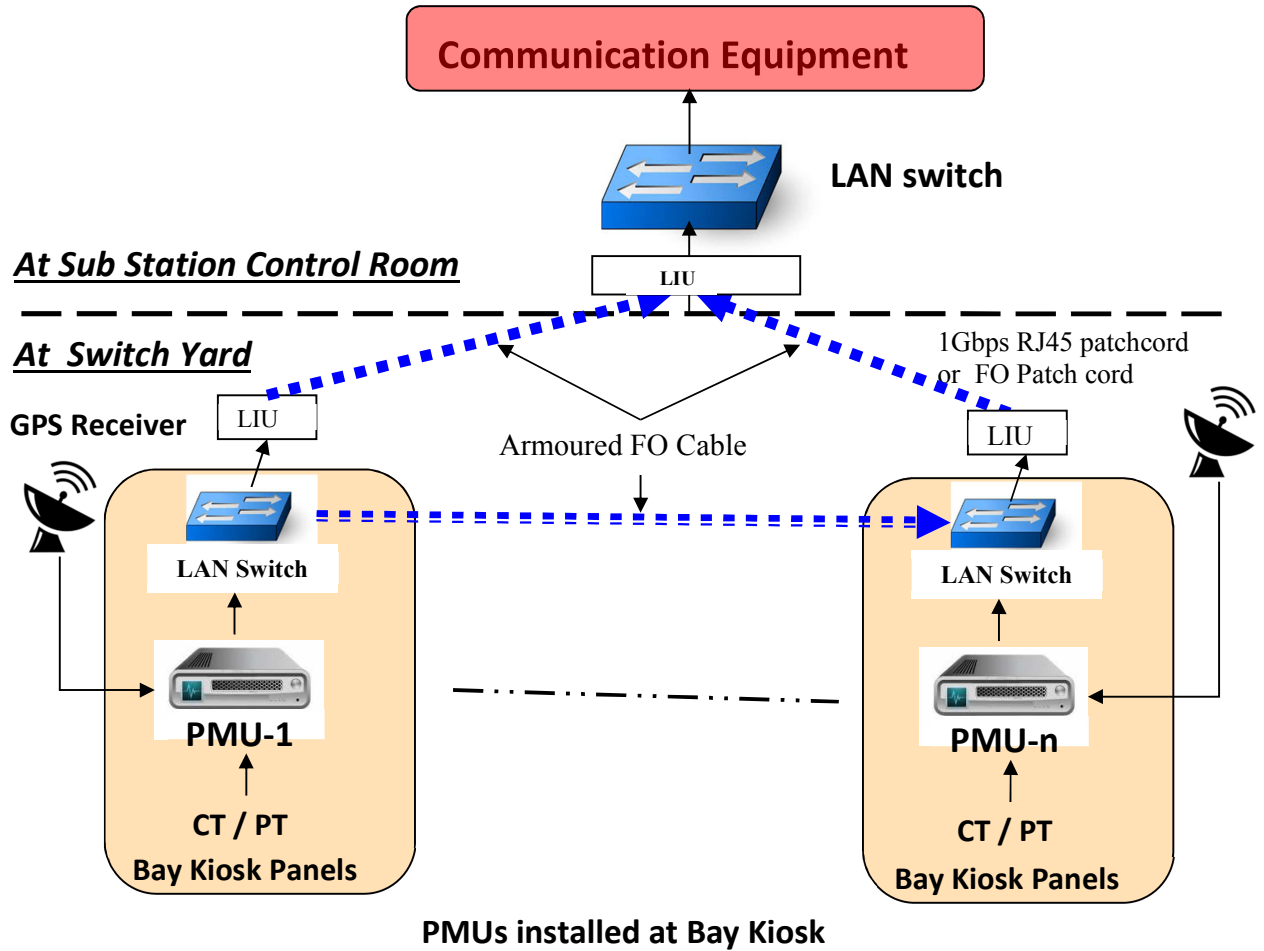


Fig 1.2: Typical Network Architecture at Sub Stations having Bay Kiosks at Switch Yard.

PMUs shall be provided to measure Voltage and Current Phasors of feeders and transformers specified in the BoQ. PMU shall also measure status of master protection and circuit breakers for units, feeders and transformers as per SLD. The PMUs shall be able to measure/calculate following:

- 3-phase voltage Phasors,
- 3-phase current Phasors,
- positive sequence voltage,
- positive sequence current,
- Breaker Status
- Main Protection Status
- Frequency,

- Rate of Change of Frequency (ROCOF) $-df/dt$,

Provision shall be made for user selection of measured value.

A time synchronization system (GPS receiver) shall be provided with PMU. The PMU shall have internal clock, which shall be synchronized with GPS clock. Upon loss of signal from the GPS source, the PMU shall detect a loss-of-signal and generate an alarm which will be transferred to PDC. Upon loss of signal, the PMU time facility shall revert to an internal time base. The internal clock shall have minimum stability of 1 ppm.

There shall be provision for HMI (Human Machine Interface) in PMU for configuration. The HMI shall also display the real time measured values. Alternatively Portable configuration device for PMUs can be provided for configuring the PMUs. Testing & configuration accessories such as test switch, connector, software, hardware etc., which are required for testing and configuration changes locally, shall be supplied.

The PMUs shall have continuous self-monitoring ,diagnostic feature and capable to identify & communicate problems and shall generate alarm in case of any abnormality which shall be displayed locally as well as shall be transferred to the PDC.

The Data Requirement Sheets (DRS) of PMU are mentioned at **Annexure-I**.

1.2 GPS based Time Facility

The PMU requires time reference to UTC. A GPS based time facility to synchronize PMU clock with Coordinated Universal Time (UTC), shall be provided except in case of in-built GPS in each PMU. The GPS receivers to be offered shall meet the supplied PMUs interface and accuracy requirements.

The time receiver shall include propagation delay compensation and shall also include an offset to permit correction to local time to achieve time accuracy of at least ± 0.2 microseconds (μs). Within one minutes of reacquisition of signal, the time shall return to within 0.2 micro-second of UTC. Proper correction of leap second shall be provided. The signal sent to PMU from the GPS receiver shall be UTC or provide information to the PMU to correct the time to UTC by using the IRIG-B time profile as per IEEE Standard C37.118. The supplied GPS shall be IEEE1588v2.0 (PTP) compliant.

The supplied GPS shall have “one IRIG-port plus 1 PPS port” and one Ethernet port as minimum.

In some of the locations, GPS shall be installed in switchyard along with PMU. GPS must be suitable to work in such Electrical environment.

1.3 Industrial Grade Layer-3 LAN Switch

The PMUs at Substations/Power Plants shall be connected to the communication equipment through an industrial grade Layer-3 LAN switch. The industrial grade LAN switch shall interface PMUs on one side and communication equipment on the other side. The LAN switch shall operate on 220V DC or 110 V DC or 48V (+10%, -15%) DC supply voltage of station.

1.4 Armoured Fibre Optic cables

Fibre optic cables within the control room shall be of armoured type for protection against rodents and physical stresses. Fibre optic cables, required to be laid in the switchyard shall also be of armored type. The characteristics of the fibre optic shall be as per the IEC 60870-5-103 standard. The fibre optic cables shall be run in GI conduit pipes while passing through cable trenches / cable racks outside the control room building. The fibre optic cables inside the panel shall be neatly laid and tied. Data Requirement Sheets (DRS) of armoured FO cables are given in **Annexure-I**.

1.5 Cabling & Interconnections

All cabling between component units of the PMU, PMU to GPS along with antenna and to the Employer control and relay panels (located in the substation control room) shall be supplied and installed by the Contractor and shall be shown on Contractor supplied drawings. Plug-type connectors with captive fasteners or compression type connectors shall be used for all internal interconnections. The connectors shall be polarized to prevent improper assembly. Each end of interconnection cables shall be identified by a marker which includes the cable number and the identifying number and location of each of the cable's terminations. This information shall match with the Contractor's drawings.

Adequate space and hardware shall be provided for routing of the field wiring within the enclosures. Contractor wiring within enclosures shall be neatly arranged and shall not be directly fastened to the enclosure frame. All internal interconnection wiring and cables shall be routed separately from field wiring to the PMU terminals & power wiring. All wiring shall use copper conductors and have flame retardant insulation. Conductors in multi-conductor cables shall be individually colour coded.

The use of non-flammable, self-extinguishing, plastic wire troughs is permissible. Metal clamps must have insulating inserts between the clamps and the wiring. Wiring between stationary and movable components, such as wiring across door hinges or to components mounted on extension slides, shall allow for full movement of the component without binding or chafing of the wiring.

The bidder shall be responsible for laying and termination of all cables required under the project which includes interconnections among bidder supplied equipment and their interconnection with employer's panels. Testing and commissioning of these interconnections shall also be done by the bidder.

1.6 Wiring/Cabling requirements

Shielded (screened) cables shall be used for external Cabling from the PMU/ SIC panels. These external cables (except communication cables) shall have the following characteristics:

- a) All cables shall have stranded copper conductor.
- b) Minimum core cross-section of 2.5 sq.mm for PT cables, 4 sq.mm for CT cables and 2.5 sq.mm for Power & Control outputs and 1.5 sq.mm for Digital Status inputs, transducer mA current output
- c) Rated voltage U_0/U of 0.6/1.1KV
- d) External sheathing of cable shall have oxygen index not less than 29 & temperature index not less than 250. Cable sheath shall meet fire resistance test as per IS 1554 Part- I.
- e) Shielding, longitudinally laid with overlap.
- f) Dielectric withstand 2.5 kV at 50 Hz for 5 minutes
- g) External marking with manufacture's name, type, core quantity, cross-section, and year of manufacture.

The Communication cable shall be of shielded, twisted pairs and of minimum 0.22sq mm size Copper cable or Fibre optic cable.

1.7 PMU TESTING

(a) Type Testing

The list of Type tests applicable on the PMU is mentioned in **Table-1** & type test requirements are mentioned in **Table-2**. The contractor may optionally submit type test reports for all the tests conducted at accredited laboratory for review & approval by Employer. However, in the event, the type test reports are not meeting the specification requirement, Employer may ask for the type testing above tests (EMI/EMC, Environmental & Functional tests) as required at no additional cost.

(b) Routine Testing

Each complete unit shall undergo routine testing. The list of Routine tests to be performed in the factory is mentioned in **Table-1**. Few samples of PMUs from each Package shall be tested at the PMU Test Lab being set up in India by POWERGRID before taking up mass production.

(c) Field Tests

The Contractor shall carry out the field-testing of PMUs after installation and integration with C&R panels. The list of field tests is mentioned in **Table-1**.

Table-1: List of Tests on PMU:

**Technical Specifications
for Phasor Measurement Unit**



Test Nos.	DESCRIPTION OF THE TEST	Type test	Routine test	Field test
	FUNCTIONAL TESTS FOR PMU			
1.	Check for BOQ, Technical details, Construction & Wiring as per PMU drawings		√	√
2.	Check for PMU database & configuration settings		√	√
3.	Check the operation of all Analog inputs, Digital and Status input points of PMU		√	√
4.	Check operation of all communication ports of PMU	√	√	√
5.	Check for communication between PMU and PDC	√		√
6.	Test for PMU time synchronization from GPS	√		√
7.	Test Power Supply Voltage Margin, Ripple Levels and Short Circuit Protection	√		
8.	Test for PMU operation with DC power supply voltage variation	√		
9.	Check for auto restoration of PMU on DC power recovery after its failure	√	√	√
10.	Test for PMU diagnostic feature	√		
11.	Accuracy tests as per IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014 standard	√		
12.	Test for PMU internal Clock stability	√		
13.	End to end test (between PMU&PDC) for all I/O points			√
14.	Testing and Configuration of PMU from HMI or Portable Configuration tool	√	√	√
	EMI/EMC IMMUNITY TESTS FOR PMU			
15.	Surge Immunity Test as per IEC 61000-4-5 & IEC 60255-22-5	√		
16.	Electrical Fast Transient Burst Test as per IEC 61000-4-4 & IEC 60255-22-4	√		
17.	Damped Oscillatory Wave Test as per IEC 61000-4-18 & IEC 60255-22-1	√		
18.	Electrostatic Discharge test as per IEC 61000-4-2 & IEC 60255-22-2	√		
19.	Radiated Electromagnetic Field Test as per IEC 61000-4-3 & IEC 60255-22-3	√		
20.	Damped Oscillatory magnetic Field Test as per IEC 61000-4-10	√		
21.	Power Frequency magnetic Field Test as per IEC 61000-4-8	√		
	INSULATION TEST FOR PMU			
22.	Power frequency voltage withstand Test as per IEC 60255-22-5	√		
23.	1.2/50 μ s Impulse voltage withstand Test as per IEC 60255-22-5	√		

**Technical Specifications
for Phasor Measurement Unit**



24.	Insulation resistance test	√		
ENVIRONMENTAL TEST FOR PMU				
25.	Dry heat test as per IEC60068-2-2 / 2-3	√		
26.	Damp heat test as per IEC60068-2-78	√		
27.	Cold Test as per IEC60068-2-1	√		

Note: Test levels for above type tests are elaborated in Table 2

Table-2: PMU Type Test Requirements

Test Nos	Test Name	EUT Status	Test Level	Power Supply Points		I/O Points	Passing Criteria
				CM	DM	CM	
1	Surge Immunity Test	ON	Level 3	2 kV	1 kV	2 kV	A
2	Electrical Fast Transient Burst Test	ON	Level 3	2 KV	-	1 kV	A
3	Damped Oscillatory Wave Test	ON	Level 3	2.5 kV	1 kV	2.5 kV	A
4	Electrostatic Discharge Test	ON	Level 3	+/- 6 kV in Contact discharge mode or +/- 8 kV in Air discharge mode			A
5	Radiated Electromagnetic Field Test	ON	Level 3	10 V/m electric field strength			A
6	Damped Oscillatory Magnetic Field Test	ON	Level 3	10 A/m at 1MHz of magnetic field strength			A
7	Power frequency magnetic field	ON	Level 3	30 A/m of magnetic field strength (Continuous duration sine wave)			A
8	Power frequency voltage withstand	OFF	-	1 kV rms for 1 minute			No break down or flashover shall occur
9	1.2/50μs impulse voltage withstand	OFF	-	2 kVp			No break down or flashover shall occur
10	DC Voltage Dips & Interruptions / Variation as per IEC 61000-4-29	ON	-	-			-

Technical Specifications for Phasor Measurement Unit



11	Insulation Resistance Test	OFF	-	Measure Insulation resistance using 500 VDC Megger before & after Power Freq& Impulse voltage withstand tests	As per manufacturer standard
12	Dry heat test	ON	-	Continuous operation at 55 ⁰ C for 16 hrs	0
13	Damp heat test	ON	-	at 95% RH and 40 ⁰ C for 16 hrs	0
14	Cold test	ON	-	Continuous operation at 0 ⁰ C for 96 hrs	0

Note:-

1. EUT - Equipment Under Test
2. CM - Common Mode; DM - Differential mode
3. I/O points do not include Communication ports
4. Passing Criteria
 - 0 - no failure: normal performance within the specified limits
 - A: minor failure: temporary degradation or loss of function or performance which is self- recoverable
5. Functional test as per the sl. nos. 1-14 of Table-1 shall also be done during type testing.

Annexure-I: BOQ for PMUs and associated items

BOQ for PMUs and associated Substation items			
S. No	Name of the item	Unit	Substation Name
			No of 400kV transmission lines – “x”
	Hardware		
1	PMU	No.	X
2	Time System (GPS Receiver)	Nos.	X
3	Substation Grade Layer-3 LAN Switches with minimum 4 x 10/100 Mbps Ethernet ports and 2 x 1 Gbps Ethernet ports	Nos.	X+1
4	Armoured Fibre Optic Cable and associated termination	Lot	1
	Services		
5	Integration - PMU with PDC at RLDC and SLDC	Lot	X

Note: ‘X’ is the no. of 400kV and above transmission lines of substations under the respective package.

In case of substations with conventional Control & relay panels.

- The no of PMUs shall be decided as per no of 400kV transmission line feeders under the scope of respective package.
- One GPS receiver shall be supplied for every 4 PMUs.
- No of LAN switches (no of ports in the LAN switch) shall be decided based on no of PMUs in a given Substation with C&R panels.

Annexure-II: Data Requirement Sheets (DRS) of PMU and associated items

1. Phasor Measurement Unit (PMU) :

The supplied Phasor Measurement Units (PMUs) shall be compliant to IEEE 37.118 Standard (latest version released in 2014):

S.No	Description of the Features	Minimum Quantity of the features	Offer by the Contractor
1.	Device	Phasor Measurement Unit (PMU)	
2.	Manufacturer		
3.	Model No.		
4.	Country of origin		
	Inputs		
5.	Minimum Analog Channel	6	
6.	Minimum Digital Channels	6	
7.	CT core	Capable for Metering Core	
8.	Auxiliary Power Supply Source	220 V DC or 110V DC or 48V DC (+10%, -15%) power supply source	
9.	Communication ports	One Ethernet port of 10/100 Base Tx and one optical fiber port of 100 Mbps	
10.	Interface ports for Time synchronization	IRIG-B interface port for either a standard or high-accuracy demodulated IRIG-B time-synchronization input signal or Ethernet port on IEEE 1588v2.0 (PTP)	
11.	Communication Protocols	Both Multicast and Unicast	
	Measurement Output		
12.	Performance Class	M class	
13.	Test Compliance as per IEEE 37.118	Bidder to fill the values as per test conducted in the lab for each individual values both in steady state and Dynamic State as per IEEE C37.118 Standard	
14.	Environmental Condition During testing	Bidder to fill the environmental condition during testing for each test.	

Technical Specifications for Phasor Measurement Unit



15.	Reporting rates (Frame per second)	25 and communication port wise	
	Environmental condition		
16.	Temperature	-10 to 50 degree Celsius	
17.	Humidity	10% to 95%	
18.	Configuration tool		
19.	HMI facility	Yes	
20.	Remote configuration Change	Yes	

2. GPS based time facility

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Country of origin		
4.	Time stability of internal time base	Minimum 1 ppm	
5.	Propagation delay compensation	Yes	
6.	Include an offset to permit correction to local time	Yes	
7.	Reverting to internal time base upon loss of signal from UTC source	Yes	
8.	Resynchronization Delay	Not more than 5 minutes.	
9.	Accuracy of resynchronization	< 1.5 Micro Sec	
10.	Interfaces	Minimum one Ethernet port and One IRIG-B port & 1 PPS port.	

3. Industrial grade Layer-3 LAN Switch (Substation LAN Switch)

S.No	Description of the Features	Minimum Quantity of the features required	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		

Technical Specifications for Phasor Measurement Unit



3.	Country of origin		
4.	Performance	Minimum 5 Gbps Switching Capacity	
5.	Functions	Data Exchange between PMU and PDC	
6.	Layer-2 & Layer-3 features required	Static Routing for IPv4 and IPv6	
		RIP for IPv4 (RIPv1/v2) and IPv6 (RIPng)	
		OSPF for IPv4 (OSPFv2) and IPv6 (OSPFv3)	
		Border Gateway Protocol 4 with support for IPv6 addressing wherever applicable.	
		Policy-based routing	
		IPv6 tunneling to allow IPv6 packets to traverse IPv4-only networks by encapsulating the IPv6 packet into a standard IPv4 packet.	
		Dynamic Host Configuration Protocol (DHCP) client, Relay and server.	
		Support for Multicast VLAN	
		Support for Jumbo frames	
		Should provide for 32K MAC Address Table	
		Should have facilities such as IPv6 to IPv4 tunneling, DHCPv6, ICMPv6	
7.	Features to support	Support IEEE 802.3u: Auto-negotiation on TP, IEEE 802.3x, 802.1p: flow control and prioritization, IEEE 802.1Q: VLANs, maximum 32 VLANs, IEEE 802.1d, 802.1w: Spanning Tree, Rapid Spanning Tree including RSTP 2004 extensions providing sub-second hop on rings, IEEE 802.1p: DiffServ, traffic prioritization for routed IP flows/ports Shall support Multicast and Unicast. Shall be PTP enabled as per IEEE1588v2.0 (Power Profile)	
8.	Network management	- Console port for configuration of software features - Shall able to manage the switch through Command-line interface; Web browser; SNMP etc.,	
9.	Security	a. Access Control Lists for both IPv4 and IPv6 for filtering traffic to prevent unauthorized users from accessing the network	
		b. Port-based rate limiting and access control list (ACL) based rate limiting	
		c. IEEE 802.1x to provide port-based user authentication with multiple 802.1x authentication sessions per port	
		d. Media access control (MAC) authentication to provide simple authentication based on a user's MAC address	
		e. Dynamic Host Configuration Protocol (DHCP) snooping to prevent unauthorized DHCP servers	

Technical Specifications for Phasor Measurement Unit



		f. Port security and port isolation	
10.	Speed configurability at each port	WAN ports optional 64kbps to 2Mbps	
11.	Interface ports	As per BoQ The BOQ requirement is the minimum in every switch at Substations. The no. of ports in LAN switches at Substations shall be optimised as per the Phasors list given at Appendix-H of Part-B and additional 50% expansion ports shall also be provided in the LAN switch.	
12.	Mounting	Rack mountable	
13.	Environmental Compliance	IEC61850-3 and IEEE1613 (Electric Utility Substation), EMS-IEC61000, EMI: FCC part15 A	
14.	Operating temp	- 10 to 75°C, no fans	

4. Armored FO Cables

S. No	Description of the Features	Minimum requirements	Offered by the Bidder
1	Manufacturer	Powergrid Approved Vendor	
2	Application	Between kiosks & Control Room	
2	Cable Type	4F Multimode Cable 62.5/125 um	
3	Armoured/Un-Armoured	Armoured	
4	Wavelength	850nm/1300nm	
5	Attenuation	< 3.5 dB/km @850nm, <1.0 dB/km @1300nm	
6	Band Width	>= 200 MHz/km @850nm, >=500 MHz/km @1300nm	
7	No. of Fibers	24*	
8	Colour for Fiber	Blue , Orange, Green, White	
9	Cladding Diameter	125um ± 2	
10	Core Diameter	62.5 um ± 3	
11	Cable Diameter	Vendor Specific	

**Technical Specifications
for Phasor Measurement Unit**



12	Numeric Aperture	0.275+/- 0.015	
13	Bending Radius	20xD where D is diameter of cable	
14	Armored Type	ECCS Tape (Electromagnetically Coated Corrugated Steel Tape)	
15	Operating Temperature	-20°C to +70°C	

Note: * 24 fibers to cater the need of PMU as well as for other substation applications

SECTION-3
PROJECT DETAILS & GENERAL SPECIFICATION

1.0 SITE INFORMATION

Sl No	Particulars	Details
PROJECT DETAILS		
a)	Owner	Power Grid Corporation of India (POWERGRID)
b)	Customer	Power Grid Corporation of India (POWERGRID)
c)	Project Title	Substation Package for Extension of 400kV Tumkur Pooling station (Pavagada) (including transformer & Reactor), Extension of 400/220kV Mysore Substation and Extension of 400/220kV Tumkur (Vasanthnarsapur) (Including Transformer) under Transmission System for Ultra Megar Solar Power Park (2000MW) at Tumkur (Pavagada), Karnataka-Phase-II (Part-A)
d)	Location	1. Tumkur (at Pavagada), Karnataka 2. Mysore, Karnataka 3. Tumkur (at Vasanthnarsapur) (Existing Madhugiri Substation), Karnataka
e)	Transport Facilities	Road/ Train/Air Connectivity: Nearest Railway Station 1. Tumkur (at Pavagada), Karnataka: Hindupur (AP)/ Bengaluru 2. Mysore, Karnataka: Mysore/ Mysore 3. Tumkur (at Vasanthnarsapur) (Existing Madhugiri Substation), Karnataka: Tumkur/ Bengaluru
SITE CONDITIONS		
a)	Max. ambient air temp.	50°C
b)	Min. ambient air temp.	0°C
c)	Max. design ambient emp.	50°C
d)	Design reference temp.	50°C
e)	Average Humidity	Shall be provided during detailed engineering.
f)	Special corrosion	Shall be provided during detailed engineering.

	conditions	
g)	Solar Radiation	Shall be provided during detailed engineering.
h)	Atmospheric UV radiation	Shall be provided during detailed engineering.
i)	Altitude above sea level	Less than 1000 meter above sea level (MSL)
j)	Snow Fall	NIL
k)	Seismic Zone	As per IS 1893
l)	Wind Zone	As per IS 875
MAIN ELECTRICAL PARAMETERS:		
a)	Fault Levels	Tumkur (Pavagada) 400kV: 50kA for 1 sec. 220kV: 40kA for 1 sec. Mysore 400kV: 40kA for 1 sec. Tumkur (Vasantnarsapur i.e. existing Madhugiri SS) 400kV: 50kA for 1 sec 220kV: 40kA for 1 sec
a)	Creepage Distance	25mm/kV

2.0 GENERAL

This Section covers General Technical Requirements and Requirements of Auxiliary Items.

- 2.1 The contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification during detailed engineering.
- 2.2 It is recognized that the Contractor may have standardised on the use of certain components, materials, processes or procedures different from 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 Purchaser.
- 2.3 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. For lighting fixtures, makes shall be as defined in Section- Lighting System.
- 2.4 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 and bid price schedule but which are necessary for commissioning and satisfactory operation of the switchyard/ substation 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 provided, shall be inter-changeable with one another.

- 2.5 In case any Deviation Schedule, Bid Proposal Sheet, Schedule of Data Requirements (DRS), test reports or any other document/information are not furnished along-with the bid, the bid is liable to be rejected. Unless brought out clearly, the Bid will be deemed to conform to the specification scrupulously. All deviations from the specification shall be clearly brought out in the respective deviation schedule.
- 2.6 The Bidder shall clearly indicate in the bid, the specific standards in accordance with which the works will be carried out.
- 2.7 The equipment must be new, of highest grade, the best quality of their kind, to best engineering practice and latest state of art, and in accordance with purpose for which they are intended and ensure satisfactory performance throughout the service life.
- 2.8 All similar parts of the equipment shall be made to gauge and shall be interchangeable with and shall be made of same materials and workmanship as the corresponding parts of the equipment. Where feasible, common components, units shall be employed in different pieces of equipment in order to optimize the spare part stock-up and utilization.
- 2.9 The requirement regarding external RIV as specified for equipment shall include the terminal fittings and the equipment shall have been tested preferably with fittings, if any.

3.0 STANDARDS

- 3.1 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.
- 3.2 The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the originally scheduled date of bid opening) of standard specified under Annexure-C of this section, unless specifically mentioned in the specification.
- 3.3 The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement each other.

- 3.4 The Contractor shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC.
- 3.5 When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the specification shall take precedence.
- 3.6 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure-C / individual sections for various equipment shall also, be accepted, however the salient points of difference shall be clearly brought out in the Additional information schedule of the bid along with English language version of such standard. The equipment conforming to standards other than specified under Annexure-C/ individual sections for various equipment shall be subject to POWERGRID's approval.

4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED

- 4.1 The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc. under such over voltage conditions.
- 4.2 All equipment shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.
- 4.3 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.
- 4.4 The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.
- 4.5 The equipment shall also comply with the following:
- a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".
 - b) All piping, if any between equipment control cabinet / operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

5.0 ENGINEERING DATA AND DRAWINGS

- 5.1 The list of drawings/documents which are to be submitted to the Purchaser

shall be discussed and finalised by the Purchaser at the time of award. The supplier shall necessarily submit all the drawings/ documents unless anything is waived.

- 5.2 The Contractor shall submit 4 (four) sets of drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports for the approval of the Purchaser. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.

5.3 Drawings:

- 5.3.1 All drawings submitted by the Contractor 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, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

- 5.3.2 Drawings 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. POWERGRID has standardized a large number of drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings alongwith type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.

- 5.3.3 The review of these data by the Purchaser 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. This review by the Purchaser may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Purchaser 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.

- 5.3.4 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.

- 5.3.5 All engineering data submitted by the Contractor after final process including review and approval by the Purchaser 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 Purchaser in Writing.

5.3.6 Approval Procedure

The scheduled dates for the submission of the drawings 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 and for providing final documentation.

- | | | |
|-------|---|--|
| (i) | Approval/comments by Purchaser on initial submission | As per agreed schedule |
| (ii) | Resubmission (whenever required) | Within 3 (three) weeks from date of comments |
| (iii) | Approval or comments | Within 3 (three) weeks of receipt of resubmission. |
| (iv) | Furnishing of distribution copies (5 hard copies per substation and one scanned copy (pdf format) for Corporate Centre) | 2 weeks from the date of approval |
| (v) | Furnishing of distribution copies of test reports | |
| (a) | Type test reports (one scanned softcopy in pdf format per substation plus one for corporate centre & one hardcopy per substation) | 2 weeks from the date of final approval |
| (b) | Routine Test Reports (one copy for each substation) | -do- |
| (vi) | Furnishing of instruction/operation manuals (2 copies per substation and one softcopy (pdf format) for corporate centre & per substation) | As per agreed schedule |
| (vii) | As built drawings (two sets of hardcopy per substation & one softcopy (pdf format) for corporate centre & per substation) | On completion of entire works |

NOTE:

- (1) The supplier may please note that all resubmissions must incorporate all comments given in the earlier submission by BHEL/POWERGRID or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.
- (2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.
- (3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
- (4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the supplier to BHEL/POWERGRID.
- (5) The manufacturer shall furnish to the Purchaser catalogues of spare parts.
- (6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

6.0 MATERIAL WORKMANSHIP

6.1 General Requirement

- 6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.
- 6.1.2 In case where the equipment, materials or components are indicated in the specification as "similar" to any special standard, the Purchaser shall decide upon the question of similarity. When required by the specification or when required by the Purchaser the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it being understood that the cost as well as the time delay associated with the rejection shall be borne by the supplier.

- 6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw, threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the BHEL/POWERGRID.
- 6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.
- 6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer's recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer's tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer's limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.
- 6.1.6 The supplier shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The supplier shall apply all operational lubricants to the equipment installed by him.

- 6.1.7 All oil, grease and other consumables used in the Works/ Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. In such is the case he shall declare in the proposal, where such oil or grease is available. He shall help POWERGRID in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.
- 6.1.8 Corona and radio interference voltage test and seismic withstand test (for 132kV and above voltage level) procedures for equipments shall be in line with the procedure given at Annexure-A and B respectively.

6.2 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 equipments located in non-air conditioned areas shall also be of same type.

6.2.1 Space Heaters

- 6.2.1.1 The heaters shall be suitable for continuous operation at 240V as supply voltage. On-off switch and fuse shall be provided.
- 6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.
- 6.2.1.3 Suitable anti condensation heaters with the provision of thermostat shall be provided.

6.2.2 FUNGI STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on parts which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

6.2.3 Ventilation opening

Wherever ventilation is provided, the compartments shall have ventilation

openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust. Outdoor compartment openings shall be provided with shutter type blinds and suitable provision shall be made so as to avoid any communication of air / dust with any part in the enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc.

6.2.4 Degree of Protection

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall provide degree of protection as detailed here under:

- a) Installed out door: IP-55
- b) Installed indoor in air conditioned area: IP-31
- c) Installed in covered area: IP-52
- d) Installed indoor 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

The degree of protection shall be in accordance with IS: 13947 (Part-I) / IEC-60947(Part-I) / IS 12063 / IEC-60529. Type test report for degree of protection test, shall be submitted for approval.

6.3 RATING PLATES, NAME PLATES AND LABELS

Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to 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 of substation in question has been designed to operate, and such diagram plates as may be required by the Purchaser. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

6.4 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 supplier unless specifically excluded under the exclusions in these specifications and documents.

7.0 DESIGN IMPROVEMENTS / COORDINATION

- 7.1 The bidder shall note that the equipment offered by him in the bid only shall be accepted for supply. However, the Purchaser or the Contractor may propose changes in the specification of the equipment or quality thereof and if the Purchaser & contractor agree upon any such changes, the specification shall be modified accordingly.
- 7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.
- 7.3 The supplier shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.
- 7.4 The supplier has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Purchaser. The names of agencies shall be intimated to the successful bidders.
- 7.5 The supplier will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Purchaser (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at POWERGRID Corporate Centre, Gurgaon (Haryana) or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

8.0 QUALITY ASSURANCE PROGRAMME

- 8.1 To ensure that the equipment and services under the scope of this Contract whether manufactured or performed within the supplier'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 supplier shall adopt suitable quality assurance programme to control such activities at all points necessary. The detailed programme shall be submitted by the contractor after the award for reference. A quality assurance programme of the supplier shall generally cover the following:

- (a) His organization structure for the management and implementation of the proposed quality assurance programme;
- (b) Documentation control system;
- (c) Qualification data for 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.
- (l) 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.

POWERGRID/BHEL or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the supplier/his vendor's quality management and control activities.

8.2 Quality Assurance Documents

The supplier would be required to submit all the Quality Assurance Documents as stipulated in the Quality Plan at the time of POWERGRID/BHEL inspection of equipment/ material

9.0 TYPE TESTING, INSPECTION, TESTING & INSPECTION CERTIFICAT

- 9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.
- 9.2 The reports for all type tests as per technical specification shall be furnished by the supplier alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all project with similar requirement. 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 accreditation body of the country where laboratory is located) or witnessed by POWERGRID or representative authorized by POWERGRID or Utility or representative of accredited test lab or reputed consultant.

The test reports submitted shall be of the tests conducted within last 10 (ten) years prior to the originally scheduled date of bid opening i.e. 08.08.2016. In case the test reports are of the test conducted earlier than 10 (ten) years prior to the date of bid opening, the contractor shall repeat these test(s) at no extra cost to BHEL.

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the originally scheduled date of bid opening.

- i) Lightning Impulse Test
- ii) Switching Impulse Test
- iii) Multiple Chopped Impulse Test (For CT)
- iv) Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the originally scheduled date of bid opening i.e. **08.08.2016**, the contractor shall repeat these test(s) at no extra cost to the purchaser.

Further, 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 type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

The supplier shall intimate the BHEL/POWERGRID the detailed program about the tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

Further, in case type tests are required to be conducted/repeated and the deputation of Inspector/Purchaser's representative is required, then all the expenses shall be borne by the supplier.

- 9.3 The Purchaser intends to repeat the type tests on Power Transformer and Shunt Reactor except Dynamic short circuit tests on transformers, for which test charges shall be payable as per provision of contract. The price of conducting 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 test charges would be considered in bid evaluation. In case 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. BHEL/POWERGRID reserves the right to witness any or all the type tests. The BHEL/POWERGRID also reserves the right to waive the repeating of type tests partly or fully and in case of waiver, test charges for the same shall not be payable.

The Purchaser shall bear all expenses for deputation of purchaser's representative(s) for witnessing the type tests under this clause except in the case of re-deputation if any, necessitated due to no fault of the purchaser.

For outdoor receptacles, trefoil clamps, diesel engine, alternator, motors, cable glands, lighting fixtures, ACSR/AAC conductor, IPS aluminum tube and junction boxes, type test reports are not required to be submitted for the makes indicated at Annexure-C /POWERGRID approved list of subvendors. For the new makes(other than those indicated at Annexure-C / POWERGRID approved list of subvendors), type test reports as per relevant standard shall be submitted for BHEL/POWERGRID's approval.

- 9.4 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 Contractor's/sub-vendors 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 part 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.

- 9.5 The supplier shall give the Purchaser /Inspector fifteen (15) days written notice for on-shore and six (6) weeks notice for off-shore material being ready for joint testing including contractor and POWERGRID. Such tests shall be to the Contractor's account except for the expenses of the Inspector. The Purchaser/inspector, unless witnessing of the tests is virtually waived, will attend such tests within fifteen (15) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed alone with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector duly certified copies of tests in triplicate.
- 9.6 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.
- 9.7 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 CIP by the Purchaser.
- 9.8 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.

- 9.9 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.
- 9.10 The Purchaser will have the right of having at his own expenses any other test(s) of reasonable nature carried 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.
- 9.11 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.

10.0 TESTS

10.1 Pre-commissioning Tests

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 are given in respective chapters and shall be included in the Contractor's quality assurance programme.

10.2 Commissioning Tests

- 10.2.1 The available instrumentation and control equipment will to be used during such tests and the Purchaser will calibrate, all such measuring equipment and devices as far as practicable.
- 10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be provided by the Contractor, free of cost.
- 10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.
- 10.3.3 The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed by

POWERGRID on production of requisite documents.

11.0 PACKAGING & PROTECTION

11.1 All the equipment 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 Purchaser, the Contractor 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 Bidder shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Purchaser takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discoloration 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 and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

12.0 FINISHING OF METAL SURFACES

12.1 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.

12.2 HOT DIP GALVANISING

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above. 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 be 610 gm/sq. m minimum.

12.2.2 The galvanized 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.

12.2.3 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 galvanization.

12.2.4 The galvanized steel shall be subjected to six one minute dips in copper sulphate solution as per IS-2633.

12.2.5 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. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness

- Uniformity of zinc

- Adhesion test

- Mass of zinc coating

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

12.3 PAINTING

12.3.1 All sheet steel work shall be degreased, pickled, and 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 at least 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.

12.3.2 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.

- 12.3.3 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.
- 12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. Unless specifically mentioned under respective sections of the equipment. Glossy white color inside the equipment /boards/panels/junction boxes is also acceptable. The exterior colour for panels shall bematching with the existing panels in case of extension of a substation. Each coatof 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.
- 12.3.5 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 alongwith the Bids for Purchaser's review & approval.
- 12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

S.No.	PIPE LINE	Base color	Band color
Fire Protection Svstem			
1	Hydrant and Emulsifier system pipeline	FIRE RED	-
2	Emulsifier system detection line –	FIRE RED	Sea Green
3	Emulsifier system detection line – Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
Air Conditionina Svstem			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

- 12.3.7 For aluminum casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures, the surface shall be coated

with powder (coating thickness of 60 microns) after surface preparation for painting.

13.0 HANDLING, STORING AND INSTALLATION

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Purchaser or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, and square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energization at rated voltage.

13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

13.3 The contractor shall have to ensure that the hard and flat indoor and outdoor storage areas are in place prior to commencement of delivery of material at site. Contractor shall also ensure availability of proper unloading and material handling equipment like cranes etc. and polyester/nylon ropes of suitable capacity to avoid damage during unloading and handling of material at site. All indoor equipments shall be stored indoors. Outdoor equipment may be stored outdoors but on a hard and flat raised area properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress. However, all associated control panels, marshalling boxes operating boxes etc. of outdoor equipments are to be stored indoors only. Storage of equipment on top of another one is not permitted if the wooden packing is used. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations. During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Purchaser. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections

between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments necessary for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

- 13.6 Supplier shall be responsible for examining all the shipment and notify the Purchaser immediately of any damage, shortage, discrepancy etc. for the purpose of Purchaser's information only. The Contractor shall submit to the Purchaser every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- 13.7 The supplier shall be fully responsible for the equipment/material until the same is handed over to the Purchaser in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/ material while in storage as well as after erection until taken over by Purchaser, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- 13.8 Where material/ equipment is unloaded by Purchaser before the Contractor arrives at site or even when he is at site, Purchaser by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.
- 13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.
- 13.10 The words 'erection' and 'installation' used in the specification are synonymous.
- 13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- 13.12 Equipment Bases
- A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Purchaser. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for

anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.

14.0 TOOLS

14.1 Tools and Plants (T&P)

The Contractor shall arrange all T&P (such as necessary supports, cranes, ladders, platforms etc.) for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of contractor.

14.2 Special Tools and tackles

The bidder shall include in his proposal the deployment of all special tools and tackles required for Operation and maintenance of equipment. The special tools and tackles shall only cover items which are specifically required for the equipment offered and are proprietary in nature. However a list of all such devices should be indicated in the relevant schedule provided in the Bid Price Schedule. In addition to this, the Contractor shall also furnish a list of special tools and tackles for the various equipment in a manner to be referred by the Employer during the operation of these equipment. The scope of special tools and tackles are to be decided during detail engineering and the list of special tools and tackles, if any shall be finalized.

15.0 AUXILIARY SUPPLY

15.1 The sub-station auxiliary supply is normally met through a system indicated under section “Electrical & Mechanical Auxiliaries” 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 the parameters as indicated in the following.

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/W	Neutral connectio
415V	± 10%	50 ± 5%	3/4 Wire	Solidly
240V	± 10%	50 ± 5%	1/2 Wire	Solidly
220V	190V to 240V	DC	-	Isolated 2 wire System
48V	—	DC	—	2 wire system (+) earthed

Combined variation of voltage and frequency shall be limited to ± 10%.

16.0 SUPPORT STRUCTURE (If in the scope of supplier)

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 14.0 meter, 8.0 meter and 5.9 meter from plinth level for 765 kV, 420 kV and 245 kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

16.2 Support structure shall meet the following mandatory requirements:

16.2.1 The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55meters.

17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS

17.1 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 | Aluminum alloy casting, conforming to designation of IS:617 and all test shall conform to IS:617 |
| b) | For connecting equipment terminals made of copper with ACSR conductors | Bimetallic connectors made from aluminum alloy conforming to designation of IS:617 with 2mm thick bimetallic liner and all test shall conform to IS:617 |
| c) | For connecting G.I | Galvanised mild steel shield |
| d) | i) Bolts, nuts & Plain, washers | i) Electrogalvanised for sizes below M12, for others hot dip galvanised. |
| | ii) Spring washers for items 'a' to 'c' | ii) Electro-galvanised mild steel suitable for atleast service condition-3 as per IS: 1573 |

17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. The requirement regarding external corona and RIV as specified for any equipment shall include its terminal fittings. 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.

17.3 Where copper to aluminum connections are required, bi-metallic 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.

- 17.4 Low voltage connectors, grounding connectors and accessories for grounding Equipment as specified in any particular case, are also included in the scope of Work.
- 17.5 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 aluminum body or 2 mm thick bi-metallic strips shall be provided for Bi-metallic clamps.
- 17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.
- 17.7 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.
- 17.8 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.
- 17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.
- 17.10 Clamps and connectors shall be designed to be corona controlled.
- 17.11 Tests**
- 17.11.1 Clamps and connectors should be type tested as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval as per clause 9.2 above except for sl. no. (ii) & (iii) for which type test once conducted shall be applicable (i.e. The requirement of test conducted within last ten years shall not be applicable).
- i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)
 - ii) Short time current test
 - iii) Corona (dry) and RIV (dry) test (for 220 KV and above voltage level clamps)
 - iv) Resistance test and tensile test
- 18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES & MARSHALLING BOXES FOR OUTDOOR EQUIPMENT**
- 18.1 All types of boxes, cabinets etc. shall generally conform to & be

- tested in accordance with IS-5039/IS-8623, IEC-60439, as applicable, and the clauses given below:
- 18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes shall be made of sheet steel or aluminum enclosure and shall be dust, water and vermin proof. Sheet steel used shall be atleast 2.0 mm thick cold rolled or 2.5 mm hot rolled or alternately 1.6 mm thick stainless steel can also be used. 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 aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.
- 18.3 A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.
- 18.4 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.
- 18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan, IS: 11149 and IS: 3400. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.
- 18.6 All boxes/cabinets shall be designed for the entry of cables from bottom by mean 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 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. 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.
- 18.7 A 240V, single phase, 50 Hz, 15 amp 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.
- 18.8 For illumination, a fluorescent tube or CFL of approximately 9 to 15 watts shall be provided. The switching of the fittings shall be controlled by the door switch. .
- For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.
- 18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.
- 18.10 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.
- 18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.
- 18.12 a) The following routine tests alongwith the routine tests as per IS:5039 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 conform to IP-55 as per IS:13947 including application of, 2.5 KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test.
- 19.0 DELETED**
- 20.0 TERMINAL BLOCKS AND WIRING**
- 20.1 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.
- 20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non breakable type. These 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 of Elmex or Phoenix or Wago or equivalent make.

- 20.3 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.
- 20.4 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.
- 20.5 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.
- 20.6 The terminal blocks shall be of extensible design.
- 20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.
- 20.8 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.
- 20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.
- | | | |
|----|------------------------------------|---|
| a) | All circuits except CT/PT circuits | Minimum of 2 nos. of 2.5 sq mm copper flexible. |
| b) | All CT/PT circuits | Minimum of 4 nos. of 2.5 sq mm copper flexible. |
- 20.10 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.
- 20.11 At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.
- 20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.
- 20.13 The supplier shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well

as between phases and common terminal boxes or control cabinets. For equipments 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 overvoltages either transferred through the equipment or due to transients induced from the EHV circuits.

- 20.14 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.

21.0 LAMPS & SOCKETS

21.1 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.

21.2 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.

21.3 Switches and Fuses:

- 21.3.1 Each 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 miniature circuit breaker / switchfuse 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.

- 21.3.2 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.

22.0 BUSHINGS, HOLLOW COLUMN INSULATORS AND SUPPORT INSULATORS:

- 22.1 Bushings shall be manufactured and tested in accordance with

IS:2099 & IEC- 60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155/IS:5621. The support insulators shall be manufactured and tested as per IS:2544/IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable. The bidder may also offer composite hollow insulators, conforming to IEC-61462.

22.2 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.

22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

22.4 Support 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.

22.5 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.

22.6 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

22.7 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.

22.8 Tests

In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS: 2099 & IS:2544 & IS : 5621.

23.0 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 be subjected to routine tests as per applicable standards. The motors shall be of approved make.

23.1 Enclosures

- a) 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.
- b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
- c) 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.
- d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

23.2 Operational Features

- a) 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.
- b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

23.3 Starting Requirements:

- a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.
- b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
- c) 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.

- d) 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 atleast 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.
- e) 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 accelerating time whichever is greater. In case it is not possible to meet 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.

23.4 Running Requirements:

- a) 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.
- b) 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.
- c) 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.

23.5 Testing and Commissioning

An indicative list of tests is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./Instructions of the equipment Contractor or Purchaser without any extra cost to the Purchaser. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Purchaser for approval.

- (a) Insulation resistance

- (b) Phase sequence and proper direction of rotation.
- (c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

ANNEXURE-A

CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST

1. General

Unless otherwise stipulated, all equipment together with its associated

connectors, where applicable, shall be tested for external corona (for 400kV & above) both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV) for 132kV and above.

2. 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. Test Methods for RIV:

- 3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 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 microvolts.
- 3.2 Alternatively, RIV tests shall be in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.
- 3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements 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 in the vicinity 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%, and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.
- 3.5 The metering 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 noise meter.

4. Test Methods for 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 voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of specified corona extinction voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, otherwise test shall be continued and the voltage will then be decreased slowly until all 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 purposes 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%, and 110%. 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.

For recording purpose, modern devices utilizing UV recording methods such as image intensifier may also be used.

- 4.1 The test shall be recorded on each photograph. Additional photograph 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.
- 4.2 In addition to photographs of the test object preferably 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 trial energisation of test object at a voltage which results in

corona.

- 4.3 The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.
- 4.4 However, both test 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.

5. 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 100microvolts 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 on the complete equipment (for 132kV and above) shall be carried out along with supporting structure.

The Bidder shall arrange to transport the structure from his Contractor's 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. 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.

ANNEXURE-C
LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED

Project: 400kV Mysore
Customer: Power Grid Corporation of India

Technical Specification
Section-3: Project Details & General Specification

Doc No. TB-
Rev. No. 00

SL. NO.	ITEM DESCRIPTION	MAKE
1.	Outdoor receptacles	CGL/ B&C / BCH / Sakti, Chennai /Indo Asian
2.	Trefoil clamp	Moulded Fibre Glass Products, Calcutta
3.	Diesel Engine	Cummins / Ruston & Hornsby
4.	Alternator	AVK / KIRLOSKAR / STAMFORD
5.	Motors	KEC / Siemens/ NGEF/Crompton/ABB
6.	Cable Glands	Sunil & Co. / Arup/ Comet / QPIE
7.	Junction Box	Sarvana / ECS / C&S /Vikas/ Maktel/Unilac/Jasper/ Amara raja
8.	Lighting Fixtures	Phillips/CGL/Bajaj
9.	ACSR Conductor (Bersimis/ Moose/ Zebra)	Sterlite/Apar/HVPL/ Sharavathy/Hiren Aluminium Ltd./Smita/Deepak Cables/Polycab wires/Cabcon
11.	AAC Conductor (BULL)	Sterlite/Cabcon
12.	G.S. Earth Wire	Sharavathy/Bharat Wire Ropes/Ramswarup

Note: For a new make other than above/POWERGRID approved list of sub vendor, type test reports as per relevant standard shall be submitted for Purchaser's approval.

Annexure-II: Data Requirement Sheets (DRS) of PMU and associated items

1. Phasor Measurement Unit (PMU) :

The supplied Phasor Measurement Units (PMUs) shall be compliant to IEEE 37.118 Standard (latest version released in 2014):

S.No	Description of the Features	Minimum Quantity of the features	Offer by the Contractor
1.	Device	Phasor Measurement Unit (PMU)	
2.	Manufacturer		
3.	Model No.		
4.	Country of origin		
	Inputs		
5.	Minimum Analog Channel	6	
6.	Minimum Digital Channels	6	
7.	CT core	Capable for Metering Core	
8.	Auxiliary Power Supply Source	220 V DC or 110V DC or 48V DC (+10%, -15%) power supply source	
9.	Communication ports	One Ethernet port of 10/100 Base Tx and one optical fiber port of 100 Mbps	
10.	Interface ports for Time synchronization	IRIG-B interface port for either a standard or high-accuracy demodulated IRIG-B time-synchronization input signal or Ethernet port on IEEE 1588v2.0 (PTP)	
11.	Communication Protocols	Both Multicast and Unicast	
	Measurement Output		
12.	Performance Class	M class	
13.	Test Compliance as per IEEE 37.118	Bidder to fill the values as per test conducted in the lab for each individual values both in steady state and Dynamic State as per IEEE C37.118 Standard	
14.	Environmental Condition During testing	Bidder to fill the environmental condition during testing for each test.	

Technical Specifications for Phasor Measurement Unit



15.	Reporting rates (Frame per second)	25 and communication port wise	
	Environmental condition		
16.	Temperature	-10 to 50 degree Celsius	
17.	Humidity	10% to 95%	
18.	Configuration tool		
19.	HMI facility	Yes	
20.	Remote configuration Change	Yes	

2. GPS based time facility

S.No	Description of the Features	Minimum Quantity of the features	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		
3.	Country of origin		
4.	Time stability of internal time base	Minimum 1 ppm	
5.	Propagation delay compensation	Yes	
6.	Include an offset to permit correction to local time	Yes	
7.	Reverting to internal time base upon loss of signal from UTC source	Yes	
8.	Resynchronization Delay	Not more than 5 minutes.	
9.	Accuracy of resynchronization	< 1.5 Micro Sec	
10.	Interfaces	Minimum one Ethernet port and One IRIG-B port & 1 PPS port.	

3. Industrial grade Layer-3 LAN Switch (Substation LAN Switch)

S.No	Description of the Features	Minimum Quantity of the features required	Offered by the Contractor
1.	Manufacturer		
2.	Model No.		

Technical Specifications for Phasor Measurement Unit



3.	Country of origin		
4.	Performance	Minimum 5 Gbps Switching Capacity	
5.	Functions	Data Exchange between PMU and PDC	
6.	Layer-2 & Layer-3 features required	Static Routing for IPv4 and IPv6	
		RIP for IPv4 (RIPv1/v2) and IPv6 (RIPng)	
		OSPF for IPv4 (OSPFv2) and IPv6 (OSPFv3)	
		Border Gateway Protocol 4 with support for IPv6 addressing wherever applicable.	
		Policy-based routing	
		IPv6 tunneling to allow IPv6 packets to traverse IPv4-only networks by encapsulating the IPv6 packet into a standard IPv4 packet.	
		Dynamic Host Configuration Protocol (DHCP) client, Relay and server.	
		Support for Multicast VLAN	
		Support for Jumbo frames	
		Should provide for 32K MAC Address Table	
		Should have facilities such as IPv6 to IPv4 tunneling, DHCPv6, ICMPv6	
7.	Features to support	Support IEEE 802.3u: Auto-negotiation on TP, IEEE 802.3x, 802.1p: flow control and prioritization, IEEE 802.1Q: VLANs, maximum 32 VLANs, IEEE 802.1d, 802.1w: Spanning Tree, Rapid Spanning Tree including RSTP 2004 extensions providing sub-second hop on rings, IEEE 802.1p: DiffServ, traffic prioritization for routed IP flows/ports Shall support Multicast and Unicast. Shall be PTP enabled as per IEEE1588v2.0 (Power Profile)	
8.	Network management	- Console port for configuration of software features - Shall able to manage the switch through Command-line interface; Web browser; SNMP etc.,	
9.	Security	a. Access Control Lists for both IPv4 and IPv6 for filtering traffic to prevent unauthorized users from accessing the network	
		b. Port-based rate limiting and access control list (ACL) based rate limiting	
		c. IEEE 802.1x to provide port-based user authentication with multiple 802.1x authentication sessions per port	
		d. Media access control (MAC) authentication to provide simple authentication based on a user's MAC address	
		e. Dynamic Host Configuration Protocol (DHCP) snooping to prevent unauthorized DHCP servers	

Technical Specifications for Phasor Measurement Unit



		f. Port security and port isolation	
10.	Speed configurability at each port	WAN ports optional 64kbps to 2Mbps	
11.	Interface ports	As per BoQ The BOQ requirement is the minimum in every switch at Substations. The no. of ports in LAN switches at Substations shall be optimised as per the Phasors list given at Appendix-H of Part-B and additional 50% expansion ports shall also be provided in the LAN switch.	
12.	Mounting	Rack mountable	
13.	Environmental Compliance	IEC61850-3 and IEEE1613 (Electric Utility Substation), EMS-IEC61000, EMI: FCC part15 A	
14.	Operating temp	- 10 to 75°C, no fans	

4. Armored FO Cables

S. No	Description of the Features	Minimum requirements	Offered by the Bidder
1	Manufacturer	Powergrid Approved Vendor	
2	Application	Between kiosks & Control Room	
2	Cable Type	4F Multimode Cable 62.5/125 um	
3	Armoured/Un-Armoured	Armoured	
4	Wavelength	850nm/1300nm	
5	Attenuation	< 3.5 dB/km @850nm, <1.0 dB/km @1300nm	
6	Band Width	>= 200 MHz/km @850nm, >=500 MHz/km @1300nm	
7	No. of Fibers	24*	
8	Colour for Fiber	Blue , Orange, Green, White	
9	Cladding Diameter	125um ± 2	
10	Core Diameter	62.5 um ± 3	
11	Cable Diameter	Vendor Specific	

**Technical Specifications
for Phasor Measurement Unit**



12	Numeric Aperture	0.275+/- 0.015	
13	Bending Radius	20xD where D is diameter of cable	
14	Armored Type	ECCS Tape (Electromagnetically Coated Corrugated Steel Tape)	
15	Operating Temperature	-20°C to +70°C	

Note: * 24 fibers to cater the need of PMU as well as for other substation applications

SECTION 5
CHECK LIST FOR INFORMATION TO BE FURNISHED WITH OFFER 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.

BHEL ENQUIRY. NO:

BIDDER:OFFER REFERENCE:

S.No.	Parameters	Data	Yes	Remarks
1.	Applicable standard for the PMU system offered	IEEE C37.118.1-2011, IEEE C37.118.2-2011 & C37.118.1a-2014	Yes	
2.	Mounting Arrangement(PMU, LIU and L3 Lan Switches	Dedicated PMU Panel for each line. (Qty and Price of Panel included in BOQ and Quoted price)	Yes	
3	PMU Class requirement as per IEEE C37.118 std	a) P & M Class compliant b) Shall be possible to configure PMU in either P class or M class	Yes	
4	PMU functional Requirements: PMU shall be used to measure/Calculate			
		a) 3- phase voltage phasors	Yes	
		b) 3- phase Current phasors	Yes	
		c) Positive sequence voltage	Yes	
		d) Positive sequence current	Yes	
		e) Breaker status	Yes	
		f) Main Protection Status	Yes	
		g) Frequency	Yes	
		h) Rate of change of frequency-df/dt	Yes	
5	GPS receiver	Provided with each PMU	Yes	
6	Internal Clock	Having minimum stability of 1 ppm	Yes	
7	HMI(Human Machine Interface)	Having the provision of	Yes	

		HMI		
8	Alarm in PMU	Can generate alarm in any abnormality. Which can be displayed locally and shall also transferred to PDC	Yes	
9	PMU Features			
	a) Minimum analog Channel	6	Yes	
	b) Minimum digital Channel	6	Yes	
	c) Communication ports	One ethernet port of 10/100 Base Tx and one optical fibre port of 100 Mbps	Yes	
	d) Communication protocols	UDP Multicast and Unicast and TCP/IP	Yes	
	e) Temperature	-10 to 55 degree Celsius	Yes	
	f) Humidity	10% to 95%	Yes	
10	GPS Reciver: IRIG –B time profile	As per IEEE Standard C37.118	Yes	
11	Layer-3 LAN switch for communication	Operating voltage 220V, 110V, 48V DC.	Yes	

II. A) TYPE TESTS

- 1) Type test of PMU are as per Table-1 and Table-2 given in section-2 of Technical Specification. Whether reports are available. **(YES)**

B) ROUTINE TESTS

- 1) The list of Routine tests to be performed as mentioned in table-1 given in section-2 of Technical Specification

Date:
Bidder

Signature of the authorized representative of

Company Seal