SECTION – 2.11

UPS SYSTEM

1.0.0 INTRODUCTION

This section covers the requirements of the design, engineering, supply, installation, testing and commissioning requirements for the 2x100% redundant uninterruptible power supply (UPS)system for 20MW/120MWh Vanadium Redox Flow Battery project in GIPCL complex.

The Bidder shall provide a fully engineered, complete and operational system, including all power equipment, controls, monitoring interfaces, cabling, protections, supports, documentation and testing required to meet the functional needs of the project.

All equipment and accessories required for completeness whether explicitly mentioned or not shall be included in the Bidder's scope.

2.0.0 SCOPE OF WORK

2.1.0 The scope of work shall include the following equipment:

- Two UPS units (UPS-1 and UPS-2) configured as 2 × 100% parallel-redundant single-UPS systems, ensuring uninterrupted supply even if one UPS is out of service. Each UPS shall independently support 100% of the connected load.
- One 110 V DC incomer per UPS, each coming from independent 110 V DC Distribution Boards (110 V DCDB-1 and 110 V DCDB-2). Each DCDB shall be fed from an independent battery bank to ensure full DC-side redundancy. DC cabling and terminations up to the UPS input terminals are also in Bidder scope.
- A 415 V, 3-phase AC incomer from the 415 V LT Panel shall supply the Static Voltage Stabilizer (SVS). The SVS shall provide a stabilized AC supply to the UPS static transfer switch and bypass arrangement. AC incomers shall be protected using MCCB/MCB with auxiliary contacts wired to SCADA.
- Each UPS shall include a static transfer switch.
- Two UPS Distribution Boards (Main UPS DB-1 &2) shall be provided at Main Control Building Located near 132 kV switchyard.
- Two UPS Distribution Boards (Sub UPS DB 1 & 2) shall be provided at BESS yard with required caballing.
- Main UPS DB-1 & 2 at the Main Control Room (adjacent to the 132 kV switchyard) and in the same room as the UPS.
- Sub UPS DB-1 and UPS DB-2 may be suitably located in the BESS yard.
- A common UPS system is tentatively indicated in the SLD for optimization of resources. However, the Bidder may propose either a common UPS system or separate/dedicated UPS systems for each area, i.e., BESS plant and MCR, or a common system located in the BESS yard.
- In all above cases, it shall be the sole responsibility of the Bidder to optimize the system design without any cost to the Owner
- UPSDBs shall be inter-connected through a tie feeder, ensuring seamless supply during UPS or feeder outage.

- UPSDB tie breaker/ MCB/MCCB status and multifunction meter (MFM) readings shall be integrated to SCADA / SAS
- Communication between UPS and SCADA shall be via RS-485 MODBUS protocol.
- UPS system (including but not limited to UPS's, UPSDB's, SVS's shall be fully integrated to the SCADA / SAS system) MODBUS mapping shall be provided by the Bidder.
- Potential free contacts shall be provided for essential alarms and status.
- UPS shall have true Sinewave output

2.1.1. UPS supply shall be made available for ABT metering system. Redundant UPS supply shall be provided through dedicated UPS MCB with Aux monitoring contact which will give alarm to SCADA on UPS MCB failure and wiring shall done up to ABT meter TB terminal even though 110 VDC redundant power supply is available for ABT metering system.

2.1.2. Minimum 02 -hour (Two) battery backup shall be provided for entire UPS system and However CEA guidelines for the backup of communication system shall be complied.

2.1.3. The UPS System hardware shall be from the latest established product range of a qualified manufacturer. The Bidder shall furnish documents to satisfy the purchaser that the design, performance and high availability of the proposed UPS System and all system components have been established by a considerable record of successful operation in utility power station for similar application. All UPS system cabinets, enclosures and distribution boards shall be manufactured, assembled, wired and fully tested as a complete assembly as per the requirements of this specification in the manufacturing works of a qualified manufacturer prior to shipment to the project site. Class of insulation of wound components (All transformers, chokes/inductances etc.) shall be class H.

2.1.4. The UPS equipment and the complete system shall have surge withstanding capability (SWC) to meet the requirements of ANSI C 310.90a – IEEE Standard 472 –1974. UPS should be provided with Class C type surge protection device. The Class C type surge arrester should be single MOV type , pluggable, should have fault indication and should be tested as per IEC 61643-1 to withstand 40KA 8/20 µs pulse. The arresters should have potential free contact to ensure maintainability.

2.1.5. All non-interrupting components of UPS system shall be capable of withstanding all available short circuit current without damage. Additionally, all circuit interrupting components shall be capable of withstanding and interrupting all encountered short circuit currents without damage.

2.1.6. All control and instrument circuits shall be fused. Fuses shall be mounted inside the enclosures and shall have easy accessibility. Fuses shall be Buss man low-peak type or Purchaser approved make. All load fuses shall be to Purchaser's approval. The Bidder shall co-ordinate all load and line fuses applications to ensure that load fuses operate properly.

2.1.7. The bidder shall be responsible for ensuring that UPS System and the downstream power distribution system for equipment to be serviced by are coordinated such that UPS loads continue to operate without interruption and in accordance with the power supply tolerance requirements (both voltage and frequency) for these UPS loads as long as at least one source is within the limits of voltage and frequency as specified herein. The Bidder shall furnish single line diagrams with his proposal to demonstrate how this requirement is met for all equipment and system covered under Bidders scope.

2.1.8. Number of distribution feeders in completely redundant configuration shall be offered to suit the load distribution as decided during engineering. Spare feeders of at least 20% (rounded up to next whole number) of the total number of feeders of each rating and type shall be built in. No adjustment in contract price is admissible on account of number or variation in size of feeders during detailed engineering.

2.1.9. All necessary equipment required for protecting UPS equipment and connected inputs and outputs shall be furnished by the Bidder as an integral part of this system. Complete UPS system shall be automatic without any manual interference at any time of operation.

2.1.10. Complete cabling (DC, AC, control, communication), terminations, lugs, glands and routing up to equipment terminal blocks.

2.1.11. UPS and UPSDB panels shall be installed on suitable size ISMC base frames, fabricated, painted (Shade - Black Color) and anchored as per the specification.

2.1.12. Gaskets, earthing, mechanical supports and accessories shall be included.

- Complete system testing including functional testing, UPS redundancy tests, bypass tests, alarm verification and load tests. All test instruments shall have valid NABL calibration.

2.1.13. Bidder shall refer drawing no: Annexure-2 or indicative basic conceptual single line diagram of UPS & UPSDB system. However, UPS & UPSDB single line detail drawing and GTP shall be submitted by bidder during detail engineering stage.

2.1.14. Bidder will do all load calculation and submit to owner for approval. Based on it UPS capacity shall be finalized.

2.1.15. Bidder to submit all drawing and UPS sizing calculation to owner for approval.

2.1.16. Submission of IEC certificate and test reports to owner.

2.1.17. All MFM, CT and PT shall have 0.2s and PT shall be of 0.2 Class accuracy class.

2.1.18. UPS shall be sized to feed Substation automation system, servers, workstations and printers etc. Power supply for UPS shall be derived from the 415V Station Service Board (SSB) using suitable cables.

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the latest version of the relevant IS / IEC / IEEE standards including amendments, if any, except where modified and / or supplemented by this specification.

IEC : 62040	:	Uninterruptible Power Systems (UPS)
IEC 61643-1	:	Surge Protective Devices
IS: 4540	:	Mono crystalline semiconductor rectifier assemblies and equipment.
IS: 6619	:	Safety code for semiconductor rectifier equipment.
IS 6297	:	Transformer and inductors for electronic equipment
IS 6553	:	Environmental requirements for semi-conductor devices and integrated circuits
IEEE 1184	:	IEEE guide for batteries of Uninterrupted Power Supply System

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 To provide uninterrupted power supply to LT & HT Electrical system, communication system, emergency lighting, CCTV, Fire System, GPS system, EMS, SCADA, PPC, ABT metering system workstations, printers, and other uses identified by bidder and Owner at time of finalization of Engineering drawing of 230V AC UPS system is envisaged. The UPS system shall be parallel redundant consisting of inverters and static switches. Emergency lighting shall be fed directly from the UPS DB's on continuous basis.

4.2.0 The rating indicated is minimum requirement. Bidder shall carry out sizing calculations and provide required rating.

4.3.0 UPS shall be designed with 2 × 100% redundancy (one UPS fully supports load if the other is out). A design margin of 20% shall be considered in UPS system sizing calculations. The calculation shall be submitted to the owner for approval. The power factor to be considered for UPS shall be 0.8. Spares panels and future panels wherever space provision is mentioned shall be included in the UPS sizing.

4.4.0 The overall efficiency of UPS system shall not be less than 88%.

4.5.0 The UPS system shall be capable of operating without battery in circuit under all conditions of load and the performance of various components of UPS like an inverter, charger, static switch etc. shall be guaranteed without the battery in circuit.

4.6.0 The UPS shall have an overload capacity of 110% of rated capacity for 1 hour, 125% of rated capacity for 10 minutes and 150% of rated capacity for 1 minute. The inverter shall have sufficient I^2t capacity to clear fault on the maximum rated branch circuit.

4.7.0 The UPS shall have programmable power walk in facility.

4.8.0 The design shall provide high reliability by ensuring high mean time between failures (MTBF) and low mean time to repair (MTTR). The availability shall be more than 99.99% per year. The formula for availability is: Availability = (1 – (MTTR/MTBF)) x 100%

4.9.0 The static inverter shall be solid state type using pulse width modulation (PWM) insulated gate bipolar transistor (IGBT) design. The steady state voltage regulation shall be less than ±1% and frequency regulation less than ±0.5% for all conditions of input supplies, loads and temperature occurring simultaneously or in any combination. The total harmonic content shall be less than 2% at full load.

4.10.0 All necessary equipment shall be provided to protect the inverter against overload, output short circuit, 100% loss of load, input under / over voltage, output under/over voltage, battery current limit, Rectifier over voltage, battery low, battery overvoltage, over temperature etc. The inverter shall be self-protecting against damage if energized with full load connected.

4.11.0 Inverter equipment shall include all solid-state circuitry and devices to enable inverters to operate in parallel sharing mode with each inverter taking 50% load during normal operation.

4.12.0 In case of either inverter being out of service, 100% load shall automatically be transferred to healthy inverter without any break and degradation in the quality of UPS output and disconnecting the faulty inverter automatically.

4.13.0 The inverter failure shall be annunciated, and the healthy inverter shall get synchronizing signal from the standby AC source (bypass supply) and remain synchronized within set limits. The limits for the synchronization between healthy inverter and bypass supply shall be field adjustable.

On failure of both inverters, the loads shall be transferred to bypass supply without a break if within synchronization limits. However, such transfer shall be inhibited during operation of inverter on its internal oscillator, if bypass supply frequency is beyond the synchronization limits. Provision of asynchronous transfer with a break in case of inverter being out of synchronization limits shall be provided.

4.14.0 Static switch shall perform the following operations:

- Connects inverter output to the load under normal operation
- Automatically transfers the load to its bypass supply within 5ms if both inverters fail or are overloaded
- Automatically retransfers the load from bypass supply to the inverter, once the inverter is healthy or the overload condition has ceased

4.15.0 Maintenance bypass switch shall be used for isolating UPS during maintenance.

4.16.0 The rectifier transformer shall be dry type copper wound with class F insulation with temperature rise limited to class B.

4.17.0 The UPS System shall have the following measuring instruments:

UPS 1 & 2
- MFM at input side
- MFM at output side

SVC
- MFM at input side
- MFM at output side
- MFM at output of Manual Maintenance Bypass Switch

Main UPS DB 1 & 2
- MFM at incoming supply
- Bus Voltmeter
- Voltage & current at input side and output side

Tie Feeder
- MFM at input side of the feeder (UPS-DB-1)
- Voltmeter at output side of the feeder of UPS DB-1

Sub UPS DB-1 &2 at BESS Plant
- MFM at input side of the incomer.
- Bus Voltmeter

Measuring instruments shall be provided with required CT / PT. PT's shall be provided with MCB's on input and output side. (Fused are not acceptable). All measuring instruments shall be integrated to SAS / SCADA for comprehensive parameters.

4.18.0 The UPS shall have microprocessor based self-diagnostic features.

4.19.0 For remote indication / annunciation in SAS, required communication link and potential free contacts for essential signals shall be provided:

4.20.0 The UPS shall have the following alarm / status indications:

- System normal
- AC Input supply failure
- DC input supply (110 V DC) failure
- Inverter ON/OFF
- Inverter on load
- Inverter failure
- Over temperature
- Overload trip
- AC Input over voltage

- AC Input under voltage
- DC input under voltage
- Static switch failure
- Fuse failure
- Transfer inhibited
- Standby ON
- Fan failure
- Oscillator failure

During detailed Engineering additional alarm/status indication shall be added if required by owner without any cost to the owner.

4.21.0 Separate UPS DB's shall be provided with required MCB outgoing feeders. Outgoing feeders indicated in the SLD are illustrative and number , raring and type of feeders shall be finalized during detail engineering. 20% (Rounded up to next whole number) spare outgoing feeders of each type and rating shall be provided for future use by owner (ready to use)

4.22.0 The UPS shall be capable to work in non-air-conditioned room; room shall be well ventilated. Site ambient temperature of 48 Degree centigrade or as per CEA working committee report whichever is higher shall be considered for design of UPS system.

4.23.0 The UPS system. shall be suitably housed in sheet steel panels and shall be complete with all interconnections. The panels shall be fabricated with 2mm thick cold rolled sheet steel and structural steel. Degree of protection of cubicles shall be IP55.

4.24.0 UPS shall have sufficient number of cooling fan. Heat dissipation calculation shall be submitted to owner during detailed Engineering. UPS system training shall be provided to the owner at site for free of cost.

4.25.0 UPS Panel, UPSDB material and coating shall be such that they can withstand the local environmental condition for 25 years without any damage. All Indoor UPS panels and UPSDBs shall be pre-treated as per IS 6005 before being factory-painted with epoxy-based paint shade of paint shall be RAL 7035. Corrosivity grade C4-M as per ISO 12944 shall be considered for indoor equipment. Painting shall be carried out by approved process. Sufficient quantity of touch-up paint shall be furnished for application at site. All indoor UPS panels and UPSDBs shall be of Rittal Make.

4.26.0 **UPS HMI:**

The UPS system shall be provided with a dedicated Human Machine Interface (HMI) for local monitoring, operation, and status indication of the UPS. The HMI shall be panel-mounted or door-mounted as per UPS manufacturer's standard design and shall be suitable for continuous operation in an electrical control room environment.

The HMI shall be a color graphical touch screen type with a minimum screen size of 7 inches (or as per OEM standard), with adequate resolution for clear display of parameters, alarms, and trends. The display shall have back-lit illumination suitable for normal indoor lighting conditions.

The HMI shall communicate with the UPS controller through a dedicated internal communication link or standard industrial communication protocol supported by the UPS manufacturer. The HMI shall support integration with SCADA / SAS / EMS / HPCMS through the UPS system communication gateway, if applicable.

The HMI shall display real-time operating status of the UPS system including overall system status, operating mode (Normal / Battery / Bypass / Maintenance), and health status of major sub-systems. The HMI shall provide clear graphical representation of power flow from input to output, including rectifier, inverter, battery, and bypass paths.

The HMI shall display electrical parameters including AC input voltage, AC input current, AC input frequency, AC output voltage, AC output current, AC output frequency, output load percentage, active power, apparent power, power factor, and DC bus voltage. Battery parameters including battery voltage, battery current, battery state of charge, battery autonomy / backup time, and battery charging status shall be displayed.

The HMI shall display alarm and event information with date and time stamping. Alarm messages shall be presented in clear text with alarm description, priority, and status. The system shall retain a historical log of alarms and events with configurable storage capacity.

The HMI shall provide access to operating statistics such as power ON hours, UPS operating hours in different modes, number of transfers to battery, and number of transfers to bypass. The HMI shall support viewing of trend data for selected parameters over configurable time intervals, if supported by the UPS controller.

The HMI shall allow controlled user access through password-protected login levels such as operator, maintenance, and admin. Critical control actions, if permitted by the UPS design, shall require appropriate authorization to prevent unauthorized operation.

The HMI shall be powered from the UPS auxiliary supply and shall retain display data and alarm/event logs during mains supply disturbances. The HMI shall automatically restore display and communication after power recovery without manual intervention.

The HMI shall comply with relevant EMC and safety standards applicable to industrial electronic equipment. The HMI hardware and software shall be fully compatible with the supplied UPS system and shall be supplied, configured, and commissioned by the UPS manufacturer.

4.27.0 Multi-Function Meters (MFM)

Multifunction meters shall be provided at various locations as indicated in the UPS SLD schematic drawing.

Multi-Function Meters (MFM) shall be provided with 0.2S accuracy class, suitable for 3-phase, 4-wire, 3-element AC systems and DC systems, as applicable. MFMs shall operate on 110 V DC auxiliary supply and shall be provided with RS-485 communication port. All MFMs shall be capable of integration with SAS / SCADA / EMS / HPCMS. All panel-mounted MFMs shall be of minimum 96 × 96 sq. mm size. Digital bus voltmeters with MCB protection shall be provided wherever voltmeters are required.

All AC MFMs shall be suitable for LT application and shall be provided with external CT inputs. Voltage inputs shall be taken directly from the bus through MCB protection. Current inputs shall be through CTs of 1 A or 5 A secondary, with CT accuracy class 0.2 / 0.2S. DC MFMs shall be suitable for DC voltage, current, power, and energy measurement using appropriate shunts or transducers. All MFMs shall have a separate 110 V DC auxiliary supply and shall retain measured data during auxiliary supply failure.

All MFMs shall have built-in Real Time Clock (RTC) with battery backup and shall be connected to HPCMS (High Performance Control and Monitoring System). HPCMS shall have provision to collect data from each MFM and generate 15-minute interval (block) data for load profiling, energy monitoring, trending, and reporting.

AC MFMs shall measure, display, record, and communicate the following parameters:
- Phase-to-Neutral Voltage
- Average Phase-to-Neutral Voltage
- Phase-to-Phase Voltage
- Average Phase-to-Phase Voltage
- Line Current (L1, L2, L3)
- Average Line Current

- Active Current
- Reactive Current
- Frequency
- Power Factor (per phase)
- Average Power Factor
- Active Power (per phase)
- Total Active Power
- Reactive Power (per phase)
- Total Reactive Power
- Apparent Power (per phase)
- Total Apparent Power
- Active Energy – Import
- Active Energy – Export
- Reactive Energy (Q1, Q2, Q3, Q4)
- Apparent Energy – Import
- Apparent Energy – Export
- Cumulative Maximum Demand (kW / kVA)
- Phase Angle
- Power ON Hours
- Power OFF Hours
- Load ON Hours
- Load OFF Hours
- Feeder Interruption Count (including auxiliary supply failure)
- Voltage THD (%)
- Current THD (%)
- Voltage Unbalance
- Current Unbalance

Communication protocol shall be Modbus RTU on RS-485.

DC MFMs shall measure, display, record, and communicate DC voltage, DC current, DC power, DC energy, Power ON / OFF hours, Feeder interruption count, and related DC operational parameters.

5.0.0 BATTERY

5.1.0 Batteries shall be OPzS / TBS type as stated in Section 2-16: 'DC SYSTEM'. (i.e. common battery bank for station DC and UPS system) However battery bank shall be sizes accordingly.

6.0.0 UPS DISTRIBUTION BOARDS

6.1.0 UPS Distribution boards (UPSDB) shall be metal enclosed, indoor, fixed type, single front, non-compartmentalized construction. The distribution board frame shall be fabricated using CRCA sheet steel of thickness not less than 2.0mm. The frames shall be enclosed by CRCA sheet steel of thickness not less than 1.6mm.

6.2.0 Suitable synthetic Neoprene gaskets shall be provided to make boards completely dust and vermin-proof with a degree of protection of IP55.

6.3.0 The handle of incoming switch shall be mounted on the door of the board, with padlocking facility in both 'ON' and 'OFF' positions.

6.4.0 UPS DBs shall have bottom entry for cables.

6.5.0 Cable entry facilities shall be provided with removable aluminum gland plates of suitable thickness. All incoming and outgoing cables shall be terminated on suitable terminal blocks. All the cable gland plates shall be pre-drilled. Spare holes shall be kept with grommet. All cable entry shall be from bottom only.

6.6.0 All UPS DBs shall be pre-treated as per IS 6005 before being factory-painted. Surface shall be prepared with Sand / Shot Blasting. Two Coats of Polyurethane high build enamel coating system with high build mastic primer. Epoxy based paint shade shall be RAL 7035. Corrosivity grade C4-M as per ISO 12944 shall be considered for indoor equipment & ISMC channel also. Painting shall be carried out by approved process. Sufficient quantity of touch-up paint shall be furnished for application at site.

7.0.0 UPS AND UPSDB MOUNTING ARRANGEMENT

7.1.0 The UPS panel and UPS Distribution Board shall be mounted on base frames made of ISMC 100 all around and their base is to be bolted with the ISMC base frame. The ISMC base frames are to be welded with the existing floor EPs. The base frames shall be primed and painted with same colour as enclosure. The painting shall be of C4-M grade as per ISO 12944. The welding of the base frames to the floor EPs and post weld touch up painting shall be carried out by the bidder including supply of necessary consumables, paint and hardware. The pad between panel and mounting base frame shall be of 50mm thickness and made of rubber material.

7.2.0 Provision for transportation and handling shall be made on the cabinets and marked up for slinging.

7.3.0 The UPS and UPSDB are to be installed side-by-side. The UPSDB shall be installed along with one set of UPS.

8.0.0 DRAWINGS, DATA AND MANUAL

8.1.0 **To Be Submitted After Award of Contract.**

- Technical data sheet
- Dimensional general arrangement drawing
- Sizing calculation for UPS
- Schematic and wiring diagram
- Quality plan
- Test certificates
- O&M manual
- MODBUS Mapping Manual
- Load Distribution SLD
- List of Mandatory Spares for approval from owner.
- Bill of Material (BOM)
- Cable Sizing calculation

9.0.0 TESTS

9.1.0 The equipment offered shall be of type tested and proven type. All type test reports shall be submitted for approval. All routine, acceptance and special tests in accordance with the latest version of applicable standard shall also be conducted in presence of Owner.

9.2.0 Functional tests on the system shall be carried out.

9.3.0 The details of test to be carried out shall be finalized during detailed engineering. All testing and measuring equipment/items required for UPS testing shall be calibrated from NABL laboratory and calibration period shall not exceed one year as on date of carrying out testing of UPS. The calibration report shall be made available to owner and a copy of it shall be handed over to Owner.

10.0.0 TECHNICAL PARAMETERS

Sl. No.	Description	Data
A	**UPS**	
1	Type	Digital UPS
2	Rating of each set of UPS	Rating to be decided during detail engineering (Parallel redundant) two pairs of UPS each having 100% plant load capacity
3	Installation	Indoor
4	Input Supply Voltage	By pass supply: 415 +/- 10%, 3 phase (from 415V SSB) Main Supply: 110 V DC, +10% to -15%
5	Combined frequency & voltage variation	10% (absolute sum)
6	PF Range	Capacitive to Inductive over entire PF range
7	Overall efficiency of UPS	>88%
8	UPS output voltage	230 V AC, Single phase, 50Hz
9	Output Voltage form	True Sinusoidal
10	Operating Temperature	0-50 °C
11	Relative Humidity	95 % Non-Condensing
B	**INVERTERS**	
1	Type	Digital PWM IGBT design or superior
2	Output Voltage	230 V A.C, 50 Hz, 1 Phase
3	Output voltage waveform	Sinusoidal
4	Steady state output voltage regulation from no-load to full load for input line variations for balanced loads	+/- 1%
5	Total harmonic distortion	< 2% for Linear full loads and < 3% for Non-linear full loads
6	Crest factor	3:1
7	Over load	150% for 10 sec, 125% for 10 min and 110% for 60 min.
8	Power factor	0.6 to Unity
C	**UPS DB**	
1	Type	Compartmentalized (Maximum two feeders in each compartment and single

Sl. No.	Description	Data
		compartment for incomers and tie feeders). In built in UPS enclosure. Two (02) nos. UPS DB interconnected with Tie cable. For each output both UPS DB shall have MCB with Aux monitoring relay which shall generate alarm in SCADA on its failure.
2	Quantity	04 or as required at site which shall be finalized during detailed engineering.