SECTION – 2.01

VANADIUM REDOX FLOW BATTERIES AND POWER CONVERSION SYSTEM

1.0 INTENT OF SPECIFICATION

This specification defines the minimum technical, functional, performance, safety, reliability, engineering, testing, operation, maintenance, and warranty requirements for design, engineering, manufacturing, supply, transportation, erection, testing, commissioning, operation and maintenance of a grid-connected utility scale 20 MW / 120 MWh Vanadium Redox Flow Battery (VRFB) based Battery Energy Storage System (BESS) at GIPCL's 165 MW Gas Power Plant Complex, Vadodara, Gujarat.

The BESS shall be designed as a utility-grade long duration storage system suitable for peak shaving, load shifting, renewable integration, ancillary services, frequency regulation, reactive power support, black start capability and grid forming operation.

2.0 SCOPE OF WORK

The EPC Contractor shall execute the complete project on turnkey basis including complete design & engineering, process engineering, electrical engineering, civil & structural engineering, protection engineering, EMS/SCADA engineering, grid integration studies, harmonic studies, dynamic load flow studies, short circuit studies, protection coordination studies, fire safety engineering and hazardous area classification.

The scope shall include supply of electrolyte, electrolyte tanks, cell stacks, membranes, pumps, valves, piping, sensors, Battery Management System (BMS), Power Conversion System (PCS), transformers, HT/LT switchgear, EMS, SCADA, communication systems, fire protection systems, gas detection systems and complete balance of plant.

3.0 SITE CONDITIONS

Location: Vadodara, Gujarat
Ambient Temperature: 0°C to 50°C
Relative Humidity: Up to 95%
Grid Voltage: 132 kV
Grid Frequency: 50 Hz

The BESS shall operate continuously under all site conditions without derating.

4.0 APPLICABLE STANDARDS

The BESS shall comply with latest editions of IEC 62932 Series, IEC 62933 Series, IEC 62485, IEC 62619, IEC 60076, IEC 62271, IEC 61000, IEEE 519, NFPA 855, NFPA 70, IEC 60079, IEC 62477, applicable IS standards, CEA regulations, CEIG requirements, GERC regulations and GETCO standards.

5.0 SYSTEM CONFIGURATION

Rated Power: 20 MW AC at POI

Rated Energy: 120 MWh usable at POI

Storage Duration: 6 Hours

Cycles per Day: 1.5

Project Life: 25 Years

O&M Period: 10 Years

Availability: ≥95%

RTE at POI: ≥70%

Dispatchable capacity shall be maintained throughout O&M period.

6.0 BATTERY TECHNOLOGY REQUIREMENTS

Only commercially proven Vanadium Redox Flow Battery (VRFB) technology shall be acceptable.

7.0 ELECTROLYTE SYSTEM

The electrolyte shall be high purity vanadium electrolyte suitable for long-term stable operation. Bidder shall provide electrolyte composition, impurity limits, regeneration methodology and recovery methodology.

Electrolyte storage tanks shall be chemically resistant, UV resistant and leak-proof. Minimum containment capacity shall be 110% of largest tank volume.

8.0 STACK REQUIREMENTS

The stack shall support modular replacement and maintenance without complete system shutdown. Bidder shall provide stack efficiency, pressure drop, thermal characteristics and lifetime data.

9.0 POWER CONVERSION SYSTEM (PCS)

PCS shall be bi-directional, support four quadrant operation, grid forming capability and black start operation.

PCS efficiency shall be minimum 97% with operating power factor range from 0.8 lead to 0.8 lag.

PCS shall comply with latest grid code requirements as specified in various CEA documents.

10.0 RELIABILITY REQUIREMENTS

The system shall be designed such that single point failure shall not impact more than 2% of plant capacity.

Redundancy shall be provided for pumps, BMS, communication systems, PCS, EMS and auxiliary systems.

11.0 BATTERY MANAGEMENT SYSTEM (BMS)

The BMS shall monitor voltage, current, temperature, pressure, flow, SOC and SOH. The BMS architecture shall be redundant and support IEC 61850 and Modbus TCP/IP communication protocols.

12.0 EMS & SCADA

The EMS shall support remote dispatch, load forecasting, scheduling, SLDC integration, historical trending and alarm management.

13.0 CYBERSECURITY REQUIREMENTS

The BESS shall comply with IEC 62443 cybersecurity requirements including RBAC access, firewall segregation, VPN access, event logging and patch management.

14.0 SAFETY REQUIREMENTS

The BESS shall include fire detection, gas detection, leak detection, emergency shutdown systems, ventilation systems and spill management systems.

Hydrogen concentration shall remain below 25% of LEL.

15.0 FIRE PROTECTION SYSTEM

The BESS shall comply with NFPA 855, NBC and TAC requirements. The system shall include smoke detectors, heat detectors, flame detectors, clean agent suppression systems, hydrant systems and portable extinguishers.

16.0 ENVIRONMENTAL REQUIREMENTS

The Contractor shall comply with Hazardous Waste Rules, Battery Waste Management Rules and Pollution Control Board regulations.

17.0 GRID COMPLIANCE

The BESS shall comply with CEA Grid Standards, GETCO requirements and SLDC requirements. The system shall support LVRT, HVRT, frequency support, voltage support and reactive power support.

18.0 BLACK START CAPABILITY

The BESS shall support dead bus energization, auxiliary startup, synchronization and island mode operation.

19.0 PERFORMANCE GUARANTEES

Rated Power: 20 MW

Rated Energy: 120 MWh

RTE: ≥70%

Availability: ≥95%

Design Life: 25 Years

Cycle Life: ≥20,000 cycles

20.0 TESTING REQUIREMENTS

Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) shall include stack testing, PCS testing, protection testing, communication testing, leak testing, insulation testing, 6-hour discharge test, harmonic test and black start test.

21.0 WARRANTY REQUIREMENTS

The Contractor shall provide minimum 25 years warranty for the VRFB system and minimum 10 years / 20,000 cycles performance warranty.

22.0 O&M REQUIREMENTS

The Contractor shall provide 24x7 support, diagnostics, annual performance testing, spare management and emergency response support.

Response time for critical alarm shall be within 1 hour.

23.0 SPARE PARTS

Minimum 2-year critical spare inventory shall be maintained at site including pumps, membranes, sensors, PCS modules and communication modules.

24.0 DELETED

25.0 DOCUMENTATION

Contractor shall submit GA drawings, SLDs, protection schemes, calculations, O&M manuals, training manuals and as-built drawings.

26.0 TRAINING

Minimum 30 man-days training shall be provided for GIPCL personnel covering erection, testing, commissioning, operation, maintenance and emergency response.

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29.0 COMPLETION SCHEDULE

Engineering: 4 Months

Supply: 10 Months

Erection: 4 Months

Commissioning: 18 Months

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