Book 3

Technical Specification and Requirements of Battery Energy Storage System (BESS)

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1. GENERAL

1.1 The system shall confirm to the following specification.

BESS shall consist of:

1) A power conversion system (PCS) suitable for outdoor installation on a user-furnished concrete pad or the user-furnished box pad;
2) An energy storage unit of at least 3MW/at least 1.5 MWh at20%-95% SOC, at least 0.5 hour at 3 MW to load as described in Fig. 1.
3) Lithium-ion battery with life expectancy rating of 10 years under normal operating conditions, suitable for outdoor installation, and a battery management system (BMS).
4) Specification requirements of the PCS are further discussed in Section 4.0. Specification requirements of the energy storage unit and BMS are further discussed in Sections 5.0 and 6.0, respectively.

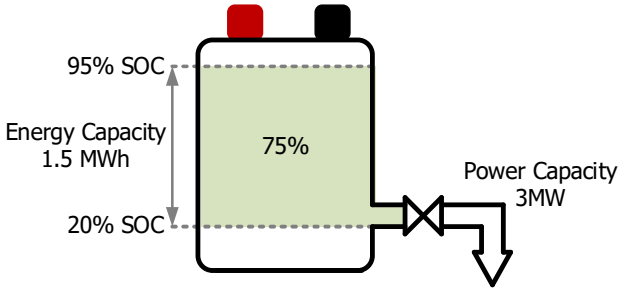


Figure 1: Requirement of energy storage capacity (energy and power capacity).

1.2 Electrical grid connection

The BESS shall be connected to the medium voltage 22kV AC three phase distribution line at a frequency of 50Hz. A step-up transformer shall be provided to allow connection between the BESS and the 22kV distribution line.The contractor shall provide and make connection power cable between BESS with Mae Sariang substation. Rating of a step-up transformer is at least 4 MVA.The winding type of transformer can be defined by bidder.The vector group of transformer shall be YNd group. The PCS shall be designed to operate under the following condition:

Phase	3
Rated voltage	22kV
Voltage range	Max 23.1 kV, Min 20.9 kV
Voltage fluctuation/Flicker	According to PEA regulations
Rated frequency	50 Hz
Frequency range	50 $\pm$ 0.5 Hz
Harmonics	According to PEA regulations
Voltage unbalance	< 2%

1.3 Operation

In normal operation, BESS shall operate in current-source mode, providing such functionality as voltage regulation, power factor correction, peak shaving and **load following** (for PV output smoothing). It shall have the ability to perform **four-quadrant control**.

If the utility power source is interrupted, the BESS shall have **low-voltage ride through (LVRT)** capability according to PEA Grid connection code 2016 as shown in Fig. 2 to support the transition from grid connected to islanded condition. The energy storage unit and converter shall then power the islanded 3.0 MW load for at least 0.5 hours, or until utility service is resumed for the energy storage unit is depleted.

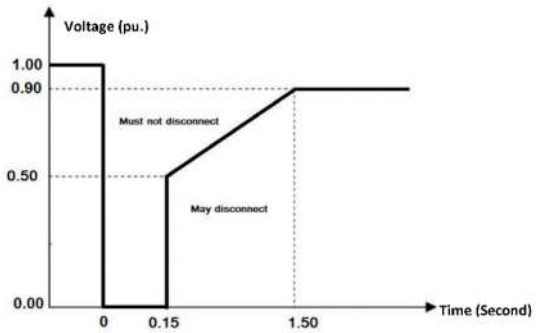


Figure 2: LVRT requirement according to PEA Grid connection code 2016.

1.4 Communications

The BESS shall be capable of communicating over a standard protocol, like DNP 3.0 over IP or IEC61850 protocol, furnished and installed by the system manufacturer, which shall permit - communication to the microgrid controller (MGC- This will allow PEA to monitor and control such parameters as battery voltage, current, temperature, state of charge and state of health at the cell/module/tray and rack levels; as well as allow to control charging, discharging and other functions of BESS, as necessary.Battery management system (BMS)shall connect and transfer data to MGC/ADDC

The PCS shall communicate with the energy storage unit controller via a standard protocol defined by vendor, e.g. Modbus RTU or Modbus TCP, etc. In case of Modbus communication, all Modbus detail shall be provided.

The BESS shall have a maintenance port (serial, WiFi, Bluetooth, etc.) to allow monitoring and control of BESS at local level via a PC.

The BESS shall have security access for maintenance battery container.

2. STANDARDS AND CODES

Equipment furnished shall meet the guidelines defined in the applicable sections of the standards and codes listed below.

- ANSI/IEEE Standard C2-2007: National Electrical Safety Code
- ANSI C57.12.28-2005: Pad-mounted Equipment Enclosure Integrity
- ANSI Z535.4-2002: Product Safety Signs and Labels
- ANSI C62.41.2-2002: IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000V and Less) AC Power Circuits
- IEC 61000: Electromagnetic compatibility (EMC)
    - EN61000-6-2 EMC immunity

  - EN61000-6-4 EMC emission
  - Reference - FCC Sections 15.109&15.209: FCC Code of Federal Regulations Radiation Emission Limits
- IEEE Standard 519-2014: IEEE Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
- IEEE Standard 1547.1-2005: IEEE Standard Conformance Test Procedures for Equipment Interconnecting Distributed Resources with Electric Power Systems
- IEEE Standard 1547.3-2007: Guide for Monitoring, Information Exchange, and Control of Distributed Resources with Electric Power Systems
- IEEE C37.90.2-2004: IEEE Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- IEEE Standard C37.90.1-2002: IEEE Standard for Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems (ANSI)
- International Building Code: Applicable to seismic rating, requirements, location and design of mounting pad (designed by others).
- NISTIR 7628: Guidelines for Smart Grid Cyber Security
- IEC 62619 or UL 1973 - Safety Requirements for Secondary Lithium Cells and Batteries or Standard for Stationary Batteries
- IEC62109 or UL 1741: Safety of power converters for use in photovoltaic power systems or Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources
- PEA Grid Connection Code 2016.

3. ENVIRONMENTAL REQUIREMENTS

The system shall be designed for use in the following environment

Operating temperature	0°C - 45°C without derating
Humidity	0 – 95% non-condensing
Maximum altitude	1,000 m without derating
Seismic Rating	Uniform Building Code Zone 4
Audible Noise	Audible Noise shall be complied with Thailand environmental standard less than 80 dBA.

Supplier must provide sufficient information specific to their particular product to facilitate utility personnel training and communications with emergency response and environmental agencies. Material Safety Data Sheets (MSDS) shall be provided as applicable.

4. POWER CONVERSION SYSTEM (PCS)

4.1 General

Grid-tied energy storage units are predominately DC in nature. To utilize the energy storage capability on the AC electric grid, the energy from batteries must be converted to a standard AC level and regulated through a converter, generally known as the Power Conversion System (PCS). The PCS serves as the interface between the DC battery system and the AC system, providing bi-directional conversion from DC to AC (for discharging batteries) and AC to DC (for charging batteries). The PCS may consist

of one or more parallel units. The PCS shall be bi-directional converter that can be operated in inverting mode for battery discharging and rectifying mode for battery charging.

The PCS shall be cooled, with final rejection of waste heat to the ambient air. The air-handling systems shall include filtering that is adequate to keep dust from the interior of the PCS system. Replacement of filter shall not require special tools or involve more than two hours of labor at the site.

The PCS shall consist of an converter area, user-accessible AC termination area, user-accessible DC termination area, and user-accessible control area.

1. Converter area:

The converter area shall contain an AC circuit breaker, converter and DC circuit breaker.

- AC circuit breaker – The AC circuit breaker shall isolate the power unit from the utility source if needed.
- Converter – Upon opening of the AC circuit breaker in response to interruption of the utility source, the three-phase converter shall power the islanded load until utility service is resumed or energy in the battery pack is depleted.
- DC circuit breaker – The DC circuit breaker shall provide isolation of the battery pack, permitting routine maintenance to be performed on PCS.

2. AC termination area

The user-accessible AC termination area shall include bus terminal pads for connection of utility source and the customer load cables.

3. DC termination area

The user-accessible DC termination area shall include terminations for cables from the battery pack.

4. Controls area

The user-accessible controls area shall contain the master controls and associated circuitry to support operation. Within the control area shall be the following:

- Control panel – The control panel shall include a three-position rotary switch for selecting the control mode of the power unit)MGC or ADDC-enabled, MGC or ADDC-disabled, and Remove From Service.(
- Master control board – The master control board shall provide the main processing and control functions of the converter.
- Power supply – The power supply shall provide the necessary DC control power for the system controls .

4.2 System Operation

4.2.1 Start/stop characteristics

The PCS starts or stops by pushing buttons “RUN” or “STOP”, respectively, or receiving control commands from a local HMI, or MGC (or ADDC in case MGC fails).

4.2.2 Operation during normal condition

The following functions shall be required with the PCS for the grid-connected and islanded (off grid) operation.

1. The AC power transformed efficiently from the DC power of the battery arrays shall be bi-directionally transferred to or from the distribution line without causing harmonics higher than the PEA regulation.
2. The following operation modes shall be provided:
   a. Virtual synchronous generator
   b. Active and reactive power control
   c. Voltage and frequency control
   d. Voltage and frequency droop for parallel operation (BESS may be paralleled with Solar Farm, Diesel Gen Set, Run of River Hydro)
3. Black start capability
4. The PCS shall contain a remote synchronization feature, as well as the standard synchronization used when starting the PCS online. The remote synchronization feature allows the PCS to synchronize its voltage and frequency to any other remote AC bus or generator.
5. PCS shall be stable against the usual change in voltage and frequency of the grid.

Mode selection and control parameter setting shall be done by local HMI, or control command from MGC (or ADDC in case MGC fails).

In addition, the PCS shall have the following capability:

- The PCS shall have the ability to perform four-quadrant control.
- The PCS shall be able to perform load following (for PV smoothing) Voltage shall be maintained at +/- 5% nominal under normal operating conditions and +/- 10% under emergency conditions.
- The PCS shall have low-voltage ride through capability to support the transition from grid connected to islanded condition. Please state your compliance to the latest draft of IEEE 1547
- The PCS shall have the synchro-check function to allow parallel operation with the grid, diesel and PV generators.

Operation Mode Definition

- ***Virtual synchronous generator:*** This mode of operation makes the PCS work as a voltage source converter. Under this mode, the BESS shall be able to provide its own voltage and frequency to an islanded grid, or to work in parallel with the utility grid in the grid-connected mode.

- ***Active and reactive power control:*** In this mode of operation, PCS controls the output active and reactive powers supplied to the grid following their reference values which may be set locally or remotely.
- ***Voltage and frequency control:*** In this mode of operation, PCS controls its own voltage and frequency, enabling it to create an islanded grid. Voltage and frequency control is possible when the PCS is in the voltage source operating mode.
- ***Voltage and frequency droop for parallel operation:*** The voltage droop allows reactive power sharing when the BESS is in an islanded mode or paralleled with other voltage sources. The frequency droop allows active power sharing when the BESS is in an islanded mode or paralleled with other voltage sources.

4.2.3 Operation during abnormal condition

The PCS shall operate as follows during abnormal operation:

- The PCS stops automatically when serious abnormal conditions are detected.
- When not-serious errors are detected, the PCS continues operation with error signals which shall be reported to MGC and ADDC.

4.3 Detailed Technical Specifications

Table 1 Summarizes PCS technical specifications.

Table 1. PCS technical specifications

Details	Technical requirement
AC ratings	
Total rated output power to load @ nominal voltage	3MW (charge) to 3 MW (discharge)
Apparent power @ nominal voltage	≥3 MVAR
Rate output power of each unit	≥ 500 kW
Real and reactive power control accuracy	±1%
Voltage range	as defined by bidder
Type of output	AC three-phase system
Frequency	50 Hz ±1%
VAR production	Full VAR production at rated voltage
Harmonics	according to PEA standards
DC input ratings	
Voltage range	as defined by bidder
Ripple voltage	Less than 4V RMS
Ripple current	Less than 10% of full current peak to peak
Environmental ratings	
Operating temperature	0°C - 45°C* without derating
Humidity	0 – 95% non-condensing
Maximum altitude	1,000* m without derating
Seismic Rating	Zone 4
Functions/Features	
Power flow operation	Yes, support four-quadrant control
Real power control	Yes, positive and negative
Reactive power control	Yes, capacitive and inductive
Combination of real and reactive power control	Yes, with real power taking priority
Load following (renewable smoothing)	Yes, allowing renewable smoothing

Details	Technical requirement
Low-voltage ride through	Yes, supporting transition from grid connected to islanded operation
Synchro-check function	Yes, supporting parallel operation with the grid, PV and diesel generator
Operation modes	
Black start	Yes, external command
Commanded power	Yes, external command
Commanded VAR	Yes, external command
Frequency regulation	Yes, external command
Frequency response	Yes, automatic
Islanding	Yes, automatic (when utility source is lost) or external command (from MGC or ADDC)
Renewable smoothing	Yes, automatic
Scheduled power	Yes, preconfigured time/date of work power profiles
Voltage regulation	Yes, external command
Response time of PCS to the command received	< 100 ms
Communications	
Communications with MGC	Yes, via DNP 3.0 over IP or IEC61850
Communications with ADDC	Yes, via DNP 3.0 over IP
Battery technologies	
Battery technologies supported	Li-ion
Physical systems	
Protection class	Containerized solution for indoor installation or IP54 for outdoor installation
Cooling system	Yes
Time source	
Time source	CSCS via MGC
Monitoring and control	
Interface, status and control panel	Yes
Battery voltage (AC/DC)	Yes
Battery current (AC/DC)	Yes
Active power (AC/DC)	Yes
Reactive power	Yes
Energy (AC/DC)	Yes
Capacity (Ah)	Yes
Power factor	Yes
Fault	Yes
Battery information	Yes
Audible alarm	Yes
Battery temperature (average/extreme)	Yes
State of Charge (SOC)	Yes
Warning messages	Yes
Efficiency	
Efficiency of power conversion	≥ 95%
Protection system	
Under/over voltage (DC and AC)	Yes
Under/over frequency	Yes
Over current protection	Yes
Ground fault protection	Yes
Over heat protection	Yes
Smoke detection (Trip/Alarm)	Yes
Surge protection (DC and AC)	Yes

Details	Technical requirement
Automatic AC & DC open circuit when fault detection	Yes
Insulating monitoring	Yes
Function Features	
Overload capability of 3 MW Switching frequency	120% 30 seconds >= 1 kHz
Insulation resistance	Over 3 M-Ohm at DC 1000 V (exclude the circuit less than DC 60V)
Withstand voltage	AC 2000V 1 minute (exclude the circuit less than DC 60V)
Withstand impulse voltage	$\pm$ 5000V 1.2 x 50μS each 3 times
Noise level	
Noise level	Audible Noise less than 80 dBA.

4.4 Standards

The PCS shall be of high quality product, preferable produced by a manufacturer certified with ISO 9001 or equivalent.

The PCS shall comply with IEC62109or UL 1741: Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources.

4.5 PCS Electrical Protection

The PCS shall be protected against thermal overload, over-current and over-voltage. Insulating monitoring ground fault detection shall be provided. The following protective function shall be provided:

- DC over-voltage
- DC under-voltage
- DC over-current
- AC over-voltage
- AC under-voltage
- AC over-current
- Anti-Islanding
- Battery protection
- Internal fault (over temperature, logic failure, etc.)

The electrical shield cable shall be adopted for the signal and control cable. The surge absorber shall be connected on both sides.

EMC requirement shall meet IEC 61000 or equivalent standard.

Neutral point high resister grounding type (DC side) for ground fault alarm shall be provided.

5. ENERGY STORAGE

5.1 Battery Type

Battery shall be off Lithium-Ion type suitable for utility scale BESS. Different chemistry of Lithium-Ion batteries, such as Lithium Manganese (LMO), Lithium Phosphate (LFP), Lithium Nickel Manganese Cobalt Oxide (NMC), Lithium Nickel Cobalt Aluminum Oxide (NCA), can be proposed.

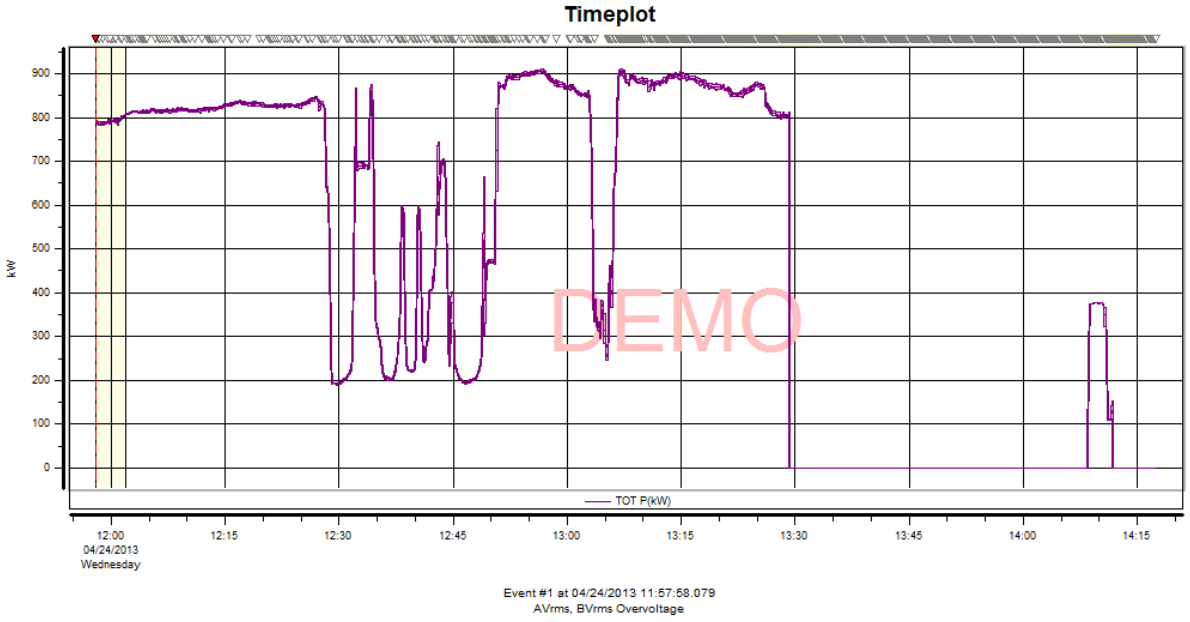
5.2 Detailed Technical Specifications

Table 2 Summarizes technical specifications of the battery energy storage system (BESS).

Table 2. Energy storage unit technical specifications

Details	Technical requirement
Rated output power @ nominal voltage	3MW (charge) to 3 MW (discharge) (Continuous discharge measured at PCS output)
Energy	At least 1.5 MWh at 20%-95% SOC,at least 0.5 hour at 3 MW to load
Type	Li-ion
Allowable charging capacity	See Note #1 below table
Discharging capacity	See Note #1 below table
Round-trip AC energy efficiency (including auxiliaries) at 22 kV system	>80%
Cycle life	> 4,000 at 20-80% SOC

Note #1 – Charging and discharging requirements shall meet the requirements of the worst case solar smoothing requirements, full charge and full discharge: the PV output at the site indicates a quick drop from 818kW to 5kW (for a1MWunit, 1/4 of the total 4MW unit) in 0.1 second. This implies that PEA can possibly have a drop from 3.272MW (818kW*4) to 0.02MW (5kW*4) in 0.1 second.



5.3 Standard

Battery preferable produced by a manufacturer certified with ISO 9001 or equivalent

5.4 Battery Module/Tray

- Battery module shall consist of many battery cells connected in series/parallel.
- Module/tray battery management system (BMS) shall be provided.
- Automatic module balancing shall be provided.
- Module/tray cooling system shall be provided.

5.5 Battery Rack

- Battery modules shall be connected in series/parallel in the battery rack so that the nominal voltage of the DC is more than 480V, suitable for PCS DC voltage.
- Rack BMS with battery fuse, DC current measurement devices and contractors shall be provided.
- Electrical connection shall be at rack front side.
- Many racks shall be connected in parallel to total capacity required for this project.
- 300 kWh spare space for rack extension shall be provided.

5.6 Battery Protection

The following protections shall be provided:

- Over-charge protection
- Over-discharge protection
- Over-temperature protection
- Over-current protection
- Ground-fault detection
- Internal battery fault detection
- Cell balancing

Protective devices should include for DC-side protection:

- Battery fuse for each battery cell and module (preferred)
- DC contactor for each battery rack
- Grounding over current (76G)

5.7 Cycle Life

- If the product is sensitive to depth of discharge, the manufacturer must state the limitations and the product should be sized such that the depth of discharge corresponds to the required cycle life.
- For purposes of estimating and demonstrating cycle life, cycles are defined in the same manner as system efficiency.
- For lifetime assessment the supplier should provide a graph that displays the relationship between depth of discharge and the corresponding number of cycles available within the system’s life.
- Results of charging and discharging are tested at 1C.

6. BATTERY MANAGEMENT SYSTEM (BMS)

6.1 General

BMS is used to monitor, protect, maintain safety and optimal operation of each battery cell, module and rack. BMS consist of: Module/tray BEMS, rack BMS and system BMS.

6.2 Minimum Functions of Module/Tray BMS

- Metering and monitoring
  - Battery cell voltage (all cells)
  - Battery module voltage
  - Battery cell temperature (at least one or several measured locations in battery module/tray)
  - Battery module current
- Cell balancing
  - Module/tray BMS should balance voltage of cells
- Safety protection
  - Module/tray BMS should protect the battery cells and module/tray from:
    - Over and under voltage
    - Over current
    - Short circuit current
    - Over and under temperature
- Data communication: all metering items and contactor status shall be provided for rack BMS control and monitoring system.

6.3 Minimum Functions of Rack BMS

- Metering and monitoring
  - Battery rack voltage
  - Battery rack current
  - Battery rack temperature (one or several locations in battery rack)*
  - Battery SOC of battery modules
- Module/tray balancing
  - Balancing battery modules/trays scheme
- Safety protection
  - Rack BMS should protect the battery rack from:
    - Over and under voltage
    - Over current
    - Short circuit current
    - Over and under temperature
- Data communication: all metering items and contactor status shall be provided for system BMS control and monitoring system.

6.4 Minimum Functions of System BMS

- Metering and monitoring
  - Battery system voltage
  - Battery system current
  - Battery rack voltage
  - Battery rack current
  - Battery rack temperature (one or several locations in battery rack)*

  - Battery SOC of each rack and battery system
  - Battery SOH (state of health) of each rack
- Safety protection
  - System BMS should protect the battery system from:
    - Over and under voltage
    - Over current
    - Short circuit current
    - Over and under temperature
- Data communication: all metering items and contactor status shall be provided for PCS control and monitoring system by a standard protocol, e.g., Modbus RTU or Modbus TCP protocol. Data sampling rate should be configured based on process requirement but not more than 2 seconds.
- Preferred functions of system BMS: Controlling individual battery rack
- BMS data communication: All metering items and contactor status shall be provided for PCS control and monitoring system by a standard protocol, e.g., Modbus RTU or Modbus TCP protocol.

7. FUNCTIONAL REQUIREMENTS

7.1 Voltage Regulation

Voltage deviation should be controlled within +/- 1% for a specified sec sampling rate.

7.2 Reactive Power Regulation

The system shall maintain a defined VAR flow level within +/- 5%.

7.3 Frequency Regulation

Frequency deviation should be controlled within plus/minus ½ cycle per second.

7.4 Round-trip Efficiency

The roundtrip AC-AC energy efficiency, measured at the point of common coupling22 kV system, shall be provided and include parasitic and auxiliary losses under worst case conditions. The calculation is as follows:

$$\eta = \frac{kWh_{out}}{kWh_{in}} \times 100\% = \frac{(rateddischargepower) \times (dischargetime)}{(ratedchargepower) \times (chargetime) + losses} \times 100\%$$

Wherein, the discharge time is from a fully charged to fully discharged system, and charge time is from a fully discharged to fully charged system. If the auxiliary power is provided by a separate connection from the energy storage system, these measured values should be reflected in the losses term in the equation.

7.5 Self-Discharge

Supplier shall provide self-discharge characteristics.

7.6 Basic Insulation Level

The BESS AC system equipment shall have a Basic Insulation Level in accordance with IEC62109/UL 1741and ANSI C62.41.2-2002 standards.

8. ALARMS AND RESETS

8.1 Alarms

The BESS shall provide the following alarms.

- Informational Notification—indicates the status of the unit.
- Warning Alarm—indicates a problem with the converter requiring attention (not affecting proper operation).
- Converter Inhibit—indicates a problem with the converter affecting proper operation. The converter will stop operation.
- Trip Offline Alarm—indicates a severe problem with the converter. The system will not operate.
- Isolate Alarm—indicates a problem affecting proper operation of the system. The system will operate with limited functionality.
- Fire detection remote alarm status for main fire alarm control panel, and control and monitoring system.

These alarms shall be reported to MGC and HMI of BESS system.

8.2 Resets

Energy storage unit alarms shall be reset by any of the following means.

- Manual Reset—via the reset button located on the control panel, or via a personal computer connected to the control panel Ethernet port.
- Auto Reset—automatically performed until reaching a predetermined reset count.
- Self Reset—automatically performed whenever require.

9. ENCLOSURE CONSTRUCTION

9.1 Modular Replacement

The BESS PCS, control, energy storage system and current sensors shall be modularized and connected in a manner that enables field replacement of each module. It is expected that most maintenance will be accomplished while maintaining service.

9.2 Enclosure

The PCS shall be contained within a weatherproof, moisture-sealed, tamper-resistant, metal enclosure with a minimum IP54 or equivalent rating suitable for outdoor installation on a concrete pad or cover of a fiberglass box pad, in accordance with the following requirements.

- The enclosure shall not utilize replaceable filters, dehumidifiers, or similar features requiring periodic maintenance. Air intakes are designed so that any entrance of water or dust is directed away from internal components and does not affect operation of the unit.
- The enclosures shall be equipped with complete and failsafe fire detection/extinguishing system.

- The enclosure shall comply with security requirements of IEEE C57.12.28 Section 4. The enclosure shall limit access to the controls and physical network connections.
- The enclosure shall comply with coating system requirements of IEEE C57.12.28 Section 5.
- Enclosure grounding shall be provided.
- The enclosure shall have access control.
- If applicable, wiring and weather-tight enclosure egress to an external antenna shall be provided.
- A nameplate shall be provided specifying the following:
  - Manufacturer name
  - Connection diagram
  - Unit ratings: Power, energy, voltage, BIL
  - Specimen data: serial number, date of manufacture
- Signage shall indicate Source and Load-Side AC Buses, Neutral Bus, DC Bus, Isolation Contactor, and Module names. Custom signage will be in accordance with specific utility requirements.
- All necessary safety signs and warnings as described in ANSI Z535-2002 shall be included on the unit.
- All necessary signs and warnings for identification of hazardous materials as described in NFPA 704 shall be included on the unit.

10. SAFETY

10.1 General

- The BESS must be compliant with IEEE 1547, IEC 62619, and UL 1973 as appropriate. Systems must be able to protect themselves from internal failures and utility grid disturbances.
- For all BESS equipment, the Supplier shall provide information on specific safety issues related to the equipment, including appropriate responses on how to handle the energy storage system in case of an emergency, such as fires or module ruptures.

10.2 Fire Mitigation

- Provisions shall be included to extinguish internal container fires without the need to open container doors.

11. SYSTEM TESTING, DOCUMENTATION, TRAINING COURSE AND WARRANTY

11.1 Testing

The following test procedures shall be conducted on the unit prior to shipment.

- Battery connection and configuration check
- Circuit boards and subassembly functionality
- Mechanical inspection
- Wiring continuity
- Alarm functionality

The user shall witness the factory acceptance testing at the manufacturer's production facility.

11.2 Quality Assurance

- Factory Testing—Prior to shipment, the bidder shall complete a documented test procedure to test all required functions of the BESS and guarantee compliance with the specifications. These are, but not limited to, the followings:
  - The ability to perform PV output smoothing
  - The ability to perform 4-quadrant control
  - The ability to perform black start
  - The ability to deliver zero-voltage ride through
  - The ability to operate in an islanded operation
  - The ability to perform parallel operation with the grid, PV and diesel generator
  - The ability to communicate with MGC via DNP 3.0 over IP or IEC61850
  - The ability to communicate with ADDC via DNP 3.0 over IP or IEC61850

  The user shall witness the factory acceptance testing at the manufacturer's production facility.

- Assemblies and Materials—All materials and parts shall be new, of current manufacture, and shall not have been used in a prior service, except as required during factory testing. The system manufacturer shall conduct inspections on incoming parts, assemblies and final products.

11.3 Documentation

The bidder shall provide the following documentation for installing and operating the BESS:

- Product Data—This documentation includes catalog sheets and technical data sheets indicating physical data and electrical performance, electrical characteristics, and connection requirements.
- Operation and Maintenance—This documentation includes a manual for preparing, operating, and maintaining the energy storage unit. This includes equipment wiring connection outlines and written instruction for troubleshooting.
- System Electrical Connection Drawings—This documentation includes drawings for properly connecting electrical wiring at the time of installation.
- Installation Instructions—This documentation includes step-by-step installation instructions for properly installing the unit.

- Recommended spare parts (with list) – If applicable, the instruction book will list the required spare parts to be furnished with the energy storage system. Each spare part shall be interchangeable with, and shall be made of the same material and workmanship as the corresponding part included with the product furnished under these Specifications.
- Special tools - The contractor shall furnish a complete set of any special tools, lifting devices, templates and jigs, which are specifically necessary for installation and/or maintenance of the energy storage system.

Additionally, special tools for PCS configuration and system parameter setting including link cable and software licenses shall be provided.

11.4 Approval Drawings

Drawings shall be provided for each energy storage system, which clearly indicate the physical parameters, electrical characteristics, and auxiliary equipment. These drawings shall include, but are not limited to, the following:

11.4.1 Nameplate system drawing to be located on the doors of the container or cabinets.

11.4.2 Outline drawing including the following:

- Assembly of principal component, converter, control cabinet, parts and accessories.
- Power requirements for all control and auxiliary equipment.
- Shipping Center of Gravity – shown on two (2) views
- Installed Center of Gravity – shown on two (2) views
- Centerlines for external conduit and grounding cable connections.
- Projected floor space for container systems if applicable, including air conditioning units mounted on the side.
- Weight of the components and container.
- Kilowatt & Kilowatt-Hour rating.

11.4.3 Control Elementary Wiring Diagrams, with cross references for checking and verifying all of the control circuit and wiring diagrams, along with the terminal designations for termination of field wiring of all equipment.

11.5 Warranty

Manufacturer warranty shall be provided for the period of at least thirty-six (36) months from the date of commissioning. Please submit price reduction for 12 month warranty. The warranty shall cover all defects of the PCS and the energy storage unit from manufacturing and non-compliance with the contract; and manufacturer shall repair or replace the defect product at their own cost. The certified warranty issued by battery vendors/manufacturers shall be transferred to PEA before the issuance of Final Acceptance Certificate.

12. INFORMATION SECURITY

Supplier shall design the BESS to be hardened against willful attack or human negligence as per NISTIR 7628. Supplier shall contract information/cyber security scans and penetration tests by a 3rd party security company.

13. EXCEPTIONS TO SPECIFICATIONS

Supplier shall submit a redline/tracked changes documents to any and all exceptions herein this specification and include an explanation for the same. Supplier shall also submit a written signed letter on company letterhead should they elect to not take any exceptions to this specification.