DNV

EXHIBIT A

BESS Scope of Work

DNV – 23 Dec 2022

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1 INTRODUCTION

1.1 General Description

St. Vincent Electricity Services Limited ("VINLEC") is pursuing a Battery Energy Storage System (BESS) to be installed and commissioned at its Cane Hall Power Station on mainland St. Vincent (the "Facility"). The Facility will utilize Li-ion battery technology and be capable of delivering 5 Megawatts (MW) continuously over a duration of 1 hour to achieve a usable energy capacity of 5 Megawatt-hours (MWh). The BESS will interconnect to an existing 11 kV busbar at the Cane Hall power station. The primary function of the BESS will be to improve VINLEC grid operational efficiency by providing cost effective spinning reserve and thereby accommodating higher levels of renewable energy penetration.

2 DEFINITIONS

Term	**Definition**
AC	Alternative Current
AHJ	Authority Having Jurisdiction
Applicable Laws	Means all laws, treaties, ordinances, judgments, decrees, injunctions, writs, orders, rules, regulations, interpretations and permits of any authority having jurisdiction over the Facility Site, or the performance of the Work, and the Contract documents and each other document, instrument and agreement delivered hereunder or in connection with the Work, the Facility, the Facility Site, health and safety, or the environmental condition of the Work, the Facility or the Facility Site.
Applicable Permits	Governmental permits required to perform the Work
Applicable Codes and Standards	Governmental and industry codes, standards and requirements to which the Work shall comply
BESS	Battery energy storage system
BESS Plant Controller	The BESS controller with an integrated hardware/software solution that provides supervisory control and monitoring in concert with the Solar PV system
BDS	Bid Data Sheet contained within the Bidding Document for Procurement of Plant Design, Supply, and Installation
BMS	Battery Management System
BOF	Balance of Facility
Contract	The legal document as defined in the Bidding Document for Procurement of Plant Design, Supply, and Installation document, Section VIII of the General Conditions – Contract and Interpretations
Contractor	The party as defined in the Bidding Document for Procurement of Plant Design, Supply, and Installation document, Section VIII of the General Conditions – Contract and Interpretations
CT	Current Transformer
DAS	Data Acquisition System
DC	Direct Current
Design Life	20years
Employer	The person or party as defined in the Bidding Document for Procurement of Plant Design, Supply, and Installation document, Section VIII of the General Conditions – Contract and Interpretations
EPC	Engineer, Procure, and Construct

Term	Definition
Equipment	Includes all equipment, machinery, apparatus, materials, articles, components, raw materials, supplies, parts, systems, structures and any other equipment or items comprising or otherwise necessary or appropriate for completion of the Work in accordance with the requirements of this Technical Specification.
ESMP	Environment and Social Management Plan
Facility / Facilities	The storage energy generation facility as defined in Bidding Document for Procurement of Plant Design, Supply, and Installation document, Section VIII of the General Conditions – Contract and Interpretations
Governmental Approvals	Means all authorizations, consents, decisions, licenses, certifications, grants, registrations, exemptions, permits, certificates and approvals from any Governmental Authority.
Governmental Authority	Any federal, national, state, municipal, local, territorial, or other governmental department, commission, board, bureau, agency, regulatory authority, instrumentality, judicial or administrative body, and any arbitral tribunal, including any state Governmental Authority.
Inverter	The piece of Equipment, including all enclosures, attachments and software, used for converting the DC power to AC power.
IL	Maximum demand load current at POI
Isc	Maximum short circuit current at the POI
kV	Kilovolts
kW	Kilowatts
kWh	Kilowatt hours
LOTO	Lock-out, tag-out
LV	Low Voltage, defined as less than 1,000 volts
MV	Medium Voltage, defined as between 1,000 V and 35kV
O&M	Operations and Maintenance
Point of Interconnection (POI)	As defined in the BDS contained in the Bidding Document for Procurement of Plant Design, Supply, and Installation.
Professional Engineer	An engineer registered or licensed in a jurisdiction deemed appropriate by the Employer and by the applicable AHJ.
RTE	Round-trip Efficiency
Safety System	Safety systems including gas detection (i.e., hydrogen and all other gasses generated during Li-ion batteries storage, cycling, and operating in abnormal conditions), fire detection, fire suppression, exhaust ventilation, deflagration venting .among others
SCADA	Supervisory Control And Data Acquisition
SOC	State of Charge
STC	Standard Test Conditions (1000 W/m2, 25^{o}C module temperature and AM1.5 spectrum)
String	Circuit of PV Modules connected in series
Test, Testing	Any visual, mechanical, electrical or functional inspection or examination required to confirm Facility and/or systems have been installed in accordance with this agreement, good industry practices, Applicable Laws, Applicable Codes and Standards and manufacturer recommendations.
UL	Underwriters Laboratories
UL Listed	A product listing issued by a Nationally Recognized Testing Laboratory certified by OSHA to perform product testing to the relevant UL standard
Work	Work shall mean the design, engineering, procurement, system construction, installation, commissioning, acceptance tests and related services necessary for the construction and installation of

Term	Definition
	the BESS and, to the extent provided in the EPC agreement and in accordance with those Technical Specifications
Wp	DC capacity measured as the sum of the nameplate rating of each PV Module

3 FACILITY DETAILS

3.1 Scope

The Contractor shall be responsible for engineering, procurement, and construction (EPC) and commissioning of all components required to furnish the BESS and associated power conversion system (PCS), BESS Plant Controller, low voltage (LV) to medium voltage (MV) transformer(s), and Balance of Facility (BOF) components. All components shall comply with the technical requirements of this Technical Specification. The contractor scope of work includes:

(a) Containerized BESS solution for outdoor installation
(b) Bi-directional PCS (Inverter)
(c) Controls' hardware and software, including inverter controls, battery management system (BMS), SCADA and BESS Plant Controller
(d) BESS thermal management system and all associated components
(e) LV:MV transformer(s) and associated components
(f) All BOF components for the BESS
(g) Provision of spare parts as explained in the tender document
(h) Integration of the BMS, BESS Plant Controller, and SCADA systems with the VINLEC SCADA system, and electrical power system protection equipment
(i) Commissioning and testing of all aspects of the Facility
(j) Provision of operational manuals, emergency response plan, and VINLEC operator training
(k) Providing and supporting performance guarantees for the installed BESS
(l) Installation of auxiliary power for BESS HVAC and other quiescent loads required for equipment operation, e.g., for SCADA, BESS Plant Controller, Inverter controller, if needed, and control house.

3.1.1 Coordination with VINLEC and Third-party Contractors

Contractor shall provide the required support for coordination of the design, material selection, and installation required to ensure successful integration of the Facility components. The support shall include but not be limited to:

(a) Physical Site layout design guidance.
(b) Any applicable permitting questions related to the safety standards of the BESS.
(c) Integration between any components.
(d) All relevant electrical engineering information required for third party to conduct a protection study or other relevant engineering studies of the Facility
(e) Any related permitting support related to the components installed by VINLEC or a third-party contractor.
(f) Any related facility fire risk assessment and fire safety matters

(g) Relaying coordination for electrical system protection.

3.1.2 Procurement and Shipping

(a) All materials shall be new and conform to applicable law and Prudent Industry Standards, such as UN 38.3.
(b) Contractor shall be responsible for all transportation, shipping, loading, storage, customs clearance etc. associated with the components listed in this scope.
(c) The Contractor shall submit a shipping plan for approval by VINLEC no less than sixty days before any materials are shipped.
(d) Contractor shall prepare materials and equipment for shipment to protect them from damage while in transit.
(e) Contractor shall be responsible for any special permits and arrangements required for transportation.
(f) The Contractor shall include all rigging arrangements for transport and setting the equipment on the foundations.
(g) All battery modules shall have anti-shock labels. Contractor shall be responsible for checking all modules' labels at time of delivery.
(h) Contractor shall keep record of temperatures during transportation and provide the record to VINLEC at time of delivery.

3.2 Facility Site

(a) The Facility is to be located in Saint George, Saint Vincent and the Grenadines, more specifically at the Cane Hall Power Station. The wider area of BESS installation in Cane Hall Power Station is showed in the Figure 3-1.
(b) The coordinates of the location of Cane Hall Power Station are 13.152° N, 61.199 ° W
(c) Contractor shall have construct the Facility in either of the two optional sites shown in VINLEC CANE HALL BESS - E200 SITE PLAN.

3.2.1 Point of Interconnection

(a) The electrical Point of Interconnection (POI) shall be as defined in the Bidding Document for Procurement of Plant Design, Supply, and Installation.
(b) Connection point: Cane Hall Power Station 11 kV Bus A as described in described in Exhibit D - Cane Hall BESS - E200 SITE PLAN

Figure 3-1 – Cane Hall Power Station (11kV Bus A) and surrounding area of BESS installation

3.3 Development Schedule

(a) The project shall maintain the milestone schedule outlined in Table 3-1..

Table 3-1 Milestone Dates

Milestone Event	Date
Notification of Award	
Contract Agreement target Effective Date	
Target Guaranteed Substantial Completion	
Target Guaranteed Final Completion	
Target Commercial Operation Date (COD)	

3.4 Facility Functional Requirements

The VINLEC BESS is intended to be a flexible resource that can be charged and discharged in response to grid events and in coordination with renewable generation. To that end, at a minimum, the BESS shall meet the following Facility Functional Requirements.

(a) The BESS shall provide spinning reserve services.

(b) Grid-forming and Black-start capability

   (i) The Facility shall be designed to have black start operation feature and shall be able to form a microgrid with the BESS and local loads connected to it.

   (ii) The Facility shall be able to operate in grid forming mode following the direction of the Grid System Operator (VINLEC), in its sole discretion. Such mode of operation can be indicated to the VINLEC through telemetry.

   (iii) The Facility shall include safeguards to prevent the unintentional switching of the Facility into and out of grid forming mode. The safeguards shall be approved in writing by VINLEC and implemented in the Facility prior to control system testing.

   (iv) The Facility inverters shall have the capability of operation in grid forming mode and supporting system operation under normal and emergency conditions without relying on the characteristics of synchronous machines. This includes operation as a current independent ac voltage source during normal and transient conditions and the ability to synchronize to other voltage sources or operate autonomously if a grid reference is unavailable.

   (v) The facility shall set and automatically control the microgrid voltage and frequency within acceptable limits and shall charge or discharge the battery based on microgrid requirement.

   (vi) The facility shall control the active and reactive power (or power factor) of the BESS by providing required set point to the BESS Inverters and control (close / trip) the HV circuit Breaker located at the POI for load control purposes.

   (vii) The facility shall have all the required hardware, control and protection feature for safe operation of the microgrid.

   (viii) The BESS shall discharge its battery to support the load power requirement.

   (ix) The Facility shall be able to provide sectionalization to parts of the grid to allow the microgrid to operate using the BESS limited resources.

(c) BESS Energy Management System (EMS) / Plant Controller

   (i) The BESS EMS may be provided as part of the Plant Controller or furnished separately

   (ii) The BESS shall include an EMS / Plant Controller capable of providing the Facility Functional Requirements and capabilities described in these Technical Specifications.

   (iii) The BESS EMS shall be fully integrated with the battery management system (BMS) of all battery units and the Facility's supervisory control and data acquisition (SCADA) system.

   (iv) Additional EMS requirements are provided in Exhibit C – BESS SCADA Specifications

(d) The BESS shall allow for remote monitoring and control

(e) The BESS shall allow for manual control – BESS may be dispatched via active power (P) and reactive power (Q) setpoints. The setpoints shall be received directly, in real-time, or shall be scheduled.

(f) The BESS shall allow operation in automatic control modes

   (i) Reactive power control – The reactive power control function will calculate the reactive power reference of the Facility and additional reactive power compensation equipment as appropriate, to attain the reactive power quantity at the connection point requested by VINLEC

   (ii) Voltage control – Automatic adjustment of the reactive power in response to a voltage deviation in high or low voltage events around a specific value set by VINLEC, by default at

11 kV. This voltage control will observe droop law, with a provisional droop value by default of 4%, optimized at the beginning of the operating phase.

(iii) Power factor control – This power factor control mode will calculate the reactive power of the Facility and additional reactive power compensation equipment as appropriate, to attain the power factor set point as requested by VINLEC

(g) Frequency response – The Facility shall be capable of providing fast response services such as primary frequency response and frequency regulation with a frequency droop characteristic reacting to system frequency at the point of interconnection (POI) in both the over frequency and underfrequency directions; except as limited by the minimum and maximum available capacity and energy potential at the time of the event including BESS state of charge and the active power-frequency control system, and overall response of the inverter-based resource.

(i) The response characteristics shall be coordinated with VINLEC.

(ii) The power vs frequency response characteristics shall be adjustable/programmable by VINLEC or designated BESS operator.

(h) For Alternate Active Power/ Frequency Response Modes, the Facility shall be capable to supply black-start or fast frequency response modes of operation, in addition to normal droop.

(i) Undervoltage/Overvoltage Ride-Through – The Facility shall provide voltage ride through capabilities as required by VINLEC.

(j) Underfrequency/Over-frequency Ride-Through – The Facility shall provide frequency ride through capabilities as required by VINLEC.

(k) Simulation of the battery storage system operation on VINLEC's grid to understand the impacts on the network during normal and abnormal conditions.

(l) Safety System including, but not limited to, fire protection system.

(m) Material selection for resilience in a corrosive tropical environment.

4 GENERAL REQUIREMENTS

4.1 Scope of Work

(a) Contractor shall design, engineer and construct the Facility in accordance with the requirements set forth in this Technical Specification. The information and design requirements that follow form an integral part of the Work.

(b) Conflicts between this Technical Specification and any other term or condition of the Contract Agreement shall be immediately brought to the attention of VINLEC in writing.

(c) Contractor's Scope of Work is to engineer, design, procure, assemble, oversee on-site installation of, commission, startup, test, and provide training and operational support for the Project's BESS. The BESS shall be built to the capacity and metering functionality as indicated in these Technical Specifications and shall meet commissioning and testing requirements identified in Section 11 herein.

(d) Contractor is responsible for commissioning the BESS including the BESS Plant Controller.

(e) Contractor shall perform, supply, or cause to be supplied all equipment, materials, labor, services, supervision, testing devices, drawings, calculations, specifications, and manuals required for the execution of its Scope of Work.

(f) Contractor shall comply with as-requested inspection of materials, documents, equipment, or any other information related to the Project by the Owner or Owner's agent during construction.

(g) Contractor shall provide training, and related manuals and guides, on System installation, commissioning, operations, maintenance, decommissioning, and emergency and fault management.
(h) Contractor shall provide Project Management of the Work, including but not limited to:
   - Site safety and environmental management for Contractor's personnel
   - Project administration
   - Scheduling
   - Quality control
   - Weekly and monthly progress reporting
   - Meetings and teleconferences, as identified in RFP
   - Coordination of Contractor's personnel and sub-Contractors
   - Training and guideline provision
(i) Storage prior to shipment of all equipment, including the BESS, in accordance with manufacturer specifications.
(j) Shipping and logistics arrangements.
(k) Construction of Project facilities including, but not limited to:
   - Construction management and supervision for installation of the BESS and associated control system hardware.
   - Training of local construction labor, especially in the installation of battery modules.
   - Construction and installation of all BESS Equipment
   - Environmental Management Program
   - Safety program
   - Quality program
   - Specialty construction equipment or tools as required for installation, assembly, testing, and commissioning of the BESS. At a minimum, any specialized construction equipment or tools shall be provided with one extra furnished component in case of loss or damage.
(l) Inspection, testing and commissioning activities as required.

4.2 Warranties

(a) Warranty periods: Contractor shall include all standard warranty periods for any Equipment, including workmanship warranties. Optional warranty periods and associated costs for additional warranty periods shall also be listed where available. All Equipment shall be new, unused, of recent manufacture and shall carry the manufacturer's standard warranty, unless otherwise specified. Major Equipment (including inverters, transformers, skids, BESS BOF components, SCADA system, and circuit breakers) shall have a minimum 5-year manufacturer's warranty period starting at Facility substantial completion, and both the form of warranty and the warranty provider shall meet the credit approval of VINLEC and the Facility lender.
(b) BESS containers shall have a minimum of 20-years manufacturer's warranty period starting at Facility substantial completion.
(c) Warranties shall protect the Project against serial defects and provide clear path to resolve disputes related to equipment defects.
(d) Contractor shall ensure that all warranties are valid in St Vincent and Grenadines.
(e) Contractor shall explicitly describe any Equipment that has a less than 5-year manufacturer's warranty period.
(f) All Equipment warranties shall be transferrable to VINLEC upon Facility Commissioning

4.3 Facility Operations

(a) The Facility design shall consider and facilitate the proper operation and maintenance of the Facility throughout its expected Design Life, including taking into account:
  (i) that the Facility operates 365 days per year
  (ii) remote operation and monitoring;
  (iii) the need to perform periodic visits for maintenance, such as checking and replacing worn parts, checking electrical connections, BESS capacity maintenance, and performing routine maintenance including cleaning the Facility as required to maintain energy production.

4.4 Equipment Spacing/Alignment/Location

(a) The following minimum spacing requirements shall apply:
  (iv) Equipment shall be aligned to provide straight-through access aisles where feasible.
  (v) No process Equipment or unrelated electrical Equipment shall be allowed to occupy space reserved for administration, maintenance shops, or warehouses.
  (vi) All electrical Equipment clearances shall meet the requirements of all Applicable Laws, including fire department, NFPA, NEC, NESC, IEEE, ANSI standards and BS 7671. All Equipment and the Facility's layout shall conform to all Applicable Laws and be able to withstand environmental and other conditions local to the Site. For clarity, this requirement applies to all Equipment, even if supplied preinstalled on skids or within enclosures.

(b) Equipment Removal/Disassembly
  (i) Unless otherwise specified, all Equipment assemblies requiring maintenance and weighing more than 365 lbs (136 kg) shall be provided with trolley steel or be accessible by forklift, mobile 'A' frame hoist, or mobile crane and within their lifting limits. A maintenance door shall be provided for each assembly and sized appropriately for removal of individual components requiring maintenance.

(c) Equipment Pads
  (i) All Equipment pads shall be located such that personnel access is provided to such Equipment. A minimum of 4 feet of horizontal clearance from obstructions that would otherwise limit access to the Equipment on the pad shall be provided around all Equipment pads. The pads shall be sized sufficiently to allow adequate working space around the Equipment and comply with NEC requirements for access and egress.
  (ii) Equipment pads shall be designed and installed to prevent ponding of moisture.
  (iii) Bollards shall be placed near vehicular pathways to prevent pad and equipment damage as necessary.

4.5 General Access Requirements

(a) Adequate access shall be provided to allow satisfactory and safe operation and maintenance of all Facility systems and Equipment.

(b) Contractor shall provide permanent access to all doors, manways, test ports, instruments, etc., that require accessibility for normal Facility operation and/or Equipment inspection and maintenance.

(c) Metal platforms, stairs, and walkways shall be provided for access to all Equipment as required for maintenance and operation and surfaced to prevent slippage. Platforms shall be sized to comply with OSHA and other Applicable Standards. Design shall incorporate a minimum of one set of permanently fixed steps to each pad and/or skid where sloping of surrounding grade exceeds 8" or as per Applicable Laws. Sloping of grade is not an acceptable means of access.

4.6 Safety Guidelines for Site Layout

(a) The installation should be compliant with the following NFPA 855 guidelines:
  - (i) Container separation per NFPA 855: BESS shall be separated by at least 10 ft from lot lines, public ways, buildings, etc.
  - (ii) Exceptions: spacing between containers and exposures may be reduced to 3 ft if the enclosure is noncombustible
  - (iii) Max container size per NFPA 855: containers shall not exceed 53 ft x 8 ft x 9.5 ft (L x W x H)
  - (iv) Egress provisions per NFPA 855: containers shall be separated from any means of egress by at least 10 ft
  - (v) Rack spacing per International Fire Code (IFC) 2018 Supplement: systems be sited 3 ft between each rack and 3 ft from all walls
    - If container is non-combustible, 3 ft from the walls not required

4.7 Sound Level

(a) The Facility shall be designed to comply with all Applicable Laws, including all applicable local noise ordinances and Governmental Approvals. Measurement procedure shall be per ANSI/IEEE standards.

4.8 Corrosivity

(a) All Equipment shall be constructed of materials that are corrosion-resistant according to the corrosivity of the environment, otherwise painted, coated, or protected in a manner appropriate for the Design Life of the Facility.

(b) Above-ground components shall be resistant to atmospheric corrosion. Underground support structures, pipes, piles, grounding conductors, and conduit shall be selected and designed according to the geotechnical report and corrosion report results regarding soil corrosiveness. For steel pile foundations, rate of corrosion shall be estimated based on independent and professionally sealed corrosion report, and the reduced section properties shall be used in foundation design calculations. Design life of foundation elements shall be estimated, and design life must meet or exceed Design Life of the Facility.

(c) The region of the underground support structures exposed to the soil-to-air interphase shall be adequately protected against corrosion threats.

(d) Contact of dissimilar metals and finishes shall be avoided or intentionally managed to prevent premature galvanic corrosion.
  - In cases where dissimilar metals may be in contact, an electrical isolator shall be installed to minimize the effects of bimetallic coupling corrosion.

(e) The electrical continuity between the equipment's electrical ground and the buried metallic structures shall be taken into consideration when assessing the corrosivity of the environment around the buried metallic structures. Possible macro galvanic cells could reduce the operational life of the structural components.
(f) Aluminum shall not be in direct metallic contact with steel, concrete or copper.
(g) Wood pole structures shall not be in direct contact with concrete.
(h) Design of concrete elements shall adhere to ACI procedures for durability to limit corrosivity of concrete material and embedded steel reinforcing.
(i) All corrosivity methodologies and resulting calculations shall be approved by VINLEC.

4.9 Recycling, Disposal, and Decommissioning

(a) The Contractor is responsible for properly containerizing, removing, and disposing all solid waste, including any hazardous materials waste generated during construction and during any applicable performance guarantee or O&M agreement period.

(b) Prior to any battery arriving on-site, Contractor shall provide a decommissioning plan to address the following:

(i) End of life decommissioning of the BESS.

(ii) Decommissioning of the BESS due to an abnormal failure or fire event.

(iii) Disconnect all electrical Equipment with appropriate Lock Out Tag Out (LOTO).

(iv) Disassemble and completely remove the BESS Equipment and all BOF Equipment.

(v) Remove all site foundations, concrete pads, and overhead steel structures.

(vi) Recycling, disposal, and decommissioning shall be in compliance with the Contractor's Environment and Social Management Plan (ESMP) as well as in accordance with the laws and environmental regulations of St. Vincent and the Grenadines.

4.10 Design Specifications

The Facility shall meet the design specification values presented in the table below unless otherwise specified, in accordance with the requirements of this Technical Specification.

Table 4-1 Minimum Design Specifications

Facility Parameter	Design Specification	Units	Notes
BESS Auxiliary Loads	5	MWh/year	BESS auxiliary loads to be fed from VINLEC auxiliary service. The number given is provided as guidance only.
BESS Lifespan (Minimum)	20 years or 60% SOH	years or %	DNV expects the system to reach the EOL by 20 years or 60% SOH, whichever comes first. BESS shall deliver 5MW power and 5 MWh usable energy capacity throughout the BESS lifespan
BESS Control House Auxiliary Loads	3	MWh/year	BESS control house loads to be fed from VINLEC auxiliary service. The number given is provided as guidance only.
LV:MV Transformer Ratings	6,000	kVA	
LV:MV Transformer Windings		LV: 300 V – 600 V MV: 12.47 kV – 13.8 kV	
Interconnection Voltage	11	kV; 3 phase	
Interconnection Frequency	50	Hz	
VAR Control Required	Y	Y/N	
Voltage Ride Through Capability	Y	Y/N	

Facility Parameter	Design Specification	Units	Notes
Power Factor Range	1 - 1 (lead and lag)		xx lead / xx lag, as observed at 11 kV POI
Current Total Harmonic Distortion (THDi)	<5	%	Guidance Isc/IL at the POI
Voltage Total Harmonic Distortion (THDv)	<5	%	Guidance Voltage at the POI
BESS Ramp Rate	> 50 < 500	MW/min	
BESS Response time	<500	ms	
BESS Settling Time	<500	ms	
Site Noise Limits	<75	dBA @ 1 m distance	
BESS Technology	LFP	Li-Ion: NMC, LFP	
BESS AC Power rating	5,000	kW, as observed at 11 kV POI	
BESS AC Energy rating	5,000	kWh, as observed at 11 kV POI	
BESS operational DC Voltage Range	1000~1500	V	
BESS Maximum Charge Current	140	A	Assuming 0.5 C rate
BESS Maximum Discharge Current	140	A	Assuming 0.5 C rate
BESS Roundtrip Efficiency (Minimum)	>87	%	Excluding Aux but include other losses. RTE is measured at the POI
Operating temperature range	20 to 35	℃	
Humidity	≤98	%	Non-condensation
Container Color	No specific colour(s) required		
Availability %	≥98	%	Annually

Facility Parameter	Design Specification	Units	Notes
Cycles per day	1	cycle	
Cycle Life	7,300	cycle	Assuming 1 cycle per day for 20 years
ESS Enclosure Type	Containerized solution preferred		

5 PROCUREMENT

(a) Certain materials and Equipment suppliers that are acceptable to the VINLEC are specified in this Technical Specification. Other materials and Equipment provided by the Contractor must meet the minimum requirements of quality required for the applications indicated. Notwithstanding the above, it is the responsibility of the Contractor to select materials and Equipment suitable for the conditions of operation.

(b) All new materials shall be of high quality for the service intended. All new materials shall conform to Applicable Law and Prudent Industry Standards. No test specimens shall be required other than those dictated by Contractor's standards and/or the mandatory requirements included in the Applicable Law and Prudent Industry Standards, unless specified otherwise.

(c) Procurement of equipment, materials, and services including but not limited to:

- Procurement of all materials, including but not limited to, BESS modules and racks, BESS inverters, control system, disconnect switches, circuit breakers, fuses, current transducers, potential transducers, fuses, meters, communication equipment, hardware and fasteners, conduits and raceways within the battery containers, conductors, junction boxes, bonding and grounding equipment, and all related materials
- Providing or procuring services including, but not limited to, subcontracted services required to prepare, install, construct, connect equipment, and conduct component testing at the Project site.
- Development of specifications and bid packages for any subcontracted Work listed under Contractor's scope.
- Bid evaluation and selection for any subcontracted work.
- Obtaining all datasheets, relevant technical notes, installation, operations and maintenance (O&M) manuals for all Project Equipment
- Obtaining job books for the manufacture of all major system components and subsystem assemblies.
- Obtaining priced list of critical and recommended operating spare parts with manufacturer-recommended quantities based on the quantity installed at the Project.

(d) Contractor shall be responsible for the procurement, handling, shipping costs, and delivery of all equipment, materials, and services, including, without limitation, locating, negotiating, inspecting, expediting, shipping, shipping permits, unloading, receiving, verifying, and claims.

(e) Contractor shall be responsible for the reception, storage, and handling of the BESS at Project Site per the requirements provided by the BESS manufacturer.

(f) Packing lists shall be maintained by Contractor at the Project site and shall be available for Owner review.
(g) Contractor shall update a schedule of values maintained in electronic format that accurately describes the quantities of all equipment received at the Project site. The schedule of values shall be updated within seven (7) days after each delivery of equipment. The schedule of values shall be available for Owner review.
(h) All freight costs for all equipment shall be the responsibility of the Contractor.
(i) All applicable taxes, tariff fees, and import duties shall be the responsibility of the Contractor.
(j) All customs documentation and fees in the nation(s) where shipments originate or make intermediate stops shall be the responsibility of the Contractor.
(k) All equipment stored at the Project site shall be in accordance with Good Industry Practices and manufacturer's recommendations. Contractor shall use all reasonable measures to keep the equipment free from dirt and debris.
(l) The BESS shall be stored according to manufacturer recommendations. Storage conditions of the BESS should include, at a minimum, the following considerations:
    - Keep away from combustibles
    - Have a robust fire extinguishing system
    - Do not tilt, vibrate, drop, puncture, stack, or expose to the elements
(m) Contractor shall perform all inspection and pre-installation maintenance activities to ensure compliance with manufacturer's recommendations. Contractor shall maintain a log of such maintenance activities, such log to include the date of such activities and the names and signatures of the personnel performing such activities. Such log shall be available to Owner for review.
(n) Contractor shall obtain all warranty information for all Project Equipment. All Key Equipment warranties shall permit assignment to Owner without consent.
(o) Contractor shall obtain all installation, operations and maintenance manuals for all Project Equipment, as well as appropriate emergency response manuals.

5.1 Spare Equipment & Parts

(a) Contractor shall submit a complete bill of material (BOM) for the Facility. The BOM shall include all components, assemblies, and spares.
(b) The spare parts listed shall be procured and delivered to the Facility Site by Contractor. All spare parts to be provided by the Contractor shall meet the following requirements:
    (i) All spare parts shall be interchangeable with the original ones. They shall be of the same material, of identical manufacture and shall present the same properties as the corresponding parts of the main Equipment.
    (ii) The conditions concerning the Contractor Tests, treatment of surfaces and painting etc. of the main Equipment according to the requirements of this Technical Specification shall also be valid for spare parts.
    (iii) All spare parts shall be properly treated and packed for a prolonged storage, considering the ambient conditions prevailing at the Site. Spare parts warehouse's environment shall be controlled to allow the proper storage of spare batteries. VINLEC to confirm storage conditions.
    (iv) All boxes and other packing shall be marked and numbered for their identification.

(v) Contractor shall supply instructions to VINLEC for all necessary precautions to be taken for proper storage of spare parts.
(vi) Spare parts shall be delivered with the container, if applicable, 30 days prior to the Circuit Substantial Completion Date of the first Circuit.
(vii) Spare parts serial defect shall be deemed to exist if, during the warranty period, ten percent (10%) or more of the same part, component, or system purchased, contain the same defect. All parts, whether installed in the equipment or stored Spare Parts, must be replaced with a superior component at no additional cost to the Owner
(viii) Spare parts shall be available for procurement over the design life of the facility

6 MAJOR EQUIPMENT SPECIFICATIONS

6.1 Systems overview

Contractor shall design and engineer the Facility, with all necessary equipment and components, to facilitate provision of the Facility Functional Requirements described in Section 3.4. The Facility includes a standalone BESS and associated BOF components. The BESS will charge and discharge at the utility POI.

6.2 Facility Metering and Auxiliary Power

(a) Contractor shall ensure metering capabilities in compliance with Project Agreements.
(b) Contractor shall coordinate all aspects of metering with VINLEC, including meter placement and accuracy class.
(c) If required, Contractor shall install AC check meters for testing and control purposes.
(d) Contractor shall verify that BESS equipment measurements at the battery and inverter interfaces, and corresponding values recorded by the SCADA system are in line with measurements at the POI metering point; when adjusted for efficiency losses, ohmic losses, transformer losses, parasitic loads, power factor impacts, and auxiliary loads.
(e) Station service and auxiliary load:
    (i) Contractor shall provide all BESS auxiliary load supply equipment
    (ii) Contractor shall coordinate station service supply with VINLEC.

6.3 Battery Energy Storage System Requirements

6.3.1 General

(a) The BESS includes any software and hardware components to electrically and mechanically connect to the system inverters and provide monitoring and communication with the utility interface.
(b) Contractor shall engineer, design, procure, assemble, oversee on-site installation of, commission, startup, test, and provide training and operational support for the Facility's BESS. The BESS shall be built to the capacity and metering functionality as indicated in this Technical Specification and shall meet commissioning and testing requirements identified in Exhibit B – BESS Testing Specifications to this Technical Specification.

(c) BESS equipment is provided by the Contractor. The Contractor shall coordinate to ensure all equipment necessary to operate the BESS is provided, including DC-side subsystem, AC-side subsystem, control systems (including BMS and EMS), protective relaying, synchronization equipment, metering, Plant Controller, and SCADA.
(d) The BESS shall conform to all Applicable Laws, including the appropriate local building code including all safety, health, environment, electrical, and fire codes and standards.
(e) The BESS shall be rated in terms of net delivered power and usable energy, as measured (or calculated, if not measured) at the POI.
(f) The BESS with its inverter shall be capable of charging and discharging active power and reactive power and, dispatching energy in both leading and lagging reactive power factors and in accordance with local Grid Code and VINLEC requirements.
(g) The BESS must be designed to meet the design criteria described in this Technical Specification, with operational requirements for the entirety of the Design Life. Power, energy, and ampacity ratings are assumed to apply throughout the full operating temperature range and various states of charge. The Contractor must supply documentation detailing changes with respect to these variables. If system requires energy capacity overbuild or energy capacity maintenance plan to meet such specifications, this should be identified and explained by Contractor.
(h) Approved battery manufacturer: All batteries shall be new, shall come from the same manufacturing line and shall be purchased from the same battery manufacturer. If capacity maintenance is expected to sustain BESS ratings over time, it is expected that the same requirements noted for initial installation are respected. A plan should be provided which reflects how batteries of different ages may be integrated into the system. The battery manufacturer shall be a reputable and bankable provider with proven track record in the industry.
(i) BESS manufacturer shall provide a failure mode and effects analysis (FMEA) with detailed review of fault modes and resulting system effects. The FMEA shall address the adequacy of circuit protection in the event of a fault. If required, a detailed fault analysis including current magnitude calculations shall be performed to support FMEA.
(j) All BESS losses experienced during normal operation, stand by, or while shut down shall be specified by the Contractor.
(k) Contractor shall provide a battery degradation curve applicable to expected BESS use case. The battery degradation curve shall be regularly updated to reflect the change in BESS use cases. In case the degradation curve does not meet the required energy retention, Contractor shall provide a maintenance plan including capacity augmentation schedule for maintaining energy capacity through system life.
(l) Contractor shall provide the cost for maintenance plans that include and exclude capacity augmentation schedule through system life
(m) The Plant Controller should be well coordinated with the operator's SCADA system to ensure proper operation of the BESS system based on the Facility's operational requirements. The Plant Controller should be able to toggle between multiple modes/applications such as frequency regulation, energy arbitrage, VAR support etc. to enable the use of the BESS for multiple applications.

6.3.2 BESS Design Criteria

(a) Contractor shall design all aspects of the Facility in its scope to meet the minimum Design Life of 20 years.

(b) The BESS shall have a power capability of 5 MW and a useable energy capacity of 5 MWh, as measured at the 11 kV POI throughout the project life; or equivalently, the BESS shall be able to deliver 5 MWh at the POI when discharged from 100% state of charge (SOC) to 0% SOC.

(c) The BESS shall have a DC round-trip efficiency exceeding 90% at beginning of life (BOL).

(d) The BESS's RTE shall be calculated as described in Exhibit B – BESS Testing Specifications.

  (i) The BESS usage is not expected to exceed 365 annual full cycles. This requirement may be adjusted in accordance with tender rules; where one full cycle is the equivalent of discharging the Guaranteed Energy Capacity in a given operating year.

  (ii) The BESS RTE measured at the POI shall exceed 87% throughout the life of the Facility.

(e) Thermal management system: The Contractor is responsible for the independent thermal management system of the BESS. The thermal management system shall be able to maintain the temperature and humidity in the battery container within the range required by the battery manufacturer. This system should prevent high and low temperatures and humidity which could produce thermal runaway events, damage to the battery, or degrade performance beyond allowable ranges defined in the warranty. To demonstrate the capabilities of this system, documentation of the specified safe operational ranges of the batteries must be provided by the Contractor, as well as specifications and design calculations for the thermal management system, including computational fluid dynamics (CFD) and heat flux as appropriate.

  (i) Temperature monitoring and alarms shall comply with additional requirements in Exhibit C – BESS SCADA Specifications.

(f) Outdoor installation is intended. BESS to be housed in its own climate-controlled container designed for ambient conditions listed in design documents and in Table 4-1 of this Technical Specification.

(g) If BESS is walk-in it shall have a risk category (for determination of flood, wind, and earthquake loads) assigned to it that is consistent with its makeup of hazardous materials, in the local version of the IBC (International Building Code). Enclosure must have egress, fire separations and coatings, and spacing per appropriate occupancy rating.

(h) All enclosures of the BESS must meet the Governmental Authority's adopted version of the NFPA for Safety System. Batteries may require spacing per NFPA 855 for example, unless an exemption can be obtained through the demonstration of no fire propagation from battery module to battery module.

(i) Regardless of actual installed energy capacity, the system must be able to provide charge and discharge from 0 - 100% SOC for the rated energy capacity. Where SOC is defined in terms of the BESS useable energy capacity.

(j) System availability: The BESS shall maintain annual availability greater than 98%.

  (i) Alternatively, Contractor shall propose expected BESS availability.

  (ii) Contractor shall clearly state assumed component failure rates for the availability determination.

(k) Weight requirements: No requirements, except as necessitated by Site conditions to be determined by Contractor.

(l) Approximate size of BESS equipment: No containerized or skid-mounted equipment greater than 53 feet in length, 8 feet in width, or 9.5 feet in height. All equipment shall be transportable by standard land and sea shipping modes without the need for oversize load trailers or other specialty transportation arrangements.

(m) Contractor is responsible for securing all equipment per all permit requirements.

(n) Any fault originating within BESS, i.e., before the BESS inter-tie will not propagate to the rest of the interconnecting utility electrical power system (EPS).

(o) Self-discharge: All losses the system experiences during normal operation, stand by, or while shut down shall be specified in the contract.

(p) Isolation/Disconnect: In case of fault, surge, or other emergency, the BESS shall be able to break the full-rated power of the system.

(q) BESS Contractor shall provide evidence of calculations and test results that qualify arc fault protection with high/low impedance fault scenarios below, between batteries and DC-DC converters or inverters: beginning of life Isc at 100% SOC, at 0% SOC, as well as end of life Isc at 100% SOC and at 0% SOC. Arc flash hazard calculations shall be in line with normative references such as IEEE Std. 1584.

(r) Contractor to ensure the system will be protected against uncontrolled reverse current flow under fault conditions.

(s) All equipment shall be new, fit for purpose, and of the specified quality.

(t) All components and workmanship must be free from physical and electrical flaws and imperfections. The design shall not only be effective in engineering characteristics, it must comply with the finish requirements stated herein.

(u) Any components in need of replacement shall be identified in a schedule, in bid documents, stating the anticipated design life of each such component, replacement quantities required and the associated cost for supplying replacement components.

(v) All parts shall be made accurately to standard gauge when possible so that renewals and repairs may be made when necessary with the least possible expense.

6.3.3 BESS Plant Controller

(a) In order to meet the requirements of its intended applications, the BESS shall include a fully integrated EMS/Plant Controller. The Plant Controller shall be furnished as part of the SCADA system or separate from the SCADA system. The Plant Controller shall at a minimum:

   (i) Connect to a bi-directional inverter that allows both charging and discharging of the battery.

   (ii) Communicate with and, if necessary, provide power to external control systems such as the SCADA system.

   (iii) Monitor and report on the BESS, including information such as state of charge, state of health, voltage, current, battery temperatures at the module and cell level, and status; as described in Exhibit C – BESS SCADA Specifications of this Technical Specification.

   (iv) Control the BESS within design constraints for safe operation of the batteries.

   (v) Facilitate battery O&M procedures such as cell balancing.

   (vi) Provide warnings or alarms required in Exhibit C – BESS SCADA Specifications of this Technical Specification.

   (vii) Provide fault and surge detection and protection, as appropriate.

   (viii) Support autonomous operation, including stand-by mode, start-up, shut-down and disconnection of BESS from rest of Facility, in case of communication failure or emergency.

   (ix) Provide operator over-ride capabilities to all automatic control functions if manual intervention is requested.

(x) Act as a data historian/repository for easy access, storage and retrieval of BESS operational data as well as external signal data (such as ISO Automatic generation control (AGC)signal) for analysis and reporting purposes.

(b) The Plant Controller shall include an on-site master controller that receives operating instructions, local or remote, and manages BESS charge and discharge setpoints in concert with battery management system (BMS).

(c) Hardware specific to the BESS, if required, will be housed in a room or enclosure accessible only to authorized personnel.

(d) The Plant Controller shall have a dual power system rated and specified to be fed from an uninterruptible power supply (UPS).

  (i) All network switches will be supplied by dual power system rated and specified to be fed from an UPS.

(e) The Plant Controller will have a bi-directional communications and monitoring interface with system inverters, converters, BMS, and thermal management system.

(f) The Plant Controller should be able to toggle between multiple modes/applications such as frequency regulation, energy arbitrage, VAR support etc. to enable the use of the BESS for multiple applications. It should also have logistic capabilities for the operator(s) to relay dispatch strategies via time or event-based scheduling, including real-time updates (at 15 min or 5 min level) for real-time energy market participation of the BESS. The dispatch strategies may be derived by the operator(s) using algorithms/modeling outside the Plant Controller, but must be deliverable to the Plant Controller.

(g) The Plant Controller will manage disconnect/reconnect operations of BESS as appropriate to ensure safe, reliable and resilient operation.

(h) Plant Controller shall have the capability to detect and isolate faults within the BESS.

(i) Data shall be stored at a time resolution in line with Facility contractual obligations; in, at least, 1-second increments.

(j) All Plant Controller sensing, data logging, and data historian functionality shall be coordinated with SCADA system requirements described in Exhibit C – BESS SCADA Specifications.

(k) Data should be measured, recorded and stored, at a minimum at the following locations:

  (i) Battery management system cell and module data;
  (ii) Battery DC-bus data;
  (iii) Battery inverter and AC-bus data;
  (iv) BESS main AC inter-tie;
  (v) Enclosure HVAC system and,
  (vi) Enclosure Safety System

(l) At a minimum, the following data should be measured, recorded and stored:

  (i) Battery module and rack voltage, current, state-of-charge, cell and string temperature
  (ii) DC-bus voltage and current
  (iii) AC-bus phase voltage, current, real power, reactive power and power factor
  (iv) Main AC inter-tie phase voltage, current, real power, reactive power, apparent power, power factor, and frequency;
  (v) BESS state of charge;
  (vi) Status alarms, temperature and monitoring output from enclosure HVAC system;
  (vii) Status, alarms and monitoring output from enclosure Safety System .

(m) Historian data over Facility life shall be readily available for access and download by VINLEC and affiliated parties.
(n) Real time operations and performance of the system shall be available for monitoring and controls through a graphical user interface (GUI) provided through a human machine interface (HMI). HMI with monitoring and control access to BESS shall be available at the following locations:
    (i) BESS control room on Site
    (ii) Remote operations control room with primary controls of the BESS Facility.
(o) HMI monitoring access to BESS shall be available in at least one remote site as specified by VINLEC.

6.3.4 BESS Electrical Requirements

(a) BESS shall be housed in its own enclosure supplied by the Contractor or BESS supplier.
(b) BESS controls and SCADA shall be installed in control house.
(c) The following BESS requirements applicable to the Contractor and the Engineer on Record (EOR) are provided to guide the design of the Facility:
    (i) All electrical installations and systems shall be in compliance with the NEC, or equivalent, and conforming to IEEE standards.
    (ii) Batteries with exposed live parts shall be kept in a room or enclosure accessible only to authorized personnel.
    (iii) Battery trays, racks, and other surfaces shall be level, protected against corrosion from electrolyte and covered with an insulating material having a dielectric strength of at least 1500 V.
    (iv) Installation of wiring and equipment in a battery room shall be in accordance with the requirements for a wet location.
    (v) Overcurrent protection for conductors connected to batteries shall be provided in accordance with the NEC or equivalent.

6.3.5 BESS Supplier Protective Relaying

(a) Contractor shall coordinate with VINLEC on all electrical power system protection devices and settings.
(b) Protection devices shall be procured from VINLEC authorized ContractorContractorContractors.
(c) BESS shall have a protective relaying scheme, for protecting the BESS and electric power system from faults, abnormal voltage and frequency conditions.
(d) All protective relays shall be utility-grade and shall have applicable required protection functions (e.g. 25, 32, 27, 67N, 67, 59, 81u, 81o, 50/51, etc.) as prescribed in IEEE 1547-2018. Contractor shall provide protection between interconnection and inverter transformers. VINLEC will provide protective relay settings.
(e) The protection devices in the BESS should be capable of adapting to different short circuit levels based on the configuration of the Facility, and accounting for beginning of life Isc between 0% and 100% SOC, as well as end of life Isc between 0% and 100% SOC.
(f) BESS inverters shall be sized to provide sufficient fault current to trip protective relays. Minimum available fault current shall correspond to recommended relay set-point as specified by interconnecting utility.

6.4 Bi-Directional Inverter Requirements

6.4.1 Bi-Directional Inverters shall:

(a) Be a fully-integrated power conversion system with one manufacturer or integrator providing all power conversion components; the site control system to act as the "master controller" is preferred. Single manufacturer shall provide system-level documentation, manuals, warranty, field service and training.

(b) Be capable of providing the Facility Functional Requirements described in Section 3.4, including reactive power control.

(c) Be properly designed and rated for the range of environmental conditions present at their installed location(s). Inverters shall be rated for and able to deliver full rated power at a power factors between 0 and 1, at the following design ambient temperatures for the Site location:

   (i) ASHRAE 10 year extreme high and low dry bulb temperature

   (ii) ASHRAE extreme maximum wet bulb temperature

(d) Be functionally fully integrated into the BESS, receiving control signals coordinating power flow magnitude and direction, as well as safety and functional limits and fault thresholds.

(e) Have capability to perform primary frequency response (including regulation and droop control).

(f) Provide all essential operating data, functional limits and fault thresholds across communications circuitry in real time, as commanded from system's master controller.

(g) Provide automated switches (contactors) that break the current path between energy sources and the inverter, and between energy sources, in the event of a potentially destructive fault condition.

(h) Be capable of charging the battery from the grid, and non-volatile control settings in the inverter must allow disabling this feature.

(i) Provide ground fault detection of the presence of ground current, annunciate the condition in the form of a fault condition and disconnect the equipment from the inverter. Rapid disconnection of the inverter upon ground fault detection shall not harm the energy storage equipment or energy sources.

(j) Inverter manufacturer shall provide lab or field test data demonstrating operation of proposed inverter for a stand-alone storage configuration, and under various load and operational conditions.

(k) Inverter manufacturer shall provide field reliability data (calculated or accumulated) indicating the frequency of field issues and/or failures for inverters deployed for a stand-alone storage configuration.

(l) Be non-isolated with galvanic isolation provided by the step-up/isolation transformer has an output voltage appropriate for interconnection with the AC power collection system.

(m) Be designed to operate properly with the specified isolation transformer, including transformer impedance and available fault current.

(n) Be three-phase, operating with AC line current balance within 1%.

(o) Provide over-current protection for battery source in the form of fuses.

(p) Be rated for use in 1500 V-DC applications.

(q) Operate with a nominal line frequency of 50 Hz.

(r) Operate at an elevation of 2000 meters without power de-rating.

(s) Operating in an environment of up to 100% relative humidity if outdoor rated, and 95% relative humidity if indoor rated.

(t) Carry a cabinet rating that is appropriate for the level of protection to be provided at the installation site.
(u) Be designed to be compatible with its step-up transformer based on the requirements of IEEE C57.159 regarding harmonics and resonance
(v) Be provided with automatic operation including start up, shut down, self-diagnosis, and fault detection.
(w) Be provided with protective features described in IEEE 929 and IEEE 1547-2018 (abnormal operating performance Category II), including over-voltage, under-voltage, ride through, and frequency safeguards, unless otherwise required by the Reliability Rules or the Local Electric Utility.
(x) Be provided with inverter shut off and reset switches with remote restart capabilities.
(y) Be provided with standard AC metering functions, including output power, power factor, output voltage, current, and cumulative kW-hr. Metering functions shall be integral to the inverter unit and capable of being monitored remotely using the Facility SCADA.
(z) Be provided with standard DC metering functions, including total DC input current and DC input voltage.
(aa) Meet all control, operation, and SCADA requirements as identified in this Technical Specification.
(bb) Be listed to all applicable UL standards (UL 1741 and Supplement A), unless written approval from VINLEC is provided.
(cc) Comply with IEEE 1547-2018, including testing to IEEE 1547.1 and IEEE C62.45. Regulatory standards compliance shall also include IEEE C62.41.2.
(dd) Include "Smart" inverter features meeting all Reliability Rules, including VINLEC's Technical Requirements for Interconnection for voltage and frequency ride through at 50 Hz. Contractor shall provide test reports from the manufacturer confirming this requirement is met.
(ee) If located outdoors, be enclosed in lockable, NEMA 3R, or better protection rating enclosures, with coating to protect surface/functional integrity under the ambient conditions similar to those expected at the Site. Inverters must provide condensation protection and dust protection for sensitive internal components. A shading structure, such as a small awning, shall be incorporated, if required, in order to keep temperatures below the manufacturer's recommended operating temperatures and to protect inverter display.
(ff) Have inverter output protected by a circuit breaker with short and long time adjustable over-current protection. This circuit breaker shall be externally operable, or the ContractorContractorContractor shall furnish an external on/off (start/stop) switch.
(gg) System shall be negatively grounded unless written approval from VINLEC is provided. For any positively grounded or bipolar systems, a nighttime depolarization device shall be included from the inverter manufacturer.
(hh) Accomplish grid code requirements based on regulations of local jurisdictions.
(ii) Meet IEEE 519 - IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems, requirements for harmonics.
(jj) Be capable of implementing advanced inverter functions per Rule 21 grid interconnection requirements, as demonstrated by the tests outlined in UL 1741 SA.
(kk) Have a maximum DC voltage rating compatible with BESS maximum voltage.
(ll) Have an ambient temperature operating range that exceeds the site requirements, typically -20 °C to +50 °C at full rated power. Cold weather sites may require an extension to -40°C, requiring inverter modifications to extend the range.

(mm) Be from a supplier that is certified to ISO9001:2015 and ISO140001:2015, or later version of the same.
(nn) Be supplied with a complete points list that provides sufficient information for a SCADA engineer to communicate with the inverter and interpret all data points, including read/write status and data type.
(oo) Be completely factory-built, assembled, wired and tested as a complete unit. If it is necessary to disassemble the units for ease of transportation, all materials and instructions shall be provided for field re-assembly.
(pp) BESS Inverter warranty shall allow for unlimited usage at full rated power during the term of the warranty
(qq) BESS Inverter noise shall comply with Applicable Laws.
(rr) The Bi-directional inverter shall have integrated islanding detection methods and operate with anti-islanding enabled, in accordance with UL 1741.

6.4.2 Bi-Directional Inverter Manufacturer shall:

(a) Provide lab or field test data demonstrating operation of proposed inverter in the given BESS configuration, and under various load and operational conditions.
(b) Provide field reliability data (calculated or accumulated) indicating the frequency of field issues and/or failures for inverters deployed in the given BESS configuration.
(c) Shall have transient stability and EMT models per the latest VINLEC Modeling Requirements.
(d) Shall provide a failure mode and effects analysis (FMEA) with detailed review of fault modes and resulting system effects. The FMEA shall address the adequacy of circuit protection in the event of a fault. If required, a detailed fault analysis including current magnitude calculations shall be performed to support FMEA.

6.5 Inverter Transformer Requirements

Inverter Transformers shall:

(a) Meet transformer efficiency standards set forth in the Department of Energy “Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule” published April 18, 2013.
(b) Be supplied with a no-load tap changer with high voltage taps 2.5% above and below nominal voltage (i.e. 5 x 2.5%), which do not affect the full rating.
(c) Be supplied with disconnecting means on the transformer high voltage side to isolate the transformer in case of an internal fault. The switch/transformer configuration shall be designed for loop feed.
(d) Include over-current fuse protection on the high-voltage side of the windings.
(e) Contain less-flammable insulating fluid, Envirotemp® FR3 fluid or equivalent.
(f) Include liquid level, pressure/vacuum gauges, and a dial-type thermometer (two separate contacts: warning and fault), all shall have SPDT alarm contacts and be fully integrated into the SCADA system.
(g) Contain oil temperature indicator and winding temperature indicator to provide alarm and control signal

(h) Monitor fluid temperature, and windings
(i) Contain a pressure relief valve and a drain valve with sampler.
(j) Be compliant with applicable UL, ANSI and IEEE standards applicable to distribution transformers, specifically:
    (i) C57.12.00 - IEEE Standard for General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
    (ii) C57.12.10 - IEEE Standard Requirements for Liquid-Immersed Power Transformers
    (iii) C57.159 - IEEE Guide on Transformers for Application in Distributed Photovoltaic (DPV) Power Generation Systems
    (iv) C57.12.28 - IEEE Standard Requirements for Switchgear and Transformers, Pad-Mounted Equipment - Enclosure Integrity
    (v) C57.12.34 - IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers
    (vi) C57.12.70 - IEEE Standard Requirements for Terminal Markings and Connections for Distribution and Power Transformers
    (vii) C57.12.80 - IEEE Standard Terminology for Distribution and Power Transformers
    (viii) C57.12.90 - IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers
    (ix) C57.91 - IEEE Standard Requirements for Oil-immersed Transformer Temperature Monitoring
(k) Be compliant with other standards, including:
    (i) NEMA CC1 - Electric Power Connectors
    (ii) NEMA TR1 - Standards for Transformers, Regulators, and Reactors
    (iii) FM 3990 - Less or Nonflammable Liquid Insulated Transformers
    (iv) UL XPLH - Guide for Transformers, Distribution, Liquid-Filled Type, over 600 V
(l) Have an elbow-type surge arrester present on the high voltage winding of all the medium voltage transformers at the end of collection system feeders
(m) Have the coil and core design approved in writing by VINLEC.

6.6 Medium Voltage Skid Requirements

General requirements:

(a) All medium voltage skids shall be designed to satisfy all requirements.
(b) All medium voltage skids shall meet the requirements of this Technical Specification, including inverter requirements, inverter transformer requirements, wiring requirements, and SCADA requirements.
(c) Inverter skid enclosures shall include two (2) insulated metal exit doors, with panic hardware on the interior, located at opposite ends of the enclosure, where applicable. Any deviation in this shall be provided to VINLEC in writing for approval.
(d) All medium voltage skids shall be designed to withstand the harsh external environment it is located within. Consideration for heating/cooling, seals/gaskets, vents, hoods, paint, electrical enclosures, etc. shall be inherent in design.

(e) All medium voltage skid hoods, screens, intakes and such shall include bird/bug screens including ingress against rodents or unspecified critters that may create a problem in the medium voltage skid station.
(f) All skid equipment shall be able to withstand and operate in the outdoor and extreme climatic conditions of the installation environment (e.g. -25°C to 50°C).
(g) The skids shall be suitably bunded, to prevent any leakage from the transformer / PCS from reaching the environment. (Depending upon transformer type)

6.7 Circuit Breaker Requirements

(a) All circuit breakers shall be reviewed and approved by VINLEC.
(b) Circuit breakers shall be UL Listed and have an appropriate AIC rating (rms symmetrical amperage short circuit rating) for the specified use.
(c) Circuit breakers in the substation shall:
    (i) Depending on fault currents, be Sulfur Hexafluoride ("SF6") or vacuum type, but not air type; in case of medium voltage circuit breakers.
    (ii) Have a minimum of three, protection class, multi ratio current transformers per bushing.
    (iii) Not be live tank breakers.
(d) Circuit breakers for the feeder circuits shall be sized by the Contractor for the Facility capacity as per Applicable Laws.

6.8 Disconnect Switch Requirements

(a) Disconnect switches shall be UL Listed and approved by VINLEC for the specified use.
(b) Disconnect switches in substation and switch yard shall be reviewed and approved by VINLEC.
(c) Disconnects for branch circuit protection shall be located as near as is practical to the supply end of the conductors being protected.

6.9 Container design

(a) The systems shall be designed with efficient space usage in mind
(b) The batteries, inverters, and related system components are planned to be mounted on a concrete or equivalent pad or piers, as specified by the BESS supplier or original manufacturer, as appropriate. The Contractor should indicate how the installation will be affected for each case.
(c) The outermost container for the BESS, Inverters, and related components, whether an overall container (e.g., shipping container) or individual system component containers (e.g., for the batteries or inverter), must meet the following standards:
    (i) Container(s) must be provided with appropriate tools and instructions to allow on-site movement and installation.
    (ii) All equipment located outdoors shall have container(s) complying with IEC and/or and NEMA requirements for wet locations.
    (iii) The container(s) will have an IP or NEMA rating appropriate for exterior installations. The container(s) will have a minimum of IP54 rating or equivalent.

(iv) The container(s) will allow for main and auxiliary power, as well as communications lines, to attach to the appropriate components and connections.
(v) Where applicable, the system should be designed to minimize any potential risks of fires. However, in the case of a fire, the container(s) will be equipped according to applicable fire safety standards. This includes a detection and alarm system, documentation or training on safe firefighting methodology for the technology, and internal fire suppression equipment.
(vi) The BESS site will have fire hydrants located nearby and accessible to all container(s) in case of an emergency.
(vii) The container(s) will be equipped with appropriate heating and cooling mechanisms operating in concert with or supplemental to the thermal management system of the BESS, to maintain operation within the optimal temperature ranges for the system, given the environmental conditions noted in this Technical Specification.
(viii) The container(s) will be equipped with lockable doors, with master key(s) provided, or with a door that can be fitted with a padlock.
(ix) The container(s) must have grounding points available.
(x) Where applicable, container(s) floors will be nonconductive.
(xi) Where applicable, container(s) should provide lighting.
(xii) Comply with all local requirements for modular structures.
(xiii) Provide and bear costs associated with all required factory inspections or special inspections required by VINLEC.

6.10 Equipment marking and labelling

(a) Safety signage shall be provided
  (i) On all electrical equipment in accordance with requirements of IEC TS 62548 and ANSI Z535-2002, and for identification of hazardous materials in accordance with NFPA 704.
  (ii) At the entrance to the area and battery containers, indicating the type of energy storage system, any chemistry specific hazards, and 24/7 emergency contact information.
(b) Signage shall be weather-proof, corrosion-proof, UV-stabilized and fade-resistant and shall be capable to last the duration of the minimum Design Life.
(c) Signs shall be attached using non-corrosive materials suitable to meet the Design Life, or with a planned replacement schedule.
(d) A nameplate which meets the requirements of IEEE C57.12.00 shall be provided on all equipment including:
  (i) Manufacturer name
  (ii) Connection diagram
  (iii) As applicable: Ratings for power, energy, voltage, basic insulation level, etc.
  (iv) Serial number, date of manufacture

7 BALANCE OF PLANT ELECTRICAL SYSTEMS, EQUIPMENT AND MATERIALS

7.1 General Requirements

(a) It is the Contractor's sole responsibility to ensure that all aspects of electrical design for the Facility comply with all local Authority Having Jurisdiction (AHJ) code requirements and Applicable Standards, including, but not limited to, National Electrical Code (NEC), IEEE standards and interconnection requirements.

(b) All electrical design including cables and equipment design attributes shall comply with the applicable codes and standards listed in Section 10.3, including, but not limited to, ampacity rating, conditions of use, terminations, conduit fill, protection and isolation, disconnecting means, signage, and labeling requirements. The electrical design shall be prepared under the responsible charge of a registered Professional licensed Engineer from a jurisdiction deemed appropriate by the VINLEC and applicable AHJ.

(c) All substation and switch yard designs shall be done in accordance with interconnecting VINLEC design standards.

(d) Contractor is responsible for the Electrical Balance of Plant design studies including but not limited to DC and AC cable ampacity study, grounding study, power flow study, short circuit study, protection philosophy and relay coordination study, arc Flash study, transient overvoltage study, effectively grounded study, insulation coordination study, lightning study, and harmonic study

(e) All studies should be sealed and stamped by a registered Professional licensed Engineer

(f) Contractor is responsible for proper electrical equipment sizing to ensure full functionality during the Facility lifetime, including but not limited to, the following items:

   (i) DC and AC collection system: cabling, grounding splicing and termination.

   (ii) Inverter step-up transformer(s), auxiliary power transformers, switchgear, SCADA system.

(g) Setbacks and access ways shall comply with local revision of the International Fire Code and zoning codes.

(h) Contractor shall be responsible for working conjointly with the BESS and PCS manufacturer to determine proper DC voltage design and grounding design as allowed by Applicable Laws and VINLEC requirements.

(i) All Facility Equipment shall be Underwriters Laboratories (UL) or National Renewable Testing Laboratory (NRTL), listed, or listed/certified to approved equivalent standards, or approved by the local Governmental Authority. NEC shall be used for the Facility design along with NESC, IEEE, and IEC where applicable.

   (i) All electrical enclosures shall have the appropriate NEMA (or equivalent) ratings for their locations and applications.

(j) Equipment enclosures:

   (i) Equipment enclosure shall allow safe personnel access to AC and DC electrical connections including inverters, recombiners, transformers, panels, switchgear.

   (ii) Service power: 120V, 20A, single-phase power outlets shall be provided at Equipment pads or in Equipment rooms, spaced a maximum of 30 feet (9.2 m) apart, to support service of the Equipment.

(iii) Meters and metering equipment shall be located as close as possible to the AC switches on the Equipment pad or in the Equipment room, where applicable.

(k) If the POI is shared by multiple generation facilities, then the individual substation generation facilities shall all be able to control their own portion of the reactive power requirement at the POI. Capacitor banks/reactor banks shall not be shared between facilities (sizing determined by Contractor).

(l) The Contractor shall demonstrate that equipment ratings will withstand to the available fault current. Fault current withstand capability shall be confirmed by the short circuit study

(m) Installation and design of the switchyard and the substation shall follow IEEE, IEC, NESC, ANSI as well as other relevant standards or best practices. Switchyard and substation designs shall be reviewed and approved by the VINLEC.

(i) All electrical enclosures shall have the appropriate NEMA (or equivalent) ratings for their locations.

(ii) Contractor shall perform an arc flash study adhering to NFPA70E, NEC 110.10, IEEE 1584, NESC 410.A.3. The study shall include all AC and DC enclosures. Based on the study results, the contractor will provide and install appropriate signage as required.

(iii) The Basic Impulse Level to be considered for all substation facilities shall be confirmed with the VINLEC. The Contractor may choose to increase the nominal voltage of the insulation to provide additional clearance if desired for raptor/animal protection as well as contamination levels. This rating shall not apply to the electrical equipment such as the transformers, and circuit breakers.

(n) Bus and Conductor Connection Design Parameters

(i) The bus system for the substation facilities shall be designed for a suitable standard continuous current.

(ii) Rigid bus conductors shall be aluminum tubular electrical extruded (not seamed) round tubing, alloy 6063-T6.

(iii) All rigid bus connectors shall be welded by a certified welder.

(iv) Bus jumpers shall be stranded copper bare conductor. Flexible conductor sizes shall be standard sizes.

(v) Bus and conductors shall be sized based on IEEE Standard 738 - Standard for Calculating the Current-Temperature of Bare Overhead Conductors using no wind conditions. Additional attention shall be given to the temperature extremes encountered at the site.

(vi) Rigid bus shall be designed in accordance with IEEE 605 “Guide for Bus Design in Air Insulated Substations”.

(vii) All rigid bus design loading cases shall include short circuit force. One loading case shall include seismic forces. An extreme wind loading case shall be included.

(viii) Contractor shall investigate for all switchyard and substation facilities to determine whether requirements for higher BIL levels and extra insulation creep values will be necessary due to contamination. If required, the higher values shall be used.

(ix) Porcelain station post insulators shall be used on all bus supports and disconnect switches. The insulators shall be station class.

(x) Insulators will be selected to meet all electrical and mechanical ratings for their application in accordance with ANSI C29 series for porcelain insulators.

(xi) Reference ANSI Standard C37.32 - American National Standard for High Voltage Switches, Bus Supports, and Accessories Schedules of Preferred Ratings, Construction Guidelines, and Specifications.

7.2 AC Power Collector System

(a) System Description and Scope:

(i) The AC power collection system will consist of feeder circuits, buried in trenches or above grade (in tray applications), interconnecting the inverter AC power outputs through inverter step-up transformers, to the substation.

(ii) The AC power output from the inverter step-up transformers shall be connected in branch circuits configured so that inverters can be de-energized and isolated from the feeder circuit for maintenance or repair, while the other inverters can remain energized. The substation will aggregate the AC collection system feeder circuits and step-up the AC voltage to POI voltage. The AC collection system will be optimized to minimize electrical energy losses.

(iii) The AC power collection system shall be sized appropriately to deliver the full rating of the inverter AC output to the substation at worst case power factor. The design of the AC power collection system shall be based evaluated to ensure system performance that meets the design criteria. The evaluations shall include:

A Short circuit

B Load flow including reactive power study

C Power and energy losses

D Voltage drop

E Transformer sizing

F Transient over-voltage

G Harmonics

H Relay coordination

(b) Design Requirements – Pad Mount Switchgear:

(i) Any pad mount switchgear shall be distribution class outdoor rated switchgear with load break branch circuit disconnect switches and a fault interrupting main. The pad mount switchgear shall be electrically operable, protective relay equipped, and provide visual open disconnect windows. The pad mount switchgear shall be accessible by qualified personnel and, as required, approved by the appropriate Governmental Authority.

(ii) The fault interrupting main shall be furnished with current transformers as required for protective relaying, solid state protective relay, and an electric operator. The load break branch circuit disconnect switches do not require any instrumentation. All positions in the pad mount switchgear shall be capable of being manually operated and lockable in the open or grounded positions.

(c) All relay equipment shall be installed in the VINLEC's substation house described in Section **Error! Reference source not found.**.

7.3 DC Power Collection System

(a) General dc requirements

(i) The maximum voltage of the dc collection system shall be 1,500 Vdc where not located on or in buildings, unless otherwise approved by Owner. 600V systems shall not be accepted by Owner and all components shall be listed to support the maximum dc collection system voltage.

(ii) Based on the assumption that the design shall be based on a central inverter topology, dc collection system circuits shall be designed to limit average electrical losses at STC conditions to no more than 1.5% for 1,000 Vdc and 1.2% for 1,500 Vdc. The worst-case electrical loss for a given dc circuit (including string, harness and output circuit wiring) shall not exceed 2.5%. If string inverters are used the ac and dc loss profile shall require Owner approval.

(b) DC Cabling

(i) DC wires shall be approved to NEC 690.31 and suitable for exposed outdoor installations and rated for wet locations, as applicable. Where conductors are subject to sunlight, they shall be marked as "Sunlight Resistant" or "SR".

(ii) All ungrounded conductors exiting the arrays shall be installed in accordance with NEC 690.9 and 240.15.

(iii) Listed plug-in connectors used to connect cables between PV modules and between PV modules and home-run conductors and/or combiner box leads shall be of the locking type, be the same manufacturer and model and be rated for the voltage and current of the circuit in which they are installed.

(iv) Wiring located above ground and secured to the PV module mounting structures shall be secured to the mounting structures utilizing UV-resistant devices and secured in a manner such that no exposed wiring is in direct contact with unfinished or sharp metal edges.

(v) Listed UV resistant zip ties shall be allowed for open wiring support and located within 0.3 m of every box or fitting and at intervals of not more than 1.4 m throughout the run.

(vi) Listed stainless steel zip ties with protective backing or listed stainless steel wire clips may be used, but shall be installed in a manner not to deform or compress the cable insulation.

(vii) No splices shall be permitted.

(viii) Cable ampacity calculations and studies shall be performed according to guidelines and requirements of the NEC.

(ix) All directly buried conductors shall be protected by conduit from the trench up to the electrical enclosure termination point or three (3) feet above grade, whichever is lower.

(x) Conduit shall be UL Listed and comply with NEC requirements.

(xi) Conduit shall include a 90? conduit sweep in the trench to protect the cable as it enters the trench.

(c) DC Cable Messenger systems (if applicable)

(i) Supporting cable shall be adequately secured and electrically grounded with listed lugs that are rated for direct contact with the supporting cable material.

(ii) Hangers are spaced to satisfy manufacturer warranty requirements and maximum sag is recorded. Hanger spacing shall include considerations for conditions of use such as snow/ice loading. If warranty requirements are not clearly specified spacing shall not exceed 2.5 feet without Owner approval.

(iii) Hangers are secured to both the supporting cable and to the cable bundles.

(iv) Cable bundles do not exceed the maximum allowable conductors per bundle per the Design Documents and supporting ampacity study.

(v) All listed cables are rated as sunlight resistant.

(vi) Bundled cables are adequately secured as a bundle.

(vii) If the messenger system is used for a significant portion of the site, a detailed access plan showing ingress and egress shall be provided to support health, life and safety for installers and O&M personnel and shall be provided to the Owner for approval.

(d) Combiner Boxes

(i) If combiner boxes are replaced with a combination of harness assemblies, dc disconnects and junction boxes, specifications and preliminary design considerations shall be submitted to the Owner for approval. Harness assemblies shall be designed to eliminate/protect all "blind" or "weak" spots based on tap and OCPD locations.

(ii) Combiner boxes with fuses require disconnecting means for overcurrent protection provided for PV source circuits as per NEC.

(iii) Conduit and cable entry into combiner boxes shall be through the bottom or sides of the enclosure only and appropriate glands or conduit fittings shall not void the listing of the enclosure.

(iv) Contractor shall provide key locks for all combiner boxes.

(v) Disconnect Switches

(vi) Disconnect switches shall have visible blades and be rated for full load disconnect.

7.4 System Protection

(a) Protection and Isolation Devices

(i) Overcurrent protection devices shall be appropriately rated for the voltage and current as required by the VINLEC and NEC 240.

(ii) Overcurrent protection devices shall be rated for reverse flow.

(b) Lightning Protection

(i) Contractor shall evaluate the need for lightning protection using an NFPA 780 risk analysis; as appropriate components use shall be listed to UL 96.

(ii) Lightning arresters shall be provided to protect any transformers.

(iii) Lightning arresters shall be provided at each inverter station on the ac side.

(iv) Where lightning arresters are installed inside a building, they shall be located well away from all equipment other than which they protect and from passageways and combustible parts of buildings.

(v) Lightning arresters shall be provided on above-ground electrical power line poles.

(c) Electrical Grounding

(i) Grounding shall be performed in accordance with the VINLEC requirements and NEC.

(ii) Grounding design shall comply with requirements of the NEC and IEEE 80 for switchyards/substations and major equipment pads. All metal objects, likely to be energized including but is not limited to: battery containers, module frames, all racking structure members, metal conduit, metal enclosures, fencing, equipment pads, skids, etc.

(iii) Facility grounding shall comply with the National Electric Safety Code, IEEE Std. 665 - “Guide for Generator Station Grounding,” IEEE Std. 80 - “Guide for Safety in AC Substation Grounding,” as such standards may be revised, modified, or replaced from time to time and any applicable state and local codes.

(iv) Contractor shall provide an overall electrical grounding schematic of the Facility. The grounding schematic shall indicate the primary connections to earth and the manner in which all components are grounded.

(v) The Facility shall include remote ground fault detection within each inverter block.

(vi) All grounding and bonding conductors shall be stranded copper.

(vii) Hardware utilized in grounding design shall avoid risk of galvanic corrosion from contact of dissimilar metals.

(viii) All ground lugs and ground terminations shall be UL Listed for use in the environment installed. Grounding connections terminated below grade shall be UL Listed specifically for direct burial applications.

(ix) Equipment grounding conductors shall be routed with the associated phase conductors.

7.5 Lighting Systems

(a) System Description and Scope:

(i) A lighting system shall be furnished that provides illumination for indoor spaces for Facility operation under normal conditions and a means of egress under emergency conditions. Lighting shall also be provided at the main entrance gate and at the O&M building (if applicable), and at the substation control building. Convenience receptacle circuits shall also be supplied by the lighting transformers/panels. Emergency lighting shall be provided for indoor spaces, as applicable, to perform manual operations during a power outage for the initial twenty (20) minutes after an outage.

(b) Design Requirements – General Lighting:

(i) Contractor shall provide a complete Facility lighting system, including lighting transformers, lighting distribution panels, lighting fixtures, exit signs, DC battery pack lights, receptacles, switches, lamps, cables, wires, conduits, and supports for indoor spaces.

(ii) Lighting in the area of the O&M structure (if applicable) and main gate shall be motion activated with illumination directed down to prevent a negative visual effect when light sensors detect wildlife. Substation lighting shall be as required by Applicable Laws.

(iii) During emergency or abnormal conditions, minimum lighting shall be provided for personnel safety, emergency egress, and critical Equipment restoration.

(iv) Backup lighting shall be powered self-contained battery units.

(v) All outdoor lighting shall be controlled via a contractor, photocell, with a bypass switch.

(vi) All lighting shall be LED class, where applicable.

(c) Design Requirements – Emergency Lighting:

(i) Emergency lighting shall be powered from a normal source with local battery backup. Emergency lights shall remain unlit during normal operating conditions and shall only light up in the event of a power failure.

(ii) The self-contained battery pack units shall have a duration in accordance with the local building code and Applicable Laws. These units are utilized for emergency egress routes. All fixtures that have an integral battery and charger must be capable of recharging the battery to 100 percent charge per the local building code and Applicable Law.

(d) Design Requirements - Lighting Transformers:

- Lighting transformers shall be sized as required, but in no case utilized at greater than 75 percent of the base AA rating. Transformers shall allow for 25 percent future loading capacity.
- Transformers shall be designed to not exceed 80° C rise above 40° C ambient under full load conditions and shall be capable of continuously carrying 130 percent of nameplate rating without exceeding a 150° C rise above a 40° C ambient. Transformer windings shall have a 220° C rated insulation system.

7.6 Wire and Cable

(a) General Requirements

(i) Cable insulation shall be appropriate for the environment and voltage in which it is applied. Wire and cable must be UL approved for its intended use.

(ii) All cable specifications must be coordinated with the VINLEC.

(iii) All underground cable shall be mapped and identified along their entire run with Mylar hazard tape midway above the cable elevation and below finish grade elevation. Where non-metallic cable (fiber optic cable) is installed use tracing.

(iv) The above ground cable shall be neatly installed and protected from sunlight. Cables installed outdoors where subject to direct sunlight shall be outdoor rated, sunlight (UV) resistant, and use UV-rated tie-wraps. Where cable is to be installed in cable tray it shall be rated for cable tray installation. A cable identification system shall be installed with durable identification markers on all field installed wiring.

(v) No direct buried cable splicing shall be acceptable. Direct buried cable splicing shall be acceptable under repair circumstances using methods and materials accepted by the VINLEC.

(b) DC System Wiring

(i) Battery internal DC circuit wiring, between racks, modules, etc., is typically part of the battery manufacturer's turn-key design package and shall be compliant to all applicable local and national codes and standards.

(c) AC System Wiring

(i) AC circuit design voltage drop from the high side of the inverter transformers to the substation MV feeder breakers shall be less than or equal to 0.5% on average at rated BESS Facility power, except with written approval from the VINLEC. AC conductor losses from the substation MV feeder breakers to the POI shall be less than or equal to 0.1% at rated BESS Facility power.

(ii) Insulated AC cable rated 5kV and above shall be shielded with XLPE-TR insulation resistant to electrical treeing.

7.7 Raceway / Trays

(a) General Requirements

(i) Raceway systems shall be coordinated with the Facility layout to minimize obstruction to operation and maintenance activities. Raceway supports, where required, shall be integrated into other infrastructure elements with the approval of the VINLEC. No substation raceway shall exceed 30% cable fill.

(b) Above Ground

(i) Rigid iron conduit, of appropriate material for the service conditions and within code requirements, shall be provided for all above ground conduit runs, unless otherwise approved by the VINLEC. Flexible conduit shall be used locally for making Equipment connections, spans over expansion joints, or other transitions requiring flexibility (including if appropriate, to mitigate frost heave), as appropriate. All above ground conduits installed outdoors or subject to weather or wet conditions shall be leak tight. All conduits shall be UL Listed for the specified use.

(ii) Cable tray shall be used, if appropriate for the design and in accordance with Applicable Laws.

(c) Underground

(i) All underground cable shall be run through conduit. PVC schedule 80 or additional physical protection measures shall be used. All type PVC conduits shall be leak tight. All conduits shall be UL Listed for the specified use.

7.8 AC Auxiliary Power

(a) The Contractor shall provide a main AC auxiliary power system separately for each of the switchyard and substations by utilizing a step-down transformer.

(b) Contractor shall coordinate with BESS manufacturer and Employer to provide all equipment necessary for BESS auxiliary power supply.

(c) The Contractor shall design, install and size the system to 125% of the required initial loading-based methods prescribed by the latest Local Electrical Code.

(d) The Contractor shall provide a minimum of one AC power panel board.

(e) The panelboard shall be sized for the short circuit current available.

(f) Incoming and branch breakers shall be equipped with bolt in breakers.

(g) The Contractor shall provide space for an additional 20% future single pole breakers.

(h) The Contractor shall provide a back-up low voltage power feed.

7.9 Auxiliary & Backup Power

(a) BESS EMS, SCADA, emergency systems, safety systems, electrically operated switches, relays and protection equipment, and inverter control systems shall have two sources of DC power – an Uninterruptible Power Supply (UPS) with a 1-hour autonomy and the installed BESS.

(b) Further requirements are described in Exhibit C – BESS SCADA Specifications.

(c) Auxiliary power shall be supplied from a 240 VAC station service in coordination with VINLEC.

7.10 Signage

(a) Signs shall be posted in English indicating:

(i) the presence of electrical equipment

(ii) the presence of multiple power sources

(iii) the presence of battery energy storage systems (and any chemistry specific hazards)

(iv) that entry is restricted to authorized personnel only

(v) trespassing is not allowed

(vi) the Site is monitored by a security system

(b) A sign shall be posted at agreed upon location with contact information for Employer emergency contact, operations and maintenance contact, as well as an Emergency Management 24/7 call in number.

(c) A DC and AC single line diagram shall be posted in compliance with NEC 690 that clearly identifies the AC and DC disconnect locations. If not apparent from the single line diagrams, a Facility map shall also be provided indicating the approximate locations of the disconnect switches. AC and DC disconnect switch designations shall match the electrical drawings, device labels and LOTO procedures.

7.11 Equipment Marking and Labeling

(a) General Requirements
  - (i) Marking and labelling shall be in accordance with the VINLEC and NEC requirements.
  - (ii) Signage and labels shall be weather-proof, corrosion-proof, UV-stabilized and fade-resistant and shall be capable to last the duration of the minimum Design Life.
  - (iii) Signs shall be attached using mechanical means or non-corrosive materials suitable to meet the Design Life.
  - (iv) All combiners, inverters, transformers, disconnect switches and circuit breakers shall have an engraved permanent identification label visible and readable from distance of 48” that provides the unique equipment identification number as indicated on the electrical drawings and in the LOTO procedure.
  - (v) All conductors shall bear permanent cable labels at each end that uniquely identify the cables and are traceable to the electrical drawings.
  - (vi) DC wire color-coding shall be consistent and identified by permanent labels on associated equipment

(b) Inverters, transformers, and disconnects
  - (i) The metering cabinet and main distribution panel/switchgear containing main disconnect switch shall be properly marked “WARNING – POWER FED FROM MORE THAN ONE SOURCE” or equivalent.
  - (ii) Each transformer shall have a proper label identifying its rating, configuration, and specifications.
  - (iii) All AC and DC disconnecting means shall be marked “Battery Energy Storage System DISCONNECT MEANS – AC DISCONNECT” and “Battery Energy Storage System MEANS – DC DISCONNECT” or equivalent.
  - (iv) A single-line diagram of the as-built system shall be posted permanently to both the supply authority disconnecting means and on the metering cabinet.
  - (v) All transformers and disconnect switches shall have an engraved permanent identification label visible and readable that provides the unique identification number as indicated on the electrical drawings and in the LOTO procedure.

8 INSTRUMENTATION AND EQUIPMENT

8.1 Telecommunications Systems

(a) System Description and Scope
  - (i) Contractor shall provide all reasonable cooperation and support to the Telecom Provider and VINLEC for the construction, design and installation of telecom facilities. Contractor shall be responsible for all telecom related installations and design within the Facility. Contractor shall extend telecom facilities from the control enclosure and O&M enclosure, if applicable, to the designated demarcation point. VINLEC shall work with the Telecom Provider to ensure

telecom facilities are extended to the Facility Site. VINLEC will be responsible for setting up telecom accounts and any ongoing costs on such accounts.

(ii) Specific data interface devices shall be required for communication of Facility information directly to the Independent System Operator (ISO) and/or Local Electric Utility. Such devices may require inputs from the SCADA system or directly from system components, and may require specific services (e.g., phone lines, etc.) for data delivery.

(b) Design Requirements

(i) Contractor shall provide and install all equipment, high voltage protection devices including telephone terminal boxes, wires, fiber optic cables, vaults, conduits, fittings, telephones, routers, and supplementary supports as required for a complete functioning installation.

(ii) The general requirements for conduit, pull boxes, junction boxes, and associated supports included in this Technical Specification shall be followed except as stated below. Contractor shall ensure conduit path and plan is approved by the Telecom Provider's Outside Plant Engineer and VINLEC prior to installation.

(iii) All communications equipment shall be fed from a DC ESS and clearly marked in the distribution panel.

(iv) Ethernet shall be run over plenum rated CAT6 cable for distances up to 100 feet. For distances greater than this, fiber optic cable with media converters shall be installed for the communications network.

(v) If copper cabling is used by the Telecom Provider, Contractor shall incorporate a fiber transition terminal for all telecommunications facilities. Contractor shall work with and coordinate with the Telecom Provider, Utility and VINLEC to ensure the high voltage protection design and devices are approved prior to installation. Contractor shall perform a ground potential rise and other appropriate grounding studies to determine the 300 volt point.

8.2 Supervisory Control and Data Acquisition (SCADA) System

(a) The supervisory control and data acquisition requirements are described in Exhibit C – BESS SCADA Specifications of this Technical Specification.

9 CIVIL AND STRUCTURAL REQUIREMENTS

9.1 General

(a) It is the Contractor's sole responsibility to ensure the Facility structural and architectural facilities comply with all Applicable Codes and Standards and all Good Industry Practices.

(b) Contractor is responsible to determine all Site data necessary for the design and construction of the Facility. This includes, but is not limited to, determination of local, seismic design coefficients, flood design criteria, and any areas restricted from construction.

(c) Contractor shall perform all necessary structural studies of the Site to establish all required design-related parameters related to structural impacts of BESS installation.

(d) VINLEC will conduct a detailed Site geotechnical investigation. Contractor shall comply with the recommendations of all Site studies performed as provided by VINLEC.

(e) Contractor shall follow instructions and requirements described in Exhibit D - Cane Hall BESS - E200 SITE PLAN.
(f) The Contractor shall provide all structural calculations and drawings to VINLEC, with the 50% Design Documents.
(g) The drawings and calculations to support the design of all structural elements shall include, but are not limited to:
    (i) Inverter pad foundations, BESS foundation, and any other ancillary structure foundations if needed
    (ii) Connections between inverter pad and BESS foundations and inverter/BESS structures
    (iii) Product specifications, installation manual, operations and maintenance manuals and other commissioned or forthcoming reports
(h) VINLEC will review documents and submit comments. The Contractor shall address in writing any and all comments received from VINLEC.
(i) IEEE Std 693-2018 compliant seismic qualification reports for all equipment that falls within the scope of IEEE Std 693 and others as directed by VINLEC

9.2 Structural steel and fasteners

9.2.1 Steel members

(a) Any structural or miscellaneous steel shall meet the requirements of the applicable ASTM standard based on the application. This shall include the following ASTM designations, unless otherwise noted on the structural drawings, or unless otherwise specified by the engineer of record (EoR). For shapes for which the either the following ASTM material requirements or the EoR-specified materials differ in their minimum yield strength, the stricter (stronger) material shall govern:
    (i) Wide-flange (W-) sections: A992 minimum yield stress 50 ksi (345 N/sqmm).
    (ii) Rectangular hollow structural sections (HSS): A500 Grade B minimum yield stress 42 ksi (290 N/sqmm).
    (iii) Angles, C-channels, M-channels: A36 minimum yield stress 36 ksi (250 N/sqmm).
    (iv) Plates and flat bars: A36 minimum yield stress 36 ksi (250 N/sqmm).
(b) Equivalent standards for structural steel applicable in other markets and jurisdictions may be submitted for consideration to meet the requirements of this technical specification.

9.2.1.1 Sustainability of materials – procurement and reporting

(a) General Contractor shall provide environmental product declaration (EPD) for structural or miscellaneous steel procured for the Facility.
(b) Alternative: Structural or miscellaneous steel shall meet the following minimum recycled content:
    (i) Hot-rolled sections (W-sections, C- and M-channels, angles): 95%
    (ii) Cold-formed and hollow structural sections (HSS): 70-80%
    (iii) Plates and flat bars: 60-80%

9.2.2 Steel fasteners

(a) Stainless steel fastener hardware shall conform to ASTM F593.

(b) Mechanical fasteners used in any structural or support system shall meet the requirements of ASTM A325 or A490 for bolts nominally ½" diameter and larger, or ASTM A449 for bolts smaller than ½" diameter.
(c) Mechanical fasteners used as anchor rods shall conform to ASTM F1554 Grade 55.
(d) All structural welding shall conform to the requirements of the local revision of the IBC or AAWS D1.1 "Structural Welding Code" as adopted by the OECS Building Code.
(e) Equivalent standards for steel fasteners applicable in other markets and jurisdictions may be submitted for consideration to meet the requirements of this technical specification.

9.3 Aluminum

(a) Design of structural and miscellaneous aluminum shall be in accordance with the latest edition of the Aluminum Association - "Aluminum Design Manual" ADM1 and "Aluminum Standards and Data", and with the "Aluminum Sheet Metal Work in Building Construction" ASM 35.
(b) Materials for structural and miscellaneous aluminum, including structural shapes and plate, shall conform to ASTM B209 and ASTM B308.
    (i) Structural aluminum sections shall conform to 6061-T6 aluminum alloy having minimum yield strength of 35 ksi (241 N/mm2) for extruded tube, sheet, and plate shapes, unless otherwise noted in the construction documents.
(c) Aluminum welding shall conform to AWS D1.2 "Structural Welding Code-Aluminum", and weld filler metal shall be type 4043/4047 with minimum Ftuw of 24 ksi (165 N/sqmm), unless otherwise noted in the construction documents.
(d) Equivalent standards for structural aluminum applicable in other markets and jurisdictions may be submitted for consideration to meet the requirements of this technical specification.

9.4 Corrosion prevention

(a) All Facility Equipment shall be protected from corrosion due to known or expected atmospheric and soil conditions local to the Site in accordance with the Design Life and Good Industry Practices. Consideration shall be given to humidity, salinity, acidity, condensation, air particulates and other conditions likely to cause or accelerate corrosion of materials. The level of protection must take into account marine corrosion and other factors that are unique to the coastal locations.
(b) A service life analysis shall be completed that takes into account atmospheric conditions at the Site in order to estimate corrosion rates. The service life shall meet or exceed the required minimum Design Life.
(c) Structural design calculations shall be based on the reduction in steel thickness over the Design Life of the Facility.
(d) Contact of dissimilar metals and finishes shall be avoided or intentionally managed to prevent premature galvanic corrosion.
(e) Aluminum shall not be in direct contact with concrete or copper.
(f) Fasteners and hardware shall be stainless steel (300 series, if available with required mechanical strength) or hot-dipped galvanized steel.

(g) Galvanizing of steel products shall conform to the requirements of ASTM A123, ASTM A153, or ASTM F2329, as appropriate.
(h) For any components where the galvanization is disturbed due to factory processing or during installation, those surfaces shall be repaired in accordance with ASTM A780 and A780M-09.
(i) Concrete elements, including reinforcing steel, shall be designed consistent with ACI procedures for durability with regard to appropriate potential for corrosivity in the environment of the Site.

9.5 Structural design requirements

(a) Structural design loads
  (i) The design loads and other information pertinent to the structural design - including, but not limited to, wind design data and earthquake design data - shall be clearly indicated on the construction documents.
  (ii) Wind loads shall be developed in accordance with ASCE 7-10 procedures, using wind speeds in accordance with the OECS Building Code 7th edition:
    - Design wind speed, St. Vincent & the Grenadines: 155 mph.
    - Apply additional factors as applicable per OECS Building Code paragraph 1202.2(c)(i) and 1202.2(c)(ii).
  (iii) Seismic loads shall be developed in accordance with ASCE 7-05 procedures using spectral accelerations provided in OECS Building Code paragraph 1203.1(b):
    - For St. Vincent & the Grenadines: 0.2 s spectral acceleration = 1.091g; 1.0 s spectral acceleration = 0.363g.
  (iv) Load Combinations from IEEE std 693-2018 and ASCE MOP 113 shall be used for structural design of all substation structures and foundations, including for the BESS structure and foundations. Building structures, as approved by VINLEC, may be allowed to be designed in accordance with ASCE 7-10 procedures. Seismic and wind loads shall be in accordance with ASCE MOP 113 and IEEE Std 693-2018 for substation and BESS structures, and ASCE 7-10 procedures for building structures. For seismic design in accordance with ASCE 7 procedures, the Site classification of soil shall be as indicated in the geotechnical report for the Site.
  (v) Structural design shall account for thermal loads including thermal expansion, contraction and cycling. Buildings and structures shall be designed for forces and/or displacements resulting from changes in ambient temperature. Induced thermal loads (i.e., thermal loads induced by equipment operating temperatures) shall be considered in design of applicable structural elements.
(b) Structural design calculations
  (i) The structural analysis shall conform to procedures indicated in references listed in 9.5 a), and any referenced material design codes, including but not limited to OECS Building Code 7th edition and the 2021 IBC. This includes, but is not limited to, the following:
    - AISC-360 for steel.
    - ACI 318 for concrete.
    - AISI S100 for cold-formed steel.
    - AA ADM.
  (ii) Must account for soil and geotechnical conditions at the Project site.

(c) Equivalent standards for structural design applicable in other markets and jurisdictions may be submitted for consideration to meet the requirements of this technical specification.
(d) The effect of volcanic activity on structural support, if any, shall be considered in accordance with OECS Building Code paragraph 1309.2 with regard to slope stability.

9.6 Concrete foundations for equipment

(a) Design of structural concrete shall be in accordance with ACI 318-14. All concrete formwork shall conform to ACI PRC 347-14.
(b) Construction of the concrete foundation elements shall be in accordance with ACI 301 and ASTM C150 with a minimum 28-day compressive strength of 3,000 psi.
(c) Aggregates for normal weight concrete shall conform to ASTM C33, with aggregate size ¾" unless otherwise noted on the construction documents.
(d) Concrete mix proportions, including documentation of materials, admixture product information, and compressive strength of mix, shall be submitted and approved by VINLEC prior to placing concrete.
(e) Water used for concrete shall be clean and potable. Water-to-cement (w/c) ratio shall be in accordance with the construction documents.
(f) Steel reinforcement shall be grade 60 minimum and conform to ASTM A615. Welded steel mesh shall conform to ASTM A185. Plain wire shall conform to ASTM A82.
(g) Concrete placement shall be in accordance with Chapter 26.5 of ACI 318.
(h) Reinforcement placement shall be in accordance with Chapter 26.6 of ACI 318 and with the Manual of Standard Practice of The Concrete Reinforcing Steel Institute.
(i) Equivalent standards for structural concrete applicable in other markets and jurisdictions may be submitted for consideration to meet the requirements of this technical specification.

9.7 Roads

(a) Access paths or temporary roads, erosion control and drainage systems shall comply with Site studies, as applicable.
(b) For permanent roads, protection of equipment from impact events from vehicles should be considered to protect equipment from damage.

9.8 Trenches

(a) Cables and conduits installed in trenches shall comply with NEC requirements.
(b) There shall be no direct-bury cables.
(c) All buried conduits shall include a marker tape 12 inches below grade continuously over the conductors.
(d) Trench backfill shall comply with the recommendations of the Site studies.
(e) A sand bed of at least 2 inches shall be used as the base layer for all trenches housing direct buried cables. The sand bed shall be clean natural sand, clay, organic matter and should not include other objectionable materials.

(f) Trench shall be backfilled with clean fill material free from aggregate, debris, organic material and stones. An engineered fill shall be used if required based on the cable ampacity calculations.
(g) Trenches shall be backfilled in layers of no more than 6 inches each and mechanically compacted to 95% of maximum density at optimum moisture content per ASTM D698, or as recommended by the geotechnical engineer.
(h) Trenches shall not be backfilled while there is any standing water in the trench.
(i) Contractor shall inspect and repair sand beds in open trenches after rainfall events.
(j) Conduit stub-ups and sweeps shall be used for all conductors entering and exiting a trench.
(k) Open conduit ends shall be equipped with bushings and approved sealant to reduce intrusion of water, rodents and insects.
(l) Trenches shall be designed and constructed, to the extent possible, in straight lines and not routed below Facility Equipment.

10 ENGINEERING

10.1 Facility Design Basis

(a) Contractor shall ensure that the Facility is designed to meet the criteria listed in this Technical Specification.
(b) Approval by Governmental Authorities
    (i) When required by Governmental Authorities, Contractor shall submit documents to the Governmental Authorities for their review and approval. Contractor shall submit documents in accordance with the specific requirements of the Governmental Authority. Approval by the Governmental Authorities shall be obtained before proceeding with the affected design. Contractor shall notify VINLEC in writing in advance of submitting any documents to any Governmental Authority in connection with the Work, and Contractor shall provide a copy of the permit applications for review by VINLEC.
(c) Units of Measure:
    (i) US units of measurement shall apply on all documents such as drawings, diagrams, schedules, flow sheets, manuals, reports, correspondence, estimates, invoices, and transportation papers.
    (ii) All documents shall be in English.
(d) Design Codes and Standards:
    (i) The Facility shall be designed, installed, and tested in accordance with recognized industry standards appropriate to the duty, operational requirements, statutory obligations, and environmental conditions specified.
    (ii) The Work is to be designed and executed so as not to endanger the safety of persons, domestic animals, and property.
    (iii) The Facility will be designed and constructed in accordance with all requirements, including the standards set forth in this section.
    (iv) The Contractor shall develop a design basis document that lists design codes and where they have been applied.
    (v) Contractor is responsible for determining the specific Applicable Laws/standards applicable to the Facility and shall meet all requirements of any Governmental Authority. Contractor shall

obtain written approval from Governmental Authorities for all exceptions to the adopted codes, standards, and regulations. The following tables are provided as an example of Applicable Laws and standards that may be applicable.

10.2 Safety

10.2.1 Local Government and Jurisdictional Codes and Requirements

(a) The contractor shall engineer and construct the Facility in compliance with all current applicable local building codes and requirements adopted by the applicable authorities having jurisdiction. These typically include:
- (i) International Fire Code (IFC)
- (ii) National Electrical Code (NEC)

10.2.2 BESS Safety

10.2.2.1 Battery Cells, Modules and Racks

(a) Battery cells, modules, and racks shall meet the latest electrical and/or safety code and standard requirements including:
- (i) UL 1642 – Standard for Lithium Batteries
  - A. Specific to the battery cell
- (ii) UL 1973 – Standard for Batteries Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications
  - A. Specific to the battery module

(b) IFC 2018 and the California Fire Code requires compliance to this standard

(c) UN 38.3 – UN Transportation Testing for Lithium Batteries

10.2.2.2 Battery Containers

(a) Batter containers shall meet the latest code requirements of the following:
- (i) NEC/NFPA 70
- (ii) NEMA 4 or above

10.2.2.3 Battery Energy Storage System

(a) The BESS shall meet the latest requirements of the following electrical, fire, and safety codes:
- (i) UL 9540 – Standard for Energy Storage Systems and Equipment
  - A. IFC 2018 and the California Fire Code require compliance this standard
  - B. This standard requires compliance to UL 1973 and UL 1741, for the battery modules and inverter/power converters, respectively
- (ii) UL 9540A – Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems”
- (iii) NFPA 855 – Standard for the Installation of Stationary Energy Storage Systems
  - A. NFPA 855 requires the following for compliance:

- Large Scale fire test data shall be conducted on a representative ESS (Energy Storage System) in accordance with UL 9540A or equivalent test standard
  - Testing in accordance with UL 9540A, "Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems" is beneficial for conducting hazard mitigation analysis.
- A hazard mitigation analysis shall be conducted and provided to VINLEC for review and approval. The analysis shall evaluate the consequences of the following failure modes:
  - Thermal runaway condition in a single module, array, or unit
  - Failure of an energy storage management system
  - Failure of a required ventilation or exhaust system
  - Failure of a required smoke detection, fire detection, fire suppression, gas detection system, or any part of Safety System

10.2.3 BESS Fire Related Safety Considerations

(a) Contractor shall comply with all Applicable Laws and Governmental Approvals and all mitigation measures required by the Governmental Authority and demonstrate compliance as required by the Governmental Authority. This includes but is not limited to: appropriately siting the equipment in compliance with best practices related to safety, sufficiently and permanently securing the equipment to prevent access by unauthorized personnel, and incorporating permanent Safety System measures if deemed necessary by the Governmental Authority.

(b) The BESS shall be stored according to manufacturer recommendations. Storage conditions of the BESS should include, at a minimum, the following considerations:

   (i) Avoid lengthy exposure to heat and sun.
   (ii) Avoid exposure to high humidity (e.g., greater than 95% humidity) or wet conditions
   (iii) Keep away from combustibles
   (iv) Have a robust fire extinguishing system
   (v) Do not tilt, vibrate, drop, puncture, stack, or expose to the elements
   (vi) Request details of storage from the ContractorContractorContractor particular to the technology

(c) Setbacks and access ways shall comply with local revision of the International Fire Code, and per the local zoning and building code and all Applicable Laws.

(d) Where applicable, the system should be designed to minimize any potential risks of fires and explosions. However, in the case of a fire or explosion, the container(s) will be equipped according to applicable fire and explosion safety standards. This includes a detection and alarm system, documentation or training on safe suppression methodology for the technology, and, if demonstrated as necessary by large scale testing (aligned with UL 9540A) or if noted as required by the Governmental Authority, internal fire suppression equipment (e.g., a sprinkler) and explosion mitigation equipment (e.g., deflagration panels). Some jurisdictions may require battery spacing per NFPA requirements and egress and space requirements per the IBC depending on the occupancy rating of the enclosure/building to which the BESS solution shall be in compliance. The Contractor shall ensure the BESS design meets the following requirements.

(i) Either an automatic sprinkler system per NFPA 13 or an AHJ approved alternative fire extinguishing system that has been full scale fire tested shall be used, or an AHJ approved BESS designed to preclude thermal runaway that has been full scale fire tested.
(ii) Signage shall be located on the exterior of the enclosure in a location visible to first responders and acceptable to the AHJ. Signage shall indicate the type of energy storage system or batteries present, the type of suppression systems installed, and emergency contact information.
(iii) An approved automatic smoke detection system compliant with NFPA 72.
(iv) All fire alarm control panels shall be compliant with NFPA 72.
(v) An Explosion prevention system and/or explosion protection system shall be incorporated and shall comply with NFPA 69 and/or NFPA 68.

(e) Fire department access roads will be provided onsite to meet the following criteria: Unobstructed width of at least 20 feet, Unobstructed vertical clearance of 13 feet 6 inches, and no Dead-end access roads compliant with IFC Section 503 will be included in these projects.
(f) The Contractor shall provide comprehensive training and training material to ensure optimal safety and performance through installation, O&M, first responders, and emergency response procedures; as further described in Exhibit B – BESS Testing Specifications.
(i) As applicable, instruction shall include operation of safety system including fire detection/suppression.
(g) Decommissioning plan shall be provided both in the case of normal end of life decommissioning and in the case of an abnormal failure or fire event.

10.3 Industry Standards and Codes

10.3.1 Government and jurisdictional codes and requirements

Contractor shall engineer and construct the Facility in compliance with all applicable local building, electric, construction, mechanical, and fire codes, as well as requirements adopted by the applicable agencies having jurisdiction, as applicable to an energy storage system installed in an outdoor space. The system shall also comply with all VINLEC interconnection requirements as applicable.

10.3.2 Industry codes and standards

Additional industry codes and standards are referenced as a source of best practices. The Contractor is obligated to comply with local laws and regulations identified throughout this Technical Specification. Additional industry codes and standards, or their equivalents, which are recommended for consideration include, but are not limited to, the following:

- AA – Aluminum Association
    - Aluminum Design Manual
- AASHTO - Association of State Highway and Transportation Officials
- ACI – American Concrete Institute
    - ACI 301 – Specifications for Structural Concrete
    - ACI 318 – Requirements for Reinforced Concrete
    - ACI 347 – Guide to Formwork Concrete
- AISI - American Iron and Steel Institute

- ANSI – American National Standards Institute
  - ANSI C2 National Electrical Safety Code
  - ANSI Z535-2002 Safety Labels
- ASME American Society of Mechanical Engineers
- ASCE - American Society of Civil Engineers
  - ASCE 7-10 - Minimum Design Loads of Buildings and Other Structures
- ASTM - American Society for Testing and Materials
- AWS - American Welding Society
  - AWS D1.1 Structural Welding Code – Steel
  - AWS D1.2 Structural Welding Code-Aluminum
  - BS – British Standards
  - BS 7671 - Requirements for Electrical Installations: IET Wiring Regulations
- ICC - International Code Council
  - IBC - International Building Code
  - IFC - International Fire Code
- ICEA - Insulated Cable Engineers Association
  - ICEA S-93-639 (NEMA WC 74) - Shielded Power Cables 5,000V - 46,000V
  - ICEA S-94-649 - Concentric Neutral Cables Rated 5 through 46 kV
- IEC - International Electrotechnical Commission
  - IEC 60076: Series Ed. 2.1 Power transformers
  - IEC 60099, Surge Arresters
  - IEC 60296 Mineral Insulating oils for transformers & switchgear
  - IEC 60364-5-52, Selection and erection of electrical equipment – Wiring systems
  - IEC 60536 Classification of electrical and electronic equipment with regard to protection against electric shock
  - IEC 60529 Degrees of Protection Provided by Enclosures (IP Code)
  - IEC 60834-1:1999 - Teleprotection equipment of power systems - Performance and testing
  - IEC 60870-5-104 (Telecontrol equipment and systems - Part 5-104: Transmission protocols
  - IEC 61000-6-2:2005 - Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
  - IEC 61000-6-4:2006 - Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
  - IEC 61010 Relating to controllers
  - IEC 61140 Protection against electric shock - Common aspects for installation and equipment
  - IEC 61850 (Communication networks and systems in substations).
  - IEC 62103:2003 - Electronic equipment for use in power installations
  - IEC 62271: Series high-voltage switchgear and control gear
  - IEC 62804 Potential Induct Degradation
- IEEE - Institute of Electrical and Electronic Engineers
  - IEEE C2 - National Electrical Safety Code Capabilities for Voltages Above 1000 V
  - IEEE C12.2 - Standard for Utility Metering
  - IEEE C37.013 - AC High-Voltage Generator Circuit Breakers Rated on a Symmetrical Current Basis
  - IEEE C37.04 - Rating Structure for AC High-Voltage Circuit Breakers

- IEEE C37.06 - AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis - Preferred Ratings and Related Required
- IEEE Std C37.14: Standard for DC (3200V and below) power circuit breakers used in enclosures
- IEEE Std C37.16: Standard for Preferred Ratings, Related Requirements, and Application Recommendations for LV AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers
- IEEE Std C37.17: American National Standard for Trip Devices for AC and General Purpose DC LV Power Circuit Breakers
- IEEE Std C37.30.1 - Requirements for AC High-Voltage Air Switches Rated above 1000 V
- IEEE Std C37.40: Standard Service Conditions and Definitions for High-Voltage (>1000V) Fuses, Distribution Enclosed Single- Pole Air Switches, Fuse Disconnecting Switches, and Accessories
- IEEE Std C37.41: Standard Design Tests for High-Voltage (>1000V) Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
- IEEE Std C37.42-2009: IEEE Standard Specifications for High-Voltage (>1000V) Expulsion Type Distribution-Class Fuses, Fuse and Disconnecting Cutouts, Fuse Disconnecting Switches and Fuse Links, and Accessories Used with These Devices
- IEEE Std C37.47: Standard Specifications for High-Voltage (>1000 V) Distribution Class Current-Limiting Type Fuses
- IEEE C37.48 -Guide for Application, Operation, and Maintenance of High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
- IEEE C37.90 -Relays and Relay Systems Associated with Electric Power Apparatus
- IEEE C37.90.1 - Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- IEEE C37.90.2 - Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
- IEEE C37.91- Guide for Protective Relay Applications to Power Transformers
- IEEE C37.95- Guide for Protective Relaying of Utility-Consumer Interconnections
- IEEE C37.97- Guide for Protective Relay Applications to Power System Buses
- IEEE C37.102 - Guide for AC Generator Protection
- IEEE C37.106 - Guide for Abnormal Frequency Protection for Power Generating Plants
- IEEE C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
- IEEE C57.12.01 - General Requirements for Dry-Type Distribution and Power Transformers
- IEEE C57.13 -Requirements for Instrument Transformers
- IEEE C57.13.3 - Guide for the Grounding of Instrument Transformer Secondary Circuits and Cases
- IEEE C57.32- Requirements, Terminology, and Test Procedures for Neutral Grounding Devices
- IEEE C57.12.34: Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, three-Phase Distribution Transformers, 5MVA and Smaller: High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage and Below
- IEEE C57.116 - Guide for Transformers Directly Connected to Generators
- IEEE C62.11- Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV)

- IEEE C62.22 - Guide for the Application of Metal Oxide Surge Arresters for Alternating-Current Systems
- IEEE C62.82.1 - Standard for Insulation Coordination - Definitions, Principles, and Rules
- IEEE C62.92.1 - Guide for the Application of Neutral Grounding in Electric Utility Systems - Part I: Introduction
- IEEE C62.92.2 - Guide for the Application of Neutral Grounding in Electric Utility Systems, Part II - Synchronous Generator Systems
- IEEE C62.92.5 - Guide for the Application of Neutral Grounding in Electrical Utility Systems, Part V - Transmission Systems and Subtransmission Systems
- IEEE C84.1 Standard for Electric Power System and Equipment – Voltage Ratings
- IEEE C93.1 - Requirements for Power-Line Carrier Coupling Capacitors and Coupling Capacitor Voltage Transformers (CCVT)
- IEEE 80 Guide for Safety in ac Substation Grounding
- IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System
- IEEE 142 – Recommended Practice for Grounding of Industrial and Commercial Power Systems
- IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
- IEEE 400: Guide for Making High-Direct-Voltage Tests on Power Cable Systems in the Field
- IEEE 400.2: Guide for Field Testing Shielded Power Cable Systems Using VERY Low Frequency (VLF) (less than 1 Hz)
- IEEE 519 – Recommended Practices and Requirements for Harmonics Control in Electrical Power Systems
- IEEE 665 – Guide for Generating Station Grounding
- IEEE 693 - Recommended Practice for Seismic Design of Substations
- IEEE 979 - Guide for Substation Fire Protection
- IEEE 980 - Guide for Containment and Control of Oil Spills in Substations
- IEEE 1001 - Guide for Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems
- IEEE 1109 - Guide for the Interconnection of User-Owned Substations to Electric Utilities
- IEEE 1453 - Recommended Practice for the Analysis of Fluctuating Installations on Power Systems
- IEEE 1547-2018 – Standard for Interconnecting Distributed Resources with Electrical Power Systems
- UL 1741 SA (Supplement A) Advanced Inverter Testing and Certification for Rule 21
- IEEE 1547.1 Standard Conformance Test Procedure for Equipment Interconnecting Distributed Resources with Electric Power Systems
- IEEE 1547.2 Interconnecting Distributed Resources with Electric Power Systems
- IEEE 1547.3 Guide for Monitoring, Information Exchange, and Control of Distributed Resources Interconnected with Electric Power Systems
- IEEE 1547.4-2011 – IEEE Guide for Design, Operation, and Integration of Distributed Resource Island Systems with Electric Power Systems

    - IEEE 1547.8/D8, Jul 2014 – IEEE Draft Recommended Practice for Establishing Methods and Procedures that Provide Supplemental Support for Implementation Strategies for Expanded Use of IEEE Standard 1547
    - IEEE 1547–2003 Standard for Interconnecting Distributed Resources with Electric Power Systems
    - IEEE 1584 – Guide for Performing Arc Flash Hazard Calculations
    - IEEE 1185 – Recommended Practice for Cable Installation in Generating Stations and Industrial Facilities
    - IEEE 2030.7 – Draft Standard for Specification of Microgrid Controllers
    - IEEE 3007.3 – Recommended Practice for Electrical Safety in Industrial and Commercial Power Systems
    - IEEE 3001.8 – Recommended Practice for Instrumentation and Metering of Industrial and Commercial Power Systems
- ISA - Instrumentation Society of America
- ISO – International Standards Organization
    - 9001 Quality Management System
    - 14001 Environmental Management System
- NEC - National Electric Code
- NEMA – National Electric Manufacturers Association
    - NEMA 4 (Enclosures) or above
- NETA - International Electrical Testing Association
    - ATS - Acceptance Testing Specifications
    - ETT - Standard for Certification of Electrical Testing Personnel
- NFPA – National Fire Protection Association
    - NFPA 1: Fire Code
    - NFPA 70: National Electrical Code (NEC)
    - NFPA 70E: Standard for Electrical Safety in the Workplace
    - NFPA 780: Standard for the Installation of Lighting Protection Systems
    - NFPA 704: Standard System for the Identification of Hazard Material for Emergency Response
    - NFPA 855: Standard for the Installation of Stationary Energy Storage Systems
- NIST – National Institute for Standards in Technology
    - NISTIR 7628: Guidelines for Smart Grid Cyber Security
- OSHA - Occupational Safety and Health Administration
- TIA – Telecommunications Industry Association
    - J-STO-607-A-2002: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
- UL - Underwriters Laboratories
    - UL 96 Lightning Protection Systems
    - UL 248-1: Low Voltage (<1000V) fuses – Part 1 General Requirements
    - UL 758 Standard for Appliance Wiring Material
    - UL 1642 Standard for Lithium Batteries (cell safety)
    - UL 1741 Standard for Inverters, Converters, Controllers, and Interconnection System Equipment for Use with Distributed Energy Resources
    - UL 1741 SA (Supplement A) Advanced Inverter Testing and Certification for Rule 21

- UL 1778 Underwriters Laboratory's Standard for Uninterruptible Power Systems (UPS) for up to 600V A.C.
- UL 1973 Batteries for Use in Light Electric Rail Applications and Stationary Applications, also requires FMEA (protection system)
- UL 1977 Standard for Component Connectors for Use in Data, Signal, Control and Power Applications
- UL 9540 Outline of Investigation for Energy Storage Systems and Equipment
- Standards for miscellaneous parts and components

11 QUALITY ASSURANCE AND CONTROL

(a) Contractor is responsible for ensuring those performing the installation are trained to install the system in line with specifications, CEC, and all other applicable requirements, to an appropriate level of quality. To this end, the following items are within the Contractor's responsibility:

(b) Contractor shall implement a QA/QC program to ensure the necessary measures are taken to support successful execution of the Agreement.

(c) Contractor shall provide QA/QC supervision to maintain quality control in line with Good Industry Practices for similar work.

(d) Contractor shall provide to Owner a Site-specific, detailed QA/QC Plan. The QA/QC Plan, at a minimum, shall address all aspects of the following as related to Contractor's scope:
   - Procurement of Equipment, including inspections
   - Construction of the Project, including concrete testing details
   - Commissioning and testing of the BESS system, enclosures and control building.
   - Corrective action procedures that address defective materials, chain of supply, discrepant system components and field issues.

(e) Contractor shall updated the QA/QC Plan at Owner's request as applicable, to ensure all testing and inspection procedures satisfy Applicable Standards and regulations.

(f) Owner may perform an audit of the QA/QC Plan at any point during the Work.

(g) The QA/QC Plan shall include a continuous improvement program. All improvements shall be logged as lessons learned and made available to the Owner.

(h) Contractor shall perform inspections and field quality control testing as related to the Contractor's scope throughout the construction process including:
   - Assessing existing conditions
   - Construction installation placement and qualification measurements
   - Final inspections and tests
   - Photographs shall be taken of each open trench with all conductors prior to backfill
   - Any other tolerance requirements as outlined in the approved engineering drawings and/or manufacturer's recommendations

(i) Torque
   - Contractor shall ensure all fasteners are torqued properly according to the manufacturer's instructions.
   - Torque marks shall be provided on all structural fasteners and electrical terminations to indicate torque has been verified.

- Proper torque shall be achieved through the use of non-powered, calibrated torque wrenches. Electric and air-driven tools shall not be relied upon to provide final torque without Owner approval.
- Contractor shall compile a torque chart for the Project that includes the required torque settings for all fasteners and electrical terminations.

(j) Contractor shall coordinate and document all QA/QC requirements, inspections, and test results.

12 START UP AND COMMISSIONING

(k) All testing procedures for the startup and commissioning of the Facility shall be in accordance with the requirements of Exhibit B – BESS Testing Specifications, of this Technical Specification.

(l) Management and Supervision of Operations

(i) From initial startup until Final Acceptance, the Contractor shall be responsible for the operation and maintenance of the Facility.

(ii) The startup, commissioning and performance testing of the Facility shall be managed and supervised by the Contractor using trained personnel. Personnel shall be trained by the Contractor to VINLEC's satisfaction to ensure safe and orderly Facility startup and operation.

13 ON-SITE BUILDINGS

13.1 Transformer Shed

(a) Contractor should provide protection for medium voltage equipment (11-kV), including an overcurrent relay for the 11-kV bus at minimum.

(b) Contractor should install relay in existing Transformer Shed.

(c) If the BESS design includes additional 11-kV relaying, Contractor shall coordinate with VINLEC to install such equipment in the transformer shed.

13.2 BESS Control House

(a) The BESS control house shall be installed by the Contractor.

(b) Control house design shall be approved by VINLEC.

(c) All BESS management systems and telecommunication system, including BESS Plant Controller, BESS HMI, SCADA, and telecommunication equipment, alarms, etc. shall be installed in the control house; as described in Exhibit C – BESS SCADA Specifications.

(d) The telecommunication interface between the control house and transformer shed shall be via fiber optic connections.

(e) Contractor shall coordinate with VINLEC regarding all design aspects of the control house, including location, minimum accommodation, and size requirements.

(f) The control house shall be located adjacent to the VINLEC substation house.

13.3 Security System

(a) Contractor shall provide a security system that meets the following requirements:

- (i) Alarm system - output relays and position switches for container doors.
- (ii) Access Control on container doors.
- (iii) Provision of the required low voltage power supplies for the systems listed above.
- (iv) Program and commission this system into the VINLEC Security System, if applicable, with a VINLEC representative.
- (v) All wiring shall be installed in raceways provided by Contractor.

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