Schedule D

Standard Specification

Battery Plant Energy Management System

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1. General

1.1.1.1 This document shall be read as part of a complete Specifications package consisting of documents numbered below:

- *Energy Storage System* Request for Proposal (RFP)
- *Battery Energy Storage System* Specification
- *Power Conversion System* Specification
- Power Transformer Specification
- *Energy Management System* Specifications
- Electrical Balance of Plant and Installation Specifications
- Site Works and Civil Balance of Plant Specifications
- Containerized Building Specification
- Packaging and Shipping Requirements

1.1.1.2 Following definitions and abbreviations will be used for this Specifications:

a.) ***Balance of Plant*** or ***BOP*** – electrical and site works for the entire facility, excluding the *ESS* equipment and *EMS*

b.) ***Battery Energy Storage System*** or ***BESS*** – A lithium-ion electrochemical storage device capable of delivering or absorbing electrical energy at its *DC Bus*

c.) ***Battery Management System*** or ***BMS*** – the control and monitoring system for the *BESS* designed to manage all internal bank functions and internal protection. The *BMS* shall communicate with the *PCS* and *EMS*

d.) ***Battery Module***- An assembly of rechargeable battery cells with a convenient mechanical arrangement and a degree of protection

e.) ***Battery Rack*** – a free standing assembly of battery modules, integrated as part of an overall *BESS*

f.) ***Calendar Life*** – The expected number of calendar years that the battery is expected to last independent of charge and discharge cycles

g.) ***Contract*** – The agreement resulting from this RFP process

h.) ***Contractor***– the successful *Proponent* with whom the *LUCELEC* may enter into a *Contract*

i.) ***Current Transformer*** or ***CT*** - an instrument transformer used to step down a measured current for metering, control or protection purposes

j.) ***DC Bus*** – the direct current connection between the *PCS* and *BESS* capable of carrying rated system power

k.) ***Depth of Discharge*** or ***DOD*** – the ratio of the amount of energy discharged from the *BESS* to the maximum dischargeable energy capacity of the *BESS*

l.) ***End of Life*** or ***EOL*** – the defined remaining *BESS* capacity as a percentage of the amount of initial *BESS* capacity at which the *BESS* system becomes not functional as initially designed

m.) ***Energy Management System*** or *EMS* – the *Contractor* supplied power plant control system that communicates to the *PCS* and coordinates plant functions

n.) ***Energy Storage System*** or *ESS* – - consists of a *Battery Energy Storage System (BESS)* and a *Power Conversion System (PCS)*

o.) ***Factory Acceptance Testing*** or *FAT* – performance testing of all equipment at the factory to ensure it meets the specifications and requirements prior to shipment to site

p.) ***Factory Integration Testing*** or ***FIT*** - performance testing at the factory of an integrated system, consisting of the *ESS, PCS* and *EMS* to ensure interface between components is functional prior to shipment to site

q.) ***Input/Output*** or ***I/O –*** refers to the input or output signals associated with a control system or component of the control system such as a programmable logic controller.

r.) ***Inspection and Test Plan*** or ***ITP*** – the plan for managing the quality control and assurance of a particular the construction work providing information on the requirements, overview of the method(s) to be used, responsibilities of relevant parties, and documentary evidence to be provided to verify compliance

s.) ***Human Machine Interface*** or ***HMI*** – A user interface that serves as the main point of interaction between an operator of the battery plant and the settings, functions and commands associated with the plant

t.) ***Low Voltage Bus*** – the alternating current connection between the *PCS* inverter and the step-up transformer

u.) ***LUCELEC –*** St. Lucia Electricity Services Limited

v.) ***LUCELEC's Representative*** – The person appointed by the *LUCELEC* who has responsibility for managing the *Contract* and, unless *Contractor* is expressly advised otherwise, *LUCELEC's Representative* (1) has full authority to act on behalf of and bind *LUCELEC*, and (2) may, in writing, delegate any or all of his or her authority to any other person

w.) ***Power Conversion System*** or *PCS* – The Battery *PCS* is the power interface from the battery system to the AC electrical grid

x.) ***Proponent*** or ***Tenderer*** – Each company receiving this *Request for Proposal*

y.) ***Proposal*** – Documents submitted by *Proponents* in response to this *RFP*

z.) ***Potential Transformer*** or ***PT*** - also known as a Voltage Transformer, an instrument transformer used to step down the main connection voltage for metering, control or protection purposes

aa.) ***Programmable Logic Controller*** or ***PLC*** – A ruggedized industrial computer on which the core logic of the control system resides

bb.) ***Primary Frequency Response*** or ***PFR –*** The first stage of frequency control in response to a disturbance on the power system frequency. Traditionally provided by fast acting governor systems.

cc.) ***Request for Proposal*** or ***RFP –*** This Request for Proposal including all attached and referenced documents and subsequent addenda

dd.) ***Remote terminal unit*** or ***RTU -*** A controller that interfaces with a physical system or sub-system of the plant and transmits information to the SCADA network.

ee.) ***Supervisory Control and Data Acquisition System*** or ***SCADA*** – the plant Supervisory Control and Data Acquisition system supplied by *LUCELEC*

ff.) ***SCADA Network*** – the communications network that facilitates the communication between *PLCs* and other networked components within the *BESS*

gg.) ***Site Acceptance Testing*** or ***SAT*** – performance testing of all installed equipment at site to ensure it meets the specifications and requirements and that there was no damage during shipment or installation

hh.) ***State of Charge*** or *SOC* – the ratio of present dischargeable energy storage capacity to maximum dischargeable energy storage capacity expressed either in percentage or MWh

ii.) ***Subcontractor –*** Any firm/individual that the *Contractor* may contract with to perform a portion or all of the *Work* and for which the *Contractor* assumes liability

jj.) ***System Control Center*** or ***SCC*** – The *LUCELEC* control center that dictates power system commands to distributed generators through the *LUCELEC SCADA*

kk.) ***Uninterruptible Power Supply*** or ***UPS*** - an electrical apparatus that provides emergency power to a load when the input power source or mains power fails.

ll.) ***Work*** or ***Supply –*** All or any part of the services and obligations required to be performed under the *Contract*.

1.1.1.3 This Specification is for the supply of all labour, materials, and services required for the design, engineering, detail, programming, supply, testing, delivery and commissioning of the supervisory software and hardware controls package to be used as part a new *Energy Storage System (ESS)* to be installed in Vieux Fort, St. Lucia, beside the La Tourney Solar PV Plant. This Specification provides the software and hardware requirements for the Battery Plant *EMS*.

1.1.1.4 The work called for is subject to the purchase order documents. They include this Specification, the general conditions of contract, any specific conditions and any other attachments, all of which form an integral part of the contract. The *Contractor* shall be responsible for and be

governed by all requirements therein. **Any exceptions to this Specification shall be stated in writing by the *Contractor* and a suitable alternative can be priced as an option.**

1.1.1.5 The supplied equipment shall be designed for continuous operation and all components shall be of a robust, industrially proven design.

1.1.1.6 The *Contractor* supply shall include all components and accessories as required for the proper and safe operation of the complete system.

1.1.1.7 Compliance with this Specification does not relieve the *Contractor* of the responsibility to provide safe and reliable equipment. The *Contractor* shall have overall responsibility for the safety of the *EMS* design. Any areas of the *EMS* and its subsystems that pose a risk to the environment, personnel, or *LUCELEC*'s assets are to be clearly communicated to *LUCELEC* and its representative.

1.1.1.8 The equipment shall be complete in every aspect and ready to operate after installation and connection.

2. Codes and Regulations

2.1 General

2.1.1.1 The *EMS* shall comply with all applicable local regulations and codes for the local jurisdiction in which the *EMS* is to be installed.

2.1.1.2 All electrical components shall meet all National Building Code, and UK Electrical Industry British Standards (BS) requirements and bear a recognized certification mark such as one of CE Mark, IEC, ANSI, UL, FM, etc. All *EMS* subsystems shall either be listed or be field evaluated for installation in St. Lucia by an approved agency.

2.1.1.3 The *Contractor* shall clearly indicate in their *Proposal* the standards which the requested equipment meets. The *Contractor* shall clearly indicate if field certification is required for any necessary standards.

2.1.1.4 Certification of equipment shall be at the *Contractor*'s expense.

2.1.1.5 In case of conflict between these standards and this Specification, the *Contractor* shall notify *LUCELEC* and its representative in writing of such conflicts as soon as they become known.

2.1.1.6 *LUCELEC*'s standard design and material requirements are included in *Schedule H – LUCELEC Design Criteria and Standards*. For the *EMS* hardware components, it is preferred that *Proponents* comply with any applicable *LUCELEC* requirements when possible. However, should complying with these requirements for the *EMS* lead to considerable added costs, *Proponents* may take exception. *Proponents* shall note any exceptions.

2.2 Standards

2.2.1.1 The supplied equipment shall be designed, manufactured and tested in accordance with the most current revision of the following applicable standards, codes and regulatory bodies:

- International Electrotechnical Commission (IEC).
- UK Electrical Industry British Standards (BS)
- IET Wiring Regulations BS 7671:2018
- OECS Building Code Grenada, St. Vincent & the Grenadines, St. Lucia, Montserrat, latest version (National Building Code)
- Underwriters Laboratory (UL).
- CE Mark
- Institute of Electrical and Electronics Engineers (IEEE).
- EMC Directive (2014/30/EU) and IEC 61000 Electromagnetic Compatibility, specifically IEC 61000-1-2 and IEC 61000-6-7
- IEC 61131: Programmable Controllers
- IEC 61850: Communication networks and systems for power utility automation
- IEC 62351: Power systems management and associated information exchange - Data and communications security
- IEC 62443: Industrial communication networks – Network and system security
- IEC 60870-5: Telecontrol equipment and systems. Part 5: Transmission protocols
- IEC 61427-2: Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 2: On-grid applications
- EN 50549-1: Requirements for generating plants to be connected in parallel with distribution networks - Part 1: Connection to a LV distribution network - Generating plants up to and including Type B
- EN 50549-2: Requirements for generating plants to be connected in parallel with distribution networks - Part 2: Connection to a MV distribution network - Generating plants up to and including Type B
- IEC TS 62786: Distributed energy resources connection with the grid

2.2.1.2 The *EMS* shall have a CE mark.

2.2.1.3 The *Contractor* is responsible for any on-site certification or other inspection requirements.

2.2.1.4 *Proponents* may propose an *EMS* which have UL equivalent certifications. *Proponents* shall indicate the equivalent IEC and UL standard, if electing to supply UL certified equipment.

3. Scope of Supply

3.1 *EMS* Materials and Work Included

3.1.1.1 The *EMS* scope of supply includes but is not limited to the items identified in Table 1.

Table 1 EMS System Scope of Supply

Item	Qty	Deliverable Brief Description
		SOFTWARE
1.	1 lot	Fully programmed and tested *EMS* addressing the components of this specification.
2.	1 lot	Software source code. Contractors to state degree of access to the code by *LUCELEC*.
3.	1 lot	Communications and command interface to *LUCELEC System Control Center*
4.	1 lot	Human machine interface for interaction with the *EMS*
5.	1 lot	Spare fully programmed and tested *EMS* (main controller) for *LUCELEC's* use in a testing environment.
		HARDWARE
6.	1 lot	*EMS* system hardware package inclusive of all necessary auxiliaries, cabling, fiber, enclosures and networking equipment
7.	1 lot	On-premises data historian for logging all internal battery plant signals. This is expected to be a separate device from the *EMS* controller.
8.	1 lot	Supporting *SCADA* network infrastructure to facilitate the connection of the *EMS* with the *ESS* subsystems.
9.	1 lot	Recommended spare parts that will be stored and maintained by LUCELEC
		SHIPPING
10.	1 Lot	Packaging and Shipping to the La Tourney Solar PV farm in Vieux Fort, St. Lucia; the *Contractor* is responsible for the transportation to the site including all necessary insurances. The *Contractor* must also provide the necessary preparations and required packaging of the system for transportation.
		ENGINEERING
11.	1 Lot	Documentation The *Contractor* is to provide engineering drawings and documentation on scope of supply, as described below. Software packages • Software Functional Description. • Software Architecture and Logic Diagram. • Network Communications Drawings. • Communication Interfaces/Tag List. • Data recording tag list • Hardwired I/O Interface. • SCADA points. • Command/Control Sequence Diagrams. • Cyber Security Compliance/Certification Documentation.

Item	Qty	Deliverable Brief Description
		• Installation Manual. • Operation Manual. • Maintenance Manual and Schedule. Hardware packages • Installation Drawings. • Interconnection Drawings. • Electrical and Schematic Drawings. • General Arrangement Drawings. • Cable Schedules. • Installation Manual. • Maintenance Manual and Schedule. • Bill of Materials. • As-Built Drawings. The *Contractor* shall be responsible for sealing all issue for construction or final drawings with an APESL (Association of Professional Engineers of St. Lucia) seal.
12.	1 Lot	Certifications for the *EMS* package
		TESTING
13.	1 Lot	*Factory Acceptance Test (FAT)* plan to be submitted to *LUCELEC* and its representative for approval.
14.	1 Lot	A *Factory Acceptance Test (FAT)* must be completed at a facility of the *Contractor*'s choosing before any equipment is sent to site. The tests must be designed to prove compliance with all the Specifications described herein. A detailed *FAT* report must be provided to *LUCELEC* and its representative. *LUCELEC* or its representative **may elect** to witness the *FAT*. *LUCELEC* or its representative **may elect** to witness the *FIT*.
		SITE WORK
15.	1 lot	Installation of all *Contractor* supplied equipment.
16.	1 lot	Pre-Commissioning, Commissioning and Start-up of supplied equipment.
17.	1 lot	*EMS Site Acceptance Testing* to be completed at site to demonstrate *PCS* capabilities with respect to the Specifications described herein. The *Contractor* is to assume a minimum of two days of site assistance to conduct *EMS* acceptance tests.
18.	1 lot	Operation and Maintenance Training and Documentation The *Contractor* must prepare an operation manual for *LUCELEC* and provide training for *LUCELEC*'s staff (both engineering and operations staff). The *Contractor* is to provide a minimum of one week of site training.
		ONGOING SUPPORT
19.	1 lot	The *Contractor* shall provide yearly pricing for an Operations Support Contract that includes a minimum of 80 hours of remote support and 1 site visit per year.

Item	Qty	Deliverable Brief Description
20.	1 lot	The *Contractor* shall provide an hourly rate sheet for support above the provisions of the Operations Support Contract.
		OPTIONAL SCOPE
21.	1 lot	Spare *Energy Management System* hardware (main controller) for *LUCELEC's* use in a testing environment to be priced as an option.
22.	1 lot	Redundant *Energy Management System* hardware (main controller), that would be used in a hot-standby configuration. To be priced as an option.

4. Software & Programming Requirements

4.1.1.1 The following sections in this technical specification describe the control functions and interfaces that are required as part of the control system. This list is not comprehensive and the *Contractor* is to supply any other functions that support those listed below. Descriptions of the specific functional requirements and interfaces are described in the following sections in this specification.

4.2 General

4.2.1.1 The *EMS* system shall include a complete software/hardware package to perform all the required functions and monitor the *ESS* plant.

4.2.1.2 The supplied product shall be designed and programmed to operate continuously, 24 hrs per day, 365 days per year without excessive maintenance or operator supervision.

4.2.1.3 Redundant controllers (redundancy on both hardware and software) shall be utilized and configured as a hot standby mode of operation for reliable functioning of the *ESS*. Upon failure of the operating controller, operation must seamlessly transfer to the standby controller and alarm on the primary controller failure. Additional redundancies in the *Contractor*'s technology shall be described. If hardware redundancy is not part of the *Contractor's* core technology offering then this shall be priced as an option.

4.2.1.4 The *EMS* must have a single location where all communication to the external *LUCELEC SCADA* network will connect. For clarity, the *EMS* communication interface with *LUCELEC* is expected to have redundancy with multiple connections, however these connections shall be located in the same area.

4.2.1.5 The *EMS* shall be capable of controlling the *ESS* using multiple function/control modes. The *EMS* must be able to move freely between each mode of operation at any time. These modes are described in the subsequent sections.

4.2.1.6 The *LUCELEC System Control Center* shall be able to dictate the active control mode and any settings associated with the control modes. These shall be transmitted to the *EMS* through the *LUCELEC* grid SCADA network.

4.2.1.7 The *EMS* must be able to coordinate the synchronization and connection of the *ESS* to the *LUCELEC* grid. The synchronization procedure is to be described by the *Contractor* and presented to *LUCELEC* for validation.

4.2.1.8 Coordination and transition between different software functions, whether automatic or manual, must result in continuous smooth control of the battery system. Transitions between operating modes shall not result in step change outputs other than when a step change response is dictated by design.

4.2.1.9 The *EMS* shall have a stable response in all control modes.

4.2.1.10 The *EMS* must ensure that the operating limits of all interconnecting equipment are respected including instantaneous discharge/charge levels for *ESS* and intertie loading limitations.

4.2.1.11 The *EMS* must be able to monitor the power quality at the point of interconnection and characterize the instantaneous power system state. Direct PT/CT power system measurements by the *EMS* are required. This monitoring shall be done at a suitable accuracy and sampling rate for to meet the functional requirements.

4.2.1.12 The *EMS* must be able to monitor the power quality throughout the *ESS* facility. This monitoring can be accomplished through direct *CT/PT* connections or through networked devices throughout the *ESS* plant. Where distributed power system measurements obtained through a SCADA network are to be relied upon, the Contractor is to describe how these measurements will be obtained and communicated to the *EMS*. The Contractor is to describe how this information will be of sufficient quality and transmission speed for the function of the *EMS* and overall *ESS*.

4.2.1.13 The *EMS* shall include provisions for an orderly and safe shutdown of the *ESS* in the absence of the grid power when operating in grid-connected mode. See Section 0 – Black Start Capability Requirements for operation during grid outages.

4.2.1.14 The *EMS* shall be equipped with ramp rate limiting controls that are capable of limiting the ramp up or down of the real power of the *ESS* for the purpose of responding to dispatches or directives. The ramp rate controller shall be capable of ramp rate control of 0 to 1000 MW/min. This ramp rate shall be adjustable by *LUCELEC*.

4.2.1.15 Routine maintenance on the *EMS* will be performed by *LUCELEC* staff. The *Contractor* shall provide a comprehensive manual for routine maintenance.

4.2.1.16 The *EMS* must monitor and log all operational parameters, equipment statuses, power quality information, alarms/faults of the *ESS* power plant. This information shall be logged by the *EMS* in the *EMS* Historian and be made available to the *LUCELEC* SCADA network.

4.2.1.17 *LUCELEC* shall be provided access and instructions to periodically backup the *EMS* historian.

4.2.1.18 The *Contractor* must provide a description of the failure scenarios related to the *EMS* equipment.

4.2.1.19 The *EMS* Contractor must provide failsafe backups and supporting programs in the event of a system failure that allow *LUCELEC* to restore the system back to normal operation as quickly as possible. See Section 5.4 for more information on the data recording requirements of the system. This includes:

- Data archives of the *EMS* historical data.
- A backup of all settings that were in operation prior to the system failure.
- A faults/alarms list that was logged prior to the failure event.
- Any troubleshooting programs used to log or diagnose communication failures to the *EMS* equipment.

4.2.1.20 The *Contractor* shall have overall responsibility for the safety of the *EMS* design. Any areas of the *EMS* that pose a risk to the environment, personnel, or *LUCELEC* assets are to be clearly communicated to *LUCELEC* and their representative.

4.2.1.21 The *EMS* design must allow for future expandability. Expandability includes the addition of control functions and new modules for additional energy storage capacity.

4.2.1.22 Safety policy/features must be specified in the control and operation philosophy under normal operation and under emergency situations. Clear safety instructions must be provided to *LUCELEC* Operators.

4.2.1.23 The *EMS* must be able to support remote access to the *HMI* and any other *LUCELEC*-accessible software provided by the *Contractor*.

4.2.1.24 The *Contractor* is to supply any specific or proprietary diagnostic and troubleshooting tools/software packages.

4.3 Software Access by LUCELEC

4.3.1.1 The *Contractor* is to describe the level of software code access and modification available to *LUCELEC*. *Contractors* are to describe the impact of *LUCELEC*'s accessibility to the *EMS* software related to:

- Warranties.
- Training required for *LUCELEC*'s staff.
- Black box components that are not accessible to *LUCELEC*.

4.3.1.2 The *EMS* shall be programmed using a utility-recognized programming language based on the IEC 61131 standard.

4.3.1.3 *LUCELEC* shall have access to *EMS* operating variables within the user programming environment to read *EMS* parameters and to set plant-level operating parameters.

4.3.1.4 The *Contractor* shall provide documents with detailed instructions on how the software code can be modified. All appropriate licenses required to operate the software shall be provided.

4.4 Active Power Dispatch Functionality

4.4.1.1 The *ESS* shall be designed to contribute to *LUCELEC*'s operating reserve, allowing other generation assets to operate at more efficient setpoints. The *EMS* shall receive a setpoint from the *LUCELEC SCADA* system if the *ESS* Operating Reserve is required. **The Operating Reserve Functionality will follow an Active Power Dispatch structure as described below. The *Contractor* shall advise if any additional functionality is required to meet this use case.**

4.4.1.2 The primary operation mode of the *EMS* and ESS will be to receive an active power setpoint command from the *LUCELEC SCADA*. The logic to determine the active power setpoint will be calculated within the *LUCELEC System Control Center*.

4.4.1.3 The *EMS* shall receive an active power setpoint (in MW) from the *LUCELEC SCADA* system and the *EMS* must coordinate the battery plant as a single entity on the *LUCELEC* grid to ensure that the *LUCELEC* setpoint is met at the point of interconnection for the plant

4.4.1.4 The *EMS* must allow for *LUCELEC SCADA* to issue a setpoint command, echo that setpoint back to *LUCELEC SCADA* and then receive a binary command to execute the setpoint change.

4.4.1.5 The *EMS* must also have to option to receive the *ESS* setpoint in the form of a daily schedule. The dispatch interval of the schedule shall be adjustable between ten minutes and one hour.

4.4.1.6 The *EMS* must also have the option to react to pulse commands to raise/lower the output power by a set increment. Two separate pulse commands shall exist; fine and coarse control with different increments. The increments must be adjustable through the *LUCELEC SCADA* and local *HMI* and be between 100 kW and 1 MW.

4.4.1.7 The *EMS* shall notify the *LUCELEC SCADA* system if the desired power setpoint is unable to be met and should set a suitable alarm.

4.4.1.8 Any changes in the *EMS* setpoint as received from *LUCELEC SCADA* shall have the applicable ramp rate limit applied to the setpoint change as defined in 4.2.1.14.

4.4.1.9 During the times when there is no control signal from the *LUCELEC SCADA*, the *EMS* may charge or discharge the *BESS* until it reaches a *State-of-Charge* setpoint (e.g., 50%), as described in Section 4.5.2 (*State-of-Charge* Management).

4.4.1.10 The timestep and polling rate of this function shall be configurable between 1 second and 10 minutes in 1 second timesteps.

4.4.1.11 The active power dispatch of the *EMS* shall be decoupled from the reactive power dispatch within the limitations of the system MVA rating.

4.4.1.12 The *EMS* must be able to meet and support the response times for active power dispatch found in Table 2.

Table 2 Active Power Dispatch Response Times for *EMS*

Parameter	Performance Target	Parameter Definition
A: Controller Reaction Time	< 100 milliseconds	Reaction time of the *EMS* measured as the time between receiving a setpoint from the *LUCELEC SCADA* and the transmission of the command to distributed components in the *ESS*.
B: *PCS* Response Time	< 200 milliseconds	Response time of the *Power Conversion System*(s) distributed throughout the *ESS*. This response is detailed in the *PCS* Specification and captures both the *PCS* reaction time and rise time.
C: Total Response Time of the *ESS* Plant	< 300 milliseconds	Representative of the total time from receipt of a *SCADA* command to when 100% of the power setpoint is detected at the point of interconnection.
Setpoint Accuracy	Within +/- 2%, +/-1% preferred	Accuracy of the measured power at the POI after stabilization

4.5 Primary Frequency Response (PFR)

4.5.1.1 The *ESS* shall be capable of providing primary frequency response to frequency deviations from 50 Hz. Voltage and current transformers shall be supplied as part of the *Electrical Balance of Plant Specification.*

4.5.1.2 The *PFR* functionality can either reside on the *EMS* or, if the *PCS* technology has the capability to provide this function, the *EMS* shall be responsible for managing the operating mode of the distributed *Power Conversion Systems* to provide this functionality. Regardless of the methodology the entire *ESS* plant shall act as a single entity in response to frequency variations with negligible delay times between distributed power converters.

4.5.1.3 This function shall have the capability to be activated or deactivated while the other active power modes are active. Any response elicited by the primary frequency control function shall be combined with any other *ESS* response that may be active at the time of frequency event.

4.5.1.4 The *PFR* function of the *EMS* must:

- Be continuously in service, free to respond to frequency changes and controlling the response to frequency changes while the *ESS* is connected to the transmission system.
- Be able to respond in both the upward (under-frequency) and downward (over-frequency) directions.
- Have a fixed droop characteristic that is adjustable from 0 to 10% in increments of 0.01 Hz
- Have a configurable deadband set around 50 Hz. The deadband shall be settable between +0.015 Hz and +1.0 Hz for an over-frequency response and from -0.015 Hz down to –1.0 Hz for an under-frequency response.
- Have a resolution of at least 0.004 Hz.

- Have a response that inherently becomes zero when the frequency returns within the applicable deadbands due to the proportional response. The *PFR* response may be layered on another control function, in which case the total output will trend towards the steady state output of the other active control functions.

4.5.1.5 For a step change in frequency, the *EMS* shall have the capability to meet or exceed the dynamic performance requirements shown in

4.5.1.6 Table 3. These performance characteristics apply to the closed-loop response of the entire *ESS* as measured at the point of interconnection. The *EMS* response time shall be considered with the overall *PCS* and *BESS* response.

4.5.1.7 The *EMS* shall be the single point of communication for the *PFR* configurations and coordinate any control settings changes that need to occur on the *PCS* level. These settings will either be configured on the *EMS* or received from an external device. These settings shall be coordinated with existing *LUCELEC* systems and information provided by *LUCELEC*.

4.5.1.8 During the times when there is no need for primary frequency response, the *EMS* may charge or discharge the *BESS* until it reaches a *State-of-Charge* setpoint (e.g. 50%), as described in Section 4.5.2 (*State-of-Charge* Management).

Table 3 *ESS* Frequency Response Requirements

Parameter	Performance Target	Parameter Definition
Reaction Time	< 50 milliseconds	Time between the step change in frequency and the time when the *ESS* active power output begins responding to the change.
Rise Time	< 100 milliseconds	Time in which the *ESS* has reached 90 percent of the new steady-state (target) active power output command.
Settling Time	< 1 seconds	Time in which the *ESS* has entered into, and remains within, the settling band of the new steady-state active power output command.
Overshoot	< 2 percent	Percentage of target active power output that the *ESS* can exceed while reaching the settling band.
Settling Band	< 1 percent	Percentage of target active power output that the *ESS* shall settle to within the settling time.

4.5.2 State-of-Charge Management

4.5.2.1 The *EMS* shall manage the steady-state *State-of-Charge* of the *BESS* to a defined setpoint (MWh or %) that will be configurable on the *EMS* or a *SCADA* signal.

4.5.2.2 The *State-of-Charge* management function shall not interfere with the reactionary functions of the *EMS*. This function shall always be active in coordination with the other control modes. *Proponents* shall describe how the *State-of-Charge* management will be coordinated between other functions.

4.5.2.3 The *State-of-Charge* management function shall always result in smooth, continuous charging/discharging of the *ESS*. This function should never result in a step change on the battery charging/discharging power.

4.5.2.4 The *EMS* shall consider the availability of *BESS* lineups/racks/strings within the system in the overall *SOC* maintenance. A loss of a *BESS* lineup shall not result in an immediate charge of the *BESS* due to the reduction in available energy.

4.5.2.5 When an offline *BESS* lineup/rack/string is re-added to the overall system the *BESS* shall consider the string balancing required to equalize the overall *BESS*. The *EMS* shall initiate a charge to the appropriate level. This action shall not result in a step change on the charging power.

4.5.2.6 The following settings related to *State-of-Charge* management shall be made available to the *LUCELEC SCADA*:

- *State-of-Charge* setpoint (MWh or %).
- *State-of-Charge* gain value (represented as MW/MWh_{error} or $MW/\%_{error}$) or equivalent: A setting that relates the deviation from the *State-of-Charge* setpoint to the amount of charging/discharging power.
- Maximum *SOC* management charge power: A setting that is the maximum charge power allowed for the *SOC* management of the battery.
- Maximum *SOC* management discharge power: A setting that is the maximum discharge power allowed for the *SOC* management of the battery.
- *SOC* management hysteresis band: A band around the *SOC* setpoint that prevents continuous trickle charging of the battery. Once the *BESS SOC* setpoint has been reached the *SOC* maintenance function will not reactivate until the *SOC* passes through the hysteresis threshold.

4.5.2.7 The *State-of-Charge* management function shall have the ability to be disabled by the *LUCELEC SCADA*, meaning that the *LUCELEC SCADA* will manage the *State-of-Charge* of the *ESS*.

4.5.3 Voltage Control

4.5.3.1 The *ESS* shall have the capability to provide dynamic reactive power while charging or discharging active power with full 4 quadrant operation.

4.5.3.2 The *ESS* shall have the capability to provide dynamic reactive power when the active power is zero.

4.5.3.3 The *EMS* shall have the capability to operate the *ESS* in accordance with the above requirement by both manual control of the set point of the voltage regulating system and automated action of the voltage regulating system.

4.5.3.4 The *EMS* voltage response shall have the capability to be active and respond to voltage fluctuations alongside the active power control modes. The voltage response shall be

decoupled from the active power response. When the MVA rating of the system is met the precedence is for the *EMS* to provide the active power control reaction.

4.5.3.5 The *EMS* shall have a constant power factor operating function that respects a fixed power factor and outputs the necessary reactive power based on the active power setpoint.

4.5.3.6 The *EMS* shall have a voltage setpoint control function that:

- Compares the measured point of interconnection voltage to a set point.
- Controls the reactive power resources needed to meet the voltage requirements.
- Is designed to be continuously in service and controlling while the *ESS* is connected to the transmission system. Voltage control is to cease operation if the *ESS* becomes islanded (unless operating in a black start scenario).
- Has the capability to control the terminal voltage within 0.5% of any voltage set point between 95% and 105% of the rated voltage without hunting, provided the *ESS* is operating within its MVA limits.
- Is able to seamlessly transfer from automatic control mode to manual control mode.

4.5.3.7 The *EMS* shall have a reactive power droop curve to control the *ESS* to have the voltage/reactive current characteristics as follows:

- The nominal slope of the characteristic shall be adjustable from 0 to 10%.

4.5.3.8 The *ESS* shall have the capability to meet or exceed the dynamic performance requirements shown in Table 4 and Table 5, for a step change in voltage due to small disturbance[1] and large disturbance[2]. These performance characteristics apply to the closed-loop response of the entire *ESS* as measured at the point of interconnection.

Table 4 *ESS* Dynamic Reactive Power-Voltage Performance Requirements for Small Disturbance

Parameter	Performance Target	Parameter Definition
Reaction Time	< 50 milliseconds	Time between the step change in voltage and when the *ESS* reactive power output begins responding to the change.
Rise Time	< 100 milliseconds	Time between a step change in control signal input (reference voltage) and when the reactive power output changes by 90 percent of its final value.
Overshoot	< 3 percent	Percentage of rated reactive power output that the *ESS* can exceed while reaching the settling band.

[1] Where voltage remains within the continuous operating range.
[2] Where voltage falls outside the continuous operating range.

Table 5 *ESS* Dynamic Reactive Power-Voltage Performance Requirements for Large Disturbance

Parameter	Performance Target	Parameter Definition
Reaction Time	< 16 milliseconds	Time between the step change in voltage and when the *ESS* reactive power output begins responding to the change.
Rise Time	< 100 milliseconds	Time between a step change in control signal input (reference voltage) and when the reactive power output changes by 90 percent of its final value.
Overshoot	< 20 percent	Percentage of rated reactive power output that the *ESS* can exceed while reaching the settling band.

4.5.4 Black Start Capability Requirements

4.5.4.1 The *ESS* shall be designed to have black start capability to help restore the *LUCELEC* grid. The *EMS* shall be the coordinating entity to initiate a black start of the *ESS*. The *EMS* shall be able to:

- Command the *ESS* to form and sustain an electrical island.
- Stably operate during larger frequency, voltage and power swings.
- Reliably operated in low short-circuit strength networks.
- Receive a black start command from a remote signal or directly at the *ESS* facility.
- Command the individual battery/*PCS* lineups to energize their AC busses.
- Sequentially close the AC protective devices up to the POI.
- Command the main interconnection breaker(s) to energize the bus.
- Indicate to the grid operator that the system is ready to accept load.

4.5.4.2 The *EMS* shall be capable of coordinating the energization of any internal *ESS* loads that will require self-energization from the *BESS* prior to energizing the grid.

4.5.4.3 The *EMS* shall be capable of enforcing a minimum *SOC*, if *LUCELEC* chooses to do so, to store enough energy for the duration of black start process. This is to ensure that under typical operation, the *BESS* reserves a certain amount of energy (e.g., 1 MWh), such that it is capable of providing the black start service.

4.5.4.4 The *Contractor* is to provide a written procedure for initiating a black start from the *ESS.*

4.5.5 Manual Operation

4.5.5.1 The *EMS* shall provide capability to select mode of operation to be either automatic or manual control.

4.5.5.2 The *EMS* shall reject any manual command or setting that is entered by a User that is out of bounds for a specific function or risks the stability of the power system based on current operating state. Suitable feedbacks shall be presented describing the erroneous setpoint entry.

4.5.5.3 Manual operation shall disable the automatic control. Manual control shall allow operation to be performed remotely or locally. Either local or remote control shall be activated at any one time.

- Manual control shall be available remotely from *LUCELEC SCADA* or locally from *HMI* display.
- Remote or local control capability shall be selectable via a physical hardwired selector switch. Default manual control shall be remote unless the selector switch is in local, to allow operators the ability to control if controller resets or if a problem exits.

5. Communication & Monitoring Requirements

5.1 Communication Requirements

5.1.1.1 *EMS* shall have at least two independent Ethernet and/or serial ports, via fiber connections that utilize DNP3 communication. The *EMS* shall perform monitoring and control functionality via two established communication fiber links to the *LUCELEC SCADA Network* that will be connected to a ring network.

5.1.1.2 *EMS* shall communicate with *BMS* and *PCS* control system using DNP3, IEC61850 or Modbus protocols for exchange of monitoring and control information. If any proprietary protocols are to be used within the *EMS* the *Contractor* shall notify *LUCELEC* for approval.

5.1.1.3 *EMS* shall include all the necessary equipment to support communication between the *EMS* controller(s) and the distributed subsystems in the *ESS* plant.

5.1.1.4 To accommodate communication with all devices, appropriate number of controller ports shall be provided. If an external networking device is required to be utilized, it shall be specified and provided by the *Contractor*.

5.1.1.5 Any device to be utilized for protocol conversion shall preferably be avoided.

5.1.1.6 Optical connectors shall be ST style for multi-mode and LC style for single mode.

5.1.1.7 Loss of communication

- In the event of loss of communication between the *LUCELEC SCADA* and the *EMS*, a provision shall be made for the *ESS* systems to implement *LUCELEC*'s desired behavior in such circumstance, including but not limited to maintaining the previously set operating function.
- In the event of loss of communication between *EMS*, *BMS* or *PCS* controllers, an alarm indication shall be issued to *LUCELEC SCADA*.

5.2 Monitoring Requirements

5.2.1.1 The *ESS* shall be include a networked GPS time clock source for purpose of time synchronization of recorded events and capture the performance of *ESS*. The synchronized

clock shall be capable of providing time synchronization signal to all applicable devices such as *EMS*, *BMS* controllers, *PCS* controllers etc. of the *ESS* using IRIG-B.

5.2.1.2 Standard data shall be monitored from the *ESS* and to be made available to *LUCELEC SCADA* as well as locally available on the *EMS HMI*, these data shall include but not be limited to the list below. Data must be time stamped to a <5 ms resolution:

- Status of all high voltage breakers and switches
- Status of low voltage breakers
- Net MW and MVar at POI
- Voltage and frequency at POI
- Protection relay trip statues
- Maximum available active (both charging and discharging) and reactive power (both capacitive and inductive)
- MW control set point (mirrored from the *LUCELEC SCADA*)
- Number/percentage of inverters producing power
- Number/percentage of inverters available
- Number/percentage of inverters experiencing localized problem (e.g., unit protection or operational issue)
- *ESS* ramp rate settings and capability
- *ESS* selected mode of operation
- Time constant, gain, limiters etc.
- Environmental criteria that could impact *ESS* performance (if any)
- *SOC* of overall *BESS*
- State of Health (SOH) of overall *BESS*
- Communication status

5.2.1.3 The *Contractor* must consult *LUCELEC* to confirm if additional status points are required and/or if points are more appropriate to be included in the *EMS*, prior to design.

5.3 I/O Requirements & Subsystems Interface

5.3.1.1 The *EMS* controller(s) shall have enough *I/O* channels to achieve the control and monitoring functions of the *ESS*. The minimum amount of hardwired *I/O* that shall be available on the *EMS* is:

- Analog Input
  - Phase voltages (HV and LV)
  - Phase currents (HV and LV)

- Binary Output
  - All HV and LV breakers
  - All controllable HV and LV switches
  - Failure status (watch dog)
  - General alarm
- Binary Input
  - HV and LV breaker statuses
  - All controllable HV and LV switches statuses
  - GSU transformer protection relays watchdog status
  - Hardwired emergency stop

5.3.1.2 *LUCELEC* shall review and approve the final *I/O* list. *LUCELEC* reserves the right for addition of new *I/O*.

5.4 Data Recording & Data Historian

5.4.1.1 The *EMS* shall have data recording capabilities to log all *ESS* operation metrics. At a minimum, the data that must be included are the signals listed in 5.2 the *I/O* signals described in Section 5.3 as well as the signals transmitted from the *BMS* and *PCS* systems. It is expected that these signals will be transmitted to the *EMS* from the *ESS* subsystems through the internal plant *SCADA Network*.

5.4.1.2 *LUCELEC* shall have access to the data historian and the *Contractor* shall provide any required licenses to *LUCELEC* to facilitate this access.

5.4.1.3 The data historian must be located on premises of the *ESS* plant. Cloud-based solutions are not acceptable. *LUCELEC* must be able to access the historian both locally and remotely.

5.4.1.4 The datalogging recording interval must be an adjustable value. A resolution of at least one second or faster is necessary, unless otherwise stated in the Specification.

5.4.1.5 All faults and alarms from *ESS* subsystems shall be recorded and logged.

5.4.1.6 The *Contractor* shall provide *LUCELEC* with a list of all the recorded data tags for review prior to programming and commissioning. *LUCELEC* reserves the right to add additional data tags.

5.4.1.7 The following *BESS* signals must be recorded by the *EMS* at a minimum:

- Per *BESS* module
  - Module Status
- Per *BESS* rack:
  - Voltage (Minimum, Maximum, and Average across the rack)

- Current (Minimum, Maximum, and Average across the rack)
- Temperature (Minimum, Maximum, and Average across the rack)
- Rack Status
- Min *SOC* (Minimum in the rack)
- Max *SOC* (Maximum in the rack)
- Max Charging Current (Maximum rack charging current)
- Max Discharging Current (Maximum rack discharging current)
- String Statuses
- Faults/Alarms

- Per *BESS* lineup or container:
  - Instantaneous discharge current limit
  - Instantaneous charge current limit
  - Lineup *DC Bus* Voltage
  - Lineup Measured DC Current
  - *State of Charge*
  - State of Health
  - Enclosure Humidity
  - Enclosure Temperature
  - Lineup Status
  - Contactor Status
  - Faults/alarms

5.4.1.8 The following *PCS* signals must be recorded by the *EMS* at a minimum:

- Per *PCS*
  - *PCS* status
  - DC voltage
  - DC current
  - AC voltage
  - AC current
  - *PCS* output active/reactive/total power
  - *PCS* temperature
  - Enclosure humidity (if applicable)

- Module status (if modular design)
- PCS DC breaker status
- AC breaker status
- Operating mode (voltage source, current source, grid forming etc.)
- Available active/reactive power capacity
- Faults/alarms

5.4.1.9 The following signals must be recorded as system wide *ESS* plant signals:

- Point of Interconnection Information (see sections 5.2 and 5.3 for further details)
  - Voltage
  - Current
  - Frequency
  - Active/reactive/total Power
  - Overall *State of Charge* of the *ESS* plant (MWh/%)
  - Overall State of Health of the *ESS* plant (%)
  - Availability (%)
- Ambient temperature
- Ambient humidity
- Overall plant status
- Communication status to external devices
- Fire alarm and fire suppression system status

6. Operator Interface

6.1.1.1 Operator interface shall be via an *HMI* display. All control commands and status/alarm indications required for *ESS* shall be configured with selection/windows that are easily accessible, via a graphical user interface. Capability to modify *HMI* configuration shall be available to *LUCELEC*, if changes are required in the future. Display symbols, color code and how status/alarm indications are displayed shall be pre-approved by *LUCELEC*.

6.1.1.2 There shall be a main operator interface location within the physical layout of the *ESS*, such as an operator workstation or control room.

6.1.1.3 The operator interface shall also be accessible by connecting a laptop to any ethernet port in the internal *SCADA Network*.

6.1.1.4 The user interface language shall be English.

7. Cyber Security Requirements

7.1.1.1 The *Contractor* shall provide details on the security controls/features accompanying their equipment that comply with applicable NERC CIP requirements.

7.1.1.2 The *EMS* shall be designed for compliance with NERC CIP requirements for cyber and physical security. The *EMS* shall be designed for compliance at least with NERC CIP requirements as listed below.

7.1.1.3 As per requirement, R2.1 of NERC CIP-007-6 Cyber Security-System Security management standard:

- There shall be developed procedure and document processes to notify any software patches.
- The *EMS* shall have a chronological list of all patches from the initial development of the device to the latest patch provided.
- A description of the function of the patch shall be provided and articulate any reasons for the patch update and possible problems with previous patches.
- Notification within a reasonable time ahead of any patches that are forthcoming to allow to reasonably schedule the implementation of the patch and allow testing prior to enabling them.

7.1.1.4 As per requirement, R3.1 of NERC CIP-007-6 Cyber Security-System Security management standard:

- The Software/Patches must be tested and certified, indicating that it has been tested and passed any anti-virus testing and certified/guaranteed to be free of malicious codes, especially if any coding is from third party groups. Certification of patches must guarantee no impact on functionality.
- Any 3rd party codes, must be identified in writing and must be notified prior to delivery of software/patches.
- All related incidents must be documented, filed and delivered.

7.1.1.5 As per requirement, R4.1 of NERC CIP-007-6 Cyber Security-System Security management standard:

- The *EMS* must have the capability to record the successful logins, failed access login attempts, and action taken and provide an electronic report record.

7.1.1.6 As per requirement, R4.2 of CIP-007-6 Cyber Security-System Security management standard:

- The *EMS* must have the capability to generate an electronic report of any malicious codes detected. The controller must immediately alarm and disable the device upon detection of malicious codes.

7.1.1.7 As per requirements, R5.4 and R5.5 of NERC CIP-007-6 Cyber Security-System Security management standard:

- The *EMS* shall have the capability to change default passwords with passwords that adhere to the standard for complexity.

7.1.1.8 As per Requirement, R1 (subsection 1.1) of NERC CIP-008-5 Cyber Security-Incident Reporting and Response Planning standard:

- There shall be maintained records on known cyber security incidents these records shall be provided to *LUCELEC*.

7.1.1.9 As per Requirement, R1 (subsection 1.3) of NERC CIP-008-5 Cyber Security-Incident Reporting and Response Planning standard:

- The *Contractor* shall make provision to record all entries to controllers setting update/ modifications.

7.1.1.10 As per Requirement, R1 (sub sections 1.1 & 1.3) of NERC CIP-009-6 Cyber Security-Recovery Plans for BES Cyber Systems standard:

- There shall be provided documentation and training on how to access a controller to perform the task related to purposes of backing up, storing and recovering information.

7.1.1.11 As per requirement, R3 (sub section 3.1) of NERC CIP-009-6 Cyber Security-Recovery Plans for BES Cyber Systems standard:

- There shall be provided patches/updates to known or reported incidents.

7.1.1.12 As per requirement, R1.2.1 of NERC CIP-013-1 Cyber Security-Supply Chain Risk Management standard:

- There must be immediate notification of any incidents that relates to the product or service that may pose a cyber security risk.

7.1.1.13 As per requirement, R1.2.5 of NERC CIP-013-1 Cyber Security-Supply Chain Risk Management standard:

- There must be notification of any third-party components of the software or software patches that is in the *EMS*.
- It must be ensured that the software provided does not contain any malicious algorithms that may threaten the Cyber Security.

7.1.1.14 *LUCELEC* shall immediately be advised of any *Contractor* representatives that are no longer allowed to access the cyber sensitive equipment. This may be due to termination of employment for any reason or transfer of employee's duties such that he/she should no longer be allowed access to the same equipment.

7.1.1.15 Any documented process on NERC CIP compliance including protecting/wiping during repair, or destruction shall be provided, if required.

8. Hardware Requirements

8.1 General

8.1.1.1 The *EMS* shall be built on a standard, common platform, featuring reliability, availability, expandability, openness, and security.

8.1.1.2 The *Contractor* shall provide an applicable controller for the *EMS* that supports the IEC 61131 standard.

8.1.1.3 The *Contractor* shall supply a Schneider Electric SAGE 2400 *RTU* to interface between its *EMS* and the *LUCELEC SCADA Network*. The *Contractor* shall be responsible for integrating the *RTU* with the *LUCELEC SCADA Network*. Details on the SAGE 2400 RTU are included in *Schedule J – Reference Reports and Drawings.*

8.1.1.4 The *Contractor* shall supply a GE Multilin G500 Advanced Substation Gateway to interface between the *LUCELEC SCADA Network*. The *Contractor* shall be responsible for integrating the Gateway with the *LUCELEC SCADA Network*. Details on the Multilin G500 are included in *Schedule J – Reference Reports and Drawings*

8.1.1.5 The *EMS* hardware package shall be of the *Contractor*'s design and include the necessary equipment to support the software functions of the system. *Proponents* are to describe the hardware platform(s) which will run the *EMS* software, the auxiliaries to support the hardware platform and how the hardware will be interconnected to both the power system and *SCADA Network*.

8.1.1.6 The *EMS* hardware shall be enclosed in a *Contractor* supplied cabinet.

8.1.1.7 The *Contractor* shall indicate where *EMS* hardware shall be located within the *ESS* plant.

8.1.1.8 The *Contractor* shall design in detail and carry out all the engineering necessary to produce a complete, safe, economical, fully coordinated and workable system for the equipment being supplied.

8.1.1.9 The *Contractor* is responsible for obtaining information of equipment supplied by others.

8.2 Environmental Conditions

8.2.1.1 Panels will be installed indoors and shall be designed for temperatures between 0°C to 40°C.

8.2.1.2 Panels and equipment shall be able to operate in humidity from 10%-90% (non-condensing).

8.3 Uninterruptible Power Supply

8.3.1.1 The *Contractor* shall supply *Uninterruptible Power Supply (UPS)* to service critical loads. Critical loads at the site including equipment such as:

- Communication equipment, Ethernet Hubs, and Monitors.
- Control Equipment.

- Analog and Digital Instrumentation.
- Protection and coordination equipment.
- Fire Detection and Suppression System.

8.3.1.2 Batteries shall have sufficient capacity to provide full rated output from the inverter for a period of 4 hours.

8.3.1.3 The *UPS* inverter shall consist of a solid-state switching device that converts battery power to 50 Hz output voltage having less than 5% total harmonic distortion at full load at 1.0 PF. The inverter shall be sized for 150% of the maximum estimated load.

8.4 Panels

8.4.1 General

8.4.1.1 The panels and cabinets shall be of robust construction and design, forming self-supporting self-contained housings designed generally to give maximum reliability and service in regards to the need of speed and ease of inspection and maintenance.

8.4.1.2 Panels shall be constructed in such a manner that each panel can be removed with a minimum of disturbance to its adjacent panels. The individual panels shall be bolted and not welded to each other.

8.4.1.3 Devices shall be rack mount as much as possible.

8.4.2 Materials

8.4.2.1 The equipment shall be the *Contractor*'s standard, robust, heavy-duty design. The design shall have been proven effective and reliable under similar operating conditions. No new or unproven design is acceptable.

8.4.2.2 All material shall be new and not previously built or used.

8.4.2.3 Not all parts and materials are specified in this Specification. For those that are not specified, the *Contractor* shall use their standard parts and materials, which will be subjected to the approval of *LUCELEC* and its representative. All parts and materials shall suit the specified duty.

8.4.3 Doors and Access

8.4.3.1 Panels shall be front access and back access.

8.4.3.2 Doors shall be designed to allow 160° opening, when considering adjacent panels. Alternatively, lift off hinges shall be provided. All equipment shall be easily accessible.

8.4.4 Ventilation

8.4.4.1 Ventilating louvers shall be provided where required.

8.4.4.2 Louvers shall be fitted with screens and easily removable dust filters.

8.4.4.3 Openings between adjacent cells/racks for ventilating purposes are not permitted.

8.4.5 Mounting

8.4.5.1 All panels and cubicles shall be provided with steel channel bases and anchoring bolts.

8.4.6 Cable Entry

8.4.6.1 Cables will enter the panels by the top.

8.4.6.2 Adequate removable gland plates shall be provided and positioned for ease of termination.

8.4.7 Equipment Protection

8.4.7.1 All electrical equipment, panels, cubicles, junction boxes shall have doors fit with neoprene gaskets. At main floor and other humid locations, junction boxes and panels shall be NEMA 12 type.

8.4.8 Accessories

8.4.8.1 Interior lighting shall be LED type and provided in each panel or cabinet. It shall be arranged to give an even illumination of all equipment and wiring. The lighting shall be controlled by door switches.

8.4.8.2 Each panel or cubicle shall have a convenience outlet for use with small tools or test equipment.

8.4.9 Painting

8.4.9.1 A minimum of one (1) coat of primer shall be applied to all surfaces, except those having a machined finish or those that have been corrosion treated. One finish coat shall be applied to the exterior. Before shipment, all machined surfaces shall be treated with a suitable protective coating to prevent rusting during shipment, storage, and installation.

8.4.10 Grounding

8.4.10.1 The panel door and all equipment with a ground connection shall be directly connected to the ground bus. Contact between panel body, door and ground bar shall be direct (without paint).

8.4.11 Wiring

8.4.11.1 The *Contractor* shall describe in their *Proposal* the details on the *EMS* auxiliary power supply.

8.4.11.2 All cabling and wiring should follow the BS 7671. Where possible, it is preferred that the (*LUCELEC* Design Criteria attached in *Schedule H – LUCELEC Design Criteria and Standards*) is followed within the *BESS* components/containers. The *Contractor* shall indicate if it is not possible to meet the *LUCELEC* Design Criteria in its *Proposal.*

8.4.11.3 Conductors shall be rated with insulation suitable for the application temperature and current and not less than as follows:

Table 6 Insulation and Current Requirements for Conductors

Conductor	Specification/Requirement
Main incoming connection	11 kV underground connection, Sizing TBD
Medium Voltage Bus (if applicable)	*Contractor* to propose safe and reliable design based on selected voltage level
Main current carrying conductors (Low voltage AC and *BESS* DC)	1000 V
Systems up to 120 V	600 V
Systems 24 Vdc and below	300 V

8.4.11.4 All wiring sizes shall be as per the BS 7671 and *LUCELEC* Design Criteria. Standard colours are preferred as follows:

Table 7 Colouring Standards for Wiring

Service	Wire Description	Colour
Insulated ground conductor	Any	Green or Green/Yellow
1-phase ac or dc (2-wire)	Zero (0) One (1)	Black Red
1-phase ac or dc (3-wire)	One (1) Two (2) Three (3) Neutral	Red Yellow Blue Black

8.4.11.5 Conductor sizes shall be in conformity to applicable standards and shall be at minimum:

- AWG #10 for Current Transformers circuits.
- AWG #14 for Potential Transformers circuits.
- AWG #14 for 24/125 VDC wiring.
- AWG #12 for grounding

8.4.11.6 All wires shall be connected to terminal blocks, relays, fuse holders, test switches or grounding bars, no “Tee” connection or splice will be accepted.

8.4.11.7 Wiring shall be grouped and installed in wiring ducts.

8.4.11.8 Except where wires ended on terminal blocks, all wire shall be ended with an approved type of insulated ring terminals.

8.4.11.9 No more than two wires shall be connected on one side of a terminal block.

8.4.11.10 A minimum of 10% of spare terminal block shall be present on each terminal strip.

8.4.11.11 All conductors wired into the door shall have a mechanical protection as “spiroband” or equivalent.

8.4.12 Identification

8.4.12.1 All terminal blocks and fuses shall be identified with pre-printed markers.

8.4.12.2 All wires shall be identified at both ends with wire markers. Marking method shall be selected in function of a twenty (20) years lifetime. It must be easily readable and indelible.

8.4.12.3 Components and enclosures (as applicable) shall be fitted with metal nameplates, permanently engraved in English showing manufacturer’s name, address, date of manufacture, description or title, model and serial numbers, standards built and tested to, limiting values of ambient temperature, temperature rise, voltage, current, power, short circuit rating etc.

8.4.12.4 All equipment mounted inside the panel shall be identified with “P Touch” type labels including LAN cabling.

8.4.12.5 All text shall be in English.

8.4.12.6 On each enclosure, labels shall be affixed to enclosures to warn of the presence of the multiple sources of power.

8.4.12.7 On enclosures containing *current transformer* circuits, labels shall be affixed to warn of the presence of such circuit which shall only be broken when the primary circuit is deenergized.

8.5 Vibration

8.5.1.1 The *EMS* design shall accommodate the anticipated vibrations and shocks associated with the transportation and installation at site.

8.6 Shipping and Storage

8.6.1.1 Delivery of *EMS* to the La Tourney Solar PV (13.74, -60.96); the *Contractor* is responsible for the transportation to the site including the insurances.

8.6.1.2 The *Contractor* shall provide the necessary preparations and required packaging of the system for transportation.

8.6.1.3 *Contractor* to provide any special instructions for shipping and handling of equipment.

8.6.1.4 *Contractor* to specify short-term and long-term storage requirements.

9. Factory Testing

9.1 Factory Acceptance Testing (FAT)

9.1.1.1 For all *Contractor* equipment either type test or factory test certificates shall be presented according to applicable standard. Provision shall be made to witness testing at the *Contractor*-proposed facility at *LUCELEC*’s/its representative’s option. *LUCELEC* or its *Representative*

shall witness all test, unless written authority to proceed with the tests in their absence has been received. *LUCELEC* and its *Representative* shall be notified at least two weeks in advance of the commencement of the tests to permit arrangements to be made for the witnessing of the tests.

9.1.1.2 The *Contractor* must prepare a *FAT* plan describing the tests to be completed, procedures and pass/fail criteria by design. The tests to be completed must be aligned with the performance criteria as specified. The *FAT* plan is to be submitted to *LUCELEC* and its representative for review and approval. It is expected at minimum all IEC testing protocols will be included, as well as industry standard testing for batteries, inverters, controls, and protection and coordination.

9.1.1.3 *FAT* shall demonstrate how each individual software module meets the requirements of the specification.

9.1.1.4 *FAT* shall demonstrate how the different software functions interact to provide seamless control of the plant components.

9.1.1.5 The *Contractor* shall advise if there are any training requirements for *LUCELEC* Staff or its *Representative* that must be completed prior to attending the *FAT* testing.

9.1.1.6 All relevant routine tests shall be performed. Manufacturer shall identify in their *Proposal* which tests will be performed for major equipment. These tests shall include as a minimum:

- Verification of sensors, metering and alarms.
- Verification of all control functions, including automatic, local and remote control.
- Verification of performance criteria.
- Verification of all modes of operation.
- Verification of power system components, including insulation and grounding.
- Communication functionality of all *PCS* system components.
- Simulations of Alarms and Faults

9.1.1.7 The *Contractor* shall provide certified copies of all test data. IEC certification is to be obtained.

9.1.1.8 A *FAT* report is to be submitted to *LUCELEC* and its representative documenting all tests performed. For any items that do not meet the expectations outlined in the pass/fail criteria a corrective action plan must be submitted for approval prior to implementation. Once the changes are approved and implemented, a test report demonstrating compliance shall be submitted to *LUCELEC* and its *Representative*.

9.1.1.9 The *Contractor* is expected to cover all costs associated with the *FAT*, corrective actions and retesting.

9.1.1.10 The *Contractor* to facilitate the connection of *LUCELEC* or its representative's non-invasive monitoring and measurement equipment for data gathering during *FAT* or *Factory Integration Testing (FIT).*

9.1.1.11 The *Contractor* shall provide three (3) paper copies of the *FAT* report and Test Results, each bound in a neat and professional manner complete with dividers and a table of contents. The *Contractor* shall also provide an electronic copy by e-transfer, on USB or another suitable method (as approved by *LUCELEC*) of the *FAT* report in Adobe PDF format.

9.1.1.12 The *Contractor* shall record the version of control software and firmware installed on the control and protection equipment throughout the time of the *FAT*. If the *Contractor* deems it necessary to install newer control software during or after the completion and acceptance of the *FAT*, the *Contractor* shall submit a software and software variance report to *LUCELEC*:

- Reason for change
- Details of change
- Potential impacts to other elements of the control and protection Equipment which was not changed
- Details of how the change was validated and tested
- Results of the validation and testing

9.2 Factory Integration Testing (FIT)

9.2.1.1 The objective of the *Factory Integration Testing (FIT)* is to deliver a mostly assembled and tested *ESS* to site, requiring minimum site assembly and site testing. Testing will involve the integration of the complete *ESS* (*BESS* + *PCS*) in addition to interfacing to the *Contractor*'s *EMS*. Given the size of the *ESS*, *LUCELEC* will accept *FIT* testing of a single lineup (*EMS* + 1 *PCS* + 1 *BESS* container). *LUCELEC* and its *Representative* shall be notified at least two weeks in advance of the commencement of the tests to permit arrangements to be made for the participation in the tests.

9.2.1.2 The *FIT* is to be performed immediately after the *FAT* at a *Contractor*-proposed facility and facilitated by the *Contractor*. The *FAT* must be completed before the initiation of the *FIT*.

9.2.1.3 *Factory Integration Test* Procedures shall be provided by the *Contractor* for *LUCELEC*'s and its representative's input in advance of the commencement of the tests. Test results shall be documented by the *Contractor*.

9.2.1.4 The *Contractor* shall advise if there are any training requirements for *LUCELEC* Staff or its representative that must be completed prior to attending the *FIT* testing.

9.2.1.5 *LUCELEC* or its *Representative* shall witness all test, unless written authority to proceed with the tests in their absence has been received.

9.2.1.6 Testing at the facility will be to simulate actual operating conditions. The testing bay will have sufficient capabilities for all tests including a three phase, 50 Hz power source suitable for the functional tests, as well as adequate control power.

9.2.1.7 As a minimum, the integration testing shall include:

- Communication between the *EMS* and the *BESS*.
- Communication between the *EMS* and the *PCS*.
- Startup and shutdown process of *EMS*.
- Open loop operation to follow P and Q setpoints from the *EMS*.
- Open loop operation to follow V and F setpoints from the *EMS*.
- Simulations of Alarms and Faults to the degree possible.

9.2.1.8 Any deficiencies observed during the *FIT* related to the *Contractor*'s equipment must be addressed before being shipped to *LUCELEC*'s location.

9.2.1.9 The *Contractor* is to include the cost for facilities and *Contractor* representatives (including *PCS* and *BESS*) for one week exclusive to *FIT*.

9.2.1.10 The *Contractor* shall provide three (3) paper copies of the *FIT* report and Test Results, each bound in a neat and professional manner complete with dividers and a table of contents. The *Contractor* shall also provide an electronic copy by e-transfer, on USB or another suitable method (as approved by *LUCELEC*) of the *FIT* report in Adobe PDF format.

9.2.1.11 The *FIT* Report may be included with the *FAT* Report, if applicable.

9.2.1.12 *LUCELEC* requests the *FIT* testing as an optional service and it should be priced out separately for *LUCELEC*'s review.

10. Site Work

10.1 Installation

10.1.1.1 The factory-assembled system with *Contractor* equipment will be shipped to site and will be installed by the *Contractor* or the *Contractor*'s *Subcontractor*. Installation will include unloading, placement on foundation, anchoring, reinstallation of any equipment shipped loose, connection to the grounding grid and connection of all cabling.

10.1.1.2 The *Contractor* is responsible of offloading all equipment supplied within the *EMS* scope.

10.1.1.3 *Contractor* shall install all equipment identified in the scope of work, in locations shown on the applicable layout drawings.

10.1.1.4 The *Contractor* shall prepare an *Installation and Test Plan* for all equipment installed, which shall be submitted to *LUCELEC* as part of the construction package.

10.1.1.5 The *Contractor* shall be responsible for the installation and interconnection of all instrumentation required for the operation of the *EMS* such as potential and current transformers.

10.1.1.6 The *Contractor* shall be responsible for the network connection between the *EMS*, the plant *SCADA Network* and the *LUCELEC* communications network.

10.1.1.7 The *Contractor* shall be responsible for the installation and connection of *EMS* control power including backup power systems.

10.1.1.8 The *Contractor* shall be responsible for the installation and setup of any *EMS* workstations.

10.1.1.9 Upon completion, the *Contractor* shall provide *LUCELEC* an Installation Report.

10.1.1.10 The *Contractor* shall provide three (3) paper copies of the installation report, each bound in a neat and professional manner complete with dividers and a table of contents. The Contractor shall also provide an electronic copy by e-transfer, on USB or another suitable method (as approved by *LUCELEC*) of the installation report in Adobe PDF format.

10.2 Commissioning Tests

10.2.1.1 All *Contractor* equipment shall be tested on site after installation. The tests shall be used to identify possible damages or changes that have occurred since the *FAT*/*FIT* as well as to verify the field interconnections and interfaces to *LUCELEC*'s equipment and to ensure the suitability of equipment for site energization. The *Contractor* shall include time to participate in commissioning tests.

10.2.1.2 Commissioning test procedures will be provided to *LUCELEC* in addition to any specific Commissioning tests required by *LUCELEC*.

10.2.1.3 The tests shall include:

- Mechanical integrity checks.
- Grounding verification.
- Communication with all system components that were not covered in the *FIT/FAT*.
- Command of all system components that were not covered in the *FIT/FAT*.
- Point to point power and control interconnection verifications to the field wiring.
- Operational tests on devices as required.
- Instrument transformer interfacing tests.
- HVAC system tests.
- Phasing and polarity verification.
- Start and Stop Testing.
- Tests of interlocks.
- Pre-energization inspection and Checklist completion.
- Start-up.
- Hot commissioning tests:
  - Open loop operation to follow P, V, I setpoints.

- Closed loop operation all operating modes described in this Specification.

10.2.1.4 Any deficiencies that are identified during commissioning are expected to be remedied by the *Contractor* before system sign off.

10.2.1.5 Upon completion, a Commissioning Report shall be provided by the *Contractor.*

10.2.1.6 The *Contractor* shall provide three (3) paper copies of the commissioning report, each bound in a neat and professional manner complete with dividers and a table of contents. The *Contractor* shall also provide an electronic copy by e-transfer, on USB or another suitable method (as approved by *LUCELEC*) of the commissioning report in Adobe PDF format.

10.2.1.7 The commissioning report may be integrated with the installation report, if applicable.

10.3 Site Acceptance Testing

10.3.1.1 After the installation and commissioning of the *ESS* equipment, *LUCELEC* shall conduct *ESS Site Acceptance Tests,* with the co-operation and assistance of the *Contractor*. The requirement and procedures will be specified after the award of contract.

10.3.1.2 The *Site Acceptance Tests* shall include:

- Individual control function tests.
- Combined control function tests.
- Settings modifications tests.
- Protection scheme tests.
- Remote access tests.

10.3.1.3 A minimum of 3 months of compliant operation with system availability of > 98% is required to complete *Site Acceptance Testing*.

10.4 LUCELEC Staff Training

10.4.1.1 The *Contractor* shall provide Training to *LUCELEC*'s staff, both engineering and operations and maintenance staff, to the level that is sufficient for operation and maintenance of the system.

10.4.1.2 The *Contractor* shall define the training agenda for engineering, operations and maintenance staff along with the duration of training as *LUCELEC* will need to make personnel available. The agenda will be expected to be different for the various levels of *LUCELEC* personnel.

10.4.1.3 The *Contractor* shall also define the classroom size for the training.

10.4.1.4 The *Contractor* shall also provide detailed routine maintenance plan and instructions for *LUCELEC*'s staff to complete the day-to-day operation and maintenance.

10.4.1.5 A draft of the Operation and Maintenance Manuals shall be delivered to *LUCELEC* for review, prior to training. The *Contractor* shall subsequently update and revise the Operation and Maintenance Manual, when and as necessary.

10.4.1.6 Three (3) paper copies and an electronic copy of all training material including the Operation and Maintenance Manuals, shall be provided as part of project turnover package

10.4.1.7 Each member of *LUCELEC* Personnel shall be provided with all Training Materials and the Operation and Maintenance Manuals.

10.4.1.8 All training costs are part of the fixed price and borne by the *Contractor.*

10.4.1.9 The *Contractor* shall provide Training to the local fire department to manage any fire relating the *EMS*.

10.5 Asset Management

10.5.1.1 The *Contractor* shall assist *LUCELEC* with asset criticality ranking for Asset Management Planning.

10.5.1.2 The *Contractor* shall provide any requested information to be entered into *LUCELEC's* Enterprise Asset Management System (completion of *LUCELEC* data sheets to be provided to selected *Contractor*).

10.5.1.3 The *Contractor* shall provide a compiled list of all maintenance tasks and activities, and their frequency for the entire system to *LUCELEC*.

11. Performance and Maintenance

11.1.1.1 The equipment will be installed as part of a 20-year project. It is expected that no interventions are required on the system provided it is maintained as per the recommended annual maintenance schedule and operated within its normal operating parameters.

11.1.1.2 All enclosures, auxiliaries, and controls are expected to last for the project life.

11.1.1.3 The *Contractor* shall indicate if the control system (*BMS, PCS* controls, *EMS*, and any other system controls) is forward compatible with any augmentation plan. The *Contractor* shall indicate any foreseen concerns with this future compatibility if a battery augmentation plan is proposed. The *Contractor* shall indicate any foreseen additional upgrades that may be required if a battery augmentation plan is proposed.

11.1.1.4 The *Contractor* shall provide a detail O&M manual as well as detailed lock out procedures for the equipment. The *Contractor* shall provide three (3) paper copies of the manual and lock out procedures, each bound in a neat and professional manner complete with dividers and a table of contents. The *Contractor* shall also provide an electronic copy by e-transfer, on USB or another suitable method (as approved by *LUCELEC*) of the O&M Manual and Lock Out Procedure in Adobe PDF format.

11.1.1.5 The Contractor shall describe all software suites that must be maintained by *LUCELEC* for remote support and modification of the *EMS*.

12. Spare Parts

12.1.1.1 The *Contractor* shall evaluate its design with regard to failure rates, effects and system reliability.

12.1.1.2 The *Contractor* shall provide a recommended spare including, part number, supplier, location, prices and availability. Recommended list should consider the site is on an island and resultant delivery time of spares; this may differ from spare parts recommendation for a site on mainland.

12.1.1.3 The *Contractor* shall identify any spare parts that require configuration.

12.1.1.4 The *Contractor* shall indicate the storage requirements for the spare parts. The *Contractor* shall indicate the mass and dimensions of all spare parts.

12.1.1.5 The *Contractor* shall identify any special tools required for installation of spare parts recommended.

12.1.1.6 The *Contractor* shall identify if any of these tools are proprietary.

12.1.1.7 The *Contractor* shall advise *LUCELEC* of any planned obsolescence in the *EMS* components, including the inverter modules during the project life. In this situation, the *Contractor* shall offer provisions for *LUCELEC* to purchase suitable spares to reach the end of project life.

12.1.1.8 The *Contractor* shall identify if any local/regional spare parts inventories can be accessed and, if so, what inventory is available in what time duration.

13. Contractor Data and Documentation Requirements

13.1 Information to be Supplied with the *Proposal*

13.1.1.1 The *Contractor Proposal* for *EMS* equipment shall include the following information at a minimum:

- Completed *Contractor* submission
- Software Functional Description
- Software Architecture and Control Logic
- Sample Performance and Outputs of the *EMS*
- Network Interconnection Drawings/Description
- Power System Interconnection Drawings/Description detailing the location of any remote sensors
- Manufacturing and delivery schedule including major milestones and equipment delivery, as well expected duration for site work.

- Detailed description of *Contractor* scope of supply complete with equipment datasheets in reference to this Specification, including the description of equipment design, control system, operation and special features.
- Detailed description of all included protection systems including voltage unbalance, surge protection, overvoltage, overcurrent and ground fault.
- All applicable datasheets, technical specifications, and manuals for any equipment supplied
- Physical layout, required clearances around equipment, dimensions and weights of major equipment including any take-over points.
- Description of the *EMS* maintenance requirements including anticipated equipment replacement.
- Preliminary Single Line Diagram.
- Major Equipment List/Bill of Materials, including identification of the manufacturer, model, type, ratings and number of all major components.
- Serviceability access details for *EMS* equipment.
- Statement on compliance and certification with respect to the standards referenced herein.
- Warranty information.
- Description of decommissioning requirements.

13.2 Information to be Supplied After Award

13.2.1.1 After the award the *Contractor* shall supply full documentation. Documentation shall be sufficient for the integration of the *EMS* system into *LUCELEC*'s power system and shall be supplied in a timely manner as described in the table below.

13.2.1.2 The *Contractor* shall be responsible for sealing all issue for construction or final drawings with an APESL (Association of Professional Engineers of St. Lucia) seal.

13.2.1.3 All Drawings shall be supplied in PDF and AutoCAD files (preferred AutoCad 2010 files if possible).

13.2.1.4 Three paper copies and an electronic copy of the following documentation will be provided:

- *FAT* and *FIT* Report
- Installation and Commissioning Report
- Operation and Maintenance Manual
- Detailed Lock-out Procedures
- Issue for Construction and As Built Drawing Package.

13.2.1.5 Paper copies of any Documentation shall be printed on, and/or electronic copies of any Documentation shall be formatted for, standard sized paper, which is limited to the following dimensions:

- Letter: 8 ½ x 11";
- Drawings: A1 or 11 x 17"

Table 8 Documents and Drawings Required as Indicated Weeks after Award

	ITEMS	INFORMATION	50%	85%	IFC
1	DRAWING AND DOCUMENT SUBMISSION REGISTER C/W SCHEDULE OF SUBMISSIONS	2	4	8	10
2	ENGINEERING, PROCUREMENT & MANUFACTURING CONTROL SCHEDULE (LEVEL 3)	2	4	8	10
3	GENERAL ARRANGEMENT DRAWING INCLUDING OUTLINE DIMENSIONS, CLEARANCES, CABLE ENTRY LOCATIONS AND FOUNDATION/MOUNTING REQUIREMENTS,		4	8	10
4	CROSS SECTION WITH PARTS DESCRIPTION		4	8	10
5	BILL OF MATERIALS ITEMIZED PARTS LIST FOR SCOPE OF WORK		4	8	10
6	SHOP FABRICATION AND ASSEMBLY DETAIL DRAWINGS		4	8	10
7	SINGLE LINE DIAGRAM, SCHEMATICS, TERMINAL WIRING DIAGRAMS, AND P&ID DRAWINGS		4	8	10
8	NAMEPLATE DRAWING AND DETAILS		4	8	10
9	EQUIPMENT DATA SHEET		4	8	10
10	DESIGN CALCULATIONS		4	8	10
11	ANCHORAGE AND LOADING DIAGRAMS (STATIC AND DYNAMIC)		4	8	10
12	CONTROL SYSTEM DESCRIPTION AND COMMUNICATION INTERFACE MAP AND LIST OF FAULTS AND ALARMS		4	8	10
13	PROTECTION & CONTROL FOR ESS		4	8	10
14	PROTECTION SYSTEM PARAMTERS AND SETTINGS		4	8	10
15	LIST OF SPECIAL TOOLS RECOMMENDED FOR ERECTION, TESTING, AND MAINTENANCE	10		-	-
16	LIST OF SPARE PARTS RECOMMENDED DURING COMMISSIONING WITH PRICES	10		-	
17	LIST OF RECOMMENDED SPARE PARTS FOR TWO YEARS OF OPERATION WITH PRICES	10		-	
18	COMPLETE PARTS LIST INCLUDING SELLER'S AND ORIGINAL MANUFACTURER'S PART NUMBER	10		-	
19	FACTORY TEST PROCEDURES (FAT/FIT)			4 Weeks Before Testing Starts	
20	EQUIPMENT TEST CERTIFICATES				2 Weeks after Test Completion
21	FACTORY TEST REPORTS				2 Weeks after Test Completion

	ITEMS	INFORMATION	50%	85%	IFC
22	SITE TEST, COMMISSIONING & START-UP PROCEDURES			4 Weeks Before Testing Starts	
23	SITE TEST, COMMISSIONING & START-UP REPORTS				2 Weeks after Test Completion
24	PACKING LIST C/W SIZES, WEIGHTS AND SPECIAL HANDLING INSTRUCTIONS	4 Weeks Before Shipping			
25	INSTALLATION, OPERATION AND MAINTENANCE MANUALS	4 Weeks Before Shipping			

13.2.1.6 The *Contractor* shall indicate if the proposed submission and review schedule allows for delivery within the needed timeline.

13.2.1.7 The *Contractor* shall submit drawings for review by *LUCELEC* and its representative in a timely fashion. Submission dates of drawings and documents required for manufacturing shall be at least 4 working weeks before the start of manufacturing or ordering parts such that there are at least 2 weeks of review time for *LUCELEC* /its representative followed by 2 weeks for *Contractor* to respond to changes if necessary.

13.2.1.8 Where electronic files are required, the *Contractor* shall submit the files in PDF format unless otherwise noted.

13.2.1.9 Drawings and documents submitted to *LUCELEC* and its representative will be stamped and returned to indicate review results. The stamp will be marked with one of the following results. *Contractor* shall submit drawings marked “For Construction” after receipt of their drawings from *LUCELEC* or its representative noted "Code 1" or "Code 2".

- **Code 1** "Proceed, No Exception Taken" – This indicates that the *Contractor* may proceed.
- **Code 2** "Proceed, with Exceptions as Noted and Re-submit" – This indicates that the *Contractor* may proceed after actioning the exceptions. The *Contractor* may proceed before re-submitting.
- **Code 3** "Do not Proceed, Revise as Noted and Re-submit" – This indicates that significant changes are required as noted on the drawing or document and the *Contractor* is to re-submit after changes or corrections are made. When drawings or documents are returned with Code 3, the *Contractor* shall make the necessary corrections required by *LUCELEC* or its representative, consistent with the Purchase Order and shall submit revised drawings or documents to *LUCELEC* and its representative for review.
- **Code 4** "Information Only" - This indicates that the submittal was for information not review and no response is required from *LUCELEC* or its representative.

13.2.1.10 Drawings and documents shall be re-submitted for review if the *Contractor* revises them after they were sent for review by *LUCELEC* and its representative.

13.2.1.11 *LUCELEC* and its representative’s review of drawings will be for general design only and shall not relieve the *Contractor* from responsibility for deviations from drawings and specifications, unless the *Contractor* has in writing called *LUCELEC* and its representative’s

attention to such deviations at the time of submission and secured written approval of the deviation, nor shall it relieve the *Contractor* from responsibility for errors in shop drawings.

13.2.1.12 *LUCELEC* or its representative shall approve drawings before start of manufacturing. Approval of the *Contractor*'s drawings, by *LUCELEC* or its representative, shall not relieve the *Contractor* of the responsibility for the correctness thereof, nor for the results arising from errors or omissions, nor any fault or defects, nor for the failure in the matter of guarantee which may become evident during erection or subsequent operation.

13.2.1.13 The *Contractor* shall submit all final design and record drawings in digital form.

13.2.1.14 For all *Contractor* equipment either type test or factory test certificates shall be presented per applicable standard.

13.2.1.15 All documents shall be in English language.

END OF SECTION