# Battery Energy Storage System
# Scope Book

Rev. 1
7/16/24

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 10/31/23 | All | Initial Issue |
| 1 | 7/16/24 | All | Updated safety, fire protection, and thermal runaway requirements<br>Updated spacing to 25’ |
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ENTERGY
BATTERY ENERGY STORAGE SYSTEM
TECHNICAL SPECIFICATION
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# 1.0 OUTLINE OF WORK

## 1.1 General

Owner desires a qualified bidder (Seller) to provide a Battery Energy Storage System (BESS) at Owner proposed location. The entire BESS facility shall be controlled by the BESS Supervisory Control and Data Acquisition (SCADA) System and Controller as described below in this Technical Specification. The Project includes all the necessary design, engineering, procurement, manufacture, build, construction, commissioning, start-up, testing, performance verification, and Owner personnel training. The Project shall be engineered and constructed according to Industry Standards using prudent utility practices.

## 1.2 Definitions and Abbreviations

| | |
|---|---|
| ºC | Celsius |
| °F | Fahrenheit |
| A | Ampere, unit of Electrical Current |
| AC | Alternating Current |
| AGC | Automatic Generation Control |
| ASCE | American Society of Civil Engineers |
| ASTM | American Society for Testing and Materials |
| BESS | Battery Energy Storage System |
| BOL | Beginning of Life |
| BOT | Build Owner Transfer |
| Change of Ownership | As defined in the LGIA |
| Seller | Qualified integration firm and/or OEM vendor |
| CPT | Control power transformer |
| dBA | A-weighted decibels |
| DC | Direct Current |
| DOD | Depth of Discharge |
| Down Reserve | The capability of the BESS to inject AC power to the grid at the point of interconnection (POI) in response to remote commands, and/or frequency response |
| DR | Distributed Resources |
| DNE | Data Network Engineering |
| DNO | Data Network Operations |
| EL | Electroluminescence |
| EN | European Standard |
| EOL | End of Life |
| EPC | Engineer-Procure-Construct as the primary or general Contractor |
| EPS | Electric Power System |

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|---|---|
| Frequency Response | The capability of the BESS to provide response for frequency deviations above and below the frequency set point (or dead band) of the BESS, within the ramp rate limits for the Project |
| FRT | Frequency Ride-Through |
| FNTP | Full Notice to Proceed |
| GHS | Global Harmonized System |
| GHz | GigaHertz |
| HMI | Human Machine Interface |
| HV | High Voltage |
| $HV_{AC}$ | High voltage alternating current |
| HVAC | Heating, Ventilation & Air Conditioning |
| Hz | Hertz, unit of electrical frequency |
| IEC | International Electrotechnical Commission |
| IED | Intelligent electronic device |
| IEEE | Institute of Electrical and Electronics Engineers |
| Inverter | All inverters in this specification refer to Four-Quadrant, Bidirectional, Smart Inverters. |
| ISO | Independent System Operator |
| kHz | kiloHertz |
| kW | kiloWatt |
| kWh | kiloWatt-hour |
| kV | kiloVolt |
| LGIA | Large Generation Interconnection Agreement |
| LHFRT | Low and high frequency ride through |
| LHVRT | Low and high voltage ride through |
| Load Following | The ability of the BESS to provide real power response to a specific, metered electrical location (i.e., the point of interconnection (POI)) based on the variations of real power demand at the specified location |
| LPS | Lightning protection system |
| LV | Low Voltage |
| MHz | MegaHertz |
| mil | Unit of measurement for length (thousandth of an inch) |
| MPT | Main Power Transformer |
| MTBF | Mean time between failures |
| ms | milliseconds |
| MV | Medium Voltage |
| MVT | Medium Voltage Transformer |
| MVA | Mega Volt Amp |
| MW | Megawatt |
| $MW_{AC}$ | Megawatt alternating current |
| MWh | Megawatt hours |
| NEC | National Electric Code |
| NEMA | National Electrical Manufacturers Association |
| NFPA | National Fire Protection Association |

| | |
|---|---|
| NVR | Network Video Recorder |
| O&M | Operation and maintenance |
| OEM | Original Equipment Manufacturer |
| Output Frequency Range | The range of frequency under which the Project will operate according to its specification |
| Output Voltage Range | The range of AC grid voltage under which the Project will operate according to its specification |
| Owner | Entergy |
| P/T/Z | Pan/tilt/zoom |
| PCB | Polychlorinated biphenyl |
| PCC | Point of Common Coupling |
| PCS | Power Conversion System |
| Peak Shaving | The ability of the system to provide power to the grid above a threshold power demand level during peak demand periods to maintain net power demand at the substation below the threshold level. |
| PID | Proportional Integral Derivative loop control |
| PLC | Programmable Logic Controllers integrated with the BESS and SCADA System |
| POI | Point of Interconnection, which shall be where system ties into the existing Transmission or Distribution Network |
| Project | BESS for grid support applications |
| pu | per unit |
| PV | Photovoltaic |
| PVC | Polyvinyl chloride |
| QA/QC | Quality assurance/quality control |
| QP | quasi-peak |
| Ramp Rate | The rate, expressed in Megawatts per minute, that a generator changes its power output. |
| RAS | Remedial Actions Scheme |
| Rated Apparent Power | The real or reactive power (leading/lagging) that the BESS can provide at the POI continuously without exceeding the operating limits of the BESS |
| Rated Continuous Charge Power | The rate at which the BESS can capture energy for the entire SOC range of the BESS |
| Rated Continuous Discharge Power | The rate at which the BESS can continuously deliver energy for the entire specified SOC range of the BESS |
| Rated Discharge Energy | Total energy the fully-charged BESS can deliver to the POI at the rated continuous discharge power without recharging. |
| Revenue Metering Point | There are three Revenue Metering Points: Project Totalizing meter at the POI; the Project BESS (low side of the transformer); and the Project PV (low side of the transformer – if applicable). |
| rms | root mean square |
| SCADA | Supervisory Control and Data Acquisition |

| | |
|---|---|
| SCCR | Short-circuit current rating |
| SGIA | Small Generator Interconnect Agreement |
| SOC | State of Charge, measured in % relative to the maximum possible amount of energy that can be stored by the system, with fully charged being 100% and fully discharged being 0%. |
| SOH | State of Health |
| SPCC | Spill Prevention Control and Countermeasures |
| SPD | Surge protection devices |
| Standby mode | BESS standby mode means that the battery is charged to the specified level and is not providing or receiving power from the grid |
| SWPPP | Storm Water Pollution Prevention Plan |
| System Round-Trip Efficiency | The ratio of the delivered output energy of the BESS to the absorbed input energy required to restore it to the initial SOC under specified conditions through the Design Life. |
| Total Response Time | Starting when the command is received at the BESS boundary and continuing until the BESS discharge power output reaches 100 +/- 2% of its rated power, measured at the POI |
| DOT | Department of Transportation |
| UL | Underwriters Laboratories, Inc. |
| Up Reserve | The capability of the BESS to absorb AC power from the POI in response to remote commands, and/or frequency response |
| UPS | Uninterruptible Power Supply |
| µV/m | microVolts per meter |
| V | Volt, unit of Voltage (Electric Potential) |
| VA | Volt-Ampere, unit of Apparent Power |
| $V_{AC}$ | Volts alternating current |
| VAR | Volt-Ampere Reactive, unit of Reactive Power |
| $V_{DC}$ | Volts direct current |
| VDE | Association for electrical, electronic, and information technologies |
| VESDA | Very Early Smoke Detection Apparatus |
| $V_{OC}$ | Open Circuit Voltage |
| VRT | Voltage Ride-Through |
| W | Watt, unit of Real Power |
| | |

## 1.3 Performance

Per Appendix 2.

## 1.4 Project Description

Per Appendix 2, Table 1.

## 1.5 Augmentation

Owner will manage augmentation needs to account for degradation. Seller shall prepare a strategy for future augmentation, including the following requirements:
Current and future design must allow for future augmentations in proposed site layouts and electrical designs for purposes of developing firm cost proposals. This includes allowing for additional site area that may be required and allowing for additional MV circuits to be connected into the substation switchgear as examples.

An augmentation capacity plan shall be developed for a 20year period that includes an initial overbuild of the system to avoid augmentation the first 3 years.

Seller shall assume a minimum state of health of 43% for the BESS capacity may be needed over the course of a project lifetime. Cost proposals should include required supporting infrastructure.

Seller to provide an optional pricing strategy for the 20-year augmentation plan.

## 1.6 Seller Responsibilities

Seller shall provide all required services and materials for the Project to achieve final completion and pass all necessary tests as described in Section 5.0.
Seller's responsibilities shall include:
Permits required for a BESS project.

Design and engineering

Equipment procurement

Site preparation work, foundations, installation of all equipment, bulk material and commodities supply, and Site finishing work.

Seller also shall deliver:
Project management

Construction management

Commissioning and startup

Maintenance plan and spare parts locations and list

Decommissioning

All as described herein, including all referenced appendices and standards, which will subsequently become a part of the build transfer agreement.
Seller shall construct:
Roads

Foundations

Electrical systems

Control systems, monitoring systems, communications, and ancillary structures

Storage facilities

Security systems

Fencing

Safety markings and labeling

Lightning foundation and electrical installation

Seller shall also erect and commission the BESS in the locations and orientations set forth in a proposed site plan and site layout drawing and in accordance with this specification, and all related specifications that relate thereto.

## 1.7 Conditions of Services

The BESS consists of all the direct current (DC) components from the BESS modules through the PCS plus the MVT. The BESS shall be "Utility Grade" (defined later in this Technical Specification). The balance of the Project (from the output of the PCS to the point of interconnection as defined in the LGIA shall comply with this Technical Specification and be compatible with applicable Owner standards and LGIA requirements. The balance of plant items includes but are not limited to:

Wiring, conduit, trenches, and grounding

Switchgear and current limiters

Metering, as shown in the LGIA.

Transformers

Power poles

Equipment pads

Communications to Owner equipment.

The Project shall be designed to maintain the guaranteed performance metrics presented in this Technical Specification. The Project should include BESS equipment capable of exceeding the technical and operating needs of Owner.

The Project shall include full provisions for training, operation and maintenance of the Project and all associated equipment.

## 1.8 Preferred Main Supplier List

This section contains a list of preferred materials and equipment suppliers. In the event that Seller is considering the selection of a material or equipment supplier, that is not listed herein, Seller shall inform the Owner prior to executing any contract for the procurement of such material or with such equipment supplier. Equipment catalog cut sheets shall be submitted for Owner review and approval prior to procurement. Seller should specify the lead time for each equipment and evaluate in a risk matrix the potential risk of delays.

### 1.8.1 Preferred cable suppliers:

Prysmian

Southwire

### 1.8.2 Preferred pad-mount transformer suppliers (if not integrated with PCS):

Cooper-Eaton

General Electric

Howard

Virginia Transformer

### 1.8.3 Preferred cable splice suppliers:

3M

Kanusa

### 1.8.4 Preferred Power Conversion System suppliers:

Sungrow

SMA

TMEIC

#### 1.8.5 Preferred Battery Suppliers

LG Chem

Samsung

Tesla

CATL

Toshiba

Panasonic

The seller should list the required industry standards and regulations to be complied with for each category.

## 2.0 STUDIES

### 2.1 Grounding System Study

Seller shall perform studies to determine the parameters for the Project's grounding system in WinIGS, CDEGS or equivalent.

### 2.2 Electrical System Studies

Seller shall prepare electrical system studies as required to configure the Project and to determine control response and settings. Seller shall develop a positive sequence power flow model and a dynamic model in the latest version of PSSE or equivalent software as required by the grid operator at the point of interconnect. The short circuit and arc flash models and reports shall be made in SKM and be made available for Owner's use. Seller shall include in their harmonic study, the harmonic profile of the project in the interconnection requirements. Electromagnetic Transient modeling shall be performed in PSCAD. Studies shall be provided in sufficient detail to demonstrate the functionality as described in this Technical Specification and shall be completed prior to the commencement of detailed design and identified in the project schedule. These system studies shall be updated / as-built with final system design changes and provided to Owner at the end of the Project. These studies, at a minimum, shall address and solve the following concerns:

Harmonic analysis of the proposed system

Minimum system requirements and configuration for proper operation of the BESS (i.e., requirements to stabilize a self-commutated power conversion system (PCS))

Minimum spacing requirements between equipment to maintain safe energization and maintenance conditions

Battery degradation and expected power output at end of life of the BESS

Charge and discharge curves of the project for potential tie into other renewable systems

Requirements for Volt-Ampere Reactive (VAR) support, peak shaving, battery charging and other support services as described in this Technical Specification.

Safety requirements for operation compliance with applicable codes and standards

The seller to specify when each of the above studies can be provided to the Owner as described in Appendix 3.

## 2.3 Required Dynamic Models

### 2.3.1 Frequency Models

- Seller shall prepare individual models of the fundamental positive sequence behavior of the BESS.
- Owner shall be provided PSSE models in the version required by the interconnection authority that accurately represent the control characteristics and dynamic behavior of the BESS in response to balanced voltage and frequency disturbances. This model shall be provided with all available information once the 60% design is complete and refined to reflect the final design configuration at IFC.
- Fully detailed equivalent models are required; generic models from the WECC approved model library are preferred if they can accurately model the BESS behavior in response to voltage disturbances and system frequency disturbances.
- The PSSE models shall be validated for accurate representation of disturbances that are within the model's appropriate range of application, using a validated electromagnetic transient model or full-scale testing.
- The PSSE models shall be fully documented.
- The PSSE models must be non-proprietary and shall be accessible to other utilities, system operators, asset owners, and other entities associated with the interconnection.
- The PSSE models shall be updated by Seller prior to any change to the inverter controls or control parameters that affect the dynamic performance.
- Seller shall ensure compatibility of the provided PSSE models with the version of PSSE that Owner utilizes at the start of commercial operation. Upgrades and modification of the models to maintain compatibility with ongoing PSSE versions shall be the responsibility of Seller over the lifetime of system performance.

### 2.3.2 Model Inputs

The PSSE model should reflect the current design of the power plant and a general network equivalent or detailed network, depending upon interconnection study requirements.

## 2.4 Electrical Design Parameters

For design purposes, the power system characteristics, at the Project location, and for which the BESS will be required to provide rated output, shall be considered are as follows:
Maintain frequency and voltage within the utility set limits

Supply required real and reactive power at a power factor range set by the utility

### 2.4.1 Grounding

A suitable equipment grounding system shall be designed and installed for the Project. Seller will be responsible for providing an effective grounding mechanism. Seller shall provide detailed information (such as ground-grid drawings and calculations) for all Project grounding. Seller is responsible for designing and providing the Project system grounding and equipment grounding. The Project grounding system shall provide personnel protection for step and touch potential in accordance with Institute of Electrical and Electronics Engineers (IEEE) 80. Equipment and systems not covered by IEEE 80 shall comply with grounding requirements of National Electrical Code (NEC) 2017. The system also shall be adequate for the detection and clearing of ground faults. The Project grounding system shall be reviewed and approved by Owner.

All exposed non-current carrying metal parts shall be solidly grounded. Particular attention shall be given to prevention of corrosion at the connection of dissimilar material such as aluminum and steel.
All ground conductors shall be stranded copper and may be bare if exposed. Ground conductors in conduits shall be green-insulated. Ground lugs shall be mechanical and rated aluminum to copper. All below grade connections shall be exothermic welds. Step-up transformers and inverters and the Project switchgear shall be bonded to the ground ring at opposing corners of the equipment. Mounting structures shall be grounded in a manner that is sized for maximum available short-circuit current and lightning current (if required).
Seller shall submit to Owner grounding and lightning calculations for assurance of safe step and touch potentials on the Site, in accordance with Owner's standards. Seller shall conduct a ground resistivity test to verify that the grounding system meets minimum requirements for the overall grounding scheme.
Interior fencing (including without limitation internal fences around interconnection equipment and inverters) shall be installed and grounded and substation grounding shall be done in accordance with Owner's Standards and Specification, Appendix 3. Fencing around the perimeter of the overall Project Site shall not need to meet the aforementioned Handbook standards but shall be grounded in accordance with local codes. Perimeter fences shall be at least 30 feet from the fence around the interconnection equipment. A ground grid meeting the requirements of IEEE 80 shall be installed in the area of the interconnection equipment.

### 2.4.2 Control and Instrumentation Cabling

All cabling shall be new and continuous for each run; splices are not acceptable unless reviewed and approved by Owner on a case-by-case basis. All conductors shall be copper.
All cabling, which may be exposed to mechanical damage shall be placed in conduits, wireways, overhead trays, or other enclosures suitable to Owner. All below grade runs shall be in buried conduit unless proximity to a roadway requires concrete duct bank. Alternating Current (AC) and DC circuits shall be installed in separate conduits. Wires shall have identifying labels or markings on both ends. The labels shall identify the opposite end destination.
Control and instrumentation wiring shall be separated from power and high voltage wiring by use of separate compartments or enclosures or by use of separate wireways and appropriate barrier strips within a common enclosure according to the National Electric Code (NEC) or governing standard.
BESS control and instrumentation system wiring shall be bundled, laced and otherwise laid in an orderly manner. Wires shall be of sufficient length to preclude mechanical stress on terminals. Wiring around hinged panels or doors shall be extra flexible (Class K stranding or equivalent) and shall include loops to prevent mechanical stress or fatigue on the wires.
The instrumentation and control cable shields, where applicable, shall be multi-point grounded.
Wiring to terminal blocks shall be arranged as marked on wiring diagrams. Terminal groupings shall be in accordance with external circuit requirements.
Raceway and cable systems shall not block access to equipment by personnel.

## 2.5 Permitting

Seller shall apply for and obtain all permits and authorizations necessary for construction of the Project. Copies of all applicable permits shall be provided to Owner within five business days after they are obtained or completed. Seller shall provide a permit matrix to Owner for approval.

## 2.6 Audible Noise

The maximum sound level generated from the BESS and any associated equipment supplied by Seller under any output level within the Project operating range, shall be limited to 65 dBA level in any direction from the facility fence or building exterior. Seller shall comply with all ordinances and regulations that may apply to the BESS installation as determined by the local building codes. Results of noise studies shall be provided for major equipment such as HVAC and PCS units.

Noise produced by the Project and any associated subsystems shall be designed and furnished such that the ambient noise level in the BESS control room, or any typically occupied area with applicable standards in a building shall not exceed 65 dBA.

### 2.7 Broadband Interference

Seller shall take necessary precautionary measures to ensure that there will be no missed operation, damage or danger to any equipment or system due to broadband interference and effects.
Interference to any radio service that requires a license, FCC licensees, military radio frequencies or medical devices is prohibited.
Seller should provide testing is required to validate broadband interference.

#### 2.7.1 Radio Interference

Seller shall ensure that the Project does not degrade radio reception.
Seller should provide testing is required to validate radio interference.

#### 2.7.2 Television Interference

Seller shall ensure that the Project and related equipment does not generate any discharge sources that could degrade television reception. Seller shall take all necessary action to ensure that television reception is not adversely affected.
Seller should provide testing is required to validate television interference.

#### 2.7.3 Wireless Communication Interference

Seller shall ensure that there are no discharge sources from the Project and related equipment that could cause interference with wireless communication systems. Seller shall take all necessary action to ensure that cellular and PCS communication is not adversely affected.
Seller should provide testing is required to validate Wireless Communication Interference.

#### 2.7.4 Microwave Interference

Seller shall furnish information concerning any potential interference sources and levels that might emanate from the Project and related equipment that could adversely affect microwave communication.
Seller shall take all necessary action to ensure that any microwave system is not adversely affected.
Seller should provide testing is required to validate Microwave Interference

## 3.0 DESIGN, FABRICATION AND CONSTRUCTION REQUIREMENTS

### 3.1 General

Seller shall supply the complete permitting, design, engineering, procurement, installation, construction, commissioning, start-up, and performance verification of the Project systems for the commercial operation of the Project.
The Project design and construction shall comply with all current local, state, and federal regulations, codes, and applicable standards.
All equipment supplied shall be designed to ensure satisfactory operation under the specified site temperature conditions and other atmospheric and environmental conditions prevailing at the site.
All equipment, components, and materials shall be new and free of defects in material or workmanship.
Seller shall verify all information provided by Owner, Owner's Seller, and third-party suppliers prior to incorporating the information into Seller's design.

### 3.2 Building, Structures and Systems

Seller's scope includes but is not limited to providing the following:
All site preparation including any necessary civil work

Site Storm Water Pollution Prevention Plan (SWPPP)

The BESS will be fully contained in weatherproof, environmentally-conditioned enclosure(s) or building

Supports and foundations for all buildings, enclosures, structures, transformers, switchgear, conduit, and overhead cabling

Battery packs and battery management system, racks, bus bars, and all necessary electrical and battery equipment necessary for a fully functioning BESS to be housed in modular containers or in a dedicated building. The BESS must be appropriately sized for all necessary augmentation to maintain rated capacity through the required Design Life of the facility based on the use cases and conditions contained in these Technical Specifications.

All Project Balance of Plant components

DC system with voltage sources and panel boards for communications networks and relay protection equipment

An uninterruptible power supply (UPS) system for Project control and protection systems and communication equipment

Power conversion systems

Project related medium voltage (MV) terminations, duct banks and cable routing and collection bus connections including but not limited to AC panel boards, circuit protection, and backup distribution sources with necessary isolation/step-down transformers.

The codes and standards to be complied with can be found in Section 8.
Seller shall provide comprehensive safety data sheets (formerly called MSDS) in the new Global Harmonized System (GHS) format as a written chemical inventory of every hazardous chemical in the Project to which employees are exposed.
Should any of the components within the Project require an operating environment less severe than the site environment, the Project shall provide appropriate conditioning of the enclosed space.
All portions of the Project must be sufficiently hospitable to installation, inspection, and service personnel to not restrict the performance of those duties. The Project is to be automated with no operator presence required. Seller to provide solution for remote monitoring of BESS.
Seller shall provide a description and strategy for to the de-commissioning of the Project. Seller shall include descriptions for configuration to begin disassembly, making the energy storage components safe at all times, disconnection and disassembly sequence, and packaging/handling/ shipping requirements of the BESS. A recycling plan for the battery packs shall be included. This is not required for the electrical equipment common to commercial/industrial/utility power systems unless directly related to handling of the energy storage components.

### 3.2.1 Engineering Services

Seller shall design and engineer the Project in accordance with prudent utility practices for grid-connected BESS projects for electric utilities in the United States.
The design must conform to the requirements and conditions of all applicable permits and laws, be in compliance with the operating guidelines, and meet Owner specifications.
Seller is responsible for all engineering of the Project. All design drawings, specifications, and calculations shall be signed by a professional engineer-of-record registered in the state or jurisdiction of the project. Seller shall submit to Owner all completed design drawings, data, and documents for review and comment. These engineered design drawings, data, and documents must be submitted to Owner for review and comment before construction is to begin.
Seller is responsible for ensuring that all components are installed above the 100-year flood plain (battery system, PCS, SCADA system, Security System, control building, transformers, etc.).
Any third-party study or independent engineering reviews (such as the geotechnical study) shall be provided to Owner.

### 3.2.2 Construction Services

Prior to beginning construction and not later than 30 days prior initial site mobilization. Seller shall provide the following to the owner:
a comprehensive onsite construction management plan in accordance with all applicable laws and policies

Health, Safety, and Environmental Plan.

Emergency and Fire response plan coordinated with responding AHJ consistent with NFPA-855

Seller shall also provide Owner with an evaluation and appropriate documentation of the safety record for any licensed Subcontractor that will be performing work on the Project.

The seller should also provide reference projects where the above plans and actions have been taken. When the above plans and actions have been taken, the seller will establish goals for the project, during the project the seller will report back to the owner on deviations and near misses. Seller and subcontractors must register with and be approved by ISNetworld. -
Seller shall assemble, construct, and install with its own labor forces and/or with Subcontractors labor, tools, and equipment necessary to complete the Project, including but not limited to the following Works:
Site preparation, site grading, site improvements, stormwater management facilities and removal of excess debris.

DC cabling and junction boxes.

AC trenching and cabling.

Inverters, switchgear, and transformers and accompanying supports and/or concrete pads.

Perimeter security fencing (described in Sections 3.13.3 and 3.3 Project Security).

Security lighting.

Installation of the monitoring system and revenue grade metering.

Seller shall provide all utilities necessary during construction, including but not limited to electricity, portable water, sewer/toilets, fuel and communications. Seller shall be responsible for all costs associated with construction power. Seller shall be responsible for removal of all trash and construction debris. Seller shall be responsible to provide its own job trailers, and other temporary facilities for its employees.

### 3.2.3 Quality Assurance/Quality Control Requirements

Seller shall submit a Quality Assurance/Quality Control (QA/QC) Plan for the proposed project delivery. The QA/QC Plan shall define the systems and procedures which will be used by Seller to ensure that the Project will comply with the requirements detailed in this Technical Specification in addition to any other standards and policies determined by Owner.
Seller shall submit to Owner a copy of its QA/QC Plan for review not later than 45 days after contract execution for Owner review and comment. The Project shall be managed in accordance with the program.
The QA/QC Plan shall include, but is not limited to, such procedures and systems as the following:
Road construction and compaction.

Reinforcing steel and conduit placement.

Concrete placement and testing.

All wire insulation testing—Megger testing or very low frequency testing.

Factory testing of batteries, PCS and transformers by the manufacturer.

Fuse tests.

Terminations pull testing

All visual inspections

Grounding continuity testing

Earth-ground resistivity testing

BESS inspection and manufacturer documentation of factory test per the manufacturer's existing program

Metering and instrumentation calibration testing

SCADA indication, control and operator interface verification

Step-up transformer testing

Weld testing for transformer support including other anchorage

Weld testing for racking supports

Inverter phase rotation and matching with utility

Protective relay settings

Verification of security camera system operations, including device points, sequences, and communications

Other Seller-prescribed procedures

All onsite QA/QC testing procedures shall be witnessed and documented by a qualified representative of Seller. Owner shall observe and witness QA/QC as necessary and at its discretion. A qualified engineer of Seller shall date and sign documentation indicating completion and acceptance of each onsite QA/QC test procedure.

### 3.3 Storage of Materials and Equipment

Prior to the arrival of equipment and materials at the Site, Seller shall install a fenced, secured area and provide security for the storage of such equipment and materials. Construction storage and laydown shall be sufficiently drained and elevated above the flood plain. Seller shall notify Owner of the location and layout of intended staging areas, parking areas, storage areas, office areas, workshops, and other temporary facilities. Temporary construction roads and staging areas not converted to permanent roads (if any) shall be restored in accordance with all permit requirements.

Seller shall be responsible for receiving, protecting, moving, and storing all material at the Site in a secure manner and a manner that maintains temperature control for battery cells and modules required under warrantees. OEM recommended requirements to guarantee temperature controls are maintained for BESS including the battery cells so that warrantees are not violated if needed climate-controlled facilities should be constructed before BESS including the battery cells arrive on site as well. BESS module staging during construction shall be separated to limit fire propagation between units consistent with final placement analysis. Laydown area vegetation height should be managed to reduce wildfire potential.

### 3.4 Equipment

As described in detail throughout this document, Seller shall purchase and furnish to the Site all material required to complete the Project, including but not limited to, the following material:

Miscellaneous steel

Components (nuts, bolts, clamps, etc.)

BESS

PCS

DC cabling

AC cabling

Electrical switchgear

Transformers

Remotely accessible data acquisition system

All materials related to drainage and access roads required by the civil engineering plan

All electrical conduit and junction boxes

Concrete equipment pads

Fencing, gates, lighting, security cameras, and security camera recording equipment

Communications infrastructure

Each item of equipment to be supplied by Seller shall be subject to inspection and testing during and upon completion of its fabrication and installation further described in Section 6.
Installed equipment and materials shall be new, and suitable grade for the intended purpose, and not a lower grade or quality than specified in the design and engineering plans or in manufacturers' recommendations. Utility-grade equipment shall be used. Commercial- or residential-grade equipment shall not be acceptable. No equipment shall utilize polychlorinated biphenyls (PCBs).
Seller shall provide a Spill Prevention Control and Countermeasures plan and provide secondary containment where required and to prevent accidental discharge of chemicals. Seller shall provide a BOM list to the owner listing all major equipment to be purchased, constructed, and installed as part of the Project.

## 3.5 Power Conversion System (PCS)

The PCS is the interface between the DC battery system and the AC system and provides for charging and discharging of the battery and may consist of one or more parallel units. The PCS shall be designed to have Design Life as listed in Appendix 2, Table 1.

### 3.5.1 PCS Requirements

The PCS shall be a smart static device (charger and inverter) using solid-state electronic switch arrays in a self-commutated circuit topology. Line-commutated systems or systems that require the presence of utility voltage or current to develop an AC output are not acceptable.
The PCS, in conjunction with the BESS Master Controller, shall be capable of completely automatic unattended operation, including self-protection, synchronizing and paralleling with the utility, and disconnect functions.
The control of the PCS shall be integrated with the overall BESS Master Controller. A proven and established combined instrumentation and control system shall be provided for the BESS SCADA System. Each SCADA system shall feed into a central controller that shall be the primary interface with the Owner's controls and shall be compatible with the utility's existing SCADA system.
The PCS also shall include all necessary self-protective features and self-diagnostic features to protect itself from damage in the event of component failure or from parameters beyond safe range due to internal or external causes. The self-protective features shall not allow the PCS to be operated in a manner that may be unsafe or damaging. Faults due to malfunctions within the PCS, including commutation failures, shall be cleared by the PCS overcurrent protection device(s).
Therefore, Seller shall design the PCS, including its controls, power supplies and connections to sensors, to be immune from utility system voltage and/or frequency transients and similar events. Further, the PCS shall be capable of operating continuously at rated output under the normal voltage and frequency ranges and providing full output for the required operating modes specified.

All PCS components shall be designed to withstand the stresses associated with steady state operation, transient operation and overload conditions as implied by this Technical Specification. Seller shall be responsible to demonstrate that all relevant aspects of overvoltage stresses have been considered.
The PCS shall have provisions to prevent moisture condensation and entrance of rodents, insects, and/or similar material into air intake/exhaust ports or any required structure penetration.
The PCS system shall include provisions for disconnection on both the AC and DC terminal, for maintenance work. Conductor separation must be clearly visible; flags or indicators are not acceptable. These disconnects shall be capable of being locked open for maintenance work. PCS capacitors shall be provided with bleeder resistors or other such means of discharging capacitors to less than 50 V within one minute of de-energization.
An interlock system shall be provided for access to the PCS room or enclosures if live parts are exposed when opened. A visible disconnect switch or draw-out breaker and grounding devices shall be provided for maintenance of the PCS equipment. The interlock system shall prevent access to the PCS equipment until the AC and DC circuit breakers or disconnect switches are open and the PCS bus is grounded.

### 3.5.2 Interference and Harmonic Suppression

The PCS shall not produce Electromagnetic Interference that will cause interference with instrumentation, communication, or similar electronic equipment within the Project or on Owner's system. The PCS shall be designed in accordance with the applicable IEEE standards to suppress Electromagnetic Interference effects.
The BESS must meet the harmonic specifications of IEEE 519 and Owner's power quality standards. Harmonic suppression may be included with the PCS or at the Project AC system level. However, Seller shall design the Project electrical system to preclude unacceptable harmonic levels in the Project auxiliary power system.
Seller shall perform studies to determine required AC harmonic filter types and ratings if filters are required to meet the harmonic specifications. In addition, these studies shall be used to demonstrate that the AC filters do not cause any resonance with Owner's power system and that the harmonic distortion limits can be met by the filters designed by Seller. Seller shall design the Project to be completely compatible with Owner's existing capacitor banks and their associated controls. Owner will not be required to change or modify the existing system to accommodate the Project. However, actual compliance will be based on field measurements after commissioning.

### 3.5.3 PCS Cooling System

The purpose of the PCS cooling system is to remove the heat produced by the PCS operation and transfer this heat to the outside ambient air or to be used as auxiliary heat for the building or enclosures as appropriate.
Either water cooled or air-cooled systems are allowed. However, the final rejection of waste heat shall be to the outside ambient air. No discharge of cooling system water shall be allowed.
The cooling system shall be furnished complete with all necessary equipment and facilities, including, but not limited to:
interconnecting piping and ductwork,

circulating pumps

blowers, heaters

make-up reservoirs

heat exchangers

filters

water treatment plants

Control system including alarms.

The cooling system shall be designed such that the failure of any single component of the cooling system will allow the Project to continue to operate at full capacity. All joints and gaskets are designed for high reliability and to comply with seismic requirements.

The cooling circuit for water cooling systems shall be a closed loop de-ionized water or water/glycol mixture recirculating system. Each loop and each branch shall have manual valves to isolate it from the rest of the system without disrupting the operating loop. If a water/glycol system is proposed, Seller shall prepare a Spill Prevention Control and Countermeasures plan and provide secondary containment for accidental discharges of the mixture.

The high purity (high resistivity) water (if used) in the closed loop system shall be circulated through the heat producing electrical equipment at a constant flow rate. A purifying loop to maintain the high purity in the closed system shall be provided. Freeze prevention equipment / plan shall be provided by Seller. Seller shall determine the source of the water supply for cooling system make-up water and obtain water service if required.

Non-recirculating (once-through) or recirculating air systems may be proposed, depending on the requirements of the PCS selected by Seller. If a recirculated air system is used, a heat exchanger shall be provided. If a non- recirculated (once-through) air system is used, a two-stage air filtering system shall be provided. The air handling systems shall include filtering which is adequate to keep dust from the interior of the PCS system.

, Seller is encouraged to provide the most efficient HVAC systems, including auxiliary heat recovery subsystems

### 3.6 Medium Voltage Step-Up Transformers

Transformers shall meet transformer efficiency standards. A transformer shall be used by Seller to match the secondary voltage of the PCS to the point of interconnection. The intermediate output(s) may be at any Seller determined AC voltage.

The transformer may be configured with any Seller specified winding configuration. If a grounding transformer is required due to the Seller provided step- up transformer design, the grounding transformer shall be designed, provided and installed by Seller.

Transformers shall be rated for inverter source operation and the environment in which they will operate. The transformer shall be supplied with a no-load tap changer with high-voltage taps capable of operating at 2.5 percent above and below nominal voltage at full rating. The transformer shall be supplied with a disconnect switch on the transformer high-voltage side to isolate the transformer once de-energized. The switch/transformer configuration shall be designed for loop feed. Transformers shall be either dry-type, or oil filled, FR3 or equivalent is not acceptable. Enclosure finish shall be a top powder coat that is designed for a 40-year service life. Seller shall provide and install step-up transformers as provided in the Agreement. Owner shall reserve the right to attend factory witness testing of step-up transformers.

The transformer may be used to aid in harmonic cancellation. If the transformers are a liquid-filled type, PCBs shall not be used. Seller shall provide a SPCC if transformers are liquid-filled type.

### 3.7 Revenue Meter

The owner shall provide revenue grade metering at the POI and revenue grade metering on the feed supplying the HVAC, inverter parasitic loads and battery parasitic loads. If required potential transformers (PTs) and current transformers (CTs) for protection and metering on the distribution bus or feeders shall be provided.

The Owner shall be responsible for the installation of the revenue meter.

## 3.8 Collector Substation

Switchgear shall be in a National Electrical Manufacturers Association (NEMA) 4 lockable enclosure if located outdoors. Switchgear shall include an auxiliary compartment containing all instrument transformers associated with the protective relays shown in the one-line diagram(s). The protective relay system shall be specified, designed, and installed in accordance with interconnecting utility's requirements. Switchgear monitoring and communication hardware shall be included to meet the requirements of Section 3.7 Revenue Meter and Section 5.0 Supervisory Control and Data Acquisition, and the metering requirements of Owner. Relay current transformers shall be C400 accuracy class at a minimum unless a higher class is required due to saturation current per IEEE C37.110.

Medium-voltage protective device selection and relaying should be based on the use of Schweitzer Electric Laboratories (SEL) relays or approved other.

MV switchgear shall be arc resistant type.

A complete protective relaying system shall be provided for the PCS and transformer(s) as stated below: Inverters equipped with internal relays with 27, 59, 81U/O and voltage-controlled overcurrent 51C functions shall be provided with one utility grade relay with 27, 59, 81 U/O and 51C functions as secondary protection. Otherwise, two utility grade relays and one Owner-designated interrupting device shall be installed to meet the protection requirements.

Protective relays shall be hardwired to the device they are tripping.

Interconnection interrupting devices shall have DC trip coils and tripping energy shall be derived from Seller supplied battery separate from the BESS main batteries.

Owner will review Seller's relay settings and their calibration and test results of those relays to satisfy Transmission Provider's protection practices.

Seller shall provide phase and neutral overcurrent protection for the PCS transformer(s).

Protective relays shall have backup power of 125 $V_{DC}$ system supplied by station batteries.

Relay settings files are to be included following the completion of the IFC design package.

Seller shall use microprocessor type protection equipment compatible with Transmission Provider's relay protection schemes to the extent possible.

The protective relaying and metering shall be integrated with the Project control system and communications channel to the Transmission Provider's SCADA system. However, integration into the Project control system shall not circumvent normal protective relaying functions nor shall any protective relay or revenue metering values be used for control within the project control system. The control system for the BESS and PV systems may use metering values from the revenue meters through a DNP 3.0 link if desired. These values may only be used for indication within the project control system. Metering, separate from revenue metering and protective relays, may be installed for any control purposes at Seller's discretion. Points List

The points list shall be included as a deliverable in spreadsheet form. The Master Points List is to include all equipment connections to stakeholder devices including, but not limited to:

BESS equipment

Utility

IEDs

Reliability entity (ISO)

Transformer monitoring and control

BOP SCADA

## 3.9 Auxiliary Power

Primary AC station service shall be provided from the low voltage side of the Project PCS transformer bus of a dedicated auxiliary transformer. If required by Seller's design, back-up station service shall be provided All facilities required to provide primary and back-up station service to the Project and building, including auxiliary power transformers, transfer switches, protection and distribution panels shall be Seller's responsibility.

In the event of a loss of the Auxiliary Power connections to Project, primary and/or backup station service may or may not be available. Back-up UPS to power Project controls, pumps and auxiliaries in the event of a total failure of the primary and back-up station service feeds shall be provided for orderly shutdown. The UPS shall be separate from the BESS main battery system and sized for an orderly shutdown of the Project for a loss of station service with the UPS at 80% rated capacity. The UPS shall be housed in a separate location from the BESS main battery to facilitate ease of maintenance.

All auxiliary DC station service requirements for the BESS shall be designed, engineered, furnished and installed by Seller. 125 $V_{DC}$ shall be used for protective relay power.

## 3.10 Civil/Structural

Seller shall design all systems and site improvements in accordance with applicable codes and standards. Seller shall design necessary road improvements to meet state and local transportation codes and meet or exceed requirements presented by construction equipment, delivery vehicles, and operation and maintenance traffic. All BESS and PV equipment, building or enclosure foundations and structures shall be engineered by or under the direct supervision of a qualified professional engineer or architect registered in the state of the project as applicable. All final (Issued for Construction) drawings, specifications and calculations shall be wet-stamped by Civil/Structural Engineer or Architect registered in the state of the project as applicable. All stormwater calculations and design documents shall be overseen, signed and sealed by a Civil Engineer or Landscape Architect familiar with local codes and requirements, and registered in the state or jurisdiction of the project. All design shall be in accordance with seismic design requirements as specified elsewhere in this Technical Specification, and by the Seller provided geotechnical study.

Seller shall gain access to the site from existing public and private roads. Existing roads shall not be blocked or restricted without prior approval of Owner and local agencies. Seller shall be responsible for damage to public roadways resulting from the work performed. Seller shall also be responsible for the facilities access road's preparation/interconnection with the main road.

Seller shall perform required Site preparation, to include earthworks, SWPPP, and erosion control. Seller shall attempt to minimize earthwork and vegetation disruption for the installation of the Project to the extent it is compliant with the use permits; however, vegetation should be controlled to minimize fire danger and provide the ability to operate and maintain the Project. Any land contours that may affect BESS electrical generation should be included in the BESS system performance estimate. If required, Seller shall import engineered fill to slope the Site and prevent accumulation of standing water. Any direct burial cabling shall be protected with adequate bedding materials to ensure long-term cable integrity. Dust control shall be maintained in accordance with state and local requirements until Final Acceptance is achieved. Seller shall provide other Site maintenance as needed during construction. Existing structures and utilities that are adjacent to or within the limits of the Project area shall be protected against damage. Seller shall be fully responsible to Owner or other property owners for all repairs in the event of removal or damage of any existing structure, equipment or systems that are intended to remain in place.

### 3.10.1 Geotechnical Analysis and Hydrology Report

A geotechnical analysis shall be provided by Seller and performed by a qualified geotechnical engineering firm. The required number of boreholes and location shall be determined by the engineer

to meet design requirement An engineering firm shall prepare a hydrology report. The results of the analysis shall be used when designing the foundations for the structures on the Site.
In addition to the above minimum requirements, local jurisdictional regulations may require site specific hydrologic and infiltration testing. Seller should determine specific requirements and coordinate with geotechnical engineering firm to obtain any required testing information, related to proposed stormwater management facility designs.
A detailed report shall be provided outlining the tasks performed and the results of the testing. Included in the report should be any recommendations for the foundation designs, structural support designs, corrosion protection for both underground steel and concrete, pile drive frequency, minimum pile size, and any geologic conditions that may prevent the development of the Project. Geotechnical report shall include recommendation of type of cement to be used based of the sulfate content to meet concrete durability and design life of foundations.

### 3.10.2 Environmental Loads

All structures on the Site need to be designed using environmental loads as specified in the American Society of Civil Engineers (ASCE) 7 code book *Minimum Design Loads for Buildings and Other Structures* and the applicable state building code if more stringent requirements. These include wind loads (Chapter 6), snow loads (Chapter 7), rain loads (Chapter 8), ice loads (Chapter 10), and earthquake loads (Chapter 11). Each structure on Site shall be grouped in Occupancy Category III as defined in ASCE 7. The corresponding importance factor shall be used for each load calculation.

### 3.10.3 Excavation

Seller shall perform all common and deep excavation necessary for installation of all foundations and utilities. All excavation shall be in accordance with OSHA regulations. Excavation spoils shall be the Seller's responsibility and may be used for backfill or embankment if suitable, per ASTM D 2487 for this application. Unsuitable or excess excavated material shall be properly disposed of.
Seller shall verify that earth materials exposed in excavations are consistent with those assumed for Seller's foundation designs. If earth materials are different than assumed for particular foundation design, Seller shall modify the design and/or treat the earth material (over excavate, replace, etc.) as necessary to provide foundation meeting design requirements including frost depth.
Seller should be familiar with type of soil by review the geotechnical report and boring logs, it's the responsibility of seller to determine the most efficient method to excavate considering the project schedule.
Seller shall be responsible for making all excavations in a safe manner and consistent with the requirements of the Occupational Safety and Health Administration.
Seller shall provide adequate measures to retain excavation side slopes to ensure that structures, equipment, and persons working in or near the excavation are protected.
Seller shall protect all above grade and below grade utilities. Protect below grade liquid systems from frost.

### 3.10.4 Construction Surveying

Seller shall furnish all labor, equipment, material and services to perform all surveying and staking essential for the completion of the Project in conformance with the plans and specifications. Surveying shall include but not limited to Arial, Topographic, and subsurface utility engineering (SUE level B and A)
Seller shall have necessary entities to locate all underground and overhead facilities at site. This will include sewer, irrigation, water, gas, electric, and communication that will be in direct conflict with the works. No compensation to be paid for locating of these utilities or any associated delays results from relocation works.

Seller shall retain qualified survey crews knowledgeable in proper and up-to-date survey techniques and shall use these qualified survey crews when conducting the survey. Such crews shall be under the supervision of a Professional Land Surveyor registered in the state or jurisdiction of the project. Surveying crew shall establish a permanent benchmark at the project to be used as basis to perform current and future surveying activities.

### 3.10.5 Fills

Earth fill material adjacent to and below structures shall conform to Seller's design requirements for the structure. Seller prepared specifications and drawings shall indicate the types of soil to use for particular fills, compaction, and compaction testing requirements. These same requirements apply to access roads to the Project site.
Samples of Fill material shall be tested and classified, if the fill material meets requirement, then the fill material shall be tested in accordance to determine "Max. Density – optimum moisture test" for compaction requirement.

Fill shall be placed as uniformly as possible on all sides of structural units. Fill placed against green concrete or retaining walls shall be placed in a manner that will prevent damage to the structures and will allow the structures to assume the loads from the fill gradually and uniformly.

### 3.10.6 Fencing

The entire site shall be enclosed with a permanent fence. The Seller shall ensure there are no ground gaps greater than two inches and the fence is secure.

### 3.10.7 Equipment Pads

All equipment pads shall be located such that adequate personnel access is provided to such equipment. A minimum of 4.0 feet (or 1.5 meters) 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 safety and adequate working space around the equipment. The inverter stations, switchgear, substation (if applicable), and other buildings shall be elevated 12 inches above the 100 year flood and – 24 hour design basis rainfall inundation level. The slope of the earthwork around the inverter stations and other equipment shall allow safe and ergonomic access to the equipment and provide for adequate drainage and maintenance. Above ground electrical equipment, including transformers, inverters, PV panels and BESS building or enclosures will be protected with bollards painted yellow.

### 3.10.8 Foundations and Concrete Work

All foundations and supports must be designed in accordance with the applicable state building code using the calculated environmental loads discussed above and soil properties provided in the geotechnical report. All foundations and supports must be designed according to the civil/structural design criteria to meet all loads combinations and over-load factor of safety. In addition, all placed concrete shall at a minimum comply with ACI 301 and ACI 117 publications. Form materials and required steel reinforcement shall comply with local regulations and site specifications. At a minimum, reinforcing bars shall comply with ASTM A 615 or ASTM A 706 for Low-Alloy-Steel Reinforcing bars.
Concrete mix design shall be submitted for engineering review/approval prior to any concrete works per project specifications. All concrete works shall be tested before pouring concrete for temperature, slump, and air content. Samples shall be collected and tested for concrete strength test by qualified testing laboratories.

### 3.10.9 Corrosion Protection

Corrosion protection shall be utilized on the structures of the Project. The type and amount shall depend on the selected materials of construction and conditions at the Site. A study of these conditions along with recommendations from the geotechnical report shall be used to design the corrosion protection. The corrosion protection study shall be performed by a qualified corrosion expert and documented with references and calculations showing that the foundations, supports, racking, fasteners, and conduit shall meet a Design Life in aboveground and belowground conditions, as specified in Appendix 2, Table 1. If galvanized materials are used, field-applied zinc coatings shall meet American Society for Testing and Materials (ASTM) A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings. This standard contains minimum requirements for the material, surface preparation, and application process. For example, repairs to damage due to vibratory pile driving shall conform to ASTM A780.

It is required that all holes in structural members requiring galvanization shall have the holes drilled before the galvanization is applied. Should holes be drilled in the field, galvanizing shall be applied to the exposed steel as specified in ASTM A780. All field welds shall have a field-applied galvanization as specified in ASTM A780. For example, if torque tubes with a 3.0-mil (0.003-inch) hot-dip galvanization are to be welded in the field, a field-applied coating, such as hot stick repair, shall meet or exceed the original 3.0-mil coating thickness of the torque tube per ASTM A780 requirements.

Only steel bolts with pre-applied corrosion inhibitors or stainless-steel bolts and fasteners shall be allowed in the entire mounting structure.

### 3.10.10 Erosion Control & NPDES Coverage

Seller shall submit a site-specific Erosion and Sedimentation Control Plan. If required by local regulations, this plan is to be reviewed and approved by the local jurisdiction prior to construction. The erosion and sedimentation control plan will be consistent with and incorporate applicable elements of the SWPPP in addition to local regulations. All areas of temporary soil disturbance are to be graded, if necessary, and re-vegetated in a timely manner to limit erosion as required by the local jurisdiction. In addition to the Erosion and Sedimentation Control Plans, depending on state regulation the site may need to apply for coverage under the National Pollutant Discharge Elimination System (NPDES). This coverage is normally issued by the state environmental agency and is normally required for any site disturbing 1 acre or more. Seller to investigate and apply for any permit authorizations related to earth disturbing activities.

### 3.10.11 Grading and Drainage

The grading and drainage plan shall be designed and installed in accordance with local code and permit requirements. The grading and drainage plan will be consistent with and incorporate applicable elements of the SWPPP and the erosion control plan. All structures required for the drainage plan, if any, shall comply with state standard specifications for drainage facilities. Grading and drainage will be designed to efficiently convey water away from the site, prevent ponding and point source discharge, promote sheet flow of water, and limit long-term maintenance of the Project site. Stormwater Management facility designs if required shall meet all state and local design requirements for Water Quality, Volume and Rate reduction as deemed appropriate for the site.

### 3.10.12 Dust Control

Seller shall apply dust control materials, at Seller's expense, to minimize raising dust from construction operations and traffic, including but not limited to haul routes, using only dust control mixtures approved by the local jurisdictions.

### 3.10.13 Site Finish Grade

Seller shall leave the Site in a clean condition upon completion of the work. Efforts shall be made to restore area to a clean condition as soon as practical. Seller shall remove all trash, debris, and stockpiles.

The Site access roads shall be returned to a condition that meets the original specification by repairing road damage such as ruts, gouges, and weather damage that may have occurred during construction.
The Site finish grade within the equipment footprint and in areas required for operation and maintenance of the Project shall be fully stabilized and gravel covered to prevent vegetation growth.
Provisions of the SWPPP for final storm water drainage shall be implemented.
Seller shall seed and mulch all areas of the Project Site that have been disturbed beyond the permanent portion of the Site and access road, per the SWPPP.

#### 3.10.14 Construction Signage

Seller shall provide temporary signage for local traffic control in accordance with state department of transportation and/or local city requirements and in accordance with Owner's standards.

#### 3.10.15 Human Access

Seller shall make access to all equipment safe and reasonably ergonomic for maintenance staff. For example, if an inverter pad is elevated, the earthwork surrounding the concrete pad shall have a safe approach slope.

### 3.11 Mechanical

All mechanical design shall be in accordance with the International Mechanical Code and the International Fire Code, the additional documents incorporated by reference and the additional requirements herein. All mechanical design shall be performed by or done under the direction of a Professional Engineer registered in the state. All Life Safety requirements shall meet all national, state, and local codes, as well as agree with the local Authority Having Jurisdiction.
In accordance with State and Local Laws, all final (Issued for Construction) drawings, specifications, and calculations shall be wet stamped by a Registered Mechanical Engineer in the state where the project is located.
The BESS components shall be fully contained in weatherproof, environmentally conditioned enclosures or building. The BESS shall have complete and failsafe battery and PCS thermal management systems.
Seller shall provide heating, ventilation and/or space conditioning for the BESS components, as required, to meet the equipment manufacturers' recommendations over the range of site conditions and over the full operating range. Seller shall provide documentation and design calculations supporting the adequacy of the BESS heating, ventilation and/or space conditioning.
Ventilation and space conditioning equipment controls shall be interlocked with the fire protection and if provided suppression systems to operate appropriately in the event of fire.
Ventilation system fans shall be provided with non-return, motor operated dampers. Forced ventilation air streams shall not impinge directly on electrical equipment. Inlet and outlet enclosure dampers shall be of a design that prevents wind driven water and dust intrusion. If required, ventilation systems shall be provided with an interlocked and automatic temperature control system, including appropriate alarming, for each Project building or enclosure.
Space site ambient temperature conditioning as required for the Project enclosure equipment provided shall be provided as complete systems with all accessory items required for proper operation.
Consideration shall be given primarily to requirements for efficient conditioning of the installed BESS and PV equipment except in normally occupied areas such as the control room. Normally occupied areas or areas requiring access for local operation shall consider operator comfort in addition to requirements for equipment conditioning. Space air conditioning equipment shall be designed for the loss of one unit without derating of the Project. Where heating or cooling is provided, the equipment shall have a minimum EER, IEER, SEER rating in accordance with the Energy Codes. Space air conditioning shall be provided with an automatic temperature control system, including appropriate alarming, for each Project operational enclosure.

All electrical equipment, enclosures, disconnects, and overcurrent devices shall be clearly marked and identified according the international/local standards and regulations. Markings shall reference the same designations called out in the final design drawings.

### 3.11.1 HVAC / Thermal Management

The Contractor shall provide all components to operate the BESS within acceptable operating temperatures of the projects described in Appendix 2. If necessary, provide any thermal management systems and operating strategies required to maintain the BESS and inverter temperatures within manufacturer's recommendations at all times.

## 3.12 Safety and Project Security

### 3.12.1 Fire Protection and Suppression

Fire detection and suppression system shall be provided by applicable code or as described in this document for property preservation. Detailed of the fire detection/suppression system to be provided to the owner prior to construction.

The BESS / SCDA shall have a system including current/history of data and alarms. System shall be described in the Seller's proposal and shall include:

Trouble notification when preventive maintenance is needed.

System level alerts shall be provided by the manufacturer over customer interface.

Remote Shutdown capability that shall include:

- Strobe lights and audible alarm – at least one for each of the following:
  - Fire Alarm
  - High Gas Alarm
- Physical panel that is located outside of the fence line at the gate entry that is accessible to emergency responders per section 4.13. Panel shall include contact information for remote operations facility.
- Fire alarm control panel
- Electrical remote shutdown for associated equipment on site to be safely shutdown during emergency situations.

The BESS shall include:

protective relays

circuit breakers, or fuses which self-protect the BESS in the case of internal electrical faults. Set and adjust circuit protection devices according to a short circuit and coordination study.

Battery cell thermal runaway detection including testing performed and mitigation methods used in the BESS will be included in the submittal process.

A visible disconnect will be installed that isolates BESS in accordance with utility interconnection requirements.

Seller shall develop posted instructions for tasks that site staff and local fire department may need to perform, such as system shutdown during an emergency.

### 3.12.2 Project Security

Seller shall provide a security system for the Project. The security system around the perimeter shall include a 7-foot-high chain link fence with 1-foot top guard (total 8-foot high) of three strands of nine-gage barbed wire. The perimeter fence shall include at least two locked gate pairs to restrict access: one with a width of 20 feet with a keypad or access card operated electrically driven slide gate for vehicles and one pedestrian entrance with a width of four feet.

Perimeter signage shall be provided by Owner and installed by Seller in accordance with Owner standards. Signage shall be installed every 50 feet along the perimeter fence and on all gates. Signage indicating electrical hazard and NO TRESSPASS shall be installed five feet above ground level and comply with ANSI Z535 for size and font.
Seller shall be responsible for security during construction.

This equipment shall include:

LED Spot or LED flood lights.

Security cameras must be low-light capable located such that they are capable of adequate identification of intruders or animals covering the perimeter of the Site. Cameras shall be placed at a height that permits line-of-sight access to the property.

Cameras with a control and detection system that assists in the detection and identification of intruders or animals.

Network - Digital Video Recorders used to record video that could be used for evidence in the event of theft or vandalism.

Seller shall negotiate with third party vendor to identify the scope of work that will be performed by Seller, to ensure that a complete and operational security system as described by third party vendor is provided. Third party vendor shall provide to Seller the security system design, which will indicate the location of cameras, DVRs, security lighting and any security communications equipment, based on third party vendor's overall System design. The work that may be provided by third party may include the furnishing and installation of wiring, cabling, labor, tools, equipment, and ancillary materials required for a complete and operational security system. At minimum, it is expected the Security Sub-Seller will provide the following equipment: cameras, network DVRs, and any specialized security communications equipment.

Seller shall be responsible for the furnishing and installation of all necessary conduits, 120-$V_{ac}$ power extensions for all Security related equipment.

Seller shall provide a free-standing weather-proof enclosure with adequate space required for Security Control Equipment as specified by the third party.

Installation of telephone lines, and/or cellular modem(s), and/or local area network for the interconnectivity of all related Security System Equipment.

Seller shall provide fiber optic cable for Security System Communications. Fiber optic cable shall consist of a minimum of six fiber strands between each required camera location.

The system shall be complete, tested, and fully operational. Prior to construction, Seller shall provide the following:

- Descriptive statement and single-line block diagram to show how all related equipment will interface and operate as a complete system.
- Product data: manufacturer's technical data sheets on each product to be used.
- Drawings, including plans, elevations, equipment mounting heights, and dimensions required to show devices' locations and demonstrate accessibility compliance in accordance with referenced documents.
- Detailed schematic wiring diagrams for all system devices; wiring information shall include cable type, conductor routings, quantities, and connection details at devices.
- Manufacturer's user's manuals for operations, administration, installation, and maintenance.

### 3.13 Toxic Materials

If a significant amount of a toxic substance can be emitted from the equipment during a failure, fire or emergency/protective operation, an alarm system to alert personnel shall be included in the equipment. The toxic nature of the substances as well as treatment for exposure to it shall be included in the

Operation and Maintenance (O&M) manual and emergency response plan. Sellers shall provide battery safety data sheets and test data with the bid.
Coordination and approval of an emergency response plan consistent with the guidance of NFPA-855 for the local fire protection agency is required prior to acceptance by Owner.

## 3.14 Spare Parts and Equipment

. Seller shall provide a recommended spare parts list, including prices and availability, as part of his proposal. Seller shall also identify spare parts that Seller recommends should be stocked locally to ensure prompt repair due to any failure that can be reasonably expected, considering the length of time required to obtain replacement parts. Owner will determine the need for and purchase separately all spare parts.
All spare parts for equipment covered by this Technical Specification shall comply in all aspects with the requirements of this Technical Specification. This includes documentation identical in kind and format to that required for the original equipment or material. Each of the spare parts shall be fully identified by reference to the spares list, part number, cost, and manufacturer drawing number.
If Seller, his suppliers, or sub suppliers cease manufacture of any of the spare parts, or if for any reason any spare part will become unavailable at any time during the Design Life of the facility, as specified in Table 1, Seller shall notify Owner in writing at least 180 days prior to the unavailability of such spare parts. Seller shall provide Owner the opportunity to purchase sufficient stock of spare parts to support the system for its expected life.
The initial complement of equipment shall include a supply of chemicals as may be needed to neutralize small electrolyte spills.
Seller shall provide, receive, store locally, distribute and restock spare parts, materials, test equipment, instruments, tools, and consumables required for start-up and operation of the systems and equipment within its scope until Substantial Completion.

## 3.15 Project Access

### 3.15.1 Construction Access

Seller shall abide by all load limits established by the applicable state department of transportation.

Seller shall be responsible for providing, operating, and maintaining equipment, services, and personnel with traffic control and protective devices, meeting the requirements of the local municipal traffic laws as required, allowing traffic flow on haul routes and onsite access roads in a safe manner. Seller shall be responsible for any costs to comply.

Seller is responsible for construction of temporary access around areas of excavation and other construction activity, if necessary and as required.

### 3.15.2 Site Access and On-site Roads

The Site access road shall be designed and installed by Seller and shall include a loop road that parallels the perimeter fence. This design shall be based on sufficient soils and subsurface investigation by a qualified professional engineer licensed in the jurisdiction of the project to ensure that the constructed road will meet its intended purpose. The design life of the access road shall be 30 years (assuming annual maintenance). The Site access road shall be a gravel compacted road (unless local regulations specify otherwise) sufficient to satisfy the loading requirements of class 8 commercial vehicles and to provide all-weather access for operation and maintenance of the BESS. Site access roadway design shall comply with local permit requirements and be appropriately graded for drainage. At a minimum, the site access road shall consist of the following: soil stabilized, geotextile, and two lifts of 6-inch compacted fill for a total of 12 inches with a width 16 feet with 2 feet shoulders on both sides (total of 20 feet).

Roads shall have a minimum 75-foot inside radius, unless otherwise instructed by state or local requirements. A smaller turning radius may be approved with written approval from Owner. Temporary construction roads and staging areas not connected to permanent roads (if any) shall be restored by Seller in accordance with permit requirements. Site Dimensions

| | | | |
|---|---|---|---|
| A | Fence line to Battery | 75 ft | Minimum distance or must maintain distance so that <1psi shall be felt at fence on explosion |
| B | Distance between BESS and associated Inverter | 10 ft | Minimum distance between associated support equipment |
| C | Distance between BESS units or other equipment | 25 ft | Minimum Distance required between BESS units unless an NFPA 80a exposure protection Thermal Flux Calculation demonstrates acceptable separation with no fire service intervention. |

## 3.16 Signage and Labeling

Permanent naming placards should be placed on all equipment, including inverters, combiner boxes, transformers etc. Naming on placards and/or tags shall match drawing naming convention following current Industry and local standards. Fence signage shall be placed per section 3.12.2 . Onsite roadway signage shall be posted at intersections where necessary to indicate exit routes and dead-end corridors. All gates and access points shall have a uniquely identifiable location name and 911 address with emergency contact information posted.

All cables shall be labelled to meet applicable codes and standards. All cables shall have a label affixed to the outer jacket with a Brady or equivalent cable marker at each termination of a type accepted by Owner before installation. Labelling will match the point-to-point drawings. Seller is required to place arc flash labels on all inverters, combiner boxes, and other equipment requiring such. A method for ensuring labeling is complete must be included in Seller's QC Inspection Point Program.

## 3.17 Surge and Lightning Protection

Seller shall provide a lightning risk assessment performed to Industry Standards by a certified lightning protection professional, as outlined in Section 3.18.2 External Lightning Protection System (LPS). The results of this assessment shall be the basis for determining the requirements and extent of the facility LPS and a surge protection system that provides protection of the batteries, DC power circuit, PCS, measurement control and communications systems, and other major electrical equipment including transformers.

### 3.17.1 Surge Protection

A staged, comprehensive surge protection system, inclusive of Types 1, 2, and 3 surge protective devices (SPDs), shall be incorporated as determined by the lightning risk assessment (A-3.7.1 Electrical Engineering) or as required by the PCS manufacturers in all relevant pieces of electrical equipment. Protection shall be provided within the inverter on both the DC and AC sides as required by inverter manufacturer. Additionally, surge protection shall be provided in combiner boxes, and measurement control and communication systems as determined by the lightning risk assessment study. Type 3 surge protection installed within that equipment shall be mounted on DIN rails and must have finger safe replaceable modules that can be exchanged without the use of tools. SPDs shall be applied on all power circuits (AC and DC) and all communications and control circuits in a coordinated, staged manner. The operating status of the power SPDs shall include visual indication and shall be able to be remotely monitored by a set of integral contacts.

In addition to the performance requirements indicated above, all SPDs shall be compliant to the respective domestic or international standards, including, but not limited to, the following standards and guidelines:

UL Standard 1449 3rd edition.

IEEE Guideline C62.41.1-2002

IEEE Guideline C62.41.2-2002

IEEE Standard C62.42-2005

IEEE Standard C62.45-2002

IEEE Standard 1100-2005

3.17.1.1 SPDs Applied on AC Power Circuits

SPDs applied on AC systems must meet all the requirements listed above in this general section and must be specifically designed for and compliant to UL 1449 3rd edition. SPDs must be selected for the system voltage where they are to be applied. SPDs are to have a short-circuit current rating (SCCR) higher than the short circuit availability where they are installed, therefore not requiring external fusing. SCCR of 200,000 A is ideal.

3.17.1.2 SPDs for Measurement, Control, Instrumentation, and Communications Circuits

All critical non-power circuits are to be protected with appropriate DIN rail-mounted pluggable surge protection for the system they are applied. Surge protection bases are to permit signal continuity even if the SPD module is removed from the base.

### 3.17.2 External Lightning Protection System (LPS)

Based on the findings of the lightning risk assessment, an external LPS may be required to be installed. If so, Seller shall provide an LPS to protect the overall Project from direct lightning strikes to any portion of it, including, but not limited to, inverters, outside cabinets, and buildings housing electrical equipment. The LPS shall consist of air terminals of proper height and spacing (using the rolling sphere method), properly rated and properly designed and placed down-conductors to assure safety of personnel during discharges, and a properly designed and installed ground system.

The systems shall be designed in accordance with the latest globally recognized standards for such designs, which are IEC 62305-1 and IEC 62305-3, or NFPA 780.

Grounding systems shall be in compliance with IEEE Standard 142-2007, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems.

Designs are to be provided by a recognized expert LPS design firm, supplier, or professional engineer licensed in the state of the project and are to be submitted to Owner. All components of the LPS shall be in compliance with the selected system design standard chosen.

## 3.18 Design Package

### 3.18.1 Engineering Design Package

Based on the review of the Project Site and infrastructure, Seller shall design (or have designed by consulting engineers) a Project (including all layout, civil, electrical, and structural components) that will meet the required performance and that is capable of being operated in a safe, normal, reliable, and continuous manner as required by the Contract at all operating conditions and modes specified above. The system design shall comply with all applicable laws and regulations and applicable permits. Studies prepared by Seller's third-party consultants shall be provided to Owner for review.

The Engineering Design Package shall include all items:

Studies related to the Project, such as the geotechnical engineering report and the lightning protection study.

Schematic and preliminary designs.

Design calculations.

All drawings including mechanical, fire protection, HVAC, electrical, structural, civil, and construction drawings Site plans, schematic single lines, index and detail drawings.

Project schedule.

Product and manufacturer description information.

Bill of Materials.

Equipment details, descriptions, and specifications.

Instrumentation and electrical lists, including preliminary circuit schedules.

Layout and arrangement of equipment.

The Engineering Design Package shall be provided prior to commencement of construction.
Owner shall be provided an opportunity to review, comment, and approve or reject all equipment and engineering provided by the Contractor and the Subcontractor. The requirements are as follows:
Electronic copies approval drawings depicting the physical and operational characteristics of the equipment and installation must be delivered to Owner. These drawings must clearly indicate arrangement, size, function, pertinent dimensions, interface with other equipment or material type(s) or components(s), operational limitations, and job name.
Owner must be allowed a minimum of ten (10) working days to review any drawings submitted for approval. The 10-day period will commence upon electronic receipt of drawings and end upon transmittal to the Seller.
Seller shall identify revisions by alpha characters, date and subject in a revision block on the face of the submittal for each drawing during permitting and design phase.
Following return of approved drawings, Seller, shall make corrections or revisions as required and re-submit all drawings in final form. Seller shall not proceed with purchase or fabrication until Seller has made all revisions to technical submittals that are required by the Owner. Each revision shall be identified by number, date and subject in a revision block on the face of the submittal.
Owner review and approval does not constitute an approved deviation or exemption from any Project specifications, standards, or codes. Any requests for deviations or exemptions must be formally requested and approved by Owner. Any contradicting specifications in the Project documents should be formally submitted to Owner for clarification and resolution. Owner's review of technical submittals shall not be construed as a complete check but only as a check that the general method of construction and detailing is satisfactory. Review by Owner shall not relieve Seller of his responsibility to perform the scope of Work correctly. It shall be the Seller's responsibility to make and verify all measurements required for the fabrication and installation of equipment for the Project.

**3.18.2 Maintainability**

Maintenance features shall be provided to optimize maintenance work. This shall include adequate space inside Project enclosures, adequate space around and inside DC racks removable panels in electromechanical enclosures and positioning of equipment access to allow removal of equipment, and other features that facilitate material handling. Required maintenance activities during normal operations and how it impacts system SOC and performance must be appropriately considered.

**3.18.3 Operability and Safety**

The Project shall be designed for primary operation via its own autonomous control. The secondary operation shall be via remote dispatch centers and the Project shall also have the capability to operate via local panels for normal startup, operation, shutdown, and emergency shutdown capability for all BESS related equipment. BESS, balance of plant equipment, power conversion, instrumentation,

controls and monitoring devices shall be designed for ease of operation and maintenance. Attention shall be given to adequate lighting, access, and ventilation of operational spaces.
The BESS and supporting equipment shall be operable from remote dispatch centers under all normal conditions including automatic startup and shutdowns as a load following mode of operation.
Where redundant equipment is supplied, the idle device shall be capable of immediately backing up the operating device. The switchover shall be accomplished automatically through a system local panel, or the BESS SCADA system.
"Single point of failure contingency" shall be incorporated into the Project design such that the loss of any single IT switch, server, or control system shall not interrupt BESS availability to the grid.

## 4.0 BESS FACILITY INFORMATION

The major equipment items shall include a battery, four-quadrant bi-directional PCS, MV step-up transformer, and local and remote control/monitoring equipment. Additional equipment shall include battery monitoring system, harmonic filters, HVAC system, fire suppression system, auxiliary cooling systems, wiring, connectors, protective devices, grounding, junction boxes, enclosures, instrumentation, foundations, temporary supplemental power supply connections, and all other items needed for a fully functional, utility interactive BESS, installed to meet the requirements set forth in this Technical Specification.
The BESS shall be designed to produce low-cost power capacity, with low-cost energy storage as a significant secondary factor. Costs include initial cost as well as overall BESS efficiency, cell life, disposal and replacement cost, maintenance costs and other contributors to life-cycle energy cost. The BESS shall also be designed to have high reliability, Design Life as listed in Appendix 2, Table 1, and designed for unattended operation with 24-hour remote monitoring and control by Operator in addition to Owner's SCADA system.

### 4.1 BESS Technical Objectives

The BESS shall be "Utility Grade." This means that all equipment shall be expected to last through the Design Life with only typical routine maintenance and planned consumable goods.

#### 4.1.1 Project Objectives

The overall objective of this Project is to meet the use cases called out in Appendix 2, Table 1 and optimize the priority of the system operation for revenue and grid requirements as shown in Appendix 2.

### 4.2 BESS Availability

Seller shall design, engineer, and furnish equipment with the objective of producing a BESS system that will meet or exceed stated guaranteed energy availability performance, measured at the point of interconnection, based on expected equipment availability and degradation consistent with Seller's bid and these specifications. Refer to Appendix 2, Table 1 and Appendix 3 Table 1 for Availability requirements.

#### 4.2.1 Overload Capability

Seller shall provide, a curve showing the inherent overload capability (if any) of the proposed BESS as a function of time.

### 4.3 BESS Operation

For all bids, as a part of their RFP bid response, Seller is required to provide a completed General Services Contract-Operations & Maintenance Services for Project.
Whether Seller is awarded the O&M contract or not, the BESS will require 24-hour control and oversite.
All equipment warranties shall be negotiated so that they can be assigned to Owner upon project acceptance.

Seller shall specify, for the type of battery proposed, the method used to determine the point where further discharge or charge is no longer practical or safe.-Examples of common methods to identify above are discharge cutoff voltage or the maximum amp-hour capacity that can be reliably discharged. Throughout this Technical Specification, the term discharge limit shall be used to mean Seller specified methodology.

The BESS operating functions shall be programmed in a programming language defined by the owner in Appendix 2 and made available to Owner so that software modifications can be made, or new functions can be added if the need arises at some point in the future. Any required supporting software such as compilers and linkers shall also be made available to Owner.

The operating functions described below will be limited and confirmed with the battery vendor by the charge and discharge limit to prevent damage to the battery. Termination of any operating scenario by the discharge limit, without reaching rated capacity discharge, will be deemed a failure for the purposes of calculating availability.

If part of the O&M agreement, a detailed annual report shall be provided by the Seller every year with the first one dated one year after of the commercial date of operations including the degradation of the BESS for the commercial date prior. This report shall be used for commercial and warrantee purposes during the operational phase.

The following sections discuss common inverter control functions that shall be implemented in the BESS as part of the local and remote automatic BESS controls.

### 4.3.1 Real Power Controls

Direct Charge/Discharge Storage – This is a basic function that can be used to discharge or recharge the BESS to a specified state of charge (SOC) and at a specified rate.

No-Grid-Charging Mode – System should accommodate programming times and conditions under which grid charging will not be active.

RPS: Real Power Smoothing – This is a real power control mode function for the BESS that could monitor the potential hybrid renewable energy plant real time power output for fluctuations. Although this functionality is a lesser priority, the BESS should be capable of responding to smooth out the renewable systems fluctuations and mitigate any power quality issues due to renewable systems output variability. The BESS response shall be capable of smoothing the net power output from the combined renewable systems and BESS while also preserving the BESS available stored energy.

### 4.3.2 Reactive Power Controls

If reactive power is for the Facility, it will be based on the point of interconnection agreement and the BESS services agreement identified by Entergy Transmission. Below are examples of what may be required under this section:

Direct Voltage Control – In this function the BESS shall output VARs to control the POI voltage to a specified setpoint voltage and a specified droop, and with a specified maximum and minimum kVAR range which shall not be exceeded. The BESS shall be normally operated with voltage control enabled.

Watt-Var Function – In this function the BESS shall actively control its reactive power output as a function of the real power output. The reactive power output follows a user defined Watt-Var or P-Q curve. The Watt-Var curve is a piece-wise linear user defined curve entered as X,Y point pairs where the x-axis is the power output and the y-axis is the corresponding VAR output.

Function CV: Constant VARs – This function allows the BESS to produce a constant VAR output at a specified level.

Fixed Power Factor Function – This function allows the BESS to produce or absorb power with a user entered constant power factor. The power factor range is +/- 0.00 to 1.00.

Watt Power Factor Function – In this function the BESS actively controls the BESS power factor as a function of the real power output of the BESS. This function utilizes a piece-wise linear curve defined by X, Y point pairs, to determine the power factor of the BESS output at any BESS real power output.

### 4.3.3 Miscellaneous and Support Functions

Scheduling Function – This function is used to perform the real and reactive control functions via a time-based schedule and/or a load-based schedule. The Schedule function can define when different X-Y curves become active and what the ramp rate will be when transitioning between scheduled functions. When more than one function is active for Real Power or Reactive Power control then the schedule shall define a priority order for the functions.

Event Logging and Reporting Function – this function shall be used to record any protection events triggered by the inverters including but not limited to i.e. over current, over voltage, over temperature, sequence of event reporting (SER), etc.

Status Monitoring Function – this function shall include voltages, SOC, Inverter Status, Usable Energy, BESS rack and module temperature, Present Operating Mode, Inverter Active and Reactive Power output, power factor, present line frequency, Connect/Disconnect Status, Operating Time, Connected Time, and possibly other BESS information.

Function Connect/Disconnect – This function shall be implemented by two sets of commands, one being a virtual command and the other being a physical command. The virtual Disconnect command sets the real and reactive output of the BESS to zero. A physical Disconnect provides galvanic isolation between the inverter and the grid. Additional details regarding Shutdown, Disconnect, and Operate modes are provided in the Sections 5.6.7, 5.6.8, and 5.6.9 below.

LHVRT Function – This function shall be used to specify the low and high voltage ride through characteristics of the BESS. This function will be used to specify the trip, suspend and normal operation ride through voltage characteristics as per IEEE P1547, protection coordination studies, and Owner policies.

LHFRT Function – This function shall be used to specify the low and high frequency ride through characteristics of the BESS. This function will be used to specify the trip, suspend and normal operation ride through frequency characteristics as per IEEE P1547, protection coordination studies, and Owner policies.

Local/Remote Mode Function – This function when in Local Mode shall block commands by offsite sources to enable safe local maintenance and diagnostics and provide a means for secure on-site management. This function shall also allow the return to remote control.

Automatic/Manual Mode – This function shall enable and disable the BESS from performing any of the automated control functions for real and reactive power. When switching from automatic to manual mode the BESS real and reactive outputs shall ramp down to zero at a specified ramp rate.

### 4.3.4 VAR Support

The BESS may be required to provide VAR support for voltage regulation under steady state and contingency operating conditions as described below. The BESS shall be capable of up to full rated output, when operating within the normal sustained voltage and frequency ranges specified in Section 3.3, Electrical Design Parameters, or as determined by Seller's system studies. The voltage regulator controls shall not be affected by changes in system frequency. The voltage regulator controls shall include Owner selectable setpoint and droop characteristic and shall be capable of setting by Owner's SCADA system or by a local control interface.

Nothing in this section shall be construed as limiting the ability of the BESS to operate in other modes as described in these Technical Specifications. The VAR output of the BESS may be limited based on remaining inverter capacity used for real power output unless supplemented as described above. The final VAR requirements will be provided to the successful Seller at a later date.

### 4.3.5 Charging

Seller shall specify charging requirements.
Seller shall design the charging system to ramp up from zero to the maximum capacity at an Owner selectable ramp rate as described elsewhere in these Technical Specifications to avoid shocking the system and allow generation to follow load easily. Seller shall provide a curve showing how demand from Owner's system varies with time throughout the charging cycle. The BESS control system shall allow Owner's dispatcher to initiate remotely Seller-specified/programmed charge cycle. The maximum demand required by the charging cycle shall be Owner selectable but shall not exceed Seller specified charge rate. Seller shall provide data showing how the recharge period varies as maximum demand decreases.
Seller shall also specify restrictions, if any, on operation of the BESS during any portion of the charge cycle. Seller shall provide a curve or table and data showing the state of charge of the battery as a function of time.
Automatic or programmed charge cycles shall be implemented to prevent SOC going below the battery vendor specified SOC limits whenever possible.

#### 4.3.5.1 Charge Rate

There will be times when the BESS may be directed use overload charging capability (if any) exceeding the normal maximum charging rate for a short duration. Seller shall provide, a curve showing the inherent overload capability (if any) of the proposed BESS as a function of time. It is not a requirement to design specific overload capability into the BESS. Overload charging will not be allowed if the batteries are charged above the Seller specified maximum charge level. When the BESS is nearing the Seller specified maximum charge level, the BESS charging shall ramp down linearly to zero at an Owner selectable ramp rate.
Seller shall provide adequate energy storage capacity and level of charge to accommodate the number of charge/discharge occurrences and total energy requirements described elsewhere in this Technical Specification.

### 4.3.6 Shutdown

The shutdown state shall be defined as battery DC contactor/breakers and PCS AC breaker open; non-critical power supplies de-energized; control system power may remain energized. This mode includes both normal shutdown and system trips requiring reset.
The control system shall initiate shutdown under the following conditions and remain in the shutdown state until a reset signal, either local or remote, is initiated:
Emergency trip operation.

AC circuit breaker trips (either main or PCS breaker) that isolate the BESS.

Door interlock – initiate shutdown when the door to the PCS is opened. A "defeat" feature shall allow for maintenance. Interlocks shall be self-resetting.

Smoke/fire alarm.

Fire Suppression operation.

Control logic trouble.

DC ground fault – field adjustable setting.

Failure to restart from disconnect state after automatic restart attempts.

Remote disable (no reset required).

### 4.3.7 Disconnect

The disconnect state shall be defined as balance of plant (BOP) DC contactors/breakers and battery DC contactors/breakers and PCS AC breaker open; non-critical power and control system power energized. Some faults or failures are expected to be transient in nature. The control system shall open contactors upon fault occurrence and may be manually started-up after an operational Seller determined manual reset or operational procedures agreed upon with the Owner. The control system shall go to the disconnect state under the following conditions:
Synchronization Error – The PCS is unable to synchronize with the utility grid.

Grid transient conditions (i.e., line switching or reclosure action).

Utility voltage out of emergency operating range as defined in this Technical Specification.

Utility line frequency out of emergency operating range as defined in this Technical Specification (field adjustable in 0.1 Hertz increments).

Over-temperature on the battery, PCS, controls or other equipment.

Excess explosive gas level.

Owner and grid operator requested outages.

### 4.3.8 Start Operate

The Operate state shall be defined as all contactors/breakers closed and power available to flow to or from the BESS, PCS and transformer system to the utility system. Normal operation shall include all operating scenarios as described herein and discharge and charge modes. It also may include additional modes and sequences deemed necessary by Seller.

### 4.3.9 Specific Operational Requirements

The BESS must not be damaged if there is no power available from Owner for a period of up to 168 hours with the BESS discharged to its lower operational limit. If the system proposed by Seller cannot meet this requirement, or if there are advantages to Owner to specify a shorter duration, Seller shall specify the maximum period that can be sustained without damage. The design shall include provisions for connecting a mobile generator to charge the batteries if the 168-hour requirement cannot be met. Seller will indicate any required rest (neither charging nor discharging of the BESS) periods, their duration and what event they must follow or precede.
The BESS shall have appropriate functionality to accept an emergency disconnect input. Once the emergency disconnect is activated, the BESS project must immediately cease operation.
During manual operation of the BESS project, the system must indicate which, if any, autonomous functions are disabled.
Owner may impose rest intervals, such as charging off-peak and discharging on-peak. If no other tasking is done, this will create a rest period between each half cycle. This shall not adversely affect BESS performance and shall be included in capacity calculations. Provide the maximum rest period allowed (days, weeks, months).
If another condition requires special action for a string or the battery bank, describe this condition, how often it occurs, what event triggers the need for it, what it takes to correct it, whether the string/BESS remains available during this period to be approved by the Owner on a case-by-case basis. Examples are some type of reconditioning (holding at 100 percent DOD) or charge equalization (holding at 100 percent SOC).
The cells within a battery module shall either be self-balancing, or their periodic balancing be handled automatically by battery module management electronics. Similarly, the modules within a string shall either be self-balancing or periodic balancing handled automatically by string/bank management electronics.

The BESS SCADA system shall store historic performance data metrics which describe the quality of system performance for each function over the last 168 hours minimum. Seller to ensure interface with Owner to offload reports at an agreed interval. Historical performance data metrics shall be stored for performance analysis and warranties.
The design must include prudent provisions for technology improvement. Battery modules shall allow for upgrade or replacement with higher performance cells to the extent practical. Where such changes are made to a battery module, all modules in that battery string must also be upgraded before the upgraded modules are placed into service.

#### 4.3.10 Large Generation Interconnection Agreement Requirements

The Seller shall be responsible for submitting interconnect applications. For Distribution interconnected systems, the Seller shall submit an application following Entergy's DR07 Distributed Energy Resource Standards for Distribution Interconnection. For Transmission interconnect systems, the Seller shall submit and follow the Midcontinent Independent System Operator (MISO) Interconnect Application (i.e., Attachment X: Appendix 1 Interconnection Request for a Generating Facility and associated documentation).

## 4.4 BESS Electrical Systems

Seller's scope of supply will end at the POI as defined in the Interconnection Agreement and as defined in the Points List. The electrical auxiliary power system shall be sized so that in no case it limits unit output power relative to the specified nominal capacities detailed in Table 1. Any revisions to the existing electrical power system installation (e.g., protective relaying) shall be designed for Owner coordination, safe operation and maintenance.
Load flow, dynamic stability, harmonic interaction, short circuit, voltage droop, coordination, grounding system safety and other studies shall be performed to properly determine equipment capacity, performance, withstand requirements, transformer impedances, etc. Seller shall submit design criteria, harmonic profile, short circuit characteristics, and calculations associated with these studies to Owner for review. Owner will provide data on existing Owner equipment and electric grid as necessary and will be available to facilitate Seller's performance of these studies.
Electrical systems shall not inhibit the BESS from complying with Frequency Ride Through (FRT)/ Voltage Ride Through (VRT) requirements per Owner's requirements listed in the Technical Specification.
Areas of the BESS enclosures subject to explosive concentrations of gases due to faulty systems, failure of ventilation, etc., shall be classified as hazardous locations in accordance with the latest NFPA criteria. Accordingly, electrical equipment in those areas shall be provided with the appropriate enclosures for the installed locations.
Electrical system design shall be performed under the supervision of a professional engineer. Specifications and drawings shall be sealed if required for submittal to regulatory agencies.
Electrical systems shall be equipped with protective relaying to trip circuit breakers for de-energizing and isolation of equipment in the event of electrical faults. Seller supplied relaying protection will include primary and back-up relaying and overlapping zones of protection. Seller protection relaying is to be coordinated with Owner's existing relaying. Areas of Seller supplied relaying will include, but not be limited to, MPTs, MV system, and DC/UPS systems. Protection relaying shall comply with Owner's requirements.

## 4.5 BESS Enclosure

A BESS Enclosure, if utilized, shall be one of the following three options:

1. ISO Container
2. Special Built Enclosure
3. Concrete Building

All options require the exterior of the structure to be built to a bullet resistant standard of UL 752 Level 4.

Battery enclosures or structures shall comply with the guidance of NFPA-855 with the following special requirements apply to each enclosure type.

ISO Container

Container shall be constructed per International Standard ISO 1496-1 or similar standards.

Access to the batteries modules shall be from external swing doors.

Hydrogen, Li-ion Tamer, or similar UL listed early off gas detection shall be included

Fire detection per NFPA-72

HVAC shall go into purge mode on receipt of early off gas detection.

Container environmental sample tube routed to exterior of container for FD air sampling.

Deflagration vents to exterior sized for structure integrity

Provide a manual open head sprinkler typical of NFPA 13 riser(s) internal the container, supplied by a dry FDC connection exterior the container. No releasing or alarm hardware required.

Special Built Enclosure no more than 20 MWh in size

Access to the batteries modules shall be from external swing doors.

Hydrogen, Li-ion Tamer, or similar UL listed early off gas detection shall be included

Fire detection per NFPA-72

Deflagration vents to exterior sized for structure integrity

HVAC shall go into purge mode on receipt of early off gas detection

Container environmental sample tube routed to exterior of container for FD air sampling.

Provide a manual closed head sprinkler typical of NFPA 13 riser(s) internal the container, supplied by a dry FDC connection exterior the container. No releasing or alarm hardware required.

Concrete Building

The building is expected to be Tilt-Up style on a pre-stressed slab floor

Two hour fire walls shall separate the energy storage system into no more than 20 MWh sections

Deflagration vents to exterior sized for structure integrity

Compartment environmental sample tube routed to exterior of container for FD air sampling.

Hydrogen, Li-ion Tamer, or similar UL listed early off gas detection shall be included

Fire Detection per NFPA-72HVAC shall go into purge mode on receipt of early off gas detection

NFPA 13 or NFPA 15 automatic suppression shall be provided in each fire zone. An acceptable water supply shall be provided.

### 4.5.1 Building Design

See Section 4.11.2 for Environmental loads that shall apply to the building.

Structural Framing: Design primary and secondary structural members and exterior covering materials for applicable loads in accordance with the Metal Building Manufacturers Association's (MBMA) "Design Practice Manual"Structural Steel: For design of structural steel members, comply with the requirements of the American Institute of Steel Construction's (AISC) "Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings" for design requirements and allowable stresses.

Light Gauge Steel: For design of light gauge steel members, comply with requirements of the American Iron and Steel Institute's (AISC) "Specifications for the Design of Cold Formed Steel Structural Members"

and “Design of Light Gauge Steel Diaphragms” for design requirements and allowable stresses.Welded Connections: Comply with requirements of the American Welding Society’s (AWS) “Standard Code for Arc and Gas Welding in Building Construction” for Welding procedures.

Basic Design Loads: Include live load, wind load and seismic load, in addition to the dead load. All loads shall be based on the site-specific conditions and latest IBC, state and local codes.
Live Load with Snow Load shall be based be in accordance with IBC and the state local code.

Wind Load: Wind load shall be based be in accordance with IBC and the state local code.

Seismic Load: Seismic load applied shall be in accordance with IBC and the state local code,

Auxiliary Loads: Include dynamic live loads such as those generated by suspended ceilings, sprinkler systems, electrical or mechanical systems or any suspended HVAC units, and exterior frames and doors.

Design: Each member shall be designed to withstand stresses resulting from the combination of loads that produce the maximum allowable stresses in that member as prescribed in MBMA’s “Design Practices Manual”.

#### 4.5.2 Shipping Container or Metal Enclosure

If containers are proposed, it shall be in accordance with the International Standard ISO 1496-1 or similar standards.

### 4.6 Other BESS Facility Design Requirements

#### 4.6.1 Hydrogen Mitigation

If applicable for the battery chemistry proposed, Seller shall calculate the maximum hydrogen emission rates for the battery (normal and runaway) and design accordingly a fully redundant forced-air ventilation/fan system and conflagration vents to satisfy all codes and standards. These calculations shall be included in the proposal and shall include the safety margins used.
Seller shall provide and install UL approved hydrogen detectors and configure their control logic such that the hydrogen detection system alarms at one percent hydrogen concentration. Additional alarms and logic shall be provided electrically isolate the battery if the hydrogen concentration exceeds a safe level.
Any enclosures into which a flammable gas may propagate during normal or abnormal operations shall be protected against accumulation of a flammable or explosive mixture or protect against ignition by an external spark of any such mixture that may nevertheless occur.
If flooded electrolyte cells are used, Seller shall install flash arresters on the cells.

#### 4.6.2 Painting / Logos

Seller shall paint the entire exterior of the building or enclosure with a finish coat in a color approved by Owner. The paint shall be suitable for application to the exterior material of the building or enclosure and the environmental conditions applicable to the site. Owner may supply image(s) of company logo for display on buildings or enclosures, after painting. Upon completion of painting, remove surplus material, rubbish, and debris resulting from this work and leave the building and enclosures and Site in a neat, clean and acceptable condition.
All builders’ hardware shall be suitable for the required functions. Hardware shall be of a durable grade consistent with the life expectancy of the facility and appropriate Federal specifications. Exit and fire door hardware shall conform to UL specifications. Installation of exits shall conform to NFPA No. 80.

### 4.7 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

Seller/ Developer scope of supply shall include design, supply and installation of, but not limited to, following:

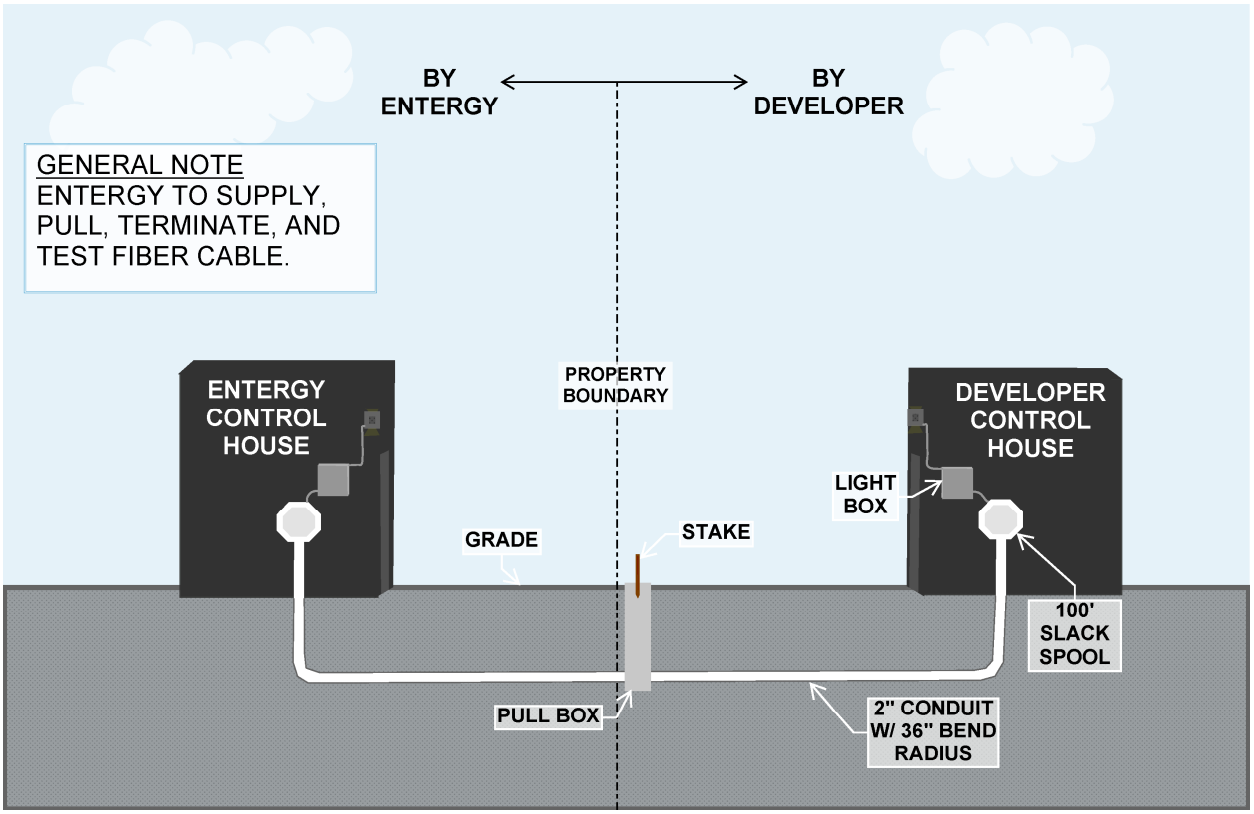
| SR. NO. | SELLER/ DEVELOPER SCOPE OF DESIGN, SUPPLY, AND INSTALLATION |
|---|---|
| 1 | A redundant fiber-based network connecting all the inverters, battery management systems, and safety systems. |
| 2 | SCADA enclosures to integrate the inverters, battery management systems, and safety systems Seller to develop communication system single line and network block diagram. |
| 3 | Communication rack layout, including BOM and elevation drawings. Project to have redundant SCADA system with primary and secondary switches and connections. |
| 4 | Furnish appropriate SCADA, communications, wiring, fiber and splice details. |
| 5 | Field installed SCADA communication panels at each inverter with layer 2,3 looped switch and fiber patch panel in a National Electrical Manufacturers Association (NEMA) 4X enclosure. |
| 6 | Seller controlled fiber to the site (i.e., ATT fiber which the seller is the account owner of) – this is to support commissioning activities. |
| 7 | The fiber from the Entergy network at the POI to the BESS SCADA shall be 96-strand, single mode, meeting Telecommunications Industry Association (TIA) 568.3-E. The fiber loop from the BESS SCADA to the BESS Assets shall be a minimum of 12 strand single mode, meeting Telecommunications Industry Association (TIA) 568.3-E |
| 9 | The SCADA System controller shall provide 20% spare hardware capacity input/output (I/O). |
| 10 | All fiber optic cable shall contain at minimum 20% spare pairs for future use. |
| 11 | Seller to land the Seller controlled fiber (i.e., ATT) on a Seller supplied and installed firewall (Palo Alto or CheckPoint are acceptable firewalls)<br>• Seller to supply and install a firewall managed Level II switch with 3 VLANs configured (Seller to supply subnet information)<br>• The 3 VLANs consist of the following<br>• Collector Substation<br>• BESS Yard<br>• Control<br>• Seller to work with Entergy's Information Technology group in configuring the firewall using allow by exemption principle and opening only ports and protocols necessary for required functionality<br>• Configure VLAN Access Control Lists to manage routing for only necessary functions |
| 12 | Redundant core switches (IE4010 switch or similar) and connect to upstream SM SFPs. |
| 13 | Fiber patch panels |
| 14 | 42U server rack |
| 15 | The UPS (uninterruptible power supply) system shall provide for 8hr back-up. |
| 16 | Miscellaneous fiber, ethernet jumpers, and cable management |
| 17 | Seller shall configure the SCADA system for access credentials |
| 18 | Seller supplies and configures a Power Plant Controller<br>• The Power Plant Controller can be two SEL 3555 – RTACs in redundant configuration or similar |

| SR. NO. | SELLER/ DEVELOPER SCOPE OF DESIGN, SUPPLY, AND INSTALLATION |
|---|---|
| | • Power Plant Controller shall be configured to support the use cases in conformance to Appendix 2. A narrative of the control configuration shall be supplied |
| 19 | Seller shall supply and configure Ignition as the plant's SCADA system. Details of the same are mentioned in subsequent clauses. |
| 20 | IT rack for Entergy's exclusive use .<br>• 19" rack with 24"x36" footprint<br>• Front and back lockable mesh doors and cable entry slots in roof<br>• 36" front clearance and 24" rear clearance<br><br>Dual 120 $V_{ac}$ UPS backed power strip with UPS ethernet monitoring capability, with UPS capable of 12 hours of backup run-time |
| 21 | All cables shall be labeled on both terminations with "from" and "to" designations including port or terminal numbers. Cable labels shall be self-laminating vinyl wraps or zip-tied. Flat labels wrapped around a cable are not acceptable. |

For the fiber between the Entergy network at POI to the BESS SCADA as called out in SR. No. 7 above:
If the distance from the Entergy interconnecting substation to the Collector Substation <~1000' and Entergy or the Seller owns the property rights, then: (refer to Figure 3)

- Underground the fiber
- Owner supplied fiberoptic cable shall be underground rated
- ADSS fiber to be pulled in microduct/conduit
- Demarcation point between Seller/Developer installed microduct/conduit from Control House and Entergy's installed innerduct/conduit is a Seller installed pull box or similar at a mutually agreed to point, typically at or the near the property boundary, between the interconnect substation and Control House (often initially marked as a stake in the ground) – refer to Figure 3
- Innerduct/Conduit shall be conduit or microduct (e.g., 2" PEX) with a minimum 2" diameter and 36" bend radius
- Seller to install lightbox and 100 ft slack spool and associated innerduct/conduit in the Collector Substation
- Owner/Entergy will supply and terminate fiber on both ends

Figure 3: SCADA connection less than 1,000 ft



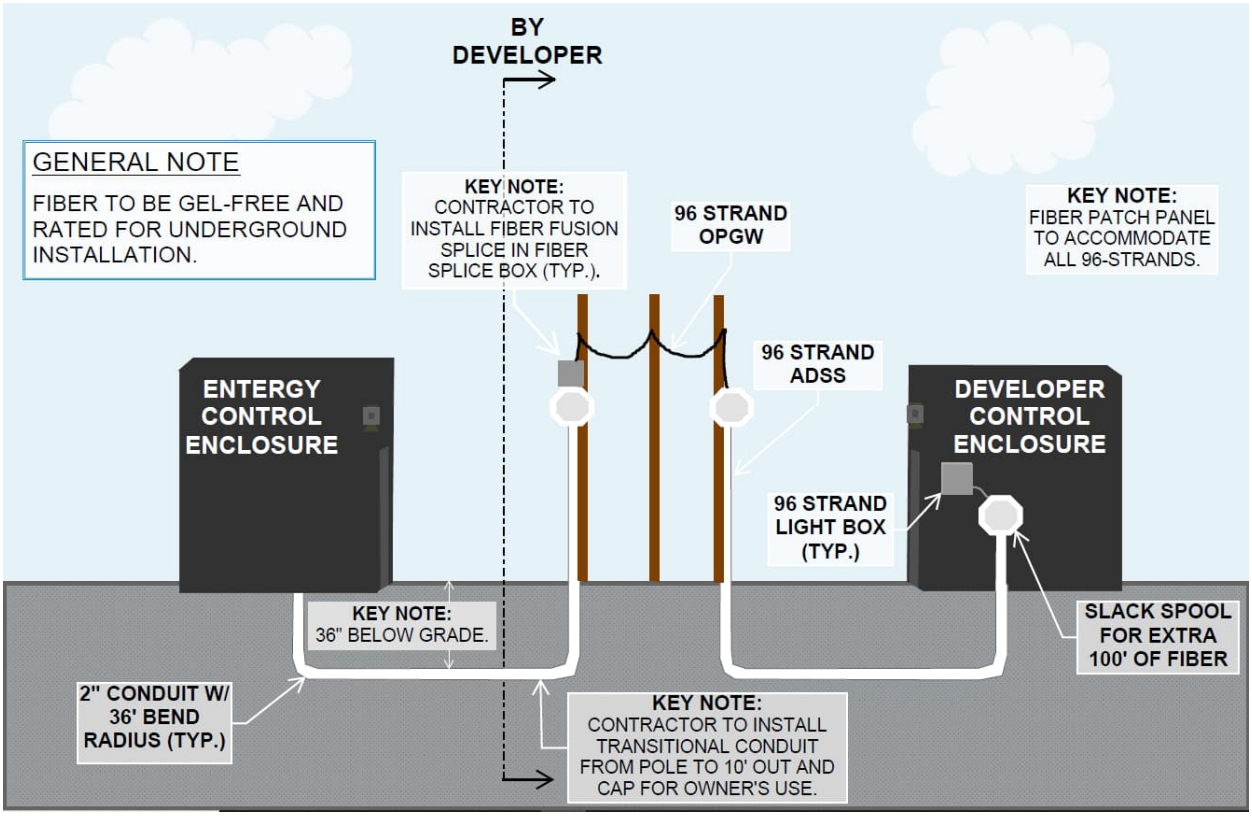

If the distance from the Owner/Entergy interconnecting substation to the BESS SCADA >~1000', OR if <~1000 and Entergy does not own property rights, then (refer to Figure 4):

- Seller/Developer to install 96-strand OPGW fiber and associated fiber splice box on pole to transition to underground to the Control House, including all fiber fusions in the splice box as required
- Seller furnished fiberoptic cable shall be underground rated (from existing control house to dead end pole)
- Seller fiber shall OTDR reel test at 1550 nm and results provided to Entergy in .SOR format
- OPGW fiber shall be installed at a height >15' on structures
- At all splice locations, a 100' plus height above ground level reel of fiber shall be installed on a Seller supplied and installed coil bracket
- Between the final structure and the Control House lightbox, Seller to supply and install innerduct/conduit and associated ADSS fiber
- Seller to terminate ADSS fiber with Control House
- Seller to leave 100' of fiber and slack spool on a Developer supplied and installed coil bracket with in the Control House
- Microduct/Schedule 40 PVC conduit with a minimum 2" diameter with 36" bend radius
- For purpose of developing a project, the Seller can assume the following:
  - Demarcation point between Developer/Seller installed Innerduct/conduit from the first structure and Buyer's installed innerduct/conduit is a Seller installed splice box or similar at a mutually agreed to point, typically at or the near the property boundary, between the

interconnect substation and first structure Control House (often initially marked as a stake in the ground)

- Seller to supply and install a splice box on the first structure
- Entergy will supply and terminate fiber on both ends
- Entergy to perform OTDR on all splices with no losses greater than 0.10 dB allowed

Figure 4: SCADA connection greater than 1,000 ft




For purposes of design, assume that the site will be a CIP Low site.

Seller shall supply and configure Ignition as the plant's SCADA system.

Seller to supply and install redundant Type I virtualized servers hosting the Ignition (DEL PowerEdge Rackmount server or equivalent)

Each Type I server shall be sized (hard drive, memory, etc.) to allow both Ignition servers to be running in either location if needed.

Seller to supply and install one KVM switch with 19" display, keyboard, mouse

Ignition shall be supplied with Historian and unlimited tag licenses

Historian shall be sized for 2 weeks of 1 second data

Seller shall supply and install one Inductive Automation Ignition HMI package

Seller shall supply and install one SQL server license (or equivalent)

Seller to configure web portal access

Within Ignition, the Seller shall buildout the Graphical interface to include the following screens at a minimum:

- Site overview
- Control
  - Alarm management
  - Trending management
  - Battery Management System details
  - Inverters details
  - Protection System details
  - SCADA health (i.e., communication detail)
  - One-Line (to include Meter details and all other high level RTU-RTU datapoints)
  - Reporting Functions

Install Ignition utilizing least functionality privilege and operating system utilizing CIS Benchmark

Seller to work with Buyer to define Ignition security user groups

Within Ignition, seller to configure the object alarm configuration based on the I/O List

Seller to configure Major Interfaces including the following:
PI

RTU-RTU (Collector Substation to interconnecting Buyer Substation) – Seller to provide Buyer the following Point List

Overall Point List

Abbreviated Point List focused on Seller's typical importance list

At Substantial Completion:
Seller to transfer all licenses procured on Buyer's behalf to Buyer

- During license procurement, Seller shall work with Entergy in establishing Terms and Conditions which will allow for seamless transfer
- Seller and its subsidiaries shall surrender all rights to software development work for this project to Entergy for use within this site at a minimum.

Buyer installs and interconnects Firewall (between Buyer's network fiber and the site's Seller supplied Palo Alto/CheckPoint firewall)

Seller to develop and supply system documentation consisting of the following

- Hardware/software manuals
- Server setup and configuration details
- All username and passwords
- Drawings list and specifications
- Testing and commission documentation

## 4.8 Control System and Communication Requirements

### 4.8.1 Control System Security

4.8.1.1 Cyber Security

Seller shall design, build, and deliver a cyber security system and plan for the Project that conforms to applicable NERC CIP rules, regulations, standards, and laws. Buyer shall provide security controls that will be required to be tested prior to site acceptance. If Seller becomes the site operator, there will be shared

responsibility between the construction and operator divisions agreed to by all parties. Seller shall develop and provide to Buyer a cybersecurity plan that includes accommodations to test the defined security controls. (Buyer may elect in its discretion to provide a sample plan for Seller to consider and possibly utilize.) The plan must include and cover:

Steps taken in software development to detect and correct security flaws, including plans for code scanning.

Methods used to protect system user identities and logins, including methods of encryptions and use of certificates.

Password policy for users' access to the system

Site access cyber security policy

Methods to assure reliable and confidential communications of inbound commands and outbound data.

A description of software maintenance processes, including the process to patch security vulnerabilities in the vendor's product

Test planning and execution to assure compliance with the cybersecurity plan.

Seller shall implement cybersecurity controls for low impact and non-CIP BESS sites testing NERC CIP in development of cyber security plan. Buyer expects to provide additional guidance or input in the development of the plan to ensure the Project's cyber systems are compatible with and provide the protection required or appropriate for Buyer's cyber systems. The plan is subject to Buyer's review and approval in advance of the FNTP date.

Buyer will contract for a third-party vulnerability assessment and penetration test during Project testing. Such testing shall be done, at Seller's expense, as a "type" test for the initial unit, with testing not required for subsequent units. Seller shall correct vulnerabilities identified in this testing and the completion of such corrections shall be a condition to substantial completion.

Seller shall:

Undertake annual reviews of emerging vulnerabilities that will potentially impact the Project.

Provide notice to Buyer of new vulnerabilities within a specified time frame from a new vulnerability becomes known.

Develop corrections (patches) to address identified vulnerabilities.

Seller shall assure the above software support, including operations and maintenance, is provided through Substantial Completion. Buyer reserves the right to perform annual independent, recurring security audits to assure compliance with the security maintenance requirements of this Scope Book during the performance of the Work.

Once the Project's cyber security system is in operation, Seller shall not provide communications directly to the system and must access the system via Buyer security controls. If Seller reasonably requires monitoring (read-only) information to perform the Work, Buyer will use commercially reasonable efforts to provide such information via internet solutions to Seller or the applicable vendor after Seller's request therefor. Any remote access to the cyber security system shall be covered in the cyber security plan, and Buyer agrees to use commercially reasonable efforts to cooperate with Seller to provide mutually agreeable solutions for gaining access to the system once in operation.

### 4.9 Metering Requirements

The Buyer shall supply the revenue grade meter(s). The Seller shall supply meter(s) required for closed loop control of the site.

### 4.10 Interconnection of Utilities

Seller shall provide all utility interconnections needed for construction, commissioning, and testing of the Project or performance of the Work in each case or any portion thereof (e.g., potable and non-

potable water, wastewater, sanitation (including sewage), temporary power, telecommunications, broadband internet, and fuel). This interconnection of utilities is separate and distinct from the site's electrical interconnect with Buyer.

### 4.10.1 Data Network Engineering and Data Network Operations (DNE/DNO)

#### 4.10.1.1 DNE Design

Buyer will provide to Seller the DNE design including address space of the affected zones. Zones to include the collector substation (if applicable), BESS, physical security (CCTV and ACCESS control), and Entergy corporate network. The DNE design will provide flexibility for future of division of responsibility for operations.

Allocation of devices in defined address space will be left up to respective parties network address space of networks will be provided by Entergy DNE and filtered by Entergy onsite firewall to ensure separation of separately managed network and in compliance with applicable Buyer and regulatory requirements. Seller is responsible for ensuring address space provided by Buyer is adequate to support devices being installed and configured by Seller. Seller shall install Cisco network devices unless otherwise approved by Buyer.

Seller's design shall be subject to Buyer approval at Buyer's sole discretion.

Seller shall provide redundant Layer 2 network switches. Network segmentation of Seller-provided network shall meet the following requirements:

Collector substation equipment (RTU, breaker relays, etc.) shall be on its own VLAN segment (if applicable)

BESS equipment (Inverters, BMS, PPC, etc.) shall be on its own VLAN segment

Access control and camera system shall be on its own VLAN segment

Prior to substantial completion, segments shall be filtered by a Seller-provided firewall. Logical segments shall be filtered by a Buyer onsite firewall after substantial completion Seller shall provide to Buyer reasonable and necessary requirements for firewall configuration between segments

Prior to substantial completion, network connectivity shall be provided by Seller. After substantial completion, network connectivity shall be provided by Buyer

Seller to use defined cable and connectors. User-defined color codes for low CIP sites are as follows: primary ethernet shall be blue, secondary ethernet shall be gray, back-up ethernet shall be green, iLO/KVM shall be yellow, and serial consoles shall be black

#### 4.10.1.2 Procurement and Ownership

Seller shall procure equipment with a minimum five-year manufacturing and support warranty with service level agreement of next day replacement.

Any items that will reside on the Buyer's network (e.g., CCTV, firewall, access control), Buyer will be responsible for procuring, installing, operating, maintaining, and managing. Special cases may be considered but are subject to strict review of cyber asset protection and monitoring. As such a third-party operation of a facility may be allowed to purchase, configure, install, and maintain network equipment if the equipment will be protected or isolated from the Entergy network via firewall apparatus or diode and the third party will be establishing means to replace failed equipment through a five-year period of operation.

### 4.10.2 Desktop Equipment

As required by Buyer for the functionality of the site and in support of Entergy associates or vendors onsite, Buyer will specify desktop equipment to be utilized. Seller shall install fixtures and wiring terminated on appropriate breaker or patch panels to allow Entergy field services to install and configure equipment. Desktop equipment includes laptops, desktop computing boxes, printers, and peripheral devices.

## 4.11 Physical Security Installations

The physical security of the site shall comply with Buyer and regulatory requirements. Seller is responsible to implement as described in Table 1 below and the following sections.

**Table 1: Physical security installation requirements**

| Location | Description | Equipment by Seller | Equipment by Buyer |
|---|---|---|---|
| Collector Substation (if applicable) | Minimum two cameras located at opposite corners of substation area | Two 1" PVC conduits with pull cables for power and communication wiring, between BESS SCADA and camera masts, and also required hardware supports and 15 ft camera masts capable of supporting pan, tilt, zoom cameras. | Cameras |
| | Electrically operated slide gate with keycard reader | Keypad, slide gate, gate operator, wiring (power and communications), grounding loop, and hardware for mounting keycard reader. In addition two 1" PVC conduits with pull cables for power and communication wiring between BESS SCADA and keycard reader. | Keycard reader |
| Control House (if applicable) | Keycard reader for lock on control house personnel door | Keypad, wiring (power and communications), and required hardware supports for mounting keycard reader | Keycard reader |
| Site Main Gate | Electrically operated slide gate with keycard reader | Keypad, slide gate, gate operator, wiring (power and communications), grounding loop, and hardware for mounting keycard reader. In addition, two 1" PVC conduits with pull cables for power and communication wiring between BESS | Keycard reader |

| Location | Description | Equipment by Seller | Equipment by Buyer |
|---|---|---|---|
| | | SCADA and keycard reader. | |

#### 4.11.1 Locks

The site will be a mix of Buyers access control system for control houses and battery storage. All equipment shall be lockable per NERC/CIP requirements. Seller responsible for project until COD. Buyer will supply its own locks at COD.
All egress and ingress doors on buildings, and access control system shall utilize approved locking hardware and release features that shall not delay egress per NFPA 101.
All minimum NEMA 3R rated equipment enclosures shall utilize a high security padlock or a clasp lock for the following use equipment types:
IT

Telecom

Inverter

Seller shall coordinate with Buyer's Security to intake and begin management of CyberLock equipment using the CyberLock system managed by Buyer.

#### 4.11.2 High Security Chain

Seller shall provide high security chains on appropriate gates or other site access points. The chain will be 0.375-inch minimum, heavy-duty construction rated either "high security" or grade 100 or higher with a through-tempered alloy and square-sided construction to minimize cutting ability.

#### 4.11.3 Lock Forms

The acceptable types of locks Seller shall provide at the Project Site are:
High Security Padlock – A padlock that meets certain levels, a minimum grade of F5/S6/K5/C4 per ASTM F883-13

High Security Puck Lock – A padlock in the form of a hockey puck with the shackle hidden in a recess on the back side. This type of lock provides its high security by protecting the shackle itself from access, uses the same high security key as the padlock, and includes a special hasp that has a surround shield protecting the hasp tab and hole from cutting where the shackle enters the padlock

Clasp Lock or Cam lock that fits the minimum NEMA 3R rated cabinets as required.

### 4.12 Integrated Automation Equipment

A proven and established instrumentation and control system shall be provided for the BESS. The Owner's control systems will supervise and monitor the BESS SCADA system.

#### 4.12.1 Network Devices

4.12.1.1 Network Servers

The BESS SCADA System shall include a networked GPS synchronized clock capable of providing time synchronization signal to other devices in the BESS SCADA System using IRIG-B via coaxial cable.

All hardware and software shall support and implement standard, open protocols and datasets as specified in the MESA-ESS and MESA-DEVICE standards. No proprietary protocols shall be utilized. The BESS SCADA System shall retrieve data from all capable devices within the BESS and interconnect substation. The BESS SCADA System shall be capable of interfacing with Owner's external historian database protocol systems with full MESA-ESS Level 3 compliance.
All servers and functionality shall be implemented with redundant hardware and software in a hot standby architecture. Virtualized systems may be utilized to provide redundancy.
All hardware shall support redundant hot-swappable power supplies, hot-swappable solid-state drives, and RAID. All software shall be installed on a commercially available operating system with regularly provided security and reliability updates.

4.12.1.2 Routers, Switches, and Modems

Seller shall supply network hardware as necessary to connect all servers, relays, meters, and other equipment capable of communicating with the BESS SCADA System and Owner's corporate SCADA via external networks. All hardware shall be implemented using ruggedized industrial models unless housed in climate-controlled cabinets.
Seller shall supply redundant network switches as necessary to the BESS SCADA System network. Switches shall meet or exceed IEEE 1613 (Class 2). Switches shall support modern security functionality, including VLAN, SNMPv3, RSTP, MAC-based port security, traffic prioritization, port mirroring, PTP time synchronization and pass through, user-based accounts, and dual power supplies.
Seller shall supply redundant network routers as necessary to connect the BESS SCADA System network to Owner's existing SCADA system via external networks. Router shall meet or exceed IEEE 1613 (Class 2). Router shall support stateful firewall with NAT, IPSec Virtual Private Networking, AES256, RADIUS centralized password management, multi-level passwords, SSH/SSL encryption, MAC-based port security, VLAN and SNMPv3, external user access logging for auditing purposes.
Seller shall supply modems as necessary to support the requirements of Owner and/or telecom utility to connect Owner's external network. Seller shall work with Owner to determine the number of internet connections needed and minimum bandwidth requirements. Seller shall work with Owner to determine a list of acceptable internet providers.

4.12.1.3 Operator Workstations

Seller shall supply one operator workstation. The workstation shall consist of one monitor, keyboard, mouse, and PC for display of the operator interface. All components of the workstation shall be utility grade off the shelf components and capable of operating in the BESS environment. Each workstation shall include all software necessary to access the BESS SCADA System and all functionality of the installed equipment with licensing for a minimum of five years.
Remote operation workstation shall be included for the remote operations of the BESS site. This can be achieved via remote access VPN tunneling or SSL.

### 4.12.2 Control and Monitoring Network

4.12.2.1 Supervisory Control

Seller shall supply BESS controllers compliant with the communication methods, protocols and datasets provided in the MESA-ESS and MESA-Device standards. Any operational function of the BESS shall be capable of being controlled through the BESS SCADA System HMI via either local or remote operator workstations. Function parameters of any operating function shall be capable of being modified remotely or locally.
The control system shall be configurable and capable of hardware, firmware or software upgrades to provide additional operating functions in the future, if needed. Seller shall provide 10 percent additional or spare hardware capacity to add to or reconfigure the modes of operation via software applications,

replacement firmware, expansion of the operating system memory or additional input/output and/or logic.

The control system shall have the necessary hardware and software such that it is compliant with the latest Owner standards and NERC CIP reliability standards for control system security requirements.

4.12.2.2 Integration Panels

Seller shall supply one or more integration panels within the BESS to install the PLCs, RTUs and other devices necessary to provide the required functionality of the BESS SCADA System. Each integration panel shall match the design of other panels as specified in this document, including power source, fuses, terminal blocks and other equipment necessary to the function of the BESS SCADA System. In the event that there is loss of Auxiliary power, UPS shall be included in the design and installation inside the panels containing essential control and network hardware.

The integration panels shall provide operators with the ability to cut out active alarms via panel mounted test switches. The integration panel shall allow operators to connect to the facility network via standard Ethernet port for control or diagnostic purposes.

4.12.2.3 Interoperability

The BESS System shall communicate with Owner's corporate SCADA system via the communication methods, protocols and datasets provided in the MESA-ESS standard. Parameters to be communicated to Owner will include, but not be limited to: SOC, actual and contractual Up Reserve and Down Reserve capability when the BESS is responding under its frequency response, status of frequency response, power output in MW, energy output in MWh, available energy capacity in MWH, circuit breaker status, physical availability in percentage, voltage at Revenue Metering Point, and other telemetered information that Owner may require for system operations.

In the event of loss of communication between Owner and the BESS SCADA System, a provision must be made for the BESS systems to institute Owner's desired behavior in such circumstance, including but not limited to maintaining the previously communicated operating behavior, accepting a curtailment command from a local terminal, or a safe and linear shutdown.

### 4.12.3 HMI Color Coding

Colors shall be used consistently throughout all software (HMI screens, etc.). Red shall indicate energized, closed, and live.

Green shall indicate de-energized, open, tripped.

Yellow shall indicate loss of communication with a device.

### 4.12.4 Local Control

The BESS local controls and indication requirements shall be designed in close coordination and with an approval from Owner. The BESS shall include a local control panel or console within the BESS control room. The local control panel may consist of manual control switches, with redundant control actions initiated by digital signals through a local control console. Emergency trip push buttons shall be manually operated and not require action from the digital control, as described elsewhere in these Technical Specifications. As a minimum, the following operator controls shall be located on the local control panel:

Trip/reset for the MV circuit breakers connected to the main step-up transformer.

Trip/reset for the PCS circuit breaker.

Trip/reset for the DC circuit breaker/contactor.

PCS on/off.

BMS on/off

Reset toggle or push-button. When reset is initiated, the control system shall resume control and proceed to the appropriate operating mode.

Reset cut-out selector switch to disable remote or local reset signals.

A selector switch to manually set the operating state (i.e., shutdown, disconnect and operate) and to have the control systems set the operating state automatically.

A selector switch to manually set the operating mode (i.e., VAR control, discharge and charge) and to have the control system set the operating mode automatically.

An emergency trip pushbutton shall be located near the control panel and be suitably protected to prevent accidental operation.

4.12.4.1 Remote Control

All functionality available through the Local Control Units shall be available via the BESS SCADA System for remote operation via Owner's SCADA connection and remote operations center.

4.12.4.2 Application-Specific Control Panels

Where appropriate, additional control panels shall be provided to control specific functionality and applications of BESS equipment. All functionality available at these panels shall be available remotely via the BESS SCADA System.

### 4.12.5 Integrated Automation Controls

The BESS SCADA System shall consist of established manufacturers' components such as balance of plant instruments, equipment and integral controls, process input/output equipment and companion PID "loop" controllers, equipment specific controllers, communication processors and various other necessary devices. The integrated BESS SCADA System electronic components taken together shall form the interconnecting means and functions required to; control, monitor, alarm protect, interlock, diagnose, maintain, and safely operate BESS facilities installed under an assigned project scope of work. The installed BESS SCADA System equipment shall perform the requirements of supervisory and discrete control, equipment protection and process interlocking, component diagnostic, upset analysis, maintenance guidance, and alarm/data logging or archiving functions. Seller selected BESS SCADA System hardware and software provided shall meet all desired modes and conditions of operation, assuring a safe, environmentally compliant, and economic operation of distributed energy storage capabilities described in the scope of work.

BESS related systems startup, manual operation, shutdown, response to upsets, and other operating conditions shall be performed by: 1) intervention by an operator in any specific BESS local control point: or 2) remotely from a central or dispatch center via HMI operator positions with necessary software for that BESS facility. Once desired and stable functional BESS mode has been achieved, autonomous and selected supervisory modes shall automatically maintain, within tolerance, that selected mode until override, or manual intervention by the central or dispatch operators is enabled.

Supervisory, monitoring and mode management required BESS functions shall be gained by means of both local and/or remote operator HMI interface workstations. Functions and logic of control, protection, and interlock of BESS components and support systems shall be distributed to independent-microprocessor based controllers or unit programmable controllers as feasible to minimize a single point of failure.

Likewise, interface and networking equipment between the BESS SCADA System and the separate process control and instrumentation packages of individual equipment shall be redundant for both communication functions and control power source. The intent of the Project is that the BESS SCADA System as a Supervisory and Control System HMI be designed and implemented for intuitive and understandable human interactions, high reliability, including critical system redundant BESS and PV control and sensing elements for specific BESS systems, to enable the desired degree of safe and automated operation.

HMI interaction and autonomous control of some independent auxiliary BESS systems may be as self-contained as practical. These independent systems may be controlled through integrated distributed controllers with local control panels incorporating a self-contained HMI. Alerts, alarms and process data along with auxiliary system diagnostic information shall be sent to the BESS System. Independent auxiliary BESS system controls shall be developed upon a common architecture, with data communications protocol compatible with the BESS SCADA System. Simplicity of operator interaction and ease of maintenance should be the design criteria.
The fundamental BESS SCADA System control logic and related functions shall be segregated to the extent that failure of one or more modes of operation does not result in the failure of other functions. The BESS SCADA System controller shall be designed with regard for redundancy in critical "control loop" functions so that no single component fault will cause the failure of process-controlled equipment in any one system or cause the BESS diagnostics and protection systems to malfunction.

BESS SCADA System indication, control and alarm element redundancy shall be provided for all events or upsets in critical "control loop" functions that may directly cause a self-protection system to activate. Redundancy in the BESS SCADA System controller architecture shall be configured such that selected standby process equipment shall alarm and start automatically upon failure of the primary system. Specific standby components shall have self-initiated automatic start capability field wired to function in parallel with fundamental BESS SCADA System control logic.

4.12.5.1 Control of Fire-Suppression Systems (if applicable)

Fire panel shall communicate with Owner's SCADA via a standard protocol as listed in this Technical Specification. The minimum remote monitoring requirements shall be as follows:
System State

Fire/Smoke Detector Status

Fire System Trouble

Countdown to discharge

Discharge Completed

Manual Release Request

Abort

Alarms/Warnings

4.12.5.2 Control of HVAC Systems

HVAC system shall communicate with Owner's SCADA via a standard protocol as listed in specifications. The minimum remote monitoring requirements shall be as follows:
System State

Area Temperatures

Fresh air operation status

Manual Control

Alarms/Warnings

4.12.5.3 Control of Electrical Systems

BESS auxiliary electrical power shall communicate with Owner's SCADA via a standard protocol as listed elsewhere in this Technical Specification. The minimum remote monitoring requirements shall be as follows:

- Availability of normal and backup power sources.

## 4.13 Instrumentation

All metering, sensors, transducers and test points in the BESS shall be easily and safely accessible for calibration, maintenance and troubleshooting by Owner. Seller shall provide and install current and voltage test switches for each protective relay and for each set of metering within a CT circuit.
Seller shall provide a complete metering system for the BESS, including any required current and voltage transformers, to measure all required parameters at the Revenue Metering Point. The metering system shall be utility grade, revenue class accuracy in all components. The metering system shall be capable of measuring all required quantities, including but not limited to, BESS MVA in/out, BESS MW in/out, MWh in/out, MVAR in/out, MVARh in/out, voltage, frequency and harmonic content. Bi-directional quantities shall be measured and recorded independently. Metering of net quantities is not acceptable.
Seller shall furnish and install a complete metering system, including any required current and voltage transformers, for the AC station service. The metering system shall be utility grade, revenue class accuracy in all components. The metering system shall measure all BESS AC auxiliary station service loads, whether served from the primary or back-up AC station service system.
As a minimum, the BESS shall include instrumentation to measure and report locally and to Owner's SCADA, as applicable to the system proposed, the following:
Battery voltage and current at sufficient points to monitor the SOH of the battery.

Cell temperature at sufficient points recommended by the seller to represent the battery temperature.

Charging system trouble alarms.

Battery ground faults, including fault location.

Temperatures in PCS, battery rooms or other critical cabinetry.

Hydrogen detectors.

Smoke detection.

Fire suppression equipment.

Battery leakage current-to-ground.

Other sensors and equipment, as needed to provide for monitoring and alarms as determined by Seller.

Provide an emergency repose interface accessible outside the fenced area main gate accessible by local fire department. As a minimum, the following indications shall be available on the BESS fire / emergency response panel for each battery:

Smoke/Fire detection status

Fire Suppression status (if provided).

Hydrogen / combustible gas concentration indication

Status of BESS

Communication channel to owner's remote operation center.

Compartment temperature indication

As a minimum, the following meters shall be installed on the BESS local control panel and/or be displayed on the local control console. Meters shall be digital displays and shall be no less than 1.0-inch high. These metering signals shall also be supplied to Owner's SCADA system.
Battery voltage overall and in each string

Battery current overall and in each string

PCS DC power overall and from each PCS

PCS AC power (real, MW) overall and from each PCS

BESS net AC power (real, MW)

BESS net AC power (apparent, MVA)

BESS net AC power (reactive, megaVARs)

PCS Transformer High Side Voltage (each phase)

BESS net AC Amperes (each phase)

As a minimum, the following indicator lights or similar displays shall be installed on the local control panel or console.
PCS breakers status

Status of all contactors and motor-operated disconnect switches (if applicable)

At a minimum, the following alarm functions shall have indicator lights or similar displays on the local control panel or console, as applicable:
PCS breaker trouble alarms (to be determined)

Grid voltage present

Battery, PCS or other equipment over temperature

Battery ground fault (DC ground current exceeds trip level)

Smoke/Fire detection

Fire Suppression Activation

Excess hydrogen level detected

Synchronization Error Shutdown

Control logic trouble

Blown fuse

Building door(s) and/or gate open

Battery under voltage

Module under voltage

String under voltage

At a minimum, alarms from the battery monitoring/alarm system, if automatic, shall be displayed locally at the control panel or console and Owner's SCADA system.
The BESS control and instrumentation systems shall include provisions for determining and storing in non-volatile memory, the sequence of abnormal events, trips and/or alarms that cause the BESS to go to a disconnect or shut down state. In addition, the BESS shall include a dynamic system monitor or fault recorder to record the BESS output and waveform, and other Seller and specified parameters, for all events where the BESS is required to operate as described elsewhere in these Technical Specifications. Waveform recording shall be triggered automatically by Seller and Owner specified means and shall record a sufficient amount of pre-event data to analyze the event.
The BESS shall transmit all the above meter quantities and alarm/status indicators to Owner's SCADA system as described elsewhere in these Technical Specifications. Seller shall provide all transducers, interposing relays, or other equipment required to interface to Owner's SCADA system. Seller shall engineer and install wiring from the BESS equipment to the interface enclosure located in the control

room. Such wiring shall be placed in conduits or wireway and shall be designed for ease of installation of future wiring by Owner.

### 4.14 Nameplates and Tagging

Nameplates shall be furnished and installed on the exterior of all major equipment supplied by SCADA Provider, including all operator interface cabinets/consoles, control and electrical panels and cabinets.
Equipment designation nameplates shall be furnished and installed on the front and back interior of all cabinets and panels.
This provides for equipment designation with doors removed.
Internal nameplates shall also be furnished and installed for all cabinet and panel internal components including, but not limited to, internal devices, modules, and terminal blocks (identification scheme to be finalized during detailed design).
All nameplates shall have white background with black engraved letters and shall be firmly and positively fastened to panels or walls by means of screws.
Unless utilization of screws would affect the NEMA and/or UL rating, in which case nameplate attachment via two-part epoxy shall be permitted.
Holes for attaching nameplates with screws shall be provided regardless of the attachment method (screws or two-part epoxy).
Nameplates shall be legible from base level.
Supplier shall provide nameplate lettering charts, which shall show engraving information for all nameplates.
SCADA Provider shall furnish spare blank nameplates of each size.

## 5.0 TESTING AND START-UP

### 5.1 General

Seller shall furnish all supervision, technical personnel, labor, normal and special test instruments, tools, equipment, spare parts and consumables and materials required to perform the electrical, instrumentation and mechanical checkout and testing of components and equipment to verify the initial operation of the systems and equipment in Seller's scope.
Seller shall perform and successfully complete Site acceptance testing followed Commissioning Tests on systems and equipment in Seller's scope of supply to demonstrate the safety, operability and reliability of the systems and equipment within specified design limits according to the contract, engineering drawings, documents and specifications. All normal and necessary tests shall be conducted using written test procedures signed and verified by seller.
For each test scope, the Seller shall provide a manual describing the test to perform and criteria for success or failure. This shall require Owner review and approval. The Seller shall be required to provide a certificate for successful completion of each test scope.
Seller shall coordinate with Owner for all tests where the BESS is to be connected to Owner's power system. No such tests shall be performed unless permission by Owner has been granted. The tests must be performed in a fashion to minimize unanticipated disturbances on the power system. These tests may have to be performed during the night or low load periods for certain types of tests.

### 5.2 Tests

Seller shall be responsible for preparing test plans and testing the equipment and systems within their scope. The tests shall include, but are not limited to:
Grounding System Testing

Megger Tests

High Pot Tests (or VLF)

Functional Tests of all Controls, Protection Relays and Interlocks

Functional tests of all Safety Devices and Alarms

AC/DC Motor Tests

Battery and UPS Test

PCS Test

Switchgear Test

Control Circuit Checkout

Instrument and Loop Calibration

Fire protection test

All manufacturer recommended equipment tests

Additional required procedures include, but are not limited to:
Start-up Program Organizational Procedure

Safety Tagging Procedure

Confined Space Entry Procedure

### 5.3 Factory Testing of the Battery Modules

Seller shall test and submit test data for the battery modules designated for use on this project. Test data provided should be for battery modules used in the system or equivalent.

### 5.4 Factory Testing of the PCS

Seller shall develop and submit a factory test plan to be approved by the Owner.

### 5.5 Acceptance and Performance Testing

Prior to BESS final commissioning, a Control System Acceptance Test developed by Seller and mutually agreed upon by Owner and the control system integrator will be performed by Seller.

**TABLE 2: PROVISIONAL PERFORMANCE TESTS**

| TEST | COMMENTS |
|---|---|
| BESS Ramp rate tests | The test sequence consists of a ramp from zero output (MW and MVAR) to full MW discharge, then ramp to full MW charging, then ramp back to zero output. The real power MW ramps will be in conjunction with reactive output (MVAR) adjustments to avoid voltage violations on the system |
| SCADA tests | Verify indication of all metering, alarms and controls for BESS, control building, and connected systems. |
| Voltage regulation testing | Test the Facility to hold the MV bus voltage as Owner system permits and within the operating conditions of the Existing Facility. |
| Curtailment interface tests | With the Facility online, verify the response to various real-power set points and ensure the Facility decreases to appropriate levels. |

| TEST | COMMENTS |
|---|---|
| Annunciator tests | Verify proper indication of annunciated alarms and conditions, including reset and acknowledgment of alarms. |
| RTU tests | Testing to verify the interface between Owners' Facility and the BESS. |
| BESS Acceptance tests<br>Startup/shut down, including emergency shut down<br>Instrumentation/control systems functions and diagnostics<br>Power in/Power out tests (including a full discharge test and a discharge test of each string summed to the total discharge capability)<br>Ramp power in and out<br>Demonstration of response to variable power commands at various states of charge<br>Verify lead/lag controller/droop response to System frequency changes<br>Verify receipt/response to Owner's Automatic Generation Control signals<br>Verification of analog BESS signals (i.e. status parameters) to Owner | |

### 5.5.1 Function Verification

After the BESS has been installed, Seller will perform comprehensive testing on the entire system to verify compliance with all requirements of this Technical Specification. Owner may, at Owner's discretion, witness these tests.

To the extent the function can be tested per Section 8 of the Energy Storage Integration Council Energy Storage Test Manual, it shall be.

Operation of all control, protective relaying, and instrumentation circuits shall be demonstrated by direct test if feasible or by simulating operating states for all parameters that cannot be directly tested.

Automatic, local, and remote operation will be demonstrated.

Seller shall perform any required modifications and repairs identified by the testing, prior to acceptance by Owner.

### 5.5.2 Performance Verification

The BESS performance verification shall include tests as determined by Seller to verify that the performance criteria specified in these Technical Specifications can be met or exceeded. Accordingly, Seller shall provide a total system performance verification plan to ensure correct BESS response to system disturbances and operating scenarios described in this Technical Specification. The tests shall include, but not be limited to a constant discharge at the rated power and energy requirements listed in Table 2, or to maximum discharge limit.

Seller shall guarantee that the Project will meet the Performance Guarantees listed below as measured in accordance with EPRI document "***Energy Storage Integration Council (ESIC) Energy Storage Test Manual***". The Seller shall provide Performance Guarantees for the first 36 months of operation of the

facility. Performance Guarantee's shall be in adherence with the above mentioned EPRI document, specifically sections 6.1.1 through 6.2.5, sections 7.1 through 7.6, and sections 8.1 through 8.10.
The total system performance verification plan shall be submitted to Owner for review and approval 60 days prior to BESS performance tests.
These tests shall demonstrate that the BESS capabilities, efficiencies, response, and features are as proposed by Seller.
Owner will not accept the BESS until all acceptance tests have been successfully completed and all provisions of the contract have been met.

#### 5.5.3 Other Compliance Tests

Seller is responsible for obtaining before and after BESS installation measurements to ensure the Project complies with this Technical Specification in the following areas. Owner reserves the right to perform (or request others to perform), at Owner's expense, identical compliance test measurements for the following:
Broadband frequency signal strength and noise voltage

Harmonic voltages and currents

Audible noise measurements

### 5.6 Commissioning and Startup

Seller shall provide a commissioning and startup plan for the Project.
Seller shall coordinate with Owner to develop an acceptable commissioning plan that includes a checkout and startup procedure. This work will assure: that systems are activated in a manner that is safe for personnel as well as for the equipment, that Seller work is complete and according to the contract documents, and that the systems perform as required by the contract documents and are ready to be turned over to Owner. As the construction and installation of the systems nears completion, Seller and Owner shall prepare punch lists and conduct system walk-downs, sub-system and system checkouts, startups, testing, and turnovers.
The final approved Acceptance Test and Commissioning Procedures shall, at minimum, include the following:
Safety plan during startup and commissioning.

Review of all QA/QC testing on the DC and AC sides of inverters.

Detailed procedure for Project startup, including switching sequencing.

Confirm testing and energizing inverters in conformance with manufacturer's recommended procedures; note operating voltages; and confirm inverter is performing as expected.

Testing the system control and monitoring system to verify that it is performing correctly.

Testing the communication system for offsite monitoring.

Testing the Project metering and protective relaying to verify they meet utility requirements.

Insulation check of auxiliary cables.

Verification of operation of station auxiliary power distribution.

DC distribution system, battery and battery charger.

Verification and tuning of cooling system (if required).

Check of operation and indications of circuit breakers disconnect and earthing switches.

Capacitance check of capacitor banks (if required).

Verify proper operation of all pump fans and motors.

Verify proper operation of heating, ventilation and lighting systems.

Check of current and voltage transformers.

Overall check of trip operations from protections to breaker.

Check of circuits through the local control interface and the remote interface.

Detailed procedure for interface and initialization with the grid and completion of all Transmission Provider forms to be provided prior to construction.

Documentation of successful startup and commissioning procedure.

Written notification submitted by Seller to Owner that the completion of Acceptance Testing and Commissioning has occurred.

### 5.7 Synchronization Procedures and Requirements

All testing shall be done in accordance with the LGIA and all the requirements to achieve electrical and mechanical completion of the Project.

### 5.8 Mechanical and Electrical Completion

Seller shall achieve Backfeed and assure that the Project has been synchronized with the Owner Interconnection Facility before conducting the Capability Verification, Guarantee Design Conditions, and Guaranteed Performance Tests.

Mechanical Completion means:

Equipment for the Project has been installed, including with the required connections and controls to discharge and charge the BESS into the system and produce electrical power.

All remaining electrical systems have been checked out and are ready for operation.

All electrical continuity and ground fault tests and all mechanical tests and calibrations have been completed.

All instrumentation is operational and has been calibrated in accordance with manufacturers' standards and guidelines and, where possible, loop checked.

## 6.0 MAINTENANCE

### 6.1 General

Operations and Maintenance requirements will be in compliance with the O&M contract and Seller must meet the technical specifications and requirements of the equipment manufacturers. All equipment and construction documentation to be compiled into O&M manuals. Seller to provide O&M procedures to properly guide the Owner for safe operations of the site.

The Project shall be designed so that regular planned maintenance may be carried out by either Seller (under a separate contract) or by the Owner or by Others. Full Operations and Maintenance manuals for all equipment, the fully integrated facility and site tasks are required by the Seller.

### 6.2 Maintenance Prior to Acceptance

Prior to Final Completion of the Project Seller shall be responsible for maintenance of all components of the Project.

### 6.3 Maintenance Procedures

O&M procedure periods shall be identified to be consistent with manufacturer specified intervals. The BESS is intended to be unstaffed on a day-to-day bas. Expected O&M intervals for all equipment shall be provided.

All equipment planned maintenance for the period of the O&M Contract shall be identified prior to Commercial Operations date and presented in an O&M Plan, in accordance with Vendor's maintenance requirements.

# 7.0 TRAINING AND TOOLS

## 7.1 General

Seller shall provide training for the Project as specified below. Seller shall determine the content and duration for each training session. The suggested class durations in this Technical Specification are meant to illustrate the level of training expected. Performance evaluation testing of all trainees (i.e., a written test) is required for all classes. Seller's minimum requirements for Training are:

Submit training plan

Plan shall be reviewed and approved by Owner

Lesson Plan for each topic shall be provided

- Learning Objectives
- Instructor Qualifications
- Class room training objectives w/safety
- Field training objectives w/ safety
- Evaluation: Either test learning or demonstration

Record keeping

- Program
- Each participant

Certification of Training Completion

## 7.2 Operator Training

Seller shall provide the necessary training in proper operation of the Project and related equipment. This training shall be conducted after completion of the Project performance verification testing, but before system commissioning. It is anticipated that this session will last one to two days and the Seller will provide an outline and syllabus prior to the session. This session will be limited to a maximum of 20 people. Emphasis shall be placed on safety and hands-on operating experience interspersed with the critical background as necessary, including switching procedures and emergency response training.

## 7.3 Maintenance Training

Seller shall provide necessary training in maintenance of the Project and related equipment, if maintenance by Owner option is chosen. The maintenance training shall be scheduled after successful completion of the availability guarantee period. It is anticipated that this session will last one to two days and the Seller will provide an outline and syllabus prior to the session. This session will be limited to a maximum of 20 people. The maintenance training shall include, but not be limited to:

Safety and grounding procedures

periodicity of inspections and maintenance

normal maintenance methods

repairs and replacement

diagnostic procedures

equipment calibration

re-energization

special tests

spare parts

special tools

## 7.4 Training Schedule

Training schedule shall be agreed upon prior Commercial Operational Date

## 7.5 Tools and Equipment

Seller shall provide all "special tools and equipment" for maintenance and operation which are not normally or readily available. Seller shall submit a complete list of tools and equipment needed for erection/installation and maintenance and a list of special tools and equipment that will be provided, including prices. Special tools and equipment shall become the property of Owner at the completion of the BESS and PV installation. Owner reserves the right to purchase additional quantities of tools if desired.

## 7.6 O&M Documentation

Seller shall supply Owner with all manuals and/or handbooks (in printable electronic format) that provide, either in a single manual or handbook or collectively, complete operating and maintenance instructions (including inventories of spare parts and tools and parts lists with ordering instructions) for each major piece of equipment and system of the Project. O&M suggested schedule shall be coordinated among major equipment.

## 7.7 Turnover Documents Including O&M Manuals

Seller shall provide Owner with three paper copies and one editable electronic copy of all manuals. The electronic copy of the manuals shall be organized in folders consistent with tabs in the paper manuals. Electronic copies of installation, operation and maintenance manuals shall be organized from the most general information in the top directory to the most specific information in the lowest level folder. The top-level folders shall include a document containing a directory of the subfolders describing the contents of each and every subfolder. Electronic copies of Installation, Operation and Maintenance manuals shall be organized by project, system, subsystem, equipment, and components. Manufacturers' or vendors' electronic manuals shall be delivered as individual files. Seller shall not merge or combine manufacturer and vendor provided files containing manuals.
The manuals to be provided shall include:

### 7.7.1 Design Manuals

Design manuals shall contain the following items:
Drawing List, Drawing and Specification Identification System, Units of Measurement and Formats

System List and Equipment Numbering System

List of applicable drawings

System design requirements

System and equipment descriptions

Equipment lists itemizing type, performance and technical requirements.

Overall performance data

### 7.7.2 Start Up, Operation and Shutdown Manual

Seller shall provide a startup, operation, and shutdown manual for the BESS, including comprehensive and complete procedures for checkout, startup and testing of the Project and will include as a minimum the following items:
BESS start-up and shutdown procedures

Startup schedule

Startup organization chart

Administrative procedures

Data sheets

Test procedures for all tests required for Mechanical and Electrical Completion and Final Acceptance.

Turnover sequences and procedures

Safety clearance procedure

Work responsibility matrix

### 7.7.3 Installation, Operation, and Maintenance Manuals

Seller shall provide installation, operation, and maintenance manuals for the Equipment, including information typically supplied for equipment and/or systems such as the following items:
System or equipment startup and shutdown procedures

Description / design criteria of each item of equipment

Nameplate information and shop order numbers for each item of equipment and components thereof

Operating procedures and instructions for commissioning, startup, normal operation, shut down, standby and emergency conditions and special safety precautions for individual items of equipment or systems

List of any start-up prerequisites

Normal range of system variables

Operating limits and hazards for all equipment and systems including alarm and trip set points for all devices

Testing and checking requirements

Effect of loss of normal power

Tolerance of electrical supply frequency variation

Final performance and design data sheets, specifications and performance curves for all equipment including test data and test curves

Preventive maintenance schedule and maintenance instructions for equipment including standard and special safety precautions and special conditions that trigger non-scheduled maintenance

Dismantling and assembly procedures for equipment with associated tests and checks prior to returning equipment to service

Detailed assembly drawings to complement assembly procedures mentioned above including parts lists and numbers for replacement ordering

Cleaning procedures, including frequency, equipment, resources needed, water source, etc.

Specifications for any gases, chemicals, solvents or lubricants

Drawing showing space provided for equipment maintenance for equipment and any fixed facilities for maintenance

Methods for trouble-shooting

List of maintenance tools furnished with equipment

Installation instructions, drawings and details

Vendor drawings as appropriate

Installation, storage and handling requirements.

The above requirements are a minimum; however, requirements which are clearly not applicable to specific items or components may be deleted, however, any additional information which is necessary for proper operation and care of the equipment shall be included.

## 8.0 SUBMITTALS

### 8.1 Documentation to be Submitted During Project Design (Documents IFC)

Seller shall prepare and submit to Buyer the following documents during the design and engineering phase of the Project. Refer to Table 8 for requirements during design.

*Table 8: Submittal requirements during project design*

| Item | Description | Due |
|---|---|---|
| 8.1.1 | Monthly progress reports | Monthly |
| 8.1.1.1 | Weekly meetings beginning at FNTP that show weekly progress of project and the following week project schedule and production plans. | Weekly |
| 8.1.2 | Project Schedule showing, among other things, design and engineering work, procurement, and delivery of major equipment, FAT of major equipment, site surveys and studies, site preparation, construction activities, SAT and commissioning activities, and performance tests | 30 days after FNTP, then with each monthly report |
| 8.1.3 | Drawings and documents provided with permit applications and copies of all correspondence exchanged prior to and after the closing date between or on behalf of Seller and any governmental authority with respect to the Project | Per design milestones in Scope Book Section 3.0 |
| 8.1.4 | The initial, baseline Environmental Assessment (subject to the main body of the Agreement) | Per design milestones in Scope Book Section 3.0 |
| 8.1.5 | The final Energy Model, inputs, parameters, and reports; 20-year estimates | As specified Appendix 2 |
| 8.1.6 | Project Plot Plan with landscaping notes | Per design milestones in Scope Book Section 3.0 |
| 8.1.7 | General arrangement drawings | Per design milestones in Scope Book Section 3.0 |
| 8.1.8 | Plans, sections, and details for each system | Per design milestones in Scope Book Section 3.0 |
| 8.1.9 | Underground arrangement drawings (mechanical, electrical, and civil) | Per design milestones in Scope Book Section 3.0 |
| 8.1.10 | Terminal point list | Per design milestones in Scope Book Section 3.0 |
| 8.1.11 | One-line diagrams | Per design milestones in Scope Book Section 3.0 |
| 8.1.12 | Three-line diagrams | Per design milestones in Scope Book Section 3.0 |
| 8.1.13 | Cable layouts | Per design milestones in Scope Book Section 3.0 |
| 8.1.14 | Electrical load flow studies | Per design milestones in Scope Book Section 3.0 |
| 8.1.15 | Electrical grounding calculations | Per design milestones in Scope Book Section 3.0 |
| 8.1.16 | Protective relaying settings and coordination study | Per design milestones in Scope Book Section 3.0 |
| 8.1.17 | Electrical short circuit analysis | Per design milestones in Scope Book Section 3.0 |
| 8.1.18 | Grading and drainage drawings, including hydrology report | Per design milestones in Scope Book Section 3.0 |
| 8.1.19 | Geotechnical Investigation Report | Per design milestones in Scope Book Section 3.0 |
| 8.1.20 | Foundation and structural steel drawings sealed by a PE licensed in the state where the project is located | Per design milestones in Scope Book Section 3.0 |

| | | |
|---|---|---|
| 8.1.21 | Structural calculations for BESS container and foundations, including:<br>Load derivations<br>Corrosion calculations<br>Detailed structural steel code checks<br>Pile load test data<br>Connection calculations | Per design milestones in Scope Book Section 3.0 |
| 8.1.23 | Structural calculations for PCS foundations | Per design milestones in Scope Book Section 3.0 |
| 8.1.24 | Structural calculations for substation structure and foundation calculations | Per design milestones in Scope Book Section 3.0 |
| 8.1.25 | Specifications and datasheets for Battery racks, modules, cells, PCS, combiner box, cables, wire management, and other equipment datasheets | Per design milestones in Scope Book Section 3.0 |
| 8.1.28 | Construction pile installation QA/QC procedure, including:<br>• Pile installation tolerances<br>• Out of tolerance remediation plan<br>• Pile rejection criteria for damage to pile, extreme out of tolerance<br>• Pile testing campaign for sampling population and acceptance criteria, pile load test procedure | 30 days prior to commencement of pile installation |
| 8.1.29 | System description of the main systems for the Project | Per design milestones in Scope Book Section 3.0 |
| 8.1.30 | Start-up and shutdown diagrams | Per design milestones in Scope Book Section 3.0 |
| 8.1.31 | Preliminary Commissioning Program with procedures for respective tests and activities | Per design milestones in Scope Book Section 3.0 |
| 8.1.32 | Draft project performance test procedures | Per design milestones in Scope Book Section 3.0 |
| 8.1.33 | Preliminary O&M philosophy | Per design milestones in Scope Book Section 3.0 |
| 8.1.34 | Property Protection Design Basis Document as described in Appendix 2 | Per design milestones in Scope Book Section 3.0 |
| 8.1.35 | Project Site Security Plan | 120 days prior to construction commencement date |
| 8.1.36 | Initial Point list for SCADA system | Per design milestones in Scope Book Section 3.0 |
| 8.1.37 | Project design basis (including design criteria) | At 30% design |
| 8.1.38 | Equipment receiving, handling, storage, and installation instructions and manuals | 120 days prior to construction commencement date |
| 8.1.39 | Corrosion engineering report | At 30% design |
| 8.1.40 | Field touch-up procedures of painted equipment | 120 days prior to construction commencement date |
| 8.1.41 | Site finish grade | At 30% design |
| 8.1.42 | I&C drawings (instrument list, network diagram, control panel layout, architecture, alarm list)) | Per design milestones in Scope Book Section 3.0 |
| 8.1.43 | MSDS documentation | 120 days prior to construction commencement date |
| 8.1.44 | Visual weld inspection procedures | 120 days prior to construction commencement date |
| 8.1.45 | HVAC equipment | Per design milestones in Scope Book Section 3.0 |

| | | |
|---|---|---|
| 8.1.46 | Electrical package including cable schedule | Per design milestones in Scope Book Section 3.0 |
| 8.1.47 | Transformer recommended assembly and filling procedure | Per design milestones in Scope Book Section 3.0 |

## 8.2 Documentation to be Submitted During Project Construction

Seller shall prepare and submit to Buyer the following documents from and after the construction commencement date through substantial completion. Refer to Table 9.

*Table 9: Submittal requirements during project construction*

| Item | Description | Due |
|---|---|---|
| 8.2.1 | Monthly progress reports in accordance with Appendix 11 | Monthly |
| 8.2.2 | Weekly construction status report in accordance with Scope Book Appendix 11 | No later than 5 PM Tuesday |
| 8.2.3 | Copy of all Project Work permits and Project operational permits when obtained | As obtained |
| 8.2.4 | Final Commissioning Program | 30 days prior to mechanical completion |
| 8.2.5 | Final performance test procedure | Prior to mechanical completion |
| 8.2.6 | Final O&M philosophy | Prior to mechanical completion |
| 8.2.7 | Construction Test Reports, including compaction test results and related documents for roads, substation pads, and at non-pile supported foundations and structures; in situ pile test results and related documents | Prior to mechanical completion |
| 8.2.8 | System graphics | Prior to mechanical completion |
| 8.2.9 | Certificate of achievement of mechanical completion | Prior to mechanical completion |
| 8.2.10 | Final post-mechanical completion punchlist | Prior to mechanical completion |
| 8.2.11 | OEM FAT and shop test reports for equipment listed in Scope Book Section 5.2 | Prior to initial energization |
| 8.2.12 | Environmental Assessment | No earlier than 180 days prior to closing |
| 8.2.13 | Environmental test reports, inspections, and records | Closing |
| 8.2.14 | Training manuals | Prior to mechanical completion |
| 8.2.15 | Coating specifications | Prior to mechanical completion |
| 8.2.16 | Paint color samples | Prior to mechanical completion |

## 8.3 Documentation to be Submitted at Substantial Completion Payment Date

Seller shall prepare and submit to Buyer the following documents as shown in Table 10 prior to Substantial Completion.

*Table 10: Submittal requirements prior to Substantial Completion*

| Item | Description | Due |
|---|---|---|
| 8.3.1 | Punchlist in accordance with the Agreement, including the agreed punchlist holdback amount | Substantial completion |
| 8.3.2 | Draft as-builts for all drawings and documents submitted during the engineering and design phase and during project construction | Substantial completion |
| 8.3.3 | Power production estimates | Substantial completion |
| 8.3.4 | OEM performance field test reports | Substantial completion |
| 8.3.5 | Software licenses and Project intellectual property rights | Substantial completion |

| | | |
|---|---|---|
| 8.3.6 | Instrument calibration list and certificates | Substantial completion |
| 8.3.7 | Protective relay settings list | Substantial completion |
| 8.3.8 | Equipment list | Substantial completion |
| 8.3.9 | Equipment O&M manuals | Substantial completion |
| 8.3.10 | Construction turnover documentation | Substantial completion |
| 8.3.11 | Commissioning turnover documentation | Substantial completion |
| 8.3.12 | Input and output list | Substantial completion |
| 8.3.13 | SCADA FAT results | Substantial completion |
| 8.3.14 | Commissioning test results, bills of material, and drawings to demonstrate compliance with NERC standards | Substantial completion |
| 8.3.15 | Project Site specific operating procedures | Substantial completion |
| 8.3.16 | Arc flash study | Substantial completion |
| 8.3.17 | NERC test reports and calibration records | Substantial completion |
| 8.3.18 | Project performance test results | Substantial completion |
| 8.3.19 | All permits | Substantial completion |
| 8.3.20 | All signed and approved design change requests | Substantial completion |
| 8.3.21 | Invoices | Substantial completion |
| 8.3.22 | Spare parts and consumables lists | 16 weeks prior to substantial completion |

## 8.4 Documentation to be Submitted after Substantial Completion Payment Date

Seller shall prepare and submit to Buyer the following documents as shown in Table 11 after Substantial Completion.

*Table 11: Submittal requirements after Substantial Completion*

| Item | Description | Due |
|---|---|---|
| 8.4.1 | Final as-builts for all drawings and documents submitted during the engineering and design phase and during project construction | Final completion |
| 8.4.2 | Red line drawings | Final completion |
| 8.4.3 | Operator and maintenance personnel training records | Final completion |
| 8.4.4 | Final equipment O&M manuals | Final completion |
| 8.4.5 | Final system descriptions of as-built systems | Final completion |

## 8.5 Supplemental Appendix Information

For each of Appendices 1 through 7 and in accordance with the other terms of this Agreement, Seller shall update all applicable cells left blank as of the effective date in the Appendix with accurate data and content. Seller shall provide to Buyer periodic updates to each Appendix at the intervals specified in the Agreement for Seller's updates to the schedules. However, no cells may be updated within 90 days of closing without the prior written agreement of Buyer and Seller.

# 9.0 CODES AND STANDARDS

Contractor shall, to the maximum extent feasible, be in compliance with one of the nationally recognized model building codes and with other applicable national, state, and local codes. The latest edition of the local and nationally recognized codes and any updated supplements in effect at the time of contract

award shall be used throughout the project design and construction. Codes and standards applicable to the BESS project can be found below.

The BESS components must comply with all codes and standards relevant to the operation and installation of energy storage equipment. All installed equipment must be tested and approved by Underwriters Laboratories (UL) or another nationally recognized testing facility. Batteries, enclosures, inverters, and other balance of system components must be certified to comply with the latest version of the following requirements:

All work must follow current National Electrical Code requirements as well as:
NFPA 855, "Standard for the Installation of Stationary Energy Storage Systems"

Other general codes are:

| | |
|---|---|
| ANSI C2 | National Electrical Safety Code |
| NFPA 70 | National Electrical Code |
| IEEE 979 | Guide for Substation Fire Protection |
| NFPA 13 | Standard for the Installation of Sprinkler Systems |
| NFPA 68 | Standard on Explosion Protection by Deflagration Venting |
| NFPA 69 | Standard on Explosion Prevention Systems |
| NFPA 72 | National Fire Alarm and Signaling Code |
| IBC | International Building Code |
| ASHRAE 169 | Climatic Data for Building Design Standards |
| ASCE 7 | Minimum Design Loads |
| ACI 318 | Building Code Requirements for Structural Concrete |

Battery cell:
UL 1642 "Standard for Lithium Batteries"

Battery module:
UL 1973 "Batteries for Use in Light Electric Rail Applications and Stationary Applications"

Battery system:
UL 9540 "Energy Storage Systems and Equipment"

UL 9540A "Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems"

Grid interconnection standards, as applicable to the project as a whole:
Institute of Electrical and Electronics Engineers (IEEE) 1547

UL 1741, "Standard for Static Inverters and Charge, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources"

UL 62109-1 "Safety of power converters for use in photovoltaic power systems – Part 1: General requirements"

Other codes and standards that will apply include:
UN 38.3 "Certification for Lithium Batteries" (Transportation)

American National Standards Institute (ANSI) C12.1 (electricity metering)

American Society of Civil Engineers (ASCE)-7 Minimum Design Loads for Buildings and Other Structures

IEEE 2030.2, Guide for the Interoperability of Energy Storage Systems Integrated with the Electric Power Infrastructure

Alternative International Electrotechnical Commission [IEC] standards where applicable:

IEC 62619

IEC 63056

IEC 62933-5-2

HVAC, Thermal Management and Fire Protection

NFPA 90A Standard for the Installation of Air Conditioning

ASHRAE 183 Peak Cooling and Heating Load Calculations in Buildings Except Low-rise Res. Buildings

ASHRAE 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings

NFPA 855 Standard for the Installation of Energy Storage Systems

NFPA 13 Standard for the Installation of Sprinkler Systems

Arresters, Circuit Breakers and Disconnect Switches

IEEE C62 Standards Collection: Guides for Surge Protection

IEEE C62.11 IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits

NEMA LA 1 Surge Arresters

IEEE C37 Standards Collection: Circuit Breakers, Switchgear, Relays, Substations, and Fuses

IEEE C37.37 IEEE Standard Loading Guide for AC High Voltage Switches (in excess of 1000 Volts)

NEMA SG 6 Fuses

IEEE C37.46 Specifications for Power Fuses and Fuse Disconnection Switches

IEEE C37.47 Specifications for Distribution Fuse Disconnecting Switches

NEMA FU 1 Low Voltage Cartridge Fuses

Protection

IEEE C37.91 IEEE Guide for Protective Relay Applications to Power Transformers

IEEE C37.99 Guide for Protection of Shunt Power Capacitors

IEEE C37.90 IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus

IEEE C37.90.1 IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays

IEEE 242 Recommended Practice for Protection and Coordination of Power Systems

IEEE 141 Recommended Practice for Electric Power Distribution for Industrial Plants

IEC 255-5 Electric Relays. P5: Insulation Tests for Electric Relays

IEC 255-22 Electric Relays. Part 22: Electrical Disturbance Tests for Measuring Relays

Control Equipment

ANSI/IPC D30OG Printed Board Dimensions and Tolerances

ANSI/IPC A610B Acceptability of Printed Boards

SCADA

IEEE C37.90.1, “Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus”

NFPA 70: National Electrical Code UL 50, “Cabinets and Boxes”

UL 508, “Industrial Control Equipment”

UL 1449, “Surge Protective Devices” (SPD) ANSI/ISA 99, “Control System Security” NERC/CIP:007-3R2, “Ports and Services”

Harmonics, Grounding and Seismic

IEEE 519 IEEE Guide for Harmonic Control and Reactive Compensation

IEEE 80 Guide for Safety in AC Substation Grounding

IEEE 693 IEEE Recommended Practice for Seismic Design of Substations

Codes and Standards will comply with the following codes and standards at a minimum.
Aluminum Association (“AA”)

American Association of State Highway and Transportation Officials (“AASHTO”)

American Concrete Institute (“ACI”)

American Institute of Steel Construction (“AISC”)

Association of Iron and Steel Engineers (“AISE”)

American National Standards Institute (“ANSI”)

American Society of Civil Engineers (“ASCE”)

American Society of Heating, Refrigeration, and Air Conditioning Engineers (“ASHRAE”)

American Society of Mechanical Engineers (“ASME”)

American Society of Nondestructive Testing (“ASNT”)

American Society of Testing and Materials (“ASTM”)

American Water Works Association (“AWWA”)

American Welding Society (“AWS”)

Applicable state requirements, including State Department of Transportation and Environmental Protection

Avian Power Line Interaction Committee (“APLIC”)

Code of Federal Regulations (“CFR”)

Concrete Reinforcing Steel Institute (“CRSI”)

Crane Manufacturer Association of America (“CMAA”)

United States Environmental Protection Agency (“EPA”)

Federal Aviation Agency, Department of Transportation (“FAA”)

Federal Energy Regulatory Commission (“FERC”).

Federal Highway Administration (“FHWA”)

IAPMO Uniform Plumbing Code

Illuminating Engineering Society (“IES”)

Institute of Electrical and Electronic Engineers (“IEEE”)

Instrumentation Society of America (“ISA”)

Insulated Cable Engineering Association (“ICEA”)

International Building Code (“IBC”)

International Code Council (“ICC”)

International Electrotechnical Commission (“IEC”)

Modular Energy Storage Architecture (“MESA”)

National Electric Code (“NEC”)

National Electrical Contractors Association (“NECA”)

National Electric Safety Code (“NESC”)
National Electrical Manufacturers Association (“NEMA”)
National Electrical Testing Association (“NETA”)
National Fire Protection Association (“NFPA”)
National Safety Council (“NSC”)
North American Electric Reliability Corporation (NERC)
Occupational Safety and Health Administration (“OSHA”)
Post-Tensioning Institute (“PTI”)
Scientific Apparatus Makers Association (“SAMA”)
Sheet Metal and Air Conditioning Contractors National Association (“SMACNA”)
Society for Protective Coatings (“SPC”)
Telecommunications Industry Association/Electronic Industries Association (“TIA/EIA”)
Underwriter’s Laboratories (“UL”)
Uniform Building Code (“UBC”)

****END OF SCOPE BOOK MAIN BODY****


# Appendix 1
# to BOT Scope Book

# Collector Substation

Rev. 1

June 6, 2024

| REVISION RECORD | | | |
|---|---|---|---|
| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
| 0 | 9/14/2023 | All | Initial Issue |
| 1 | 6/6/24 | 5.3.14 | Updated GSU/MPT Transformer Configurations |
| | | 9.1 | Updated Gates |
| | | | |
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APPENDIX 1
TO BOT SCOPE BOOK
COLLECTOR SUBSTATION
TABLE OF CONTENTS

# Appendix 1: Collector Substation

# 1 INTRODUCTION

## 1.1 Purpose

This Appendix 1 to the Scope Book (this "Appendix 1") provides design requirements and reference material for the design of renewable energy (solar, wind, battery storage) collector substations (the "Collector Substations") that will be built in or connected to the Project. This Appendix 1 is intended to provide to Seller and others acting at Seller's request requirements, recommendations, and guidance in the planning, design, construction, asset management, use, and operation of the Collector Substations.

## 1.2 Scope

This Appendix 1 applies to all new Collector Substations.

This Appendix 1 primarily describes technical requirements, both performance-based and prescriptive for the design and installation of Collector Substations. Refer to the Scope Book and other parts of the Agreement for information regarding project sequencing and milestones, the project execution plan, project schedule and schedule management, project controls reporting, health and safety information, factory acceptance tests, training, required submittals, design reviews, equipment records, specified deliverables, project documentation, and other relevant matters not covered by this Appendix 1.

## 1.3 General Data

This Appendix 1 addresses aspects of the Work relating to Collector Substations. It is not intended to be, and shall not be construed to be, a comprehensive list of each and every element or other requirement applicable to the Work and shall in no way limit Seller's obligations under the Agreement or any Ancillary Agreement. Seller shall comply with, any cause its Contractors and Subcontractors to comply with, the terms of this Appendix 1, the Scope Book, all Laws (including codes) and applicable Permits.

This Appendix 1 provides the minimum functional specification (MFS) for the Collector Substations, including scope and design requirements. In addition to the requirements set forth in the Agreement (including the Scope Book), the Collector Substations shall comply with all requirements specified in the GIA or any other Required Deliverability Arrangement.

This Appendix 1 is part of the Scope Book.

Article, Section, Table, Figure, and Attachment references in this Appendix are to this Appendix 1 unless otherwise provided or the context otherwise requires.

## 1.4 HV Collector Substation Work

The Work includes the supply, assembly, and installation of the following components:

- HV switchgear, if applicable
- MV switchgear, if applicable
- MV/HV transformer(s)
- Switchyard buses
- Revenue metering
- Circuit breakers
- Disconnect switches
- Overhead line
- Normal AC and DC Power Distribution
- Backup power supply/emergency generator
- UPS, if applicable
- HVAC
- Grounding (grid and conductors)
- Lightning protection system, if applicable
- Conduits and cable trays
- Cables
- Relay Protection
- Relay and Control Panels
- DC Control Power (including batteries, chargers, and motoring)
- Lighting systems (including emergency lighting)
- I&C system (including fire alarm system), if applicable
- Earthwork
- Structures
- Control enclosure
- Fencing

## 1.5 Deviations

Any deviations from the MFS for the Collector Substations or the terms of this Appendix 1 shall require Buyer's prior approval and will be subject to the terms of the Agreement.

# 2 DEFINITIONS, TERMINOLOGY AND ACRONYMS

Terms with initial capital letters used but not defined in this document shall have the meanings ascribed to such terms in the Agreement, unless the context manifestly requires otherwise. For the avoidance of doubt, the rules of interpretation set forth in the main body of the Agreement shall apply to this document.

Equipment support structures: Generally, refers to all structures within the Collector Substation other than the control house.

System Voltage: The root-mean-square (rms) phase-to-phase voltage of a portion of an alternating-current electric system. Each system voltage pertains to a portion of the system that is bounded by transformers or utilization equipment. (All voltages are rms phase to-phase or phase-to-neutral voltages.) (ANSI C84.1)

Nominal System Voltage: The voltage by which a portion of the system is designated, and to which certain operating characteristics of the system are related. Each nominal system voltage pertains to a portion of the system bounded by transformers or utilization equipment. (ANSI C84.1)

Maximum System Voltage: The highest system voltage that occurs under normal operating conditions, and the highest system voltage for which equipment and other components are designed for satisfactory continuous operation without derating of any kind. In defining maximum system voltage, voltage transients and temporary overvoltages caused by abnormal system conditions such as faults, load rejection, and the like are excluded. However, voltage transients and temporary overvoltages may affect equipment operating performance and are considered in equipment application. (ANSI C84.1)

Low Voltage (LV): Nominal system voltage less than 1000 volts. This term is also used as an adjective to designate the low voltage winding of a power transformer and for referring to the low voltage side of a distribution substation.

Medium Voltage (MV): Nominal system voltage above 1 kV and up to 38 kV. (Note that ANSI C84.1 defines medium voltage as nominal system voltage above 1 kV and below 100 kV).

High Voltage (HV): Nominal system voltages 69 kV and higher up to 230 kV. (Note that ANSI C84.1 defines high voltage as nominal system voltage between 100 kV and 230 kV). This term is also used as an adjective to designate the high voltage winding of a power transformer and for referring to the high voltage side of a distribution substation.

Extra High Voltage (EHV): Nominal system voltage 345 kV and above.

Ampacity: The current-carrying capacity, expressed in amperes, of an electric conductor under stated thermal conditions.

Distribution Substation: A substation whose combination of switching equipment and step- down power transformers are arranged to reduce incoming transmission and distribution voltages, from Transmission up to 230 kV, to Distribution at 34.5 kV and below, for distribution of power to rural, residential, commercial, and industrial loads. It may or may not contain transmission breakers. Distribution substations may also be a combination of switching equipment and step-down transformers arranged to reduce distribution voltages to lower distribution voltages.

Switching Station: A substation that connects three or more transmission lines 69 kV or above without power transformers. A switching station does not serve distribution load and does not include transformation.

Transmission Substation: A substation, 69 kV or above, containing switches, circuit

breakers, busses, and transformers for switching power circuits and to transform power from one voltage to another or from one system to another.

Note: the terms switching station and substation are commonly used as interchangeable.

Finished Grade (or Subgrade): Design site elevation, after site grading.

Substation Designer: For the purposes of this guide, any person, regardless of business unit or contractor or employment status, who makes decisions pertaining to the equipment to be used in a substation, or the manner in which it will be used. Generally, the term "Substation Designer" includes substation layout and relay designers.

Base flood means the flood level having a one percent chance of being equaled or exceeded in any given year. Base flood is also known as 100-year flood. Note that a 100 year flood does not mean that such a flood occurs once every 100 years; instead, it means that there is a one in one-hundred (or 1%) chance of such a flood occurring in a given year. There is approximately a 63.4% chance of one or more 100 year floods occurring in any 100 year period.

# 3 Applicable Codes and Standards

The Collector Substation shall be designed and constructed in accordance with all applicable and up to date codes, ordinances and standard industry practices including, without limitation, ANSI, IEEE, NEMA, standards and FERC, NERC and OSHA regulations. This includes, without limitation, the standards and guidelines for substation design established by the following sources:

| Applicable Standards and Organizations | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| ACI | American Concrete Institute |
| AISC | American Institute of Steel Construction |
| AISI | American Iron and Steel Institute |
| ANSI | American National Standards Institute |
| APLIC | Avian Power Line Interaction Committee |
| ASCE | American Society of Civil Engineers |
| ASHRAE | American Society of Heating Refrigerating and Air Conditioning Engineers |
| ASME | American Society of Mechanical Engineers |
| ASTM | American Society for Testing Materials |

| Applicable Standards and Organizations | |
|---|---|
| AWS | American Welding Society |
| CRSI | Concrete Reinforcing Steel Institute |
| IBC | International Building Code |
| ICE | Institution of Civil Engineers |
| ICEA | Insulated Cable Engineers Association |
| IEC | International Electrotechnical Commission |
| IEEE | Institute of Electrical and Electronics Engineers |
| IESNA | Illuminating Engineering Society of North America |
| ISO | International Standardization Organization |
| NEC | National Electrical Code |
| NEMA | National Electrical Manufacturers Association |
| NERC | North America Electric Reliability Corporation |
| NESC | National Electrical Safety Code |
| NFPA | National Fire Protection Association |
| OSHA | Occupational Health & Safety Administration |
| SSPC | Steel Structures Painting Council |
| UL | Underwriters Laboratories |
| | ACI 318: Building Code Requirements for Structural Concrete |
| | AISC 360: Specification for Structural Steel Buildings |
| | ANSI/TIA-568-C.0-2009 Generic Telecommunications Cabling for Customer Premises |
| | ASCE 113: Design of Substation Structures |
| | ASCE 48: Design of Steel Transmission Pole Structures |
| | American Welding Society (AWS) D1.1 |
| | IEEE Std 605-2008: IEEE Guide for Bus Design in Air Insulated Substations |
| | IEEE Std 693-2018: IEEE Recommended Practice for Seismic Design of Substations |
| | IEEE Std 1527-2018: IEEE Recommended Practice for the Design of Buswork Located in Seismically Active Areas |
| | NECA/FOA 301-2009 Installing and Testing Fiber Optics |

| Applicable Standards and Organizations | |
|---|---|
| | RUS Bulletin 1724-200 Rural Utilities Service Design Manual for High Voltage Transmission Lines Electrical System Requirements |
| | RUS Bulletin 1724-300 Rural Utilities Service Design Guide for Rural Substations |

The latest issued Standards and Codes at the issuance of the effective date of the Agreement shall be used. Earlier editions are not allowed unless specifically identified in this Appendix 1.

If a revision to a standard or code is issued, it is not required to be implemented unless the Authority Have Jurisdiction (AHJ) has adopted it, in which case, Seller is obligated to any increased compliance above what is required by the Standards and Codes at the effective date of the Agreement. This risk is borne by Seller.

# 4 SAFETY

The Substation Designer shall incorporate safe work practices into the design of the collector substation. The Collector Substations design and construction shall allow safe operation and maintenance under all foreseeable operating conditions. The design shall ensure that maintenance can be carried out without a significant effect on the Collector Substations operation and will allow adequate working space to maintain minimum approach distances as specified in the Section 5.2.3, Table 3.

Other aspects such as fire hazard and fire suppression and environmental aspects, such as site drainage and oil containment, shall be considered and incorporated in the design. The Substation Designer is responsible for ensuring that the Collector Substations are designed in compliance with the National Electrical Safety Code, OSHA, and other regulations. See Section 6 for further details.

# 5 GENERAL REQUIREMENTS

## 5.1 Site Environmental Characteristics

Seller shall use the criteria and values set out in "Attachment 2 – Site Environmental Characteristics" and any other criteria and values reasonably determined by Buyer to be necessary or appropriate in the design of the Collector Substation.

## 5.2 Substation Current, Voltages and Clearances

### 5.2.1 **Current Ratings**

The Collector Substation bus systems, jumpers and equipment which is part of the bus shall be designed to serve the maximum equipment ratings. Equipment attached to buses, but not a part of the bus system, shall be designed to service the equipment maximum capabilities.

Any current calculation performed shall take into consideration ambient temperature, temperature rise, conductor maximum operating temperature and coefficient of emissivity. Typical and acceptable ambient temperature value for continuous ampacity shall be 40°C.

Size, variety, and types of conductors used in the Collector Substation shall be kept as minimal as practical.

### 5.2.2 **Voltage Ratings**

The Collector Substation equipment and bus systems shall be designed for the voltage ratings in accordance with Table 1. Any project-specific voltage requirements shall be considered, such as high voltage or contamination will dictate increased Basic Impulse levels ("BIL") for a specific design. This shall be coordinated and agreed upon by Seller and Buyer during project planning phases.

Table 1: Equipment Voltage Ratings

| Nominal Voltage | Rated Voltage | BIL | BSL | Remarks |
|---|---|---|---|---|
| 13.8 kV | 15.5 kV | 110 kV | | Bus, and Disconnects shall be rated 34.5 kV, 200 kV BIL |
| 24 kV | 25.8 kV | 150 kV | | Bus, and Disconnects shall be rated 34.5 kV |
| 200 kV BIL | | | | |
| 34.5 kV | 38 kV | 200 kV | | |
| 69 kV | 72.5 kV | 350 kV | | |
| 115 kV | 121 kV | 550 kV | | Circuit breakers and instrument current transformers shall be rated 145 kV and 650 kV BIL. |
| 138 kV | 145 kV | 650 kV | | |
| 161 kV | 169 kV | 750 kV | | |
| 230 kV | 242 kV | 900 kV | | Instrument current transformers shall be rated 242 kV, and 1050 kV BIL |
| 345 kV | 362 kV | 1300 kV | 825 kV | |
| 500 kV | 550 kV | 1800 kV | 1175 kV | |

### 5.2.3 Clearances and Spacing

All Collector Substation equipment shall be designed to maintain minimum substation clearances and spacing in Table 2, Table 3, Table 4, and Table 7. The below clearances are the minimum allowable clearances for common collector substation HV and MV voltages. Values listed are for altitudes of 1000 meters (3300 feet) or less. See IEEE 1427 for altitude adjustments (if required).

Table 2: Substation Minimum Clearances

Minimum electrical clearances between the conductors, and conductors to ground, shall be as tabulated below.

| Nominal Voltage | BIL (BSL) | Minimum Clearance to Ground for Rigid Parts | Minimum Clearance Between Phases (or Live Parts) for Rigid Parts, Metal to Metal |
|---|---|---|---|
| 7.5 kV | 95 kV | 7 inches | 8 inches |
| 15 kV | 110 kV | 8 inches | 9 inches |
| 25 kV | 150 kV | 11 inches | 12 inches |
| 34.5 kV | 200 kV | 15 inches | 16 inches |
| 69 kV | 350 kV | 26 inches | 29 inches |
| 115 kV | 550 kV | 41 inches | 45 inches |
| 138 kV | 650 kV | 49 inches | 54 inches |
| 161 kV | 750 kV | 56 inches | 62 inches |
| 230 kV | 900 kV | 67 inches | 74 inches |
| 345 kV | 1300 (975) kV | 97 (100) inches | 105 (140) inches |
| 500 kV | 1800 (1300) kV | 135 (150) inches | 150 (215) inches |

Table 3: Substation Minimum Safety Clearances

Minimum horizontal and vertical clearances to live parts for worker safety shall be as tabulated below. These clearances are intended to prevent unintentional encroachment by a worker into the guard zone.

| Nominal Voltage | BIL (BSL) | Vertical Clearance | Horizontal Clearance |
|---|---|---|---|
| 7.5 kV | 95 kV | 8 ft 10 in | 3 ft 4 in |
| 15 kV | 110 kV | 9 ft | 3 ft 6 in |
| 25 kV | 150 kV | 9 ft 3 in | 3 ft 9 in |
| 34.5 kV | 200 kV | 9 ft 6 in | 4 ft |
| 69 kV | 350 kV | 10 ft 5 in | 4 ft 11 in |
| 115 kV | 550 kV | 11 ft 7 in | 6 ft 1 in |
| 138 kV | 650 kV | 12 ft 2 in | 6 ft 8 in |
| 161 kV | 750 kV | 12 ft 10 in | 7 ft 4 in |
| 230 kV | 900 kV | 13 ft 9 in | 8 ft 3 in |
| 345 kV | 1300 (828) kV | 18 ft 11 in | 13 ft 5 in |
| 500 kV | 1800 (1167) kV | 27 ft | 21 ft 6 in |

Table 4: Substation Minimum Vertical Clearances above Ground

| Maximum System Voltage | Pedestrian Traffic | Roadways |
|---|---|---|
| 7.5 kV | 14 ft 6 in | 18 ft 6 in |
| 15 kV | 14 ft 6 in | 18 ft 6 in |
| 25 kV | 14 ft 6 in | 18 ft 6 in |
| 38 kV | 14 ft 6 in | 18 ft 6 in |
| 72.5 kV | 15 ft 2 in | 19 ft 2 in |
| 121 kV | 16 ft 1 in | 20 ft 1 in |

| | | |
|---|---|---|
| 145 kV | 16 ft 7 in | 20 ft 7 in |
| 169 kV | 17 ft | 21 ft |
| 245 kV | 18 ft 6 in | 22 ft 6 in |
| 362 kV | 20 ft 9 in | 24 ft 9 in |
| 550 kV | 24 ft 4 in | 28 ft 4 in |

Note: These clearances shall be maintained under the maximum conductor operating temperatures.

Table 5: Substation Minimum Horizontal Clearance to Fence

| Nominal Voltage | BIL | Clearance to Fence |
|---|---|---|
| 7.5 kV | 95 kV | 10 ft |
| 15 kV | 110 kV | 10 ft 1 in |
| 25 kV | 150 kV | 10 ft 4 in |
| 34.5 kV | 200 kV | 10 ft 7 in |
| 69 kV | 350 kV | 11 ft 7 in |
| 115 kV | 550 kV | 13 ft |
| 138 kV | 650 kV | 13 ft 8 in |
| 161 kV | 750 kV | 14 ft 4 in |
| 230 kV | 900 kV | 15 ft 5 in |
| 345 kV | 1300 kV | 18 ft 4 in |
| 500 kV | 1800 kV | 21 ft 6 in |

## 5.3 Substation Equipment

### 5.3.1 Approved Manufacturers

An Approved Manufacturer List is included in Attachment 1. The Approved Manufacturer List includes a column with applicable Entergy purchase specifications. Approved Manufacturers should already be familiar with the applicable Entergy specifications and be able to provide equipment conforming to these specifications. Seller shall procure items from manufacturers listed in the Approved Manufacturer List in accordance with the applicable Entergy purchase specification and in accordance with this specification.

### 5.3.2 HV Cables

Seller shall comply with the requirements of the GIA for the design, manufacturing, installation, and testing of all HV cables.

### 5.3.3 **Substation Bus/Conductors**

Cable connections between the tube bus and equipment and between equipment shall be ACSR (aluminum conductor steel reinforced), AAAC (all aluminum alloy cable) or AAC (all aluminum cable). Bus connectors shall be aluminum alloy for aluminum-to-aluminum connections and tinned bronze for aluminum-to-copper connections. Hardware connectors shall be welded onto the cable or tube. Aeolian cable shall be installed in the switchyard tubing to limit bus vibration.

### 5.3.4 Insulators

All insulators for the rigid bus system and disconnect switches shall be porcelain station post and shall be ANSI 70 gray in color. High strength or extra-high strength insulators may be required based on detailed analysis. See Section 5.3.4.1. Polymer station post insulators shall be used for jumper standoff support.

Insulators shall conform to ANSI C29 standards. Insulators shall be specified to satisfy mechanical and electrical requirements including creepage based on the project contamination criteria. If contamination criteria is not available, medium (35mm/kV) shall be used.

### 5.3.5 Insulator Strength

The determination of the required cantilever strength of the insulator shall be performed in accordance with ANSI/IEEE Standard 605. The determination of the required effective bus span length due to insulator strength shall be determined for the insulator chosen and the external forces applied.

### 5.3.6 **Load Combinations:**

| | |
|---|---|
| Case 1 – Extreme Wind: | 2.5 D + 2.5 W IFW + 1.0 SC |
| Case 2 – Ice with Concurrent Wind: | 2.5 D + 2.5 IWIFI + 2.5 WIIFI + 1.0 SC |
| Case 3 – Seismic: | 2.5 D + 2.5 E (or EFS)IFE + 1.0 SC |

Refer to ASCE 113 for definitions of the load components within the load cases above. Design values for these load cases shall be as defined in Section 7.1. IEEE 605-2008 recommends a safety factor of 0.4 be applied to insulator strengths for loads other than short circuit loading and 1.0 for short circuit loading. As detailed in IEEE 605-2008, Section 12.4.2, when different load types are combined, the loads must be calibrated by the appropriate safety factor. As such, the 2.5 Load Factors on loads other than short circuit loading shown above are used to account for the safety factor on the insulator strength.

### 5.3.7 Surge Arresters

The surge arresters shall be station class, metal-oxide (MOV) type. Surge arresters shall be in accordance with ANSI C62.11. The arrester housing shall be made of polymeric silicone and shall be gray in color. Arresters up to a rated duty cycle voltage of 60 kV shall be of single unit construction, and not more than 2 pieces up through 120 kV.

Arresters shall not be used as rigid bus supports. Arresters shall be installed on all incoming line terminals and at transformer terminals. Arresters shall be installed as close as possible to the equipment being protected. Ratings for surge arresters shall be as shown in Table 5 and dimensions shall be as shown in Table 6.

Table 6: Station Class Surge Arrester Ratings

| Nominal System Voltage (kV) | System Type | Rated Duty-Cycle Voltage (kV) | Rated MCOV (kV) |
|---|---|---|---|
| 2.4 | Effectively Grounded, wye connected system | 3 | 2.55 |
| | Ungrounded or Impedance Grounded, Delta connected system | 3 | 2.55 |
| | Distribution Networks (Note) | 3 | 2.55 |
| 4.16 | Effectively Grounded, wye connected system | 6 | 5.1 |
| | Ungrounded or Impedance Grounded, Delta connected system | 6 | 5.1 |
| | Distribution Networks (Note) | 9 | 7.65 |
| 12.47-14.4 | Effectively Grounded, wye connected system | 12 | 10.2 |
| | Ungrounded or Impedance Grounded, Delta connected system | 18 | 15.3 |
| | Distribution Networks (Note) | 21 | 17 |
| 23 | Effectively Grounded, wye connected system | 21 | 17 |
| | Ungrounded or Impedance Grounded, Delta connected system | 36 | 29 |
| | Distribution Networks (Note) | 36 | 29 |
| 34.5 | Effectively Grounded, wye connected system | 30 | 24.4 |
| | Ungrounded or Impedance Grounded, Delta connected system | 48 | 39 |
| | Distribution Networks (Note) | 48 | 39 |
| 69 | Effectively Grounded, wye connected system | 60 | 48 |
| 115 | Effectively Grounded, wye connected system | 96 | 76 |
| 138 | Effectively Grounded, wye connected system | 120 | 98 |
| 161 | Effectively Grounded, wye connected system | 132 | 106 |
| 230 | Effectively Grounded, wye connected system | 192 | 152 |
| 345 | Effectively Grounded, wye connected system | 276 | 220 |
| 500 | Effectively Grounded, wye connected system | 420 | 335 |

Note: Ungrounded Distribution Network and Systems where an accidental ground can exist for long periods of time.

Table 7: Arrester Housing Dimensions by Rating

| Rated Duty-Cycle Voltage | Creepage Distance | Height |
|---|---|---|
| 3 kV | 15” | 8” |
| 6 kV | 20” | 10” |
| 12 kV | 25” | 13” |
| 18 kV | 34” | 14” |
| 21 kV | 38” | 16” |
| 30 kV | 45” | 19” |
| 36 kV | 55” | 23” |
| 48 kV | 55” | 23” |
| 60 kV | 69” | 25” |
| 96 kV | 115” | 45” |
| 120 kV | 138” | 50” |
| 132 kV | 161” | 65” |
| 192 kV | 230” | 92” |
| 276 kV | 345” | 110” |
| 420 kV | 500” | 175” |

### 5.3.8 Disconnect Switches

GSU high-side main disconnect switches are not required when there is only a single transformer configuration. The HV line disconnect shall provide isolation to HV circuit breaker and transformer without compromising safety or operations. When a dual transformer configuration is in place, the high side transformer circuit breaker shall include disconnect switches. The GSU shall include a low side disconnect switch to allow isolation of the entire transformer zone without the need of opening feeder circuit breaker hooksticks.

The disconnect switches shall be three-pole, group operated, single-throw complete with station post insulators, switch blades, contacts, operating mechanisms and include all necessary hardware for the assembly and mounting to steel structures. All disconnect switches shall conform to IEEE Standard C37.30.1 for HV switches. Ratings for disconnect switches shall be as shown in Table 7 and Table 8.

Standard practice is to orient the vertical and side break switches so that the blade shall be dead when the switch is in the open position, i.e., the hinge shall be towards the closest circuit breaker.

All disconnect switches shall be provided with arcing horns which will interrupt charging or magnetizing currents to prevent any arcing at the main switch contacts. Grounding switches will be required for HV line disconnect switches. The line disconnect switch and associated ground switch shall be mechanically interlocked to avoid mis-operation, i.e. closing the line disconnect switch when the ground switch is closed and vice versa.

Table 8: HV Disconnect Switch Ratings

| **Nominal Operating Voltage (phase-to-phase)** | **230kV** | **161 kV** | **138kV** | **115kV** | **69kV** | **34.5 kV** |
|---|---|---|---|---|---|---|
| Maximum Voltage (phase-to-phase) | See Table 1 | | | | | |
| Basic Impulse Level (BIL) | | | | | | |
| Maximum Continuous Current (amperes) | To be determined after study results | | | | | |
| Short Time Withstand (symmetrical) Current | To be determined after study results | | | | | |
| Preferred Configuration Type | Vertical Break/Double End Break/Center Break | | | | | Vertical Break/ Center Break/ Hookstick |

Table 9: EHV Disconnect Switch Ratings

| Nominal Operating Voltage (phase-to- phase) | 345kV | 500kV |
|---|---|---|
| Rated Voltage | 362 kV | 550 kV |

| | | |
|---|---|---|
| Lightning Impulse Withstand Voltage | 1300 kV | 1800 kV |
| Switching Impulse Withstand Voltage | 885 kV to ground 1120 kV across open gap | 1150 kV to ground 1450 kV across open gap |
| Rated Continuous Current: | 2000 A, or 3000 A (To be determined after study results) | 2000 A, or 3000 A (To be determined after study results) |
| Rated Short Time Withstand | 63 kA rms, 164 kA peak | 63 kA rms, 164 kA peak |
| Short-time Current Withstand Duration | 3 seconds | 3 seconds |

Line switches shall be monitored by the RTU or SCADA system.

All disconnect switches whether motorized or not will have auxiliary contacts for system monitoring. Auxiliary contacts on motorized switches will not be actuated by the motor cam but will be triggered based on the physical switch position.

Electrical interlocks shall be installed to prevent opening of motor operated disconnects and/or grounding switches when the station main breaker is in the closed position.

The complete switch assembly shall have a rated ice breaking ability to open and close with a ¾" thick coating of ice.

Gradient control rings shall be provided for switches at 230kV and higher voltages on both the hinge end and the jaw end to fully shield the live mechanism parts including the terminal pads.

Flexible braids are not acceptable as by-pass shunts. Flexible laminated current carrying components are acceptable only when welded connections are made on each end. Bolted connections are not acceptable on laminated components. All moving contact surfaces for current transfer shall be silver or silver alloy. Aluminum or plated aluminum is not acceptable.

The switches shall be free of visible corona at 110% rated voltage. The Radio Influence Voltage (RIV) shall not exceed 300 microvolts.

All fastenings, nuts, bolts and washers utilized in the non-live parts area shall be of hot-dipped galvanized steel. Plated fastenings are not acceptable.

All bearings shall be heavy duty with stainless steel balls and races. Aluminum or its alloys are not acceptable as a material for bearing raceways or bushing surfaces.

Bearings shall be maintenance free and not located in the current carrying path. Switch bearings shall be lubricated and sealed and shall not require further field lubrication. Dry type, non-lubricated type bearings

will be preferred. Lubricant shall be non-deteriorating with a projected shelf life in excess of ten years. All bearing assemblies shall be weatherproofed with corrosion-free seals.

All switches supplied with manual operating mechanism shall be readily convertible to motor operation.

Maintenance ground studs shall be supplied on both hinge and jaw sides of the switch for attachment of portable ground cables. Design of the ground stud attachment shall be such that presence or absence of the ground studs will not change the switch height from its base to the top of the switch terminal pads. Ground studs shall be capable of being added to a switch in the field without undue switch dismantling. The ground studs shall be corona-free and shall be fully shielded where necessary. The ground stud material shall be the same as that of the switch contacts. The ground stud length shall be at least 6" for attaching the portable ground cable clamps and have sufficient strength to support a 50 feet length of a 4/0 copper portable ground cable.

### 5.3.9 **Operating Mechanism**

Hookstick operated switches may be used for equipment or circuit isolation, and regulator bypass applications up to 34.5 kV. Hookstick operated disconnect shall be located to provide switch operator space to allow 45 degree switch stick angle, for opening or closing, without operator or switch stick bumping into adjacent equipment, structures or foundations. Escape paths shall be considered in layout to deal with arcing or equipment failure that might occur during switching any switch or local breaker operation.

Switches shall be supplied with a manual three-phase group operated mechanism. The operating mechanism shall be designed such that the complete three phase switch assembly can be operated to fully open and closed positions by one person with a force of not more than 35 lbs applied to the actuating handle.

The vertical operating pipe operation for switches up to and including 145 kV shall be torsion operated by a swing handle. The swing handle shall be galvanized steel pipe not less than 3 feet in length. The switch design, where operation with a swing handle would require a force greater than 35 lbs, shall utilize a worm gear operator.

The vertical operating pipe operation for 170 kV and 230 kV switches shall be torsional operated by a worm gear in lieu of swing handle.

For 363 kV and 550 kV switches, the switch shall be supplied preferably with a three-phase torsional gear drive mechanism with a gearbox for each pole. The operating mechanism shall be designed such that the complete three-phase switch assembly, can be operated to fully open and closed positions with a force of not more than 35 lbs. applied to a manual actuating handle. The worm gear operator, when supplied, shall be in a sealed housing, corrosion and maintenance free. The gear operator shall be self-locking and prevent back driving of the crank handle during operation. The operating crank handle shall be no more than 15 inches in length.

Status indication of operator position is not required for manually operated switches but is required for motor operated switches.

### 5.3.10 **EHV Switches (345 kV & 500 kV) Additional Requirements**

The mounting location for the switch operating handle and/or the motor operator shall be the center pole support column.

The switch shall use porcelain station post insulators ANSI TR number 368, rated 1300 kV BIL for 362 kV switches and ANSI TR number 391, rated 1800 kV BIL for 550 kV switches.

### 5.3.11 Line Tuners

Communication using carrier equipment (line traps and tuners) shall not be used.

### 5.3.12 Metering Devices

#### 5.3.12.1 General

Metering systems for the Project shall be designed and installed to monitor and record all energy traveling to and from the Project and to permit the evaluation of the functionality and efficiency of the overall Project.

Shorting-type terminal blocks shall be provided for all current transformer circuits to allow meters to be removed without disrupting current transformer circuits.

A set of metering current transformers on the GSU secondary shall be provided. Potential transformers shall be provided on the medium voltage buses for input to the meters. Shorting-type terminal blocks shall be provided to allow meters to be removed without disturbing current transformer circuits.

All permanently installed electrical metering instrumentation, or a combination of temporary test and permanently installed instrumentation, that will be used for the Project Performance Tests shall comply with maximum allowable measurement uncertainties per ASME PTC 22.

Except where more restrictive requirements apply, relaying class accuracy voltage and current transformers are acceptable for panel indication meter applications.

ABB FT-1 type test switches shall be provided for the voltage and current inputs to each meter.

#### 5.3.12.2 Revenue Metering

The revenue metering system shall be included in the Work except for installation of the revenue meters, which shall be performed by Buyer. Seller shall purchase the revenue meter(s) from [Entity] Transmission during the design phase of the Project. Notwithstanding anything herein to the contrary, all revenue

meters, installation and purchases thereof, and revenue metering shall be in accordance with the GIA or other applicable Required Deliverability Arrangement (to the extent applicable).

All meters shall conform to ANSI Standards C12.20, C12.1, and C12.10.

Seller shall provide and install high accuracy 0.15B1.8 extended range CTs and 0.15Z accuracy PTs for GSU high-side revenue metering. Seller shall provide the revenue meter cabinet(s) to Buyer's specifications. Seller shall design and install all wiring needed for revenue metering. Buyer shall install the revenue meters and make the final connections to the meters. Seller's schedule for the Work shall allow a reasonable period of time for Buyer to undertake, complete, and test such installation and final connections, and Seller shall use commercially reasonable efforts to cooperate with Buyer in connection with such installation and final connections.

#### 5.3.12.3 **Metering Locations**

Other than where included with standard equipment packages (e.g., inverters), indication metering shall be provided in the following locations:

- High side of each GSU (voltage, current, kW, and kVAR)
- Each medium voltage main breaker (voltage, current, kW, and kVAR)

### 5.3.13 CCVT's & PT's

Voltage transformers and/or CCVTs are required to provide a low voltage supply to protective relays and metering equipment.

Voltage transformers, CVTs and CCVTs are directly connected to the high voltage bus.

Fuses shall not be used on the high side of the Voltage Transformer.

Auxiliary transformers are not permitted.

Refer to Table 10 and Table 11 for required CCVT and PT ratings, respectively.

Table 10: CCVT Ratings

| Nominal System Voltage | Maximum Line to Ground Voltage | BIL | Performance Reference Voltage | Nameplate Ratio | Nameplate Secondary Voltage | Accuracy |
|---|---|---|---|---|---|---|
| 69 kV | 42 kV | 350 kV | 40.25 kV | 350 / 600:1 | 115 / 67.1 Volts | 0.6 WXYZ |
| 115 kV | 70 kV | 550 kV | 69 kV | 600 / 1000:1 | 115 / 69 Volts | 0.6 WXYZ |
| 138 kV | 84 kV | 650 kV | 80.5 kV | 700 / 1200:1 | 115 / 67.1 Volts | 0.6 WXYZ |

| Nominal System Voltage | Maximum Line to Ground Voltage | BIL | Performance Reference Voltage | Nameplate Ratio | Nameplate Secondary Voltage | Accuracy |
|---|---|---|---|---|---|---|
| 161 kV | 98 kV | 750 kV | 92 kV | 800 / 1400:1 | 115 / 65.7 Volts | 0.6 WXYZ |
| 230 kV | 140 kV | 1050 kV | 138 kV | 1200 / 2000:1 | 115 / 69 Volts | 0.3 WXYZ, ZZ |
| 345 kV | 209 kV | 1550 kV | 209 kV | 1800 / 3000:1 | 115 / 69 Volts | 0.3 WXYZ, ZZ |
| 500 kV | 318 kV | 1800 kV | 287.5 kV | 2500 / 4500:1 | 115 / 63.8 Volts | 0.3 WXYZ, ZZ |

Table 11: PT Ratings

| System Voltage | BIL | Primary Voltage | Marked Ratio | Secondary Voltage (each winding) | Accuracy/ Burden | Minimum Thermal Burden |
|---|---|---|---|---|---|---|
| 15 kV | 110kV | 7.2 kV/12.47 kV Y | 60 : 1 | 120 V | 0.3Z | 1000 VA |
| 15 kV | 110kV | 8.4 kV/14.4 kV Y | 70 : 1 | 120 V | 0.3 Z | 1000 VA |
| 25 kV | 150kV | 14.4 kV/24.9 kV Grd Y | 120/200 :1:1 | 120 / 72 V | 0.3 Z | 1000 VA |
| 34.5 kV | 200kV | 20.125 kV/34.5 kV Grd Y | 175/300:1:1 | 115 / 67.08 V | 0.3 Z | 1000 VA |
| 69 kV | 350kV | 40.25 kV/69 kV Grd Y | 350/600:1:1 | 115 / 67.08 V | 0.3 ZZ | 2000 VA |
| 115 kV | 550kV | 69 kV/115 kV Grd Y | 600/1000:1:1 | 115 / 69 V | 0.3 ZZ | 2000 VA |
| 138 kV | 650kV | 80.5 kV/138 kV Grd Y | 700/1200:1:1 | 115 / 67.08 V | 0.3 ZZ | 2000 VA |
| 161 kV | 750kV | 92 kV/161 kV Grd Y | 800/1400:1:1 | 115 / 65.71 V | 0.3 ZZ | 2000 VA |
| 230 kV | 1050kV | 138 kV/230 kV Grd Y | 1200/2000:1:1 | 115 / 69 V | 0.3 ZZ | 2000 VA |

5.3.13.1 Current Transformers (CT)

All current transformers shall be in accordance with ANSI-C57.13 and shall meet the following requirements.

Relaying: Bushing type, fully distributed winding, five lead multi-ratio, C800 or as specified. (X and Y positions on a breaker bushing 69kV and higher; X position on a breaker bushing 34.5kV only.)

Metering: Bushing type, fully distributed winding, single- or dual-ratio, 0.15% B-0.9 and 0.30% B-1.8 or as specified. To be installed at the Z position on a breaker bushing for 69kV and higher or on the Y position on a breaker bushing at 34.5kV. See Revenue Metering Requirements sections.

Free standing post type current transformers shall be designed to operate at an average ambient temperature of 30°C and with a winding temperature rise not to exceed 55°C. In Buyer's service area, the ambient temperature under full sun can reach as high as 45°C to 50°C.

The minimum thermal rating shall be 2.0.

If continuous load is going to be "X" amps, then the CT shall also be rated "X" amps. Before applying a lower rated CT to benefit from the rating factor the application shall be evaluated thoroughly, and it is generally acceptable only if the peak load is seldom expected and for a very short duration.

Generally, the current transformer rated primary current shall be 10% to 40% above maximum load current when peak load information in unknown. Consideration shall also be given to short circuit levels. The maximum CT ratio shall be selected so that the maximum fault current is less than 20 times the maximum current tap, and so that the maximum secondary CT current is less than 100 amps under maximum fault conditions. An additional rating margin of not less than 25% shall be provided to accommodate future increased fault levels.

Refer to Table 12 and Table 13 for required minimum CT ratios and CT accuracy, respectively.

Table 12: CT Ratios

| Fault Current | Minimum CT Ratio |
|---|---|
| 48 – 64kA | 4000/5 |
| 32 – 48kA | 3000/5 |
| 20 – 32kA | 2000/5 |
| 0 - 20kA | 1200/5 |

Table 13: CT Accuracy

| **Metering Accuracy Class** | **Accuracy** | | | |
|---|---|---|---|---|
| | **At RF *100% Rated Current** | **At 10% Rated Current** | **At 5% Rated Current** | **At ≤ 1% Rated Current (Note)** |
| 0.3 | 0.3% | 0.6% | | |
| 0.3S | 0.3% | | 0.3% | |
| 0.15 | 0.15% | 0.3% | | |
| 0.15S | 0.15% | | 0.15% | 0.15% |

The CT shall have the following primary current and minimum short-time thermal current rating, rms for one second. For bushing and slip-over CTs these ratings apply to the secondary winding only.

Table 14: CT Short-Time Thermal Current

| Maximum System Voltage | Primary Current | Short – time Thermal Current |
|---|---|---|
| 15.5 kV | 1200 A | 25 kA |
| | 2000 A | 31.5 kA |
| | 3000 A | 40 kA |
| 25.5 kV | 1200 kA | 25 kA |
| | 2000 A | 31.5 kA |
| 36.5 kV | 1200 A | 25 kA |
| | 2000 A | 31.5 kA |
| | 3000 A | 40 kA |
| 72.5 kV | 2000 A | 40 kA |
| | 3000 A | 63 kA |
| 123 kV | 2000 A | 40 kA |
| | 3000 A | 63 kA |
| 145 kV | 2000 A | 40 kA |
| | 3000 A | 63 kA |
| 170 kV | 2000 A, 3000 A | 40 kA |
| 245 kV | 2000 A | 40 kA |
| | 3000 A | 63 kA, 80 kA |
| 362 kV | 2000 A | 40 kA |
| 550 kV | 3000 A | 40 kA |

#### 5.3.13.2 CT/PT Combo Units

CT/PT Combo units are not allowed. Exceptions must be approved by Buyer in writing.

### 5.3.14 Circuit Breakers

Circuit breakers shall be three phase dead tank design with current transformers (CTs) on each bushing. A sufficient number of CTs will be supplied to support the system protection and metering requirements. Circuit breakers shall use SF6 or vacuum interrupters.

DC power for the circuit breaker operation and protection will be 125VDC.

Bushings shall comply with the requirements of IEEE Std C37.017. Voltage class and the current rating of the bushings and insulators shall not be less than that of the circuit breaker.

Continuous current rating factor (RF) shall be 2.0 in accordance with IEEE Std. C57.13.

HV and MV breakers shall not have internal 43 Local/Remote switches. If the breakers do come with a 43 device, the device shall be jumpered out. The only 43 Local/Remote switch shall be in the relay panel in the control house, near the 52 CS. The relay panel 43 switch associated with each breaker shall be a three-position switch, with Local, Remote, and Maintenance positions only (i.e., no "Off" position).

HV and MV breakers shall permit local tripping (i.e., tripping via the control switch in the breaker cabinet OR the 52 CS in the relay panel) regardless of the position of the relay panel 43 switch associated with that breaker. HV and MV breakers shall permit local closing ONLY when the relay panel 43 switch associated with that breaker is in the "Local" position. HV and MV breakers shall permit remote closing ONLY when

the relay panel 43 switch associated with that breaker is in the "Remote" position. The Maintenance position will be used when working on the circuit and shall initiate a different set of relay settings.

All circuit breakers shall have dual trip coils. Trip coil 1 and the close coil shall be on the same 125 VDC circuit. Trip coil 2 shall be on a separate 125 VDC circuit. Trip circuits shall be in separate cables.

A platform shall be installed for maintenance access if operators will not or would not reasonably be expected to be able to reach all breaker equipment while standing at grade (cabinet access 60" or higher). Seller shall perform a detailed review of breaker manufacturer drawings to ensure that operability concerns, such as proper cabinet heights or the need for a platform, are addressed.

5.3.14.1 High Voltage Circuit Breaker:

HV power circuit breakers shall be SF6 gas insulated, dead-tank, "puffer" type design with a spring-spring type operating mechanism. Auxiliary contacts for breaker internal control functions shall be provided plus additional form "a" and form "b" field convertible contacts per Table 15. Circuit breakers shall conform to IEEE C37. Circuit breaker ratings shall be as shown in Table 15.

Table 15: HV Circuit Breaker Ratings

| **Rated Maximum Voltage** | | **72.5 kV** | **123 kV** | **145 kV** | **170 kV** | **242 kV** |
|---|---|---|---|---|---|---|
| Rated Continuous Current (as specified) | | 1200 A<br>2000 A | 2000 A<br>3000 A | 2000 A<br>3000 A | 2000 A<br>3000 A | 2000 A<br>3000 A |
| Rated Short Circuit Current (to be determined after study results) | | 40 kA | 40 kA<br>63kA | 40 kA<br>63kA | 40 kA | 40 kA<br>63kA |
| Lightning Impulse Withstand Voltage | | 350 kV | 650 kV | 650 kV | 750 kV | 900 kV |
| Rated Interrupting Time | | 5 cycles | 3 cycles | 3 cycles | 3 cycles | 3 cycles |
| Rated shunt Capacitor Switching current | | 630 A | 315 A | 315 A | 400 A | 400 A |
| Additional Auxiliary Contacts | Form "a" | 12 | | | | |
| | Form "b" | 12 | | | | |

The alarm for SF6 gas breakers shall be annunciated at the operations control center. SF6 meter/monitor shall be suitable for the loss of SF6 emissions. All of the available alarms for HV breakers shall be inputs into the substation RTU and made available to the Electric Reliability Coordinating Council (ERCC) via the communications network.

All HV circuit breakers shall have low SF6 pressure alarms and emergency operations for:

Stage 1: Low gas pressure

Stage 2: Auto-trip of the Trip Coil 1 and Trip Coil 2 circuits and block close of the Close Coil circuit.

Stage 3: Block-trip of the Trip Coil 1 and Trip Coil 2 circuits and block close of the Close Coil circuit.

5.3.14.2 EHV Circuit Breakers (345 kV & 500 kV)

Additional specific requirements pertaining to 345 kV & 500 kV circuit breakers will be provided under separate cover where applicable.

5.3.14.3 **Medium Voltage: Collector Feeders and Reactive Breakers:**

MV Circuit breakers shall be rated for outdoor, three-poles, gang operated, dead tank, frame mounted vacuum type with motor charged operating mechanism in conform to IEEE C37. MV Circuit breaker ratings shall be as shown in Table 16.

Table 16: MV Circuit Breaker Ratings

| | |
|---|---|
| Nominal Operating Voltage (phase-to-phase) | 34.5 kV |
| Maximum Voltage (phase-to-phase) | See Table 2 |
| Basic Impulse Level (BIL) | See Table 2 |
| Maximum Continuous Current (amperes) | To be determined after study results |
| Short Circuit Interrupting Current (kA) | 40kA with full back to back switching capability; tested and proven* |
| Interrupting Time (cycles) | 3 |
| Independent Pole (Phase) Operators | N/A |
| Duty Cycle | O-0.3 sec – CO -3 min - CO |
| Spring Motor Voltage | 125VDC |
| AC Heaters and Receptacle Voltage | 120/240VAC |
| Additional Auxiliary Contacts | Forms “a” and “b” |

***40kA analysis - use conservative design/results. The results of final short circuit model shall dictate the final rating.**

5.3.14.4 Generator Step-up Unit (GSU) / Main Power Transformer (MPT)

This section describes requirements for the Main Power Transformer (MPT) within the collector substation. This item is also referred to as the Generator Step-up Unit (GSU). The GSU connects the medium voltage collector system to the high voltage interconnecting transmission system.

The GSU shall be built to ANSI/IEEE C57. The GSU shall be an outdoor, oil-filled power transformer and designed in accordance with the Project Site climactic conditions listed in Attachment 2. The transformer shall be a wye-g/wye-g/delta (internally buried) configuration with a neutral grounding bushing on the high and low sides.

The GSU ratings shall be based on the project expected total generation at all operating power factors, including all applicable derating factors and confirmed through software simulations. A minimum 10% design margin shall be included.

The GSU shall be purchased complete as a two winding with LV & HV bushings, current transformers, tap changers, surge arresters, cooling equipment (such as radiators & fans), and control/monitoring system equipment.

Table 17 below provide some recommended transformer specifications to consider.

Table 17: Transformer Recommended Specifications

| Project MW | | 270 | 250 | 200 | 150 | 100 | 20 |
|---|---|---|---|---|---|---|---|
| Transformer MVA | ONAN | 180 | 168 | 135 | 102 | 69 | 18 |
| | ONAF1 | 240 | 224 | 180 | 136 | 92 | 24 |
| | ONAF2 | 300 | 280 | 225 | 170 | 115 | |
| %Z (H-X, Positive Sequence) | | 9.0% | 9.0% | 8.5% | 8.5% | 8.0% | 8.0% |
| $X_0$ Neutral Reactor | | Yes | Yes | Yes | Yes | No | No |

Assumptions:

1. Power factor range required at point of interconnect is +/- 0.95
2. Inverters are capable of +/- 0.9 power factor
3. Substation is not close to synchronous generation switchyard
4. Transformers over 300 MVA not recommended due to 34.5 kV fault current
5. Based on transformer winding configuration: HV (wye-gnd); XV (wye-gnd); XV (delta-buried)

5.3.14.5 **Loss Evaluation**

The test system accuracy for measuring losses shall be as specified in IEEE C57.12.00. The calibration and the accuracy of the test equipment shall be traceable to the National Institute of Standards and Technology.

The Manufacturer shall guarantee the following losses for each transformer:

No-Load loss in kilowatts at rated voltage and rated frequency

Total losses (sum of no-load loss and load loss) in kilowatts at ONAN rated output, rated voltage and rated frequency

Auxiliary losses (all cooling in operation)

Load losses shall be evaluated on the ONAN 65°C rating for each transformer.

Transformer losses determined under tests shall be corrected to 85°C. No- Load loss shall not be corrected.

All control components shall be capable of operating in a temperature range of minus 20°C to plus 70°C in the control cabinet(s). The control cabinet design shall ensure that all control components will operate satisfactory when the transformer is loaded beyond its nameplate rating in a 40°C ambient temperature, 90% relative humidity, in full sun with no wind. The control cabinet design shall ensure that damage from condensation inside the cabinet is prevented.

The basic impulse level (BIL) of the transformer windings and bushings shall be as listed below for the specified nominal system voltage. The neutral BIL for all wye-connected windings shall be a minimum of 150 kV.

Table 18: Transformer Winding and Bushing BIL

| Nominal System Voltage | Winding Lightning Impulse Level |
|---|---|
| 500kV | 1550 kV |
| 345kV | 1175 kV |
| 230 kV | 825 kV |
| 161 kV | 650 kV |
| 138 kV | 550 kV |
| 115 kV | 450 kV |
| 69 kV | 350 kV |
| 34.5 kV | 200 kV |
| 24 kV | 150 kV |
| 13.8 kV | 150 kV |

The transformer percent impedance at the self-cooled (ONAN) rating shall be as specified in Table 19 below (for 345 kV and 500 kV, requirements will be provided under separate cover);

Table 19: GSU Impedance

| HV Winding Voltage | Impedance % | |
|---|---|---|
| | Without LTC | With LTC |
| 230 kV | 10.0 | 10.5 |
| 161 kV | 9.5 | 10.0 |
| 138kV | 9.0 | 9.5 |
| 115kV | 8.5 | 9.0 |
| 69 kV | 8.0 | 8.5 |
| 34.5 kV | 7.25 | 7.5 |
| 24 kV | 6.75 | 7.0 |
| 13.8 kV | 6.75 | 7.0 |

The maximum average winding temperature rise shall be 65°C. The maximum hottest-spot temperature rise of the winding shall not exceed 80°C. The maximum hottest-spot temperature rise of any metal components in the transformer core and tank whether in contact or not in contact with the paper insulation, shall not exceed 80°C at an ambient temperature of 40°C.

The calculated maximum temperature rise of any lead or connection shall not exceed the calculated maximum winding hottest spot temperature rise.

The temperature of any serviceable metal parts, gauges, switch handles, etc., located in the control cabinet that may be touched by an operator under normal operation shall not be affected by the transformer and shall not exceed the ambient temperature by more than 10°C at maximum rated load.

Winding hottest-spot calculations shall be made for each winding using the maximum localized losses including the eddy current losses, the insulation thickness at the points of maximum localized losses, and the oil rise in the winding. If Seller is unable to measure the oil rise in the windings, an allowance will be made for the added rise at the design review. These results shall be used in calibrating the hot-spot temperature indicator.

The use of metal oxide varistor (MOV) or other internal devices to control voltage transients is not preferred and Seller shall obtain approval from Buyer prior to use. When MOVs or other internal arrestors are used, their location shall be shown on the nameplate winding schematic and they must be accessible from the top of the transformer without oil drainage.

The calculated maximum temperature rise of any lead or connection shall not exceed the calculated maximum winding hottest spot temperature rise.

The sound pressure level of transformers with an equivalent two-winding rating of more than 25 MVA (ONAN) shall be 6 dB below the levels specified in the NEMA TR-1.

The inter-winding insulation system for windings shall be designed for a BIL impulse to one minute 60 Hz. withstand level ratio of 2.5 or less, using maximum voltage stress and with a safety margin of 20% for the oil space stresses. Weidmann oil gap curves shall be used to determine the field stresses.

Ancillary equipment such as bushings, tap changer, winding leads, etc., shall not restrict the transformer loading to levels below those permitted by the winding conductor. The transformer shall be capable of carrying loads above its nameplate rating in accordance with IEEE C57.91.

## 5.4 Short Circuit Capability

The transformer shall be designed and constructed to withstand, without damage, the effects of both three-phase and line-to-ground through-faults at either of the transformer HV, LV, or TV terminals. The windings shall not exceed the IEEE thermal limits for the duration of 2 seconds. The pre-fault operating voltage on the non-faulted terminals shall be 1.05 per unit rated voltage.

All windings shall be designed for an infinite bus condition i.e. system impedance shall not be used in the calculation of the fault currents. The inner windings shall be designed to withstand maximum short circuit forces in an unsupported buckling mode (free buckling), assuming no radial mechanical support from the core. The windings shall also be designed for forced or supported buckling.

The transformer shall be designed according to the requirements of IEEE Std 693 Annex D. The transformer assembly shall be designed to withstand seismic loading as specified in IEEE 693.

High temperature fiberglass or Nomex insulation or other Entergy approved high temperature material shall be used for the insulation between the tie plates and the core.

The iron core shall be designed such that at full load and with 105% rated secondary voltage, the maximum core temperature (hotspot) shall not exceed 120°C (80°C rise at 40°C ambient), and the maximum tie plate or core surface temperature rise shall also not exceed 120°C (80°C rise at an ambient of 40°C).

#### 5.4.1.1 Windings:

All winding conductor material shall be copper and all other current-carrying parts shall be copper or silver, or alloy(s) of copper and/or silver.

The current density in the winding conductor under maximum rated power at 65°C temperature rise shall not exceed 4 A / mm2 (2580 amps per square inch).

The winding conductor insulation shall be thermally upgraded paper meeting the life criteria as defined and verified in IEEE C57.100. The minimum nitrogen content of the upgraded paper when tested by ASTM standards shall not be less than 2%.

### 5.4.2 Tank

All welding shall be in accordance with ANSI/AWS D1.1 / D1.1M, American Welding Society Steel Structural Welding Code.

The transformer tank shall be of welded sheet steel construction, free from distortion.

The transfer tank shall withstand full vacuum and at least 10 psig positive pressure without leakage or distortion.

The transformer tank cover shall be welded on with at least a 20-inch diameter manhole.

The transformer tank cover shall be welded to the tank using flanges to facilitate removal. With the exception of the main tank top and bottom plates, no side plate welding shall be within 6" of the corners. All tank joints shall be welded both on the inside and the outside.

The tank cover shall be peaked or sloped to prevent rainwater accumulation. All oil and gas seal designs shall have grooves for gasket retention and shall have groove-depth controlled compression for maximum seal life. Glue should not be used for the gasket retention.

All gaskets shall be one-piece, oil-resistant nitrile elastomer or Fluoroelastomer, such as Viton, compatible with the transformer operating temperature. All gasket materials shall be verified in accordance with ASTM D3455 to be compatible for the intended use with transformer oil. The gasket material shall also be fully compatible with the fluids used in the bushings. Gaskets shall not be exposed to the weather. Gasket material for the LV bushings shall be viton material or equivalent rating.

The location of the "shipping" and "dressed" center of gravity shall be marked with raised letters and symbols on the transformer tank.

The oil preservation system shall be a sealed-tank system with a constant pressure inert gas-pressure or conservator/diaphragm system.

### 5.4.3 Bushings and Terminals

All Bushings shall be in accordance with IEEE Std C57.19.01.

The minimum BIL of the bushings shall be as tabulated below.

Table 20: BIL ratings for GSU Bushings and Terminals

| Nominal System Voltage | Rated Voltage of Bushing | Rated BIL of Bushing |
|---|---|---|
| 500 kV | | 1675 kV |
| 345 kV | | 1175 kV |
| 230 kV | 146 kV | 900 kV |
| 161 kV | 102 kV | 750 kV |
| 138 kV | 102 kV | 650 kV |
| 115 kV | 88 kV | 550 kV |
| 69 kV | 44 kV | 350 kV |
| 34.5 kV | 22 kV | 200 kV |
| 24 kV | 16 kV | 150 kV |
| 13.8 kV | 10 kV | 150 kV |

The rated current of the bushing shall be as specified in IEEE Std C57.19.01 but not less than 1.2 times the transformer load current corresponding to its maximum MVA rating with full cooling in operation. The bushing shall not restrict the transformer loading to levels below those permitted by the winding conductor. The rate of loss of life of bushing shall not be more than that for the transformer when the transformer is loaded beyond its nameplate rating in accordance with IEEE Std C57.91

Bushing flange or (flange with adapter) sizes shall be such that the bushings and mountings supplied allow interchangeability with older IEEE standard bushings.

All bushings including the neutral bushing shall be provided with test taps.

All bushings shall be power factor tested. Values of "C1" and" C2" shall be stamped on the bushing nameplates.

The oil sight gauges or sight glass on cover-mounted bushings shall face "outward" so that the oil level sight glass in the bushing can be seen from ground level. All bushing nameplates are to face outward to allow reading of nameplates with spotting scope.

All bushings shall be paper-oil condenser type

Minimum clearance between the live parts of bushings and surge arresters to the components of the transformer that may be serviced (e.g. gas detector relay, valves, gauges, etc.) shall be in accordance with OSHA requirements. Bottom of the bushings shall be minimum 8.5 feet above ground including six inch foundation pad. Vertical clearance between the bushing terminal and the ground shall be in accordance with National Electrical Safety Code IEEE Std C2 requirements.

Bushings shall have the following creepage distance in Table 21

Table 21: GSU Bushing Creepage Distance

| System Voltage | Creepage Distance |
|---|---|
| Up to 69 kV | 48" |

| | |
|---|---|
| 69 kV | 69” |
| 115 kV | 138” |
| 138 kV | 138” |
| 161 kV | 230” |
| 230 kV | 230” |
| 345 kV | 345” |
| 500 kV | 415” |

The H2 and X2 bushings shall be located on the same centerline, and where practicable shall be on the main tank centerline.

Minimum metal to metal clearance between the live parts of bushings in air shall be as tabulated below in Table 22

Table 22: GSU Bushing Minimum Clearance Between Live Parts

| System Voltage (kV) | Clearance (inches) |
|---|---|
| Up to 69 kV | 48” |
| 115 kV | 70” |
| 138 kV | 70” |
| 161kV | 70” |
| 230 kV | 78” |
| 345kV | 120” |
| 500kV | 160” |

5.4.3.1 Bushing Current Transformers

Internal, multi-ratio, bushing-type current transformers (CT) shall be provided with all secondary terminals wired to shorting terminal blocks using ring type lugs without intermediary splices.

Typical CT Ratios are listed below in Table 23. Actual ratios to be confirmed as required to support protection relaying scheme requirements and shall be submitted to Buyer for approval. For 345 kV and 500 kV voltages, requirements will be provided under separate cover.

Table 23: GSU Bushing Typical CT Ratios

| | kV | 600:5 | 1200:5 | 2000:5 | 3000:5 | 5000:5 | |
|---|---|---|---|---|---|---|---|
| BUSHING VOLTAGE (kV L–L) | 13.8 | 12-14 MVA | 19-28 MVA | 28-47 MVA | 47-71 MVA | 71-100 MVA | XFMR WINDING MVA RATING: 3Ph @65C |
| | 14.4 | 12-14 MVA | 19-29 MVA | 29-49 MVA | 49-74 MVA | 74-100 MVA | |
| | 24 | 12-24 MVA | 33-49 MVA | 49-83 MVA | 83-100 MVA | | |
| | 34.5 | 12-35 MVA | 48-71 MVA | 71-100 MVA | | | |
| | 69 | 12-71 MVA | 95-100 MVA | | | | |
| | 115 | 12-100 MVA | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 138 | 12-100 MVA | | | | | |
| | 161 | 12-100 MVA | | | | | |
| | 230 | 12-100 MVA | | | | | |

The continuous thermal current-rating factor RF for the bushing current transformers shall be 2.0 based on temperature rise in accordance with IEEE Std C57.13 unless specified otherwise elsewhere in this Attachment.

All current transformers shall be multi-ratio with ratios in accordance with IEEE Std C57.13.

Provision shall be made to remove and replace the CTs without removing the tank cover.

Seller shall ensure that the manufacturer provides and includes on or as part of the transformer(s) for the Project:

Magnetic liquid level indicator with alarm contacts and threaded conduit hub, with two set points and two sets of alarm contacts per set point

Liquid filling and filter press connection in the top and bottom of the tank

Combination drain and bottom filter valve with sampler

Dial-type liquid thermometer and temperature-indicating switch with alarm contacts, maximum read pointer, and threaded conduit hub, with two set points and two sets of alarm contacts per set point

Vacuum pressure gauge with bleeder

Lifting hooks on the tank, lifting eyes on the cover and provisions for jacking

Stops shall be provided to prevent over-compression of gaskets; gaskets below oil level will be eliminated unless isolating valves are provided

Pressure relief device with alarm contacts and threaded conduit hub

A hot spot dial-type winding temperature indicator with alarm contacts shall be provided for each high voltage and low voltage winding, with a minimum of two (2) per transformer; each winding temperature indicator shall have two set points and two sets of alarm contacts per set point.

De-energized tap changer (DETC). A DETC is preferred, as follows:

Conform to IEEE C57.12.10, Article 5.1.1.

Steps at +5%, +2.5%, 0%, -2.5%, and -5%.

Operable from ground level, with a single external lockable operating handle not more than five feet above ground level.

The tap setting indicator shall be visible from ground level.

Capable of withstanding without damage the short-circuit duty specified for the transformer.

Load Tap Changer (LTC): If an LTC is determined to be required due to system and equipment requirements, then the following requires apply: A high-speed motor operated load tap changer with vacuum or resistance switching conforming to IEEE C57.12.10. Furnish as follows:

Range: plus-or-minus 10% in 32 - 5/8% steps with full MVA capacity on all taps above neutral position, and reduced MVA capacity on taps below neutral position. Preventive autotransformer (PA) if used shall be rated to maintain full capacity with the unequal steps.

Rated Current: not less than the maximum winding current at its rated maximum load (2 stages of supplemental cooling) even if provision only for cooling is initially supplied.

Tap position indicator: located where it can be readable and re-settable from the ground level and visible when manually operating the LTC. The position indicator shall have markings 16L – N - 16R to signify the Normal and the range extremes, and be in accordance with IEEE Std C57.12.10.

Each tap position indication shall provide a digital or analog output for indication in the substation control room and for SCADA indication.

Operation capability: Each contact shall be capable of 500,000 electrical and mechanical operations at the top MVA rating of the transformer before requiring contact replacement. The contacts shall be easily accessible.

The load tap changing equipment shall be contained in segment 2 in a compartment separate from the core and coils to prevent mixing of oil.

The hand crank for manual operation of the drive mechanism shall be operable while standing at the base of the transformer.

The automatic or manual operation of the LTC shall be blocked if the vacuum interrupter fails to interrupt and transfer the load current during a tap change operation.

LTC control relay. Wire to provide sequential or non-sequential operation.

LTC backup control relay

Latching relay for supervisory selection of AUTO or MANUAL REMOTE operation.

LTC Control devices: housed in the transformer control cabinet.

Switch for Manual-Off-Test-Auto control functions. A contact CLOSED when the selector switch is in either the “OFF” or “MANUAL” position shall be provided for the Buyer’s supervisory indication.

Switch for Local-Remote control.

Tap Position Indicator with Drag Hands.

Tap position indication sending unit

Operations Counter.

Raise/Lower Switch.

Automatic voltage control equipment.

Terminal blocks for cable connection.

Heaters for anti-condensation

Stainless steel nameplates and tap changer warning/instruction plates; nameplates shall not be attached to the radiators

5.4.3.2 Cooling Fans:

Three-phase and wired to an auxiliary cooling equipment control panel for power connection, individually fused or otherwise thermally protected, controlled by the winding hot spot temperature.

Shall not be located on top of the radiators nor directly mounted on radiator fins. Separate, removable mounting support for fans shall be supplied and bolted to the transformer tank.

Fan guards shall be hot-dipped galvanized, totally enclose the fan blades, and meet OSHA safety requirements.

The radiators shall be equipped with bolted flanges and valves to permit the removal of any radiator without draining the oil from the transformer or any other radiator; lifting eyes shall be provided on each radiator/cooler group

Connection provisions shall be made in the cooling equipment controls circuit to allow external interlocking with the transformer protective relaying scheme, such that operation of normally closed contacts of the transformer protection lockout relay (86T) will shut down the cooling equipment in the event of an internal transformer fault

Copper grounding pads shall be provided at opposite corners of the tank base. A NEMA 4-hole compression type lug for connection of a 500 kcmil ground cable to the station ground grid shall be provided for each ground pad and for the transformer neutral bushing ground connection which shall be bussed to the tank base.

Insulating Oil: Seller shall ensure the manufacturer fills the tank with oil and the transformer shall be provided with the necessary amount of high-grade insulating oil that contains no detectable PCBs; the oil shall be manufactured and tested in accordance with the requirements of ASTM D3487; identification of non-PCB liquid shall be placed on outside of tank.

Bushing mounted, station-type lightning arresters. Arrester ratings shall be as follows:

Table 24: GSU Arrester Ratings

| System Voltage | Surge Arrester Rated Voltage | Surge Arrester MCOV |
|---|---|---|
| 500 kV | 420 kV | 335 kV |
| 345 kV | 276 kV | 220 kV |
| 230 kV | 192 kV | 152 kV |
| 161 kV | 132 kV | 106 kV |
| 138kV | 120 kV | 98 kV |
| 115kV | 96 kV | 76 kV |
| 69 kV | 60 kV | 48 kV |
| 34.5 kV | 30 kV | 24.4 kV |
| 24 kV | 21 kV | 17 kV |

| System Voltage | Surge Arrester Rated Voltage | Surge Arrester MCOV |
|---|---|---|
| 14.4 kV | 12 kV | 10.2 kV |
| 13.8 kV | 12 kV | 10.2 kV |
| 13.2 kV | 12 kV | 10.2 kV |
| 4.16 kV | 6 kV | 5.1 kV |
| 2.4 kV | 3 kV | 2.55 kV |

The height, from base to the terminal, of the arresters up to 34.5 kV shall be the same as that of the associated LV bushing to reduce probability of flash cause by wildlife. Spacers should be added at the base of the arresters if necessary.

All control wiring shall be 600-volt, 90 degrees C, and XLPE insulation, with stranded copper wire, No. 12 AWG (minimum) for power, No. 14 AWG (minimum) for controls, and No. 10 AWG (minimum) for current transformers

Terminal blocks shall be rated for 600 volts and accept conductors sized #18 through # 8 AWG; an additional 20% spare or extra terminal blocks shall be provided; heat shrink wire markers are required

A core grounding strap shall be provided and accessible from a tank top man-way.

#### 5.4.3.3 Radiators

Radiators shall be detachable from the main tank and preferably shall be interchangeable. The radiators shall be equipped with bolted flanges and valves to permit the removal of any radiator without draining the oil from the transformer or any other radiator and without the loss of cooling from other radiator banks. Lifting eyes shall be provided on each radiator/cooler group.

Studs welded to the tank or headers for mounting of the radiators are not acceptable.

Radiator shut-off valves (butterfly type) shall be provided for each detachable radiator or header, at both top and bottom openings to the main transformer tank. It shall be possible to remove individual radiators for maintenance without the loss of cooling from other radiator banks. The open and closed positions on the radiator shut-off valves shall be clearly and marked

Radiators shall be heavy hot-dip galvanized in accordance with ASTM A123. As measured in accordance with ASTM A386, minimum zinc-coating thickness shall be 3 mils or 1.8 oz/ft2. If any repair of the galvanizing coating is necessary, Supplier shall make such repairs in accordance with ASTM 780.

Radiator banks shall have lifting eyes.

Cooling Equipment Control

Winding temperature indicators/sensors shall be calibrated to simulate the winding(s) actual hottest spot temperature and shall actuate automatic control of the fans.

An alarm relay shall be provided for each stage for cooling failure.

A two-position “Fan Transfer Switch” shall be provided to allow selection of either bank of cooling equipment to operate on either stage of cooling.

A three position switch shall be provided to allow manual or automatic operation of cooling equipment. Switch positions shall be marked Auto-Off-Manual.

Each bank of cooling equipment shall be fed separately from and protected by a two pole breaker of adequate rating, 20 kA interrupting capacity minimum.

Means shall be provided to turn off the cooling system with a remote contact.

The first cooler group shall turn ON as soon as the transformer is energized.

The second cooler group shall be temperature-controlled and turn ON when the top oil reaches a pre-determined temperature – typically 65C.

### 5.4.4 Control Cabinets

Shall comply with the requirements of IEEE C37.21.

The inside pocket on the door shall contain one copy of the instruction manual. Cabinets wider than four (4) feet shall have two approximately equal sized doors.

All control, power, CT, cooling system and alarm wiring shall be terminated in the control cabinet. The control cabinet shall be insulated from transformer so that the “vibrations and heat” are not transmitted to devices within the cabinet.

Sufficient space and clearances shall be provided at the bottom of the cabinet to facilitate cable entry and termination.

Heaters: The heaters shall be rated to operate at 120 V ac and each heater shall be on its own circuit, protected by an appropriate 20 kA interrupting capacity circuit breaker. The heaters shall be PTC (Positive Temperature Coefficient for temperature limiting) heater(s) of sufficient size to prevent moisture condensation. Fan-less PTC heaters, where used, shall be oriented to facilitate convective air flow over their fins to maximize heat transfer.

A 120 volt 15 Amp weatherproof convenience duplex receptacle with ground fault protection shall be provided on the exterior of the control cabinet. A circuit breaker for this receptacle shall be provided inside the cabinet.

Lighting: Shall have a switched convenience light. Large cabinets shall have two switched convenience lights.

The cabinet shall be provided with a grounding bar for individually grounding current transformers, control cable shields, etc.

Provisions for a fall protection system

All standard accessories and maintenance devices as applicable and described in IEEE Std C57.12.10

The oil preservation system of transformer with a conservator shall be equipped with an automatically self-regenerating, maintenance-free dehydrating breather to prevent outside air from having direct contact with the desiccant. A separate unit shall be supplied for the LTC gas space (if applicable). Separate tap-changer compartments shall be equipped with separate dehydrating breathers. Top of the breathers shall be within approximately five feet of the transformer base.

See Section 11.11.5 for additional requirements for integral protective devices.

### 5.4.4.1 Transformer Monitoring

Transformer On line Monitoring Systems
The transformer shall be provided with an on-line monitoring system to continuously monitor the condition of LV and HV bushings, transformer dissolved gases and temperatures and other transformer parameters, including loss of insulation life. The on-line monitoring system shall be capable of controlling the coolers'/radiators' operation in parallel with the conventional cooler controls. Buyer currently uses Dynamic Ratings Monitoring Control Communication (DRMCC) on-line monitoring with a bushing monitoring system. The latest DRMCC monitoring system or better system approved by Buyer shall be provided with the transformer. The type and model of the on-line monitoring system and multi-gas monitoring for the transformer shall be specified in the bid proposal. The on-line monitoring system shall have communications protocols built in to monitor all parameters in Buyer's DCS and PI data server. The transformer shall be provided with the latest model of a Vaisala multi-gas monitor (or better), to be specified by Seller and approved by Buyer, for continuously monitoring and detecting fault gasses in the transformer oil. The system shall be complete with necessary hardware, software, and interfaces. This gas monitor shall perform the following functions or as specified by Buyer: Detect, analyze, and correlate quantity of all dissolved fault gasses, including hydrogen ($H_2$), carbon monoxide (CO), carbon dioxide ($CO_2$), methane ($CH_4$), ethylene ($C_2H_4$), ethane ($C_2H_6$), acetylene ($C_2H_2$) moisture-in-oil, and oil temperature.

Annunciator/Data Logger and Alarms
The transformer shall include an annunciator/data logger panel in the transformer control cabinet. The type of annunciator/data logger shall be Rochester Instrument Systems Inc. (RIS) or equivalent approved by Buyer. The annunciator shall monitor the system's health and indicate occurrences of alarms, trips, and other general signaling messages.

The annunciator shall be mounted on a hinged weather-tight panel, for easy access to rear wiring, in a cabinet of dead-front construction arranged so that water cannot enter the wiring area of the cabinet when resetting the annunciator in rainy or inclement weather. A plexiglass panel shall be provided for external viewing of the annunciator. The panel door shall be equipped with a handle mechanism to allow easy access to the annunciator.

The following is a typical list of alarms generated by the monitoring devices that the annunciator system shall be required to monitor and display. All alarms will be discussed and approved during the design review meeting with Buyer.

- Loss of Normal AC Power
- Loss of Standby AC Power
- Power Supply Auto Transfer
- Loss of AC Control Power
- Group 1 Cooler Fail
- Group 1 Cooler Oil Flow Stop
- Group 2 Cooler Fail
- Group 2 Cooler Oil Flow Stop
- Oil Level Low
- Oil Level Low-Low
- Sudden Pressure Seal-in Relay
- Top Oil Temp.100° C
- Top Oil Temp.110° C

- Winding Temp. 110° C
- Winding Temp. 120° C
- Gas Detector Relay
- Monitoring Devices Fail
- Control Cabinet Temp. High

Alarm contacts shall be Form C type, and shall be wired independently to terminal blocks in the control cabinet to make possible any grouping of alarms by Buyer for remote indications. The contacts shall be rated 125 volts dc, 5 Amps continuous and 0.2 Amps dc non-inductive tripping.

Protection and Monitoring Devices
The transformers shall be equipped with the following devices for monitoring, control, and protection of the transformer (all of which shall have independent alarm contacts wired to the terminal blocks in the control cabinet):

Oil Level Gauge
A magnetic oil level gauge, Qualitrol or Buyer-approved equivalent, with a 6-inch dial, visible from the ground level shall be provided on the transformer tank and conservator.

The oil level gauge shall be a two-stage oil level monitor. Each stage shall be provided with two normally open contacts for alarm and trip functions. Contacts of the second stage shall close when the oil level in the transformer tank falls to a critical level and will result in an internal flashover of the unit.

Top Oil Temperature Gauge
A conventional oil temperature indicator, Qualitrol or Buyer-approved equivalent, with a minimum six (6)-inch dial, with drag hands, shall be supplied to indicate the temperature of the top oil. The instrument shall be mounted at eye level. The indicator shall be vibration-insulated from the transformer. The temperature indicator shall have two adjustable normally open contacts. Top oil alarm contacts shall be set at 105ºC and used to turn on all of the cooling equipment.

Pressure Relief Devices
A spring-loaded diaphragm-type pressure relief device, Qualitrol Type XRPD or Buyer-approved equivalent, complete with animal intrusion screen P/N SCN-600-1 and a DPDT alarm contact shall be mounted on the transformer tank cover or the tank wall near the top. Transformer tanks containing more than 10,000 gallons of oil shall be provided with two pressure relief devices mounted on diagonally opposite corners of the transformer tank. The device(s) shall be located remote from the control cabinet(s) and equipped with directional shield to direct oil flow downward. Pressure relief value shall be stamped on the device.

Sudden Pressure Rise Relays
A transformer with conservator tank shall be equipped with two sudden pressure rise relays, Qualitrol Type 900-014-02, to detect rapid pressure increase in the transformer tank. The relays shall be located on diagonally opposite corners of the transformer and shall be flange-mounted with gate-type shut-off valves located between three (3) and six (6) feet above the base of the transformer.

Sealed tank transformers shall be supplied with two sudden pressure rise relays, Qualitrol Type 910, to detect rapid pressure increase in the transformer tank. The relays shall be flange-mounted with gate-type shut-off valves in the gas space on the tank wall.

The sudden pressure relays shall be provided with Qualitrol type 909-200-01 seal-in relays set up for 125 volts dc and reset feature. A target relay shall be provided to give visual indication of sudden pressure relay operation. The target relay shall also have a reset feature. The alarm and trip contacts of the relays shall be wired to the terminal blocks in the control cabinet.

Actuation of each relay will result in an alarm. Actuation of both relays will result in a unit trip.

Gas Accumulation Detecting Relay
The transformers with a conservator tank shall be equipped with a gas accumulation detection device for detecting the presence of combustible gas within the tank and auxiliary oil-filled compartments. The device shall be Qualitrol type 038-003-01 complete with a sampling valve and alarm contacts. Sample test valves shall be located a maximum of five (5) feet above the transformer base.

The design of the gas detecting system, showing the location of the gas detection device and the gas accumulation system, shall be submitted for Buyer's approval before manufacture. Seller shall also submit a complete written description of operation as applied to the particular transformer with above submittal that will later become part of the Instruction Book.

A buchholz gas monitor relay shall be installed based on the transformer design with the COPs tank.

Dehydrating Breather(s)
The oil preservation system of transformer with a conservator shall be equipped with a Waukesha/HVS, or Reinhausen or other Buyer-approved, automatically self-regenerating, maintenance-free dehydrating breather containing an oil bath to prevent outside air from having direct contact with the desiccant.

Top of the breathers shall be within approximately five feet of the transformer base.

Temperature Monitoring System
Transformer shall be provided with an electronic temperature monitoring system (ETMS) in which the temperature rise of the winding hottest spot over the top oil temperature is added digitally by calculation. The traditional simulated Winding Hotspot Measuring System consisting of winding temperature CTs, heater circuit, and analog dial type thermometers is to be supplied only when specifically requested in the purchase order.

The transformer shall be provided with sufficient number of winding temperature CTs, thermo wells, sensors, dual element RTDs (Pt100Ω or Cu10Ω), probes, etc., to monitor the transformer oil and winding temperatures using a digital temperature monitoring system. The transformer shall be equipped with an APT TTC-1000 from Advanced Power Technologies or Buyer-approved temperature monitoring system with digital displays easily readable in daylight.

The sensors, probes, thermowells, etc., shall be located on the transformer tank sidewall (not the tank cover), and capable of being installed or replaced without de-energizing the transformer, opening the transformer, or lowering the oil in the transformer.

The ETMS shall have the digital displays for the following:

- HV winding hottest spot temperature, each phase
- LV winding hottest spot temperature, each phase
- Transformer tank top oil
- Transformer tank bottom oil
- Ambient temperature
- Control cabinet temperature

The temperature monitor shall have large LED displays for easy readability in any lighting condition. The monitor shall operate with a solid state LED light source that will under normal operating conditions last for the life of the transformer without the need to replace the light source.

The monitor shall cover a temperature range from -30 0C to +150 0C, and shall have a display resolution of ± 1 0C and a 0.7% accuracy at full scale. The device should display the future temperature gradient projection and the load current. The monitor shall be complete with 4–20 mA analog outputs for oil temperature and winding temperature and have contacts to control cooling, for alarms, and for trips.

The monitoring system with digital display gauges shall be mounted in the control cabinet five (5) feet above the base of the transformer. The temperature monitor shall be installed in a manner such that all controls are visible and adjustable from the front, and such that adjustments may be made without interference to other devices. The monitor shall be labeled as TMS.

The transformer shall be provided with sufficient number of winding embedded fiber optic sensors at least three (3) fibers per phase per winding (HV & LV) for winding temperature monitoring and three fibers for top oil temperature monitoring. The fiber shall be terminated into Luma Sense digital temperature monitor or Buyer-approved equivalent located inside the control cabinet. The temperature monitor shall have outputs to connect to other plant devices, DCS, and monitors, including the transformer on-line monitoring system.

## 5.5 Generator Step-Up Transformer Warranty

The GSU transformer(s) shall be provided with an original equipment manufacturer's warranty that the GSU transformer(s) shall be free from defects in material, manufacture, workmanship, and design for a minimum period of five (5) years from the date of such GSU transformer's energization; provided that, if such GSU transformer has not been energized within six (6) months after delivery thereof to the Project Site, the warranty period shall be at least five (5) years commencing six (6) months after the date of delivery to the Project Site. The GSU transformer manufacturer shall be required to repair or replace at its cost any GSU transformer (or component thereof) in breach of such warranty. The warranty shall cover the cost of removal from the Project Site, transportation to and from the repair facility, reinstallation after repairs, and any and all other "in and out" work.

Seller shall notify Buyer of any procedure, activity, or other Work that may void a manufacturer warranty or violate any law or applicable permit reasonably in advance of the performance of such procedure, activity, or Work. Seller shall provide to Buyer all original equipment manufacturer warranty documents.

The original equipment manufacturer's warranty shall cover the equipment is free from defects in material, manufacture, workmanship, and design.

## 5.6 Neutral Grounding Reactor (NGR)

The neutral grounding reactor shall be used to limit the fault current magnitude on the 34.5kV.

The rating of the NGR shall be based on underground collection design, short circuit analysis and ampacity calculation design criteria. Table 9 shows typical MPT MVA where the X0 Neutral Grounding Reactor is required. The requirement of the NGR shall be evaluated during planning phases.

## 5.7 **Station Service Transformer (Auxiliary Loads)**

All HV substations, and other major and strategic substations, shall be provided with two independent AC station service sources with automatic transfer from one source to the other for redundancy.

Recommended station service ac voltage ratings is as follow:

- 240/120 V AC 60Hz, single phase, 3 wire.

The AC station service capacity shall be sufficient to supply all loads for the following as applicable:

- Control house lighting, heating, and air conditioning,
- Power transformer cooling fans, pumps, LTC and control cabinet space heaters,
- Circuit breaker control cabinet heaters, and operating mechanism charging motors,
- Substation lighting,
- Battery chargers.
- Maintenance equipment, including gas cart, and oil filter truck if feasible
- Future Loads

Approved sources of ac station service include the following:

- Distribution line(s) area feeder
- Distribution transformer connected to a substation bus
- Station Service voltage transformers (SSVT) up to 230 kV (suitably rated for this service, but not less than 50 kVA)

SSVTs are used as the primary station service source in critical substations or in substations up to 230 kV without a MV source. The backup station service in such substations shall be from a nearby area distribution feeder based on economics and station importance. If a distribution feeder is not available, then a second SSVT shall be used as a backup. The SSVTs shall have sufficient kVA rating to be able to supply all substation loads including maintenance equipment.

SSVTs are typically connected to the substation bus or a transmission line and are within the associated primary protection zones. Surge protection shall be required on the HV side of the SSVT unless arresters protecting other equipment are close enough to protect the SSVT.

Alternate sources of AC station service, including but not limited to the following, are to be used only in special circumstances and require Buyer approval.

- Inverter system
- Solar panels
- Autotransformer tertiary
- SSVTs above 230kV

An engine generator shall not be acceptable for providing AC station service source.

See IEEE Std. 1818; Guide for the Design of Low-Voltage Auxiliary Systems for Electric Power Substations for additional guidance.

## 5.8 **Reactive Equipment**

Reactive equipment used to provide power quality and reliability to the electrical system (where required) shall be done through capacitor banks and reactors at the 34.5 kV level. To protect and control the reactive equipment, a circuit/reactor switcher shall be used. The MV circuit breaker (See Section 5.3.13.3) shall be used to protect for external faults of the reactive zone of protection (bus differential, etc.)

### 5.8.1 Circuit Switcher

Fully rated dead tank circuit breakers shall be used for the switching of power transformers and shunt capacitor banks; however, circuit switchers may be used with Buyer approval. For switching of the shunt capacitor banks rated up to and including 170 kV, the circuit switchers shall be equipped with pre-insertion resistors for suppression of transients.

Each application where a fully rated dead tank circuit breaker is not justifiable and circuit switcher with a desired fault interrupting rating is not available, a live tank circuit breaker without post type instrument current transformers may be considered in lieu of circuit switcher with Buyer approval.

Circuit switchers are typically rated to interrupt lower fault currents than circuit breakers. As the circuit switchers are normally installed to protect shunt capacitor banks, they are designed to be rated to the expected capacitive switching current as mentioned in the IEEE standards. The circuit switcher application shall ensure that these ratings are not exceeded.

### 5.8.2 Shunt Reactors

Air core reactors present unique design and safety considerations because they produce very high magnetic fields during normal operation. The distance from adjacent iron and steel structures and apparatus must be sufficient to prevent induction heating. Safety fencing with reactor safety signage shall be provided as needed to prevent personnel from getting too close to a set of reactors. A worker approaching too close could experience overheating of ferrous items he is carrying. There is a danger that implanted medical electronic devices such as pacemakers, insulin pumps, or hearing aids will malfunction or fail, causing injury or death. The manufacturer's documentation shall include minimum phase spacing and magnetic clearance requirements for perimeter fencing and these requirements shall be adhered to in the design of the substation.

The Substation Designer shall consult with the manufacturer of the reactors with any additional questions including clear instructions for reactor grounding. To protect personnel working near the reactors the Substation Designer shall also request the manufacturer to supply magnetic field plots, needed to determine the perimeter fence spacing.

The ratings of the shunt reactors shall be provided during detail analysis (project specific not required in all projects).

#### 5.8.2.1 Shunt Capacitor Banks

Shunt capacitor banks may be installed in ungrounded wye configuration up to 115 kV, and shall be grounded wye for 138 kV and above. Fuseless capacitor units shall be installed in capacitor banks. Seller must obtain Buyer approval for any exception.

The ratings of the shunt capacitor banks shall be provided during detail analysis (project specific not required in all projects).

## 5.9 Control House

### 5.9.1 General

There shall be no wood framing or trim. Eave height is to be manufacturer's standard to accommodate a clear interior height of 10'-0" (minimum) including specified insulation.

See Section 8 for control house structural design information.

### 5.9.2 Roof

All roof panels in all locations shall have a U.L. wind uplift classification of class 90 (minimum).

### 5.9.3 Ceiling

Insulation shall be R-19 minimum and shall have a U.L. Flame Spread Rating of 25 (minimum).

### 5.9.4 Walls

For metal buildings, the exterior building walls shall be constructed with a minimum of 16-gauge aluminized steel (or a zinc-aluminum finish), flat or corrugated surface, with a factory baked on light reflecting finish including a minimum ten-year guarantee.

For concrete buildings, the exterior building walls shall be solid concrete design with 6" walls and steel rebar reinforced high strength concrete.

The building walls shall be insulated with a non-combustible blanket type insulator with a glued-on vapor barrier facing material rated at R-11 (minimum) and a U.L. Flame Spread Rating of 25 (minimum).

### 5.9.5 Doors

Substation control house doors shall be level 3 full flush doors (Level 3 - 16 gauge per ANSI/SDI A250.8-2003) with weather stripping. All doors are to be equipped with metal, weather-tight thresholds.

The main room (relay room) exit door shall be 6' wide (double leaves, 3' each). The battery room entrance and exit doors shall be 3' wide.

All doors shall be 8' in height. All exit doors shall open outwards and be equipped with panic bars and lighted or photo luminescent exit signs.

The battery room outside exit door shall have no outside handle and shall only be capable of being opened from the inside. All battery room doors (entrance and exit) shall have an emergency push bar. In the battery room, the floor and all interior wall panels shall be acid resistant.

### 5.9.6 Paint

If steel building, steel shall be coated with either aluminum or aluminum-zinc mix (containing at least 4% aluminum) and shall conform to the proper thickness as specified by ASTM. All structural steel is to have two shop coats of red oxide paint which meets or exceeds Federal Specification TT-P686.

#### 5.9.6.1 Color Schedule

| | |
|---|---|
| Exterior wall panels: | Light Gray unless specified otherwise by Entergy |
| All trim: | As specified by Entergy (specified during planning phases) |
| Interior wall panels: | White |
| Ceiling panels: | White |
| Partition door: | White |
| Exit doors: | to match exterior trim |
| Interior partition wall: | White |

### 5.9.7 Cable Tray

The tray shall be Aluminum, ladder type, two side rails, with six inch rung spacing.

All cable tray entrances into the house shall be 36 inches wide and reducers shall be utilized to connect to 24 inch cable tray inside of the control house when required. A minimum four (4) cable tray entrances is required.

A solid flanged aluminum tray cover (.040 inches thick) with heavy duty cover clamps and stainless-steel mounting hardware shall be installed over all cable trays located on the outside wall of the control house.

Separate cable tray for communication cables shall be provided.

### 5.9.8 **Lighting**

Interior lighting shall be LED (Light Emitting Diode) light fixtures that provide 40 foot-candles of light at a level of three feet above the floor.

External lighting shall be supplied above the exterior doors using weatherproof fixtures.

Exit Lighting (OSHA-approved) shall be an LED (Light-Emitting Diode) illumination or self-illuminating device.

### 5.9.9 Air Handling

The battery room exhaust fan shall be rated for 90 cfm. Battery room exhaust fan(s) shall be equipped with animal deterrent and mounted 8 feet above the floor for security purposes. Exhaust fan(s) shall be controlled and operated with an electro-mechanical timer. Operation intervals of exhaust fan shall be a minimum of four twenty-minute cycles every twenty-four hours.

The air conditioner shall be controlled by a remote low voltage heating/cooling control thermostat, such as Accustat Energy Guard or equivalent, with design set points of 78°F for cooling and 68°F for heating.

### 5.9.10 Warranty

Building finish: minimum twenty (20) year non-prorated warranty.

The walls, including all wall openings for doors and louvered openings, are to be warranted weather-tight for a period of five years from the date of completion of the building.

Ceiling: minimum ten (10) year warranty.

Roof: minimum twenty (20) year non-prorated warranty.

A full five-year warranty on the control house including equipment with parts and service is to be included.

## 5.10 **Substation Civil/Structural Design Criteria**

Seller shall complete all civil works to furnish a collector substation site design, access road(s), and any other outdoor civil works required inside the Project Site or as needed for interconnection of the Project to the Buyer's Transmission System. The design shall meet all applicable federal, state, and local Laws and regulations and requirements of the Agreement, including the Scope Book and this Appendix 1, and provide a relatively maintenance-free design (e.g., provide adequately-sized culverts to limit the possibly of clogging, provide erosion control means on slopes to eliminate maintenance re-grading, design access road cross-section to minimize rutting, etc.).

### 5.10.1 **Siting and Civil**

#### 5.10.1.1 Floodplain

#### 5.10.1.2 **Flood Risk Evaluation**

Flood risk shall be evaluated, and an Elevation Basis selected. This includes evaluation of the flood risk to the substation from rain, river elevation, storm surge, or other causes. It also includes the placement of structures within known Federal Emergency Management Agency (FEMA) special flood hazard areas (SFHA) or other flood prone areas.

The substation location flood evaluation and decisions made with respect to site and equipment elevations shall be documented on the applicable substation site and foundation drawings.

The process to establish the Elevation Basis shall be as follows:

1. Determine if the site location is located within or near a FEMA SFHA.
2. If published information is available, determine the Base Flood Elevation (BFE, 100-year flood) of the proposed site and if the location is within or adjacent to a mapped floodplain.
3. Evaluate the FEMA Flood Insurance Rate Map (FIRM) to determine the most recent revision to the map (including Letters of Map Revision).
4. Determine the date of the underlying Flood Insurance Study (FIS), if the FIS is available, and if the FIS method can be determined.
5. Evaluate local development and the potential impacts to flooding since the publication of the FIS.
6. Obtain written documentation about local ordinances regarding development in a SFHA, including any local requirements for development.

For locations outside of a mapped SFHA, but that are suspected to be at an elevated flood risk, document the known information and attempt to quantify the risk in relation to the site. An example of this type of risk evaluation is floodway extents or floodplain extents ending in a straight line in the vicinity of the site. This occurrence might indicate a road or railway embankment but may be indicative of an arbitrary study limit.

Determine planned access routes to the site for construction, operation, and maintenance and if such routes could be adversely affected by surface water flooding. The evaluation should consider the probability of surface water flooding at critical elevation points such as control houses, equipment cabinets, and access roads for the expected life cycle of the facility.

If the site is located within a FEMA SFHA, the underlying FIS was conducted within the previous 10 years, and the 100 year BFE is available, the 100-year BFI shall be used as the Elevation Basis.

If the site location is not located in a FEMA SFHA, the FIS was conducted more than 10 years ago, or the BFE is not otherwise available, engineering judgement and input from the Project Team shall be utilized to determine if local knowledge will be used as a basis for the site and equipment elevations or if a Hydrologic and Hydraulic study by a suitably experienced individual or company would need to be performed to determine.an Elevation Basis. If it is deemed a study is needed to determine a proper Elevation Basis, a study should be ordered along with a site topographic survey. If applicable, the study shall be used to determine the Elevation Basis.

#### 5.10.1.3 Flood Design Requirements

The Finished Grade of the site shall be at or above the Elevation Basis. Equipment foundation top of concrete (TOC) elevations shall be a minimum of one (1) foot above the Elevation Basis and a minimum of six (6) inches above the Final Grade. The final TOC elevations shall be chosen to keep all equipment control cabinets a minimum two (2) feet and if possible four (4) feet above the Elevation Basis. The Project Team will determine the Elevation Basis, make the final TOC elevation determination, and document those

determinations. The TOC elevations shall be recorded on the station foundation plan and foundation details.

When establishing the TOC elevation for the control house foundation, the relative elevations of the control house and equipment control cabinets shall be evaluated. In all stations the control house floor shall be a minimum of six (6) inches above the Final Grade to prevent rainwater from entering the house. If the control house has trenches in the floor, then the bottom of the trenches shall be a minimum of six (6) inches above final grade. In stations within a FEMA SFHA or otherwise determined to be prone to flooding, the control house floor should be at or above the elevation of the bottom of the lowest equipment control cabinet. A higher control house elevation may be selected to allow for easy maintenance access under the house. In existing substations where the control house is raised due to flooding concerns, the ability to raise equipment cabinets to the same elevation as the control house floor should be evaluated for feasibility.

#### 5.10.1.4 Earthwork

The existing site shall be cleared, grubbed/stripped to a depth sufficient to remove organic material, leveled, filled, compacted, and sloped to drain. The substation yard shall be graded to accommodate drainage. The preferred substation site shall be graded with a slope of no less than 0.5% - 1.5% to facilitate water drainage from the site, storm sewers, catch basins, and/or manholes may be used if required for proper drainage.

A soil drainage analysis may be performed at the same time as soil boring investigation to determine the site's characteristics for water infiltration and retention for sites with aggregate implications larger than 1 acre where AHJs may require additional site permitting.

The drawings shall note the control points on the site, and which coordinate system is to be used.

#### 5.10.1.5 Erosion Control

The design shall comply with the Storm Water Pollution Prevention Plan (SWPPP) and Environmental Management Plan (EMP).

#### 5.10.1.6 **Wetland Delineation and Mitigation**

Seller shall comply with all wetland requirements specified by Laws and applicable Permits. Wetlands shall be confirmed by a qualified third party.

#### 5.10.1.7 Stormwater Management

Seller shall design the Project Site stormwater management plan. Seller shall complete and submit all necessary permitting applications, including stormwater discharge NPDES Permit applications, to the appropriate Governmental Authorities. The design shall provide quality control of stormwater prior to discharge.

Seller's design for stormwater management on the Project Site shall meet stormwater quality and quantity requirements of local, state, and, if applicable, federal Governmental Authorities. The design shall consist of the following, as a minimum:

Size and design details of stormwater, oil containment, run-off basin, and outfall

Location and size of stormwater piping, inlets and manholes as needed

Location and size of stormwater ditches or channels

Project Site relative grades and slope including the drainage area to each stormwater feature

5.10.1.8 Site Surfacing

Thickness: The Project Site shall be graded to drain and then be surfaced with a minimum of six inches of compacted crushed stone.

Aggregate shall meet the following:

If the Collector Substation is not in Arkansas or Louisiana: Material designation - #610- Crushed limestone, primarily used in the Entergy system.

If the Collector Substation is in Arkansas: Material designation: Arkansas Department of Transportation Class 7 Base - Crushed granite or limestone, primarily used in Arkansas. Class 7 Base is a new designation that replaces the old designation (SB2). The materials in Class 7 and SB2 have the same gradation.

If the Collector Substation is in Louisiana: Material designation - Grade D Base (DGA) Dense Grade Aggregate m-crushed limestone.

Compaction: The crushed stone shall be compacted to a minimum density equal to 95% of the maximum density obtained by a Modified Proctor Test (ASTM D-1557). Do not grade ruts down; fill with additional aggregate and compact.

Sterilant: after sub grade preparation and prior to applying the crushed rock, a non-toxic vegetation eradicator (sterilant) shall be applied. Sterilant shall be applied from a minimum of five feet to a maximum of ten feet outside the fence.

5.10.1.9 Drive Access and Road Design

Substation ingress/egress points are to be compliant with all State and local permitting requirements. A permanent all-weather twenty (20) feet wide roadway shall be provided for access and egress to the substation site directly from a public street or road. Access Road shall be adequate for construction and maintenance activities including hauling heavy equipment such as the collector substation GSU. Access Road shall have no less than 50 ft. centerline turn radii.

Roadways within the substation shall be provided, along the fence if possible, for personnel and equipment movement. All roadways within the substation shall be at least twenty (20) feet wide with at least a fifty (50) feet centerline minimum turn radius. A reduced turn radius inside the substation is acceptable provided that an 18-wheeled low-bed vehicle loaded with equipment can easily negotiate all roads and turns within the substation fence enclosure. Road crossings over cable trenches, and culverts, shall be designed to withstand heavy traffic. Substation shall have only two point of entry in and out of the yard. The yard shall allow for vehicles to turn around or back out of the yard.

Note that new substations designated as CODE (see Section 13) shall include a vehicle access corridor around the exterior of the perimeter to allow drive-around access by security or law enforcement personnel.

## 5.10.2 Oil Containment

### 5.10.2.1 Federal Regulatory Requirements

Design and construction shall conform to Code of Federal Regulations, Title 40, (40CFR), Parts 110 and 112.

Oil spill containment shall be provided for the main transformer. Oil spill containment shall be provided for other equipment when required by authority having jurisdiction.

### 5.10.2.2 State and Local Regulatory Requirements

Oil containment shall comply with state and local requirements which are contained in 40 CFR Part 109. State and local governments have generally adopted the existing federal regulations prohibiting discharges of oil.

### 5.10.2.3 Containment System

Secondary oil containment type shall be an above grade containment pit.

Minimum containment volume is to be 100% of oil contained within protected equipment in addition to the volume of rainwater retained during a 24 hour 25 year recurrent interval storm event.

All designed water removal systems shall incorporate a method of monitoring discharged water quality. Monitors shall be connected to alarm systems.

In designing (sizing) a stone filled collection pit, the final oil level elevation shall be situated approximately 12 inches below the top elevation of the stone. This provides a fire extinguishing capability designed to quench flames if a piece of oil filled equipment catches fire. The use of 1.5 inch or larger stone (washed and uniformly sized) is recommended to permit quicker penetration to avoid a pool fire. Void Volume Ratio for stone filled devices shall be between 30 to 40 percent.

Pits using drainpipes shall assure that the drainpipe material shall be capable of withstanding the higher temperatures associated with an oil fire.

#### 5.10.2.4 **Oil Filled Equipment Separation**

Oil-filled equipment shall be separated from other equipment and buildings to prevent potential fire hazards that may impede restoring or maintaining electric service. The following minimum separations from NFPA 850 Section 5.1.4 are suggested:

Power transformers containing between 500 and 5,000 gallons of oil shall be located a minimum of 25 feet from any building unless the exposed walls consist of or are protected by a wall or barrier having a two-hour fire rating. The barrier shall extend horizontally and vertically such that any exposed part of the building is a minimum of 25 feet from the transformer. Transformers shall also be spaced an adequate distance from a fire-rated building wall to ensure that this 25 foot minimum is maintained to any other parts of the building that do not have a two-hour fire rating.

For outdoor transformers with an oil capacity of greater than 5,000 gallons, maintain clear separation of 50 feet from other structures or provide a 2-hour fire rated barrier

A minimum distance of 8 feet shall exist between the transformer and any building or wall to ensure there is adequate space for normal operating and maintenance work. Cable trenches shall not be routed adjacent to oil immersed equipment.

Barriers that are required due to inadequate separation to equipment or buildings shall be constructed of non-combustible, heat-resistant, fire-rated material. The barrier height shall extend a minimum of 1 foot above the top of any oil filled equipment and any of their components. Barriers shall also extend horizontally a minimum of 2 feet beyond the line of sight of the subject building or equipment.

For transformers with less than 500 gallons of oil and where a firewall is not provided, the edge of the postulated oil spill (i.e., containment basin, if provided) should be separated by a minimum of 5 feet from the exposed structure to prevent direct flame impingement on the structure.

Any transformer for the Project using a listed “less flammable” insulating oil (e.g., Envirotemp FR3) shall be installed with and maintain a separation distance and barriers as provided above. If Seller seeks a modification of a separation distance or a barrier requirement for a transformer on the basis that the transformer will use a listed less flammable insulating oil, Seller shall perform and provide to Buyer a detailed hazard evaluation of such transformer with the proposed less flammable insulating oil. Buyer will consider such evaluation in its review of the modification request.

# 6 EQUIPMENT SUPPORT STRUCTURE LOADING

## 6.1 Load Cases

The load cases specified shall include the following environmental requirements:

Dead Load: The weight of equipment and support structures shall be included with appropriate increases for all equipment accessories and structure connections.

NESC District Loading (Rule 250B) - NESC District Loading shall be selected from Table 25, Table 26, Table 27, or Table 28 based on project location (Note that these districts may not match the district depicted in NESC for a given county). The ambient air temperature shall be taken as 0°F. Note that the load factors specified in NESC Table 253-1 shall only be used for this condition.

Extreme Wind: An Extreme Wind Speed shall be selected from Table 25, Table 26, Table 27, or Table 28 based on project location (Note that the values in the tables may not match the maps depicted in NESC or ASCE 113 for a given county). Wind pressure shall be developed using ASCE 113. The importance factor (IFW) for Extreme Wind loading shall be 1.0 corresponding to a 50 year mean recurrence interval per ASCE 113, Table 3-3. The ambient air temperature shall be taken as 60°F.

Concurrent Ice and Wind: A wind speed of 30 mph from any direction and a radial ice thickness selected from Table 25, Table 26, Table 27, or Table 28: Load Districts by County – Texas based on project location applied on the equipment or structure. The importance factor (IFI) for Concurrent Ice and Wind loads shall be 1.0 corresponding to a 50 year mean recurrence interval per ASCE 113, Table 3-11. The ambient air temperature shall be taken as 15°F.

Short Circuit Loading: Determined in accordance with ASCE 113 and IEEE 605-2008 using electrical parameters determined from a site-specific analysis.

Seismic: Seismic design parameters (accelerations, site class, etc.) will be provided in the geotechnical report for each site. The seismic loads shall be calculated in accordance with ASCE MOP 113. Unless larger values are provided in the geotechnical report, the following minimum values shall be used for the mapped ground motion spectral response accelerations: Ss = 0.140 and S1 = 0.051. The ambient air temperature shall be taken as 60°F.

Other: For equipment mounted on structures, the same design weather conditions shall apply. Loads associated with operation of the equipment shall be added to applicable load combinations.

Table 25: Load Districts by County – Arkansas and Missouri

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| AR | Arkansas | 100 | | M | | 1 |
| AR | Ashley | 100 | | M | | 1 |
| AR | Baxter | 100 | | | H | 1 |
| AR | Benton | 100 | | | H | 1 |
| AR | Boone | 100 | | | H | 1 |
| AR | Bradley | 100 | | M | | 1 |
| AR | Calhoun | 100 | | M | | 1 |
| AR | Carroll | 100 | | | H | 1 |
| AR | Chicot | 100 | | M | | 1 |

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| AR | Clark | 100 | | | H | 1 |
| AR | Clay | 100 | | | H | 1 |
| AR | Cleburne | 100 | | | H | 1 |
| AR | Cleveland | 100 | | M | | 1 |
| AR | Columbia | 100 | | M | | 1 |
| AR | Conway | 100 | | | H | 1 |
| AR | Craighead | 100 | | M | | 1 |
| AR | Crawford | 100 | | | H | 1 |
| AR | Crittenden | 100 | | M | | 1 |
| AR | Cross | 100 | | M | | 1 |
| AR | Dallas | 100 | | M | | 1 |
| AR | Desha | 100 | | M | | 1 |
| AR | Drew | 100 | | M | | 1 |
| AR | Faulkner | 100 | | | H | 1 |
| AR | Franklin | 100 | | | H | 1 |
| AR | Fulton | 100 | | | H | 1 |
| AR | Garland | 100 | | | H | 1 |
| AR | Grant | 100 | | M | | 1 |
| AR | Greene | 100 | | | H | 1 |
| AR | Hempstead | 100 | | | H | 1 |
| AR | Hot Spring | 100 | | | H | 1 |
| AR | Howard | 100 | | | H | 1 |
| AR | Independence | 100 | | | H | 1 |
| AR | Izard | 100 | | | H | 1 |
| AR | Jackson | 100 | | | H | 1 |
| AR | Jefferson | 100 | | M | | 1 |
| AR | Johnson | 100 | | | H | 1 |
| AR | Lafayette | 100 | | M | | 1 |
| AR | Lawrence | 100 | | | H | 1 |
| AR | Lee | 100 | | M | | 1 |
| AR | Lincoln | 100 | | M | | 1 |
| AR | Little River | 100 | | | H | 1 |
| AR | Logan | 100 | | | H | 1 |
| AR | Lonoke | 100 | | M | | 1 |
| AR | Madison | 100 | | | H | 1 |
| AR | Marion | 100 | | | H | 1 |
| AR | Miller | 100 | | M | | 1 |
| AR | Mississippi | 100 | | M | | 1 |
| AR | Monroe | 100 | | M | | 1 |
| AR | Montgomery | 100 | | | H | 1 |
| AR | Nevada | 100 | | M | | 1 |
| AR | Newton | 100 | | | H | 1 |
| AR | Ouachita | 100 | | M | | 1 |
| AR | Perry | 100 | | | H | 1 |
| AR | Phillips | 100 | | M | | 1 |
| AR | Pike | 100 | | | H | 1 |
| AR | Poinsett | 100 | | M | | 1 |

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| AR | Polk | 100 | | | H | 1 |
| AR | Pope | 100 | | | H | 1 |
| AR | Prairie | 100 | | M | | 1 |
| AR | Pulaski | 100 | | | H | 1 |
| AR | Randolph | 100 | | | H | 1 |
| AR | St. Francis | 100 | | M | | 1 |
| AR | Saline | 100 | | | H | 1 |
| AR | Scott | 100 | | | H | 1 |
| AR | Searcy | 100 | | | H | 1 |
| AR | Sebastian | 100 | | | H | 1 |
| AR | Sevier | 100 | | | H | 1 |
| AR | Sharp | 100 | | | H | 1 |
| AR | Stone | 100 | | | H | 1 |
| AR | Union | 100 | | M | | 1 |
| AR | Van Buren | 100 | | | H | 1 |
| AR | Washington | 100 | | | H | 1 |
| AR | White | 100 | | | H | 1 |
| AR | Woodruff | 100 | | M | | 1 |
| AR | Yell | 100 | | | H | 1 |
| MO | Dunklin | 100 | | | H | 1 |
| MO | New Madrid | 100 | | | H | 1 |
| MO | Oregon | 100 | | | H | 1 |
| MO | Pemiscot | 100 | | | H | 1 |
| MO | Stoddard | 100 | | | H | 1 |
| MO | Taney | 100 | | | H | 1 |

Table 25: Load Districts by Parish – Louisiana

| State | Parish | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| LA | Acadia | 150 | L | | | 0.5 |
| LA | Allen | 125 | L | | | 0.5 |
| LA | Ascension | 150 | L | | | 0.5 |
| LA | Assumption | 150 | L | | | 0.5 |
| LA | Avoyelles | 110 | L | | | 0.5 |
| LA | Beauregard | 125 | L | | | 0.5 |
| LA | Bienville | 100 | | M | | 0.75 |
| LA | Bossier | 100 | | M | | 0.75 |
| LA | Calcasieu | 150 | L | | | 0.5 |
| LA | Caldwell | 100 | | M | | 0.75 |
| LA | Cameron | 150 | L | | | 0.5 |
| LA | Catahoula | 100 | L | | | 0.5 |
| LA | Claiborne | 100 | | M | | 0.75 |
| LA | Concordia | 100 | L | | | 0.5 |
| LA | Desoto | 100 | | M | | 0.75 |
| LA | East Baton Rouge | 150 | L | | | 0.5 |
| LA | East Carrol | 100 | | M | | 0.75 |

| State | Parish | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| LA | East Feliciana | 125 | L | | | 0.5 |
| LA | Evangeline | 125 | L | | | 0.5 |
| LA | Franklin | 100 | | M | | 0.75 |
| LA | Grant | 100 | L | | | 0.75 |
| LA | Iberia | 150 | L | | | 0.5 |
| LA | Iberville | 150 | L | | | 0.5 |
| LA | Jackson | 100 | | M | | 0.75 |
| LA | Jefferson | 150 | L | | | 0.5 |
| LA | Jefferson Davis | 150 | L | | | 0.5 |
| LA | Lafayette | 150 | L | | | 0.5 |
| LA | Lafourche | 150 | L | | | 0.5 |
| LA | Lasalle | 100 | L | | | 0.75 |
| LA | Lincoln | 100 | | M | | 0.75 |
| LA | Livingston | 150 | L | | | 0.5 |
| LA | Madison | 100 | L | | | 0.75 |
| LA | Morehouse | 100 | | M | | 0.75 |
| LA | Natchitoches | 100 | | M | | 0.75 |
| LA | Orleans | 150 | L | | | 0.5 |
| LA | Ouachita | 100 | | M | | 0.75 |
| LA | Plaquemines | 150 | L | | | 0.5 |
| LA | Point Coupee | 125 | L | | | 0.5 |
| LA | Rapides | 100 | L | | | 0.5 |
| LA | Red River | 100 | | M | | 0.75 |
| LA | Richland | 100 | | M | | 0.75 |
| LA | Sabine | 100 | | M | | 0.75 |
| LA | St. Bernard | 150 | L | | | 0.5 |
| LA | St. Charles | 150 | L | | | 0.5 |
| LA | St. Helena | 125 | L | | | 0.5 |
| LA | St. James | 150 | L | | | 0. 5 |
| LA | St. John the Baptist | 150 | L | | | 0.5 |
| LA | St. Landry | 125 | L | | | 0.5 |
| LA | St. Martin, North | 150 | L | | | 0.5 |
| LA | St. Martin, South | 150 | L | | | 0.5 |
| LA | St. Mary | 150 | L | | | 0.5 |
| LA | St. Tammany | 150 | L | | | 0.5 |
| LA | Tangipahoa | 150 | L | | | 0.5 |
| LA | Tensas | 100 | L | | | 0.5 |
| LA | Terrebonne | 150 | L | | | 0.5 |
| LA | Union | 100 | | M | | 0.75 |
| LA | Vermillion | 150 | L | | | 0.5 |
| LA | Vernon | 100 | L | | | 0.5 |
| LA | Washington | 125 | L | | | 0.5 |

| State | Parish | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| LA | Webster | 100 | | M | | 0.75 |
| LA | West Baton Rouge | 150 | L | | | 0.5 |
| LA | West Carrol | 100 | | M | | 0.75 |
| LA | West Feliciana | 125 | L | | | 0.5 |
| LA | Winn | 100 | | M | | 0.75 |

Table 26: Load Districts by County – Mississippi

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| MS | Adams | 100 | L | | | 0.5 |
| MS | Amite | 110 | L | | | 0.5 |
| MS | Attala | 100 | L | | | 0.5 |
| MS | Benton | 100 | | M | | 1 |
| MS | Bolivar | 100 | | M | | 1 |
| MS | Calhoun | 100 | | M | | 1 |
| MS | Carrol | 100 | | M | | 1 |
| MS | Chickasaw | 100 | | M | | 1 |
| MS | Choctaw | 100 | | M | | 1 |
| MS | Claiborne | 100 | L | | | 0.5 |
| MS | Clay | 100 | | M | | 1 |
| MS | Coahoma | 100 | | M | | 1 |
| MS | Copiah | 100 | L | | | 0.5 |
| MS | Covington | 110 | L | | | 0.5 |
| MS | Desoto | 100 | | M | | 1 |
| MS | Franklin | 100 | L | | | 0.5 |
| MS | Grenada | 100 | | M | | 1 |
| MS | Hinds | 100 | L | | | 0.5 |
| MS | Holmes | 100 | | M | | 1 |
| MS | Humphreys | 100 | | M | | 1 |
| MS | Issaquena | 100 | L | | | 1 |
| MS | Jefferson | 100 | L | | | 0.5 |
| MS | Jefferson Davis | 110 | L | | | 0.5 |
| MS | Lafayette | 100 | | M | | 1 |
| MS | Lawrence | 110 | L | | | 0.5 |
| MS | Leake | 100 | L | | | 0.5 |
| MS | Leflore | 100 | | M | | 1 |
| MS | Lincoln | 110 | L | | | 0.5 |
| MS | Madison | 100 | L | | | 0.5 |
| MS | Marion | 110 | L | | | 0.5 |
| MS | Marshall | 100 | | M | | 1 |
| MS | Montgomery | 100 | | M | | 1 |
| MS | Neshoba | 100 | L | | | 0.5 |
| MS | Newton | 100 | L | | | 0.5 |

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| MS | Panola | 100 | | M | | 1 |
| MS | Pike | 110 | L | | | 0.5 |
| MS | Ponotoc | 100 | | M | | 1 |
| MS | Quitman | 100 | | M | | 1 |
| MS | Rankin | 100 | L | | | 0.5 |
| MS | Scott | 100 | L | | | 0.5 |
| MS | Sharkey | 100 | L | | | 0.75 |
| MS | Simpson | 100 | L | | | 0.5 |
| MS | Smith | 110 | L | | | 0.5 |
| MS | Sunflower | 100 | | M | | 1 |
| MS | Tallahatchie | 100 | | M | | 1 |
| MS | Tate | 100 | | M | | 1 |
| MS | Tippah | 100 | | M | | 1 |
| MS | Tunica | 100 | | M | | 1 |
| MS | Union | 100 | | M | | 1 |
| MS | Walthall | 110 | L | | | 0.5 |
| MS | Warren | 100 | L | | | 0.5 |
| MS | Washington | 100 | | M | | 1 |
| MS | Webster | 100 | | M | | 1 |
| MS | Wilkinson | 110 | L | | | 0.5 |
| MS | Winston | 100 | L | | | 0.5 |
| MS | Yalobusha | 100 | | M | | 1 |
| MS | Yazoo | 100 | L | | | 0.75 |

Table 27: Load Districts by County – Texas

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| TX | Angelina | 100 | | M | | 0.75 |
| TX | Brazos | 100 | | M | | 0.75 |
| TX | Burleson | 100 | | M | | 0.5 |
| TX | Chambers | 150 | L | | | 0.5 |
| TX | Galveston | 150 | L | | | 0.5 |
| TX | Grimes | 100 | | M | | 0.75 |
| TX | Hardin | 125 | L | | | 0.5 |
| TX | Harris | 125 | L | | | 0.5 |
| TX | Houston | 100 | | M | | 0.75 |
| TX | Jasper | 125 | | M | | 0.5 |
| TX | Jefferson | 150 | L | | | 0.5 |
| TX | Leon | 100 | | M | | 0.75 |
| TX | Liberty | 125 | L | | | 0.5 |
| TX | Limestone | 100 | | M | | 0.75 |
| TX | Madison | 100 | | M | | 0.75 |
| TX | Montgomery | 110 | | M | | 0.5 |
| TX | Nacoqdoches | 100 | | M | | 0.75 |
| TX | Newton | 125 | | M | | 0.5 |
| TX | Orange | 150 | L | | | 0.5 |

| State | County | Extreme Wind mph | NESC District | | | Concurrent Ice & Wind Case Ice Thickness inches |
|---|---|---|---|---|---|---|
| | | | Light | Medium | Heavy | |
| TX | Polk | 110 | | M | | 0.75 |
| TX | Robertson | 100 | | M | | 0.75 |
| TX | Sabine | 100 | | M | | 0.75 |
| TX | San Augustine | 100 | | M | | 0.75 |
| TX | San Jacinto | 100 | | M | | 0.75 |
| TX | Trinity | 100 | | M | | 0.75 |
| TX | Tyler | 110 | | M | | 0.75 |
| TX | Walker | 100 | | M | | 0.75 |
| TX | Waller | 110 | L | | | 0.5 |
| TX | Washington | 100 | L | | | 0.5 |

## 6.2 **Load Combinations**

All substation equipment support structures shall be designed using the load cases in Section 7 and using the provisions and load combinations of ASCE 113. Wire- supporting structures shall be additionally be designed per the National Electric Safety Code (NESC), Construction Grade B.

## 6.3 Structural Analysis

Computer aided analysis and design shall include secondary moments from non-linear effects (p-delta) for structure stresses. Analysis procedures shall be based on the applicable design document (AISC 360 for steel structural shapes, ASCE 48 for tubular steel structures, ACI 318 for concrete structures, ASCE 10 for lattice structures, the Aluminum Design Manual for aluminum structures, etc.).

## 6.4 Equipment Support Structure Design

Transmission line dead ends shall be located outside the substation, with a slack span inside the substation.

Structural supports for bus work, switches, and all other equipment shall be designed in compliance with ASCE MOP 113, and IEEE 605.

All substation structures, except dead-end structures, shall be designed and constructed using hot-rolled, structural steel square, rectangular, or tapered polygonal tubes. The dead-end structures shall be designed using tapered tubular polygonal shapes.

Per ASCE 113, polygonal tube structures shall be designed in accordance with ASCE 48. Per ASCE 113, structures designed with other structural shapes shall be designed in accordance with AISC 360.

## 6.5 **Structure Deflection**

For deflection Load Combinations, the deflection extreme wind shall not be determined by using a reduced return period per ASCE 113, Table 3-14. For the Ice with Wind load Combination, the deflection ice thickness shall not be determined by reducing the ice thickness per ASCE 113, Table 3-15.

Structure deflections shall be checked for loading combinations with all load factors equal to 1.1.

The calculated deflections shall not exceed the values listed below.

Wire-Supporting Structures and Shield Poles

Horizontal deflection of vertical members: 1/100 of height

Horizontal deflection of horizontal members: 1/200 of span

Vertical deflection of horizontal members: 1/200 of span

All other Equipment Support Structures

Horizontal deflection of vertical members: 1/200 of height

Horizontal deflection of horizontal members: 1/300 of span

Vertical deflection of horizontal members: 1/300 of span

# 7 CONTROL HOUSE STRUCTURAL DESIGN

The control house shall be designed using the applicable building code as required by the Authority Having Jurisdiction (AHJ). If no AHJ oversight is required, the International Building Code 2015 edition shall be used for design.

Design, fabrication, and erection of structural steel shall meet the requirements of the IBC, AISC Steel Construction Manual (AISC specification and AISC code of standard practice). Structural design shall comply with seismic design and detailing requirements of the IBC, ASCE 7, and AISC 341. It is preferred to have an Engineered/prefabricated and delivered to site precast concrete building. Steel, concrete, and CMU buildings are all acceptable options.

## 7.1 Design Loads

Design Loads shall be determined in accordance with IBC assuming a Risk Category III.

Roof dead load: Weight of built-up roof, roof joists, insulation, structural members, permanent equipment, cable tray fully loaded with cables, lighting, and any other items supported by the roof.

Floor dead load: Weight of AC/DC panels, control/relay panels, batteries, cable termination cabinets, and other electrical equipment supported on the floor.

Roof live load: 40 psf (minimum)

Snow load: Per the applicable building code. 10 psf ground snow load minimum.

Floor live load: 250 psf or a 1,300-pound load concentrated in any 2½ square foot area.

Wind load: Per the applicable building code. 120 mph (minimum)

Seismic: Per the applicable building code.

### 7.2 **Fall Protection**

Building shall be constructed to include permanent anchorage points to accommodate personal fall protection systems capable of supporting 5,000 pounds per worker (OSHA defined impact load). For elevated houses, permanent anchorage points shall additionally be included on the walls of the control house adjacent to each exterior door to accommodate personal fall protection systems for use when working on the platform. All anchorage points shall be shown on roof drawings and marked on control house if not easily visible.

### 7.3 Roof

The roof shall have a minimum slope of ¼" in 12"; designed and constructed as specified by the IBC. Control house shall have a freestanding roof with no interior vertical supports to support the roof ridge beam.

### 7.4 Cable Tray

Cable tray and other suspended items shall be adequately supported to resist applied loads including, but not limited to, dead load, cable pulling loads, and seismic loads.

The cable tray shall be capable of carrying a uniformly distributed load of 75 lbs/ft in addition to the weight of the cable tray with a safety factor of 2.0 when supported as a simple span.

# 8 FOUNDATIONS

Foundation design will incorporate the soil capacity determined from the geotechnical study. Foundation design shall conform to ACI 318 and County and State Codes.

Drilled Pier/Shaft and Slab-type foundations shall be used. Alternative foundation systems may be considered if agreed upon between Buyer and Seller.

Ground supported pieces of equipment, such as circuit breakers and transformers, shall be supported by cast-in-place reinforced concrete slabs unless otherwise indicated by the geotechnical report.

Transformers shall be positively anchored to supporting foundations.

Foundations for the equipment support structures (bus supports, switches, etc.) and transmission line dead end structures shall be cast-in-place reinforced concrete drilled piers or spread footings, whichever is appropriate based on the subsurface soil information, unless otherwise indicated by the geotechnical report. Anchor bolts for all structures shall be of sufficient length to allow for the use of leveling nuts. The use of grout between the structure base plate and the top of the structure foundation is not required.

The control house foundation shall be piers or concrete slab. A cable routing and pulling area will be designed to facilitate connection with the conduit or pre-cast concrete cable trench entry from the substation and shall be located beneath the termination cabinet(s).

Foundation designs shall be in accordance with the following general minimum criteria:

a) Concrete Strength fc = 4,500 psi at 28 days

b) Grout Auger Cast Piling fc = 5,000 psi at 28 days

c) Reinforcing Steel (ASTM A615 Gr 60) fy = 60,000 psi

d) Foundation Loads

Structures From structure design calculations

Equipment From equipment manufacturer shop drawings or product literature

Importance Factor

Structures/Foundations - 1.0 for non-essential facilities

Safety factors (foundation reactions shall be service loads)

Shallow Foundations – Bearing Capacity 3.0

Shallow Foundations – Stability (Overturning, Sliding, and Uplift) 1.5

Drilled Piers Not less than 1.5, preferably 2.0

In general, foundations shall extend below the final grade as required by local or state code and the recommendations in the geotechnical report. The geotechnical report shall clearly state the safety factors needed for each site.

## 8.1 **Foundation Deflection and Rotation**

Deflection and rotation of drilled pier foundations shall be limited to 0.5 inch of deflection (vertical and horizontal) and 0.5 degrees of rotation due to unfactored (service) loads.

## 8.2 Materials

Structural steel shapes, plates, and appurtenances for general use shall conform to ASTM A992 or ASTM A572 grade 50 (wide-flange shape and ASTM A36 (other shapes)). Steel pipes shall conform to ASTM A53 grade B. Structural tubing shall conform to ASTM A500 grade B. Primary connection bolts shall conform to ASTM A325, type 1 or ASTM A490, type 1 with ASTM A194 grade 2H heavy hex nuts and steel washers conforming to ASTM F436 or Compressible-Washer-Type Direct Tension Indicators conforming to ASTM F959. Connection plates shall be ASTM A36 or ASTM A572 grade 50 steel. Steel components for metal wall panels, roof decking, and cold-formed girts and purlins shall conform to the North American specification for design of cold-formed steel structural members (AISI-S100).

Welded connections shall be made with welding electrodes with a minimum tensile strength of 70 ksi. Bolted connections shall be made with minimum 5/8 inch diameter ASTM F3125 Grade A325 high strength bolts, and shall typically be fully pre-tensioned Type N connections with threads included in the shear plane, unless noted otherwise. Connections subject to significant stress reversals or as otherwise required by the AISC shall be designed as slip-critical connections.

Welding procedures and qualifications for welders shall be in accordance with AWS D1.1 structural steel welding code and AWS D1.3 sheet steel welding code. Welding electrodes shall be as specified by AWS.

Preparation of metal surfaces for coating systems shall follow the specifications and standard practices of the SSPC, NACE, and the specific instructions of the coatings manufacturer. All structural steel for exterior use shall be hot dip galvanized steel per ASTM A123 and ASTM 153, unless noted otherwise. All structural bolts shall be galvanized, unless noted otherwise. Steel assemblies shall be safeguarded against embrittlement and warping during hot dip galvanizing per ASTM A143 and ASTM A384. Repair of damaged and uncoated areas of hot-dip galvanized steel shall be per ASTM A780.

## 8.3 Record documents

Seller shall provide buyer with structure and foundation detail drawings and supporting calculations. The drawings shall note all loading criteria used in the design. Foundation details shall note the structure base reactions used in the design. Drawings shall contain appropriate information (e.g. dimensions, materials, weld data, etc.) to allow reanalysis of the structure under future loading conditions.

# 9 FENCE & SIGNAGE

All substations shall have a fence at least eight feet high (seven-foot fabric and one foot of barbed wire). Fences shall consist of chain link fabric, with 3 strands of barbed wire on 45 degree extension arms, with

no ground gaps greater than two (2) inches and secure. All steel, including pipe, roll-formed sections, and fittings to be first quality, full weight, "hot-dipped galvanized" as per ASTM-F1234 or ASTM-F1083. The fence fabric shall be aluminum coated steel according to ASTM-A491. Safe step and touch potential of the perimeter fence shall be verified by an IEEE 80 compliant grounding study.

## 9.1 Gates

Drive gates shall be equipped with heavy duty drop bars, drop bar keepers, stops, and flip-over latches (as required) to be locked by standard Entergy lock. Hinges shall be heavy duty and shall allow gates to swing either in, or out, or in and out of all gate leaves.

Gates shall be operational from both sides of gate. Gates shall clear finished grade by not more than 3". Gate locking mechanism shall be installed with 3/8" diameter case hardened bolts. The nuts on the bolts shall be incapable of being removed, either by using lock nuts, splitting the end of the bolts or by welding the nuts on the bolts.

The Collector Substation shall have one motor operated sliding gate and and additional non-motor operated sliding gate or one man gate.

Features of the motor operated sliding gates shall include the following:

- Sliding gate shall be four (4') greater than width of entrance road
- An electric gate operator (Lift Master Elite or newer equivalent or better), including associated items
- A hard-wired continuous power connection (if available)
- A hard-wired keypad gate opener (not wireless) located at the gated entrance (exterior side of the PV Project Site fence)
- A pedestal mount, conduits, and wiring at the gated entrance
- A hard-wired push-button gate opener located at the gated exit (interior side of the PV Project Site fence; exit ground loop not required
- A pedestal mount, conduits, and wiring for the gated exit
- Sliding gate shall be grounded
- Additional security requirements are found in Section 12.

## 9.2 Signage

A "Danger – High Voltage – Keep Away" sign shall be placed on the exterior of the fence at a maximum spacing of 50 ft. The signs shall be visible and readable from any angle the substation fence can be approached.

# 10 SUBSTATION PHYSICAL DESIGN CRITERIA

## 10.1 **Substation Bus System**

### 10.1.1 Bus Systems

The bus system consists of the bus conductor, bus insulators and supporting structures, and jumper conductors to equipment and lines. The bus system shall be designed to meet the voltage and continuous current rating requirement, as well as the mechanical requirements for bus design strength and deflection for all cases and conditions.

Rigid Bus structures shall be designed per IEEE Standard 605, IEEE Standard 1427 and in compliance with the NESC. The bus work must be designed to withstand all required weather conditions appropriate for the location of the station and withstand all forces due to maximum fault current.

Bus dampening shall be accounted for during detailed design and be between 10% and 33% of the bus conductor weight.

### 10.1.2 **Bus Configuration**

The layout of the bus design shall minimize the crossing of bus sections and equipment by lines and other station buses. This is to reduce or eliminate possible common mode failures and to permit service work to be performed without having to take additional busses or equipment out of service.

The design shall be of the low-profile type using rigid bus in a horizontal (flat) configuration on vertically mounted station post insulators.

Hookstick-operated disconnect switches shall be provided on both sides of all feeder breakers.

If so directed, the bus configurations of the substation facilities shall take into account future expansion. The physical layout shall be made so that expansion can be accomplished with the least amount of outage time when required.

### 10.1.3 **Bus Fittings**

Bus fittings used for rigid bus connections shall consist of welded connectors.

Fittings used for stranded conductor shall consist of either bolted, compression or welded types. For incoming lines to the substation DE structure, the use of quadrant clamps is acceptable. In applications where connection to a line surge arrester is required, the use of bolted connectors is preferred to compression connectors due to the potential chance of incorrect installation and bird caging effect on the incoming conductor. If using compression fittings for the incoming transmission line span, the compression tee and dead-end fittings shall have NEMA 4-hole or 6 hole terminal pads for connection of conductor jumpers.

Fittings used for conductor jumpers shall be of the bolted, compression, or welded type to a bolted pad. Jumpers shall be designed so that they can be unbolted and removed from equipment for maintenance, repair, or replacement.

## 10.2 **Station Layout**

The collection system shall be identified and marked. This includes all the phases on pad mount transformers, as well as any time the system transitions from underground to over ground or vice versa. An acceptable method of identification is stickers.

## 10.3 **Phase Orientation**

The phasing orientation of the substation shall be A-B-C when facing the low side transformer bushing left to right. If the phasing is different for the interconnecting utility, notation shall be added to the drawings detailing the phase rotation. Additionally, all equipment and busses shall be labeled.

## 10.4 Grounding System

High voltage equipment and structures will be connected to a ground grid. All metallic equipment, structures, and fencing will be conducted to the grounding grid of buried conductors and ground rods, as required for personnel safety.

## 10.5 Grounding Design Criteria

Grounding system shall be design using field resistivity values obtained from geotechnical studies. Substation ground grid design shall be based upon IEEE Std. 80 and NESC. Parameters to be used in the design, such as fault current magnitude and duration, will come from various studies, such as the Facility Study and other interconnection studies, and relay and protection system evaluation. Seller shall use fault current split factor calculations that consider OHGW, OPGW and feeder neutral grounding, in order to lower the effective ground fault current. The substation ground grid shall be connected to the overheard transmission line shield wires unless specifically isolated due to other engineering considerations. Clearing time for grounding analysis shall not be shorter than the total time for backup relay operation plus breaker time.

The ground grid analysis shall seek to optimize the cost and complexity of the installation. Multiple design iterations shall be developed, considering varying depths of substation rock, grounding conductor size, grid spacing, ground rod depth, etc., until an optimized, lowest-cost design is achieved.

Grounding analysis shall address seasonal conditions as appropriate, such as seasonally dry soil conditions or frozen earth conditions. The ground grid shall be designed to account for the most-restrictive weather condition.

The grounding system shall be modeled using the SES CDEGS grounding analysis software or equivalent.

## 10.6 Grounding System Components

### 10.6.1 Soil Structure:

Grounding analysis software shall be used to determine the number of soil layers present based on field test results input. The soil model results are considered usable if the resultant soil model accurately reflects the measured data.

The original soil model shall be adjusted to minimize the RMS error.

### 10.6.2 Ground Grid:

Ground grid conductor shall be optimized for cost, considering the fault current magnitude and other parameters. Copper clad steel should be considered where appropriate, but soil corrosivity shall be considered when evaluating the use of copper clad steel.

The ground grid shall be installed at a minimum depth of eighteen (18) inches below finished grade (i.e. grade not including any rock cover).

Ground grid shall extend to cover the swing access for all man and vehicle gate access points as well as any pad mount transformers and other medium or low voltage station service equipment located close to the substation fence. Recommended to go 3ft beyond the fence or overall equipment/gate offset.

### 10.6.3 Grounding Rods

The standard ground rod shall be 10-foot-long and made of 5/8-inch diameter copper-clad steel rod. It is acceptable for longer lengths to be made by joining multiple rods together with ground rod couplers. Longer ground rods shall be considered before more costly methods (such as ground wells) are implemented.

Ground rods shall be installed at applicable ground grid locations or at locations dictated by design. Applicable locations include substation perimeter, dead-end structures, lightning masts, surge arrestors, control house corners, etc.

### 10.6.4 **Grounding Connections**

All underground ground grid cable-to-cable and cable-to-ground rod connections shall be made with exothermic connections (Cadweld or equivalent). All above ground grounding connections shall be made with mechanical, bolted, or compression connections.

### 10.6.5 Above Grade Grounding Provisions

The perimeter fence shall be connected to the substation ground grid at each gate post, every corner and along the fence at intervals dictated by design. Grounding of the fence shall also include grounding provisions for the fence fabric and barbed wire.

All four corners of the control house shall be connected to the substation ground grid.

Two grounding conductors shall be installed the entire length of all pre-cast concrete cable trench greater than 36 inches wide. For pre-cast concrete cable trench less than 36 inches wide a single grounding conductor shall be installed. These conductors shall provide a convenient access to the substation ground and shall provide some shielding of control cables from electrostatic interference. They shall be connected to the ground grid at all main grid crossings and sized to match the ground grid conductor size.

Personnel safety mats (galvanized steel grating) shall be installed on top of the crushed rock surfacing at each disconnect switch operator, manual or motor-operated gang switches, and each personnel entrance to the control enclosure if metal steps are used. Safety mats shall be bonded to the station ground system in accordance with IEEE 80.

Equipment and structure grounds, or "stingers," consisting of bare conductors shall connect each piece of the substation equipment and steel structure to the ground grid. The minimum conductor size shall be calculated but never be smaller than the ground grid conductor size. There will be two (2) ground connections to each structure and piece of equipment.

Ground studs shall be installed on every breaker bushing pad. Provisions for portable safety ground installations, either bus ≤ 3-inch diameter, ground studs, or grounding stirrups, shall be included at both sides of all disconnect switches. Grounding studs shall be placed such that there is no interference from other equipment (for example, disconnect switch blades).

### 10.6.6 Crushed Rock

The site will be covered with a layer of crushed rock as defined in Section 5.10.1.8. The crushed rock shall be installed throughout the entire substation area and extend 5 feet beyond the fence and swing radius of the gates.

Resistivity tests shall be performed on potential material sources early in the design phase, and those results shall be integrated into the overall grounding system design. The IFC grounding design shall use material with a known, tested resistivity; no assumptions should be made as to the availability of rock of a certain resistivity.

### 10.6.7 Grounding Drawings

The design input from the grounding calculation shall be recorded on the grounding drawing in a concise table. The table shall include all pertinent information, including, but not limited to, final design grid resistivity, depth of crushed rock, rock resistivity, length of ground rods, size of grounding conductor, soil parameters, design fault current, and fault duration. Additionally, it shall be included a field on the grounding drawing for the contractor to record the final fall of potential test results.

## 10.7 Conduit System

All conduit and raceway systems shall comply with NEC and NESC requirements. The conduit and raceway system design shall accommodate power and control cables, communication circuits, underground feeders, and optical fiber cables.

### 10.7.1 Conduits

Low voltage cables used for protection and control or station power shall be placed in conduit wherever they connect to oil immersed equipment to reduce the risk of burning oil flowing in raceways and causing severe damage to cables. All conduit systems including wiring size shall be detailed on drawings.

Conduit shall be schedule 40 or greater PVC for below grade or above grade applications. Flexible conduit may be used for transitions where necessary. Galvanized steel conduits shall not be used in below-grade applications. Conduits shall be sized in accordance with the National Electrical Code (NFPA-70). Where applicable, 2" and 4" conduits shall be used.

Designs shall incorporate one spare conduit per transformer (main GSU) and circuit breakers 138 kV and above.

All below-grade conduits shall be buried to a minimum depth of twenty-four (24) inches below the finished grade (approximately six inches below the ground grid).The conduit system for the 34.5 kV collector cables shall extend 10 feet beyond the fence and shall be concrete-encased. Additional coordination shall be made with collector system designer.

### 10.7.2 Cable Trench

For substations and collector facilities that have more than one main GSU transformer, precast concrete trench systems shall be installed. It shall be identified early in detailed design if the current project will ever be expanded with second or third phase. If additional phases are planned, the initial layout shall be designed such that adding new cable trench can be implemented while minimizing impact to existing facilities.

Precast concrete trench with a pedestrian strength rating shall be specified for the substation yard raceway system. HS-20 rated road crossing cable trench shall be used for all vehicle crossing locations. Each vehicle crossing location will be marked with high visibility bollards extending at minimum three (3) feet above the ground and visible during winter snow conditions. Applications for the use of a barrier internal to the cable trench or multiple trench systems may be utilized where required.

Conduits shall be provided between the concrete trench system and yard mounted equipment

On two transformer stations or an integrated ring bus switchyard, a partial cable trench system is normally required, and provisions shall be provided in detailed design.

### 10.7.3 Pullboxes

Cables entering the control house from the substation yard shall be routed through a pre-cast cable vault and pulling area into the control house termination cabinet.

### 10.7.4 Cable Entry and Trays

All conduit and cable entry openings into the control house shall be tightly sealed as a barrier to animals to keep out moisture and to minimize heat loss. Cables entering the control house shall be terminated at the appropriate termination cabinet or AC or DC panel board.

Inside the control house overhead cable tray suspended from the ceiling shall be used to route cables between the termination cabinet, control and relay panels, and other equipment.

## 10.8 Lightning System

The substation direct lightning stroke shielding design shall be performed in accordance with IEEE Standard 998-2012 "IEEE Guide for Direct Lightning Stroke Shielding of Substations" using the "electro-geometrical model" or the "rolling sphere technique". For small stations it is acceptable to use the fixed angle method as a means for determining proper shield protection locations.

After the substation layout is completed, the direct stroke shielding shall be analyzed to verify that the equipment within the substation fence is adequately protected. The transmission line static wires shall be connected to the substation ground grid.

The following criteria shall be used for the lightning shielding design:

- Station BIL, Table 2.
- Lightning stroke density shall be that for the project area as reported by the Fault Analysis and Lightning Location System
- A design failure rate of less than one shielding failure in one hundred (100) years.

The shielding design shall utilize a combination of shield wires, shielding masts and/or mast poles. Shield wires over substation buses shall be arranged such that there is no more than a single bus between shield wire supporting structures.

All static wires from the transmission lines shall terminate into the station lightning shielding system.

### 10.8.1 **Lighting System**

The primary purpose of substation lighting is to provide sufficient illumination for personnel safety and emergency equipment maintenance. The substation shall be provided sufficient illumination during the night for safe passage of the maintenance crew who might be performing equipment inspection or maintenance. Outdoor lighting is often also intended to deter vandalism; however excessive illumination may attract vandals or result in complaints from the surrounding community. Lighting is also used in

certain areas to deter birds from roosting and/or nesting. Yellow color lighting such as sodium vapor does not attract as many bugs, flying bats and birds that in turn attract snakes and climbing animals.

Proper placement of lighting is important. Placement of lighting shall consider the collection of insects on adjacent energized equipment. Large quantities of these bugs can attract animals and increase risk of animal outage.

At least minimum illumination levels recommended by National Electrical Safety Code C2 shall be provided in generating stations and substations. Illumination levels relevant to substations are as follows:

a) Emergency exit path: 1 foot-candle (11 lux)

b) Control house (occupied): 15 foot-candles (165 lux)

c) Control house (unoccupied): 5 foot-candles (55 lux)

d) Front of switchboards and panels: 15 to 25 foot-candles (165 to 275 lux)

e) Fence: 0.2 foot-candles (2.2 lux)

f) Substation general horizontal: 2 foot-candles (22 lux)

g) Substation vertical (on disconnects etc.) 2 foot-candles (22 lux)

h) Roadway: 0.5 foot-candles (5.5 lux)

i) Open yard: 0.2 foot-candles (2.2 lux)

The need for detailed lighting design for each substation shall be individually evaluated

depending upon the substation's location, site area, type of buswork structures, and the equipment installed in it. LED light fixtures shall be installed for all new installations. The following is required as a minimum for typical substation lighting:

a) The entrance gate into the substation shall be provided with a motion-activated photocell-controlled light.

b) The substation control house entry doors shall be provided with motion activated photocell-controlled lights.

c) The substation shall have switched, photocell-controlled lights, preferably with a timer, for safe passage. The control switch shall be in the control house.

d) A sufficient number of GFCI outlets shall be provided in the substation near the equipment e.g. circuit breakers and power transformers for portable light hookup for night time repairs and maintenance. GFCI outlets provided in the equipment control cabinets shall be used for this function.

## 10.9 **Substation Security/Safety (CODE)**

Substation Security shall not apply for substations below 161 kV. However, depending of project interconnection area, additional requirements may exist due to other evolving cyber security concerns. Check with Buyer - Transmission Planning for site specific concerns.

## 10.10 Animal Deterrents

Means for animal deterrent and mitigation shall be provided in all medium voltage substations, and the MV section of all high voltage substations.

IEEE Std 1264 provides guidance in methods and designs to mitigate animal intrusion and resulting interruptions and equipment damage.

Animal mitigation shall be achieved by applying substation insulators that have a large enough flashover distance to prevent bridging by animals, such as snakes and squirrels, by increasing phase spacing and by providing guards and covers for insulators or adding barriers between phases to prevent phase to phase bridging by birds. Guards and covers shall be installed on all MV equipment bushings listed below regardless of the spacing.

Insulating covers shall be installed on all medium voltage equipment bushings as follows:

a) Power transformers

b) Station service transformers

c) Voltage regulators

d) Circuit breakers and reclosers

e) Surge arresters

f) Capacitors

g) Instrument current and voltage transformers

h) UG cable terminations

i) MV switches and jumpers

Insulators in substations where higher BIL bus and disconnect insulators cannot be applied shall be protected by suitable guards and covers.

MV substation equipment including 34.5 kV equipment shall be provided with guards and covers and each phase shall be covered for a distance of three (3) feet, unless otherwise specified during the

constructability review. The center phase shall be fully covered. Depending upon location and known animal intrusion problems, additional mitigation may be required.

## 10.11 **Substation Protection & Control Design Criteria**

### 10.11.1 **Protection and Control Requirements**

The protective relaying shall:

a) Preserve the integrity of the Entergy transmission system by being dependable and secure to the appropriate level of required reliability as specified by Entergy Transmission Planning.

b) Properly coordinate and function with other Entergy relay schemes, and neighboring utilities.

### 10.11.2 Backup and Transfer Trip

Breaker Failure Backup and/or transfer trip circuits to interface with other stations shall always be provided.

### 10.11.3 **Transmission Line Protection**

Transmission line protective relay equipment at the collector substation shall be provided to meet the requirements of Buyer - Transmission (as the host utility).

HV transmission lines shall have a dual primary line protection scheme comprising of dual primary communication assisted tripping relaying scheme. Each primary protection scheme shall utilize separate instrument current transformers, or separate current transformer cores of a free-standing current transformer, separate CVT or PT secondary windings, and separated dc and ac supplies from a common distribution panel. Breaker Control is typically on the same line panel.

### 10.11.4 **Bus Protection**

HV and MV bus shall use single low or high impedance protection scheme. Low impedance is preferred. If using high impedance protection, all of the current transformers in the circuit shall have the same ratio and must be tapped at the full ratio.

### 10.11.5 **Transformer Protection**

Each power transformer shall be protected by a minimum of one and, preferably, two differential relaying schemes. The transformer differential relay shall be connected to the transformer high side bushing current transformers. Low-side circuit breaker or transformer bushing current transformers shall be positioned to provide a sufficient area of overlap between adjacent protective zones. Protection zones shall be created to prevent through-bus interruption for transformer differential operation.

Back up time overcurrent transformer overload relaying shall be provided.

Generator Step-up Transformers shall be purchased and supplied with the following integral monitoring devices:

a) Oil level gauge on tank wall or conservator.

b) Pressure relief device(s). The pressure relief device is used for alarms. Transformer tanks containing more than 10,000 gallons of oil shall be provided with two pressure relief devices mounted on diagonally opposite corners of the transformer tank. The device(s) shall be located remote from the control cabinet(s),. Pressure relief value shall be stamped on the device.

Sudden pressure rise relays. Transformers are specified to have two sudden pressure relays used to trip the transformer when both relays have operated. A sudden pressure or Bucholtz relay (Device 63) shall be provided, including seal-in contacts in an enclosure with a threaded conduit hub and "loss of DC indication"

Gas accumulation detecting relay (conservator tank units). Contacts of the gas accumulation detecting relay are used for alarm.

c) Temperature monitoring system to indicate top oil and winding temperatures.

Seller shall design the system so as not to trip and isolate transformers due to the operation of pressure relief devices, high oil temperature, and high winding temperatures. Main power transformers shall be tripped and isolated when the oil level in the transformer tank falls below the critical level to prevent internal flashovers. GSUs or main power transformers shall have critical oil level as an alarming feature only and no tripping.

### 10.11.6 **Capacitor Bank Protection**

See IEEE Std C37.99 Guide for Protection of Shunt Capacitor Banks for detailed guidance on the capacitor bank protection schemes. Seller shall employ Unbalance Detection scheme for the protection of the capacitor bank. The aim of this scheme is to trip the capacitor bank if there are unbalances in the phases that result in voltages 110% or more across the individual capacitor unit.

### 10.11.7 **Shunt Reactor Protection**

See IEEE Std C37.109 for guidance on the protection of shunt reactors. Studies shall be conducted to determine if snubbers are required for reactor switching. Surge arresters are recommended for all reactor applications.

### 10.11.8 HV Breaker Control

Gas insulated circuit breakers are specified to be equipped with two or more stages of gas pressure/density monitoring contacts.

a) Contact of the first stage closes on falling pressure at approximately 10% loss of pressure, and

b) Contact of the second stage closes on falling pressure at a further 10% reduction of gas pressure.

Most manufacturers comply with these requirements except that the first stage and second stage contacts may not necessarily close at 10% loss of pressure for all makes and models of the circuit breakers.

A circuit breaker retains its full electrical and mechanical rating at this second stage pressure/density of gas in the circuit breaker. However, the circuit breaker manufacturer will not guarantee any rating below this pressure and, accordingly, the circuit breaker operation shall be disabled below this pressure.

The manufacturers of circuit breakers generally do not offer any specific recommendations for the circuit breaker's continued operation when the second stage contacts of the gas density monitor close. It will be the responsibility of Buyer to determine whether a circuit breaker should be tripped (if it was already closed) or block any close/open operation under these conditions.

Since the system security, substation importance, and the circuit breaker applications within the substation vary throughout the system, a common system wide approach on whether to trip or block operation of all circuit breakers cannot be specified.

The following is a recommended plan of action, keeping in mind that the circuit breaker retains full rated values at the second alarm stage, and it is capable of withstanding normal system voltage with the gas in the interrupters at atmospheric pressure. Under ideal conditions and with a standard 0.5% gas leakage rate it would take more than five years for any alarm stage to be generated for most breakers. A second stage alarm usually signifies a rapid loss of gas.

The circuit breaker control scheme shall address the loss of gas alarms as follows:

1. First Stage Alarm: Effort shall be made to investigate the cause within eight hours (or the next day at the latest).

2. Second Stage Alarm received within one day of receiving the first stage alarm: In locations where the system continuity can be maintained (ring bus, or breaker and half bus substations) the circuit breaker shall be tripped immediately. If the system continuity cannot be maintained, then the circuit breaker operation shall be blocked. In substations with a single bus the circuit breaker operation shall be blocked. It may be necessary to include timers in the relay scheme to achieve this requirement. This should be evaluated during detail design.

3. Second stage alarm received more than one day after receiving the first stage alarm: Block circuit breaker operation

All HV Breaker Control relays shall include LOR (lockout relays).

### 10.11.9 HV Motor Operated Switch Control

When HV motor operated switches (MOS) are used, if a control building is used, it is preferred that the MOS controls be located on the applicable line protection, transformer protection, or breaker control panel.
If no control house is required, the panel design must be modified to fit in a suitable NEMA type 4X stainless steel outdoor enclosure.

### 10.11.10 **MV Collection Feeder Protection**

Primary feeder protection will be provided by an SEL-351S or similar relay at each feeder breaker. Instantaneous and time overcurrent phase and residual ground are typical elements to protect the feeder section. Additional voltage and frequency elements will be enabled to ensure compliance with NERC reliability requirements (e.g., PRC 019, 024, and 026, if applicable).

Breaker failure initiate will be enabled to ensure coordination with MV bus and transformer differential if a breaker fail occurs.

## 10.12 **Relay Calculations and Setting Requirements**

For relay settings, refer to TE-SD-AD-007 (Relay Settings Procedure) and PM1804 (Transmission Line Relay Setting Criteria, Design and Operation Guide) for guidance. Relay settings shall meet the requirements of NERC Reliability Standards PRC-019, -023, -024, -025, and -026, as applicable.

Typical Relay Engineering Calculations:

- Battery Bank Sizing & Design: IEEE-485 & NEC – Article 480.
- Battery Charger Sizing: EPRI Stationary Battery Guide (Design, Application, and Maintenance)
- DC Load Center Sizing: Requires building DC loading table (Watts / Amps) for yard and enclosure (panel) equipment – Nameplate information and/or equipment manuals required.
- AC Load Center Sizing: Requires building AC loading table (Watts / Amps) for yard and enclosure (panel) equipment – Nameplate information and/or equipment manuals required.
- Station Service Sizing
- Voltage Drop Calculations (Use as Guide only): NEC: 215.2(A)(4)
- Conductor Ampacity Calculations (Use as Guide only): NEC Table(s) 310.15 (Engineer to select correct table for use)
- Grounding Methods for Electrical Supply: NESC Sec. 9
- Size of Equipment Grounding Conductors (Use as a Guide only): NEC Sec. 250.122 and Table 250.122.
- Cable in Conduit Fill Calculations: NEC Tables 310.15(B)(2)(a) & 310.15(B)(3)(a), Chapter 9, Table 1, Table 4
- Cable Tray Fill Calculations: NEC 392.22, Table 392.22(A).

# 11 CONTROL HOUSE

The control house shall be designed to comply with the latest version of the IBC, and with local building code requirements. See Section 5.9. It is preferred to have an Engineered/prefabricated and delivered to site precast concrete building. Steel, concrete and CMU buildings are all acceptable options.

The control enclosure shall contain Vendor-provided station services such as primary and backup AC supply disconnects, an automatic AC transfer switch, AC Load Centers, DC power system and storage battery, and air conditioning units.

The Vendor shall be capable of meeting any state-specific certification and/or inspection requirements.

The control enclosure shall be suitable for placement upon both concrete slab and concrete pier foundation types. An indication of design loads for both foundation types shall be supplied with the Vendor's engineering documentation.

All Vendor-supplied equipment within the control enclosure shall use equipment enclosures conformant to at least the NEMA 1 specification. External equipment shall be appropriately rated and weatherproofed for exterior installation.
The control enclosure shall contain space for equipment including:
a) Control enclosure shall be sized to account for all necessary equipment in the station ultimate configuration. No more than sixteen 27-inch, free-standing relaying and control panels in a single row. All cable access to the panels will be from a cable tray system above the panels.
b) One wall-mounted termination cabinet having dimensions of up to 72" x 90" x 24".
c) Communications equipment including fiber-optic, telecommunications, and related interfacing gear.
d) Separated control room is required to all projects.
e) The control enclosure shall have a minimum internal ceiling height of 10'-0" to allow for adequate equipment clearance below the cable tray.
Wall space shall be left open to the greatest extent practical. Conduit and raceway provided by Vendor for building services and included equipment shall be placed at or near the ceiling with vertical service drops. Horizontal raceways and conduits between adjacent equipment such as load centers are acceptable.
The control enclosure shall include one eye-wash system with two saline cartridges when there isn't water brought to the site.

## 11.1 DC System

One (1) VLA 125 VDC battery system shall be provided along with (2) 130 VDC battery chargers. The batteries and chargers shall be size in accordance of IEEE 485 and considering substation ultimate configuration (if any). The calculation shall consider worst case tripping scenario along with dual trip coil operation. A single charger shall be able to fully charge a completed battery within eight to twelve hours while supplying normal loads.

Dual DC Load Centers shall be provided within the control house. DC load centers shall be designed with enough circuit positions for the substation's ultimate configuration. Each DC load center shall be rated

125 VDC and shall have a main circuit breaker. The DC load centers breaker position and total circuits requirement shall be dictated by final approved DC Calculation considering ultimate substation configuration. DC load centers shall be dead-front design, installed on the control enclosure wall, and provided with conduit access to the cable tray.

Battery chargers shall not have an alarm on/off switch. Each battery charger installed in the station shall alarm on zero current output. Dual charger setups shall be wired for parallel operation. When properly set up each charger shall share half of the battery bank charging current.

Battery banks shall be located in a separate room of the control house. There shall be enough space so field personnel can reach each cell and battery terminals for testing and maintenance. A minimum of 24 inches height separation between battery racks is needed to accomplish this.

Battery DC grounds shall be monitored via indicating lights on the front panel of the battery charger and indication of a DC ground shall be an input to the station RTU. Battery voltage shall be an input to the station RTU.

## 11.2 AC System

The substation will be equipped with normal and backup AC station service sources supplying 120/240 VAC, 3 wire, single phase power. Station service is preferred to be provided by low- side SSVT, local distribution, or on-site generator in that order. The design shall include two (2) fused disconnect switches for the incoming feeds (secondary feed of the SSVT and emergency feed). The system neutral must be bonded to ground in one and only one of the fused disconnects. These two disconnects shall both be in the control building. The normal station power source also needs to have a fused disconnect switch below the station service transformer. The fuses shall be Type LPN.

Also, the unprotected conductors between the normal or backup station service transformers and the first disconnect cannot be routed in the same conduit with feeders or branch circuits.

There shall be specified an automatic transfer switch (ATS) with microprocessor control. The ATS shall be equipped with alarms for loss of normal service and loss of backup service. The ATS shall be capable of managing a standby generator on the backup source. The ATS shall have neutral bonding provisions.

There shall be specified AC load centers with enough circuit positions for the substation's ultimate configuration. Each AC Load Center shall be 120/240 VAC, three-wire, single phase, having a 100% rated, main breaker. The final AC load center breaker position and total circuits shall be dictated by final approved AC Calculation considering ultimate substation configuration. AC Load Centers shall be dead-front design, installed on the control building wall, and provided with conduit or wireway access to the cable tray for use by Others. The load centers shall use a commonly available circuit breaker type.

## 11.3 Metering Requirements

The metering panel shall be designed and constructed as specified in GIA or project planning phases.

Multi-conductor cables no smaller than #10 AWG shall be used to connect the instrument transformer secondary windings to the meter location. Under no circumstances shall CT cables contain splices. Larger conductor size may be required depending on the location of instrument transformers in relation to the meters. Seller shall perform burden calculations to determine appropriate conductor size.

Conductor used for grounding the metering instrument transformer tank shall be the same size as that used for the ground grid and in no case be smaller than #4/0 AWG.

Metering CTs and PTs shall be 0.15B1.8 sized so that tapping down is not required and 3% extended range TR=2 respectively.

All meters shall conform to ANSI Standards C12.20, C12.1, and C12.10. Acceptable meters are Landis and Gyr E850 MAXsys Elite, SEL-734 or SEL-735.

## 11.4 SCADA

A Remote Terminal Unit (RTU) and/or gateway device shall be specified, and installed to provide supervisory control, status indication, alarm monitoring, and to gather accumulated and instantaneous data to be telemetered to Entergy Distribution Operations Center (DOC), Transmission Center (TCC) and Entergy Local Balancing Authority (LBA). The RTU shall comply with all GIA requirements.

While all substations require a TCC / DOC RTU to be present, some existing substations host a "dual-port" RTU design in which data is provided to a TCC and LBA SCADA host. Confirmation of existing substation RTU-SCADA host configuration shall be done by contacting the IT-OT EMCS SCADA teams and/or IT-OT Substation Services. Substations that serve as a generation interconnection or system tie boundary with another utility may also require a dual-port RTU-SCADA host configuration.

Relay Design Personnel shall perform the following activities per TMM TE-SD-AD-006;

RTU/Communication Processor Configuration and Edit Sheet Procedure.

a) Obtain Initial baseline TOC RTU Edit Sheet from IT OP- Tech Personnel of what the SCADA Host has programmed to date of the request, or latest revision if there are revisions being documented.

b) Provide SOC and/or GMS personnel needed information for them to provide new updated SOC and/or GMS edit sheets.

c) Issue final approved TCC, SOC, and/or GMS edit sheets with relay design package.

## 11.5 **Communications**

The communications media (pilot wire, fiber optic cable, power line carrier or digital microwave) required, and the communications system for supervisory control, telemetering and equipment status indication will generally be known at the project initiation stage. Note that Entergy will usually consider digital

microwave as adequate communication media. This will vary depending of the interconnection substation communication capabilities and GIA requirements.

Designers of communication circuits shall consider redundant, dual-purpose paths.

A telephone is required to facilitate voice receipt of switching orders, emergency services, and restoration of service during outages.

For fiber optic cable facilities, two conduits from the substation fence to the fiber optic cable terminal board in the control building shall be furnished and installed. The fiber optic cable between the fence and the terminal board shall be installed in conduit(s).

Multiplexers used for fiber-optic interface for digital relay communications schemes system protection shall be hardened per IEEE Std 1613; Standard Environmental and Testing Requirements for Communications Networking Devices Installed in Electric Power Substations, and compatible with IEEE Std C37.94; Standard for N Times 64 Kilobit Per Second Optical Fiber Interfaces Between Teleprotection and Multiplexer Equipment.

## 11.6 Digital Fault Recorder (DFR)

If project requires DFR, TESLA 4000 or similar DFR may be used. This shall include enough current and voltage inputs as per project design.

## 11.7 Low Voltage Cable (Wiring)

The following is a partial list of the requirements for station power, instrumentation and control cabling within the substation.

- The voltage drop for all control cables shall be verified not to exceed 10%.
- All current carrying control cables shall be sized based on the anticipated maximum load currents. Factors that shall be considered to determine the adequate cable size are conductor material, ambient conditions, cable insulation, cable stranding, proximity of parallel current carrying cables and whether the cables are in conduit, in a cable tray or suspended in the air.
- All low voltage power, instrumentation and control cables within the substation shall be insulated for a 600 volt rating.
- Coaxial and instrumentation cable shall be fully shielded both inside and outside the control house.
- All other control cables inside the control house are not required to be shielded.
- Shielded cables shall be required in 345 kV yards and above (CT, Trip and Control Circuits) and in 69 kV and above capacitor banks (grounded and ungrounded). All control and low voltage power cables outside the control house shall have a longitudinally corrugated copper tape shield.
- Returns for power, currents, potentials, controls, analogs and others shall be within the same cable.
- Cable shields and unused conductors are not required to be terminated or grounded for cables within the control house. For shielded field cables, the shield shall be terminated at one end, preferably within the termination cabinet, and unused conductors shall be left ungrounded. The termination cabinet ground bar shall be sized to accommodate shield grounding.

- Analog connections shall be made with 2 pair #18 AWG instrumentation cable, communication connections shall use shielded 4/C #18 AWG control cable, and status point connections shall use shielded 8/C #18 AWG control cable when new cables are required.
- Power line carrier signals shall be shielded via a shielded coaxial type cable.
- Splicing of cables is not permitted.

# 12 PHYSICAL AND ELECTRONIC SECURITY

Refer to IEEE Std. 1402 Guide for Electric Power Substation Physical and Electronic Security for guidance in providing physical and electronic security for the substation. Additional security design elements may be required by NERC Critical Infrastructure Protection (CIP) standards.

The following NERC CIP standards provide mandatory security requirements:

a) CIP-002; Cyber Security-BES Cyber System Categorization

b) CIP-005; Cyber Security-Electronic security Perimeter(s)

c) CIP-006; Cyber Security-Physical Security of BES Cyber Systems

d) CIP-014; Physical Security

Critical Substations are designated as Critical or CODE. CODE substations include the Critical Asset and infrastructure but also the larger assets which if destroyed, damaged degraded or otherwise rendered unavailable would have a significant impact on the Bulk Electric System (BES) affecting its stability or ability to transport large loads or would have a detrimental impact on the reliability or operability of the electric grid or would cause significant risk to the public health and safety.

NERC standard CIP-014-1 provides the following criteria for critical designation:

a) All 500 kV substations

b) Substations operating at 200 kV to 499 kV with an aggregate weight exceeding 3000 per table below

c) Substations operating at 200 kV and above and connected to three or more substations with an aggregate weight exceeding 3000 per table below:

| Voltage of Line | Weight Value per Line |
|---|---|
| 200 kV to 299 KV | 700 |
| 300 kV to 499 kV | 1300 |

In general, all 500 kV substations, all substations with four 230 kV lines or all substations with three 230 kV and several 161 kV or lower transmission lines may be considered as CODE. The criteria noted above

are the minimum threshold for CODE designation. A substation may also be designated CODE as necessary per the unique risks that justify.

Substations that are designated as Critical or Deemed Essential (CODE) assets require additional physical and electronic security from physical and electronic intrusion, vandalism as required by NERC CIP-002, -005, and -006.

Additional requirements may exist due to other evolving cyber security concerns. Check with Transmission Planning for site specific concerns.

Minimum security requirements are defined in the following able:

| Location | Description | Equipment by Seller | Equipment by Buyer |
|---|---|---|---|
| Collector Substation | Minimum two cameras located at opposite corners of substation area | Wiring (power and communications) and required hardware supports | Cameras |
| | Electrically operated slide gate with keycard reader | Keypad, slide gate, gate operator, wiring (power and communications), grounding loop, exit button and hardware for mounting keycard reader | Keycard reader |
| Collector Substation Control House | Keycard reader for lock on control house personnel door | Keypad, wiring (power and communications), and required hardware supports for mounting keycard reader | Keycard reader |

# 13 DELIVERABLES

In addition to any submittals and deliverables defined in the contract documents, in accordance with NERC reliability standards, Seller shall provide the following documentation to Buyer thirty (30) days prior to initial synchronization of the Project, along with any other documentation reasonably requested by Buyer or required by NERC:

- BAL-005 – One-line diagram that displays the Electrical Interconnection Point (and includes unique line identifiers/names ensuring that the Project Site and Buyer - Transmission use the same naming convention when referring to the PV Plant (e.g., breakers, lines, etc.) by Seller
- COM-002 – Network diagram of voice and data links by Seller
- FAC-008 – Identification of most limiting equipment factor based on application of Generator Buyers Facility Rating Methodology by Seller
- MOD-032 – Data for Power System and Analysis, as applicable, by Seller.

- VAR-002 - Transformer information, including the following, as applicable, by Seller and Buyer (or its Affiliate), and as obtained by Seller from the Approved Vendor of the GSU:

    - Tap Settings
    - Available fixed tap ranges
    - Impedance data
    - The + / - voltage range with step-change in % for load-tap changing transformers.

ATTACHMENT 1: APPROVED MANUFACTURERS LIST FOR COLLECTOR SUBSTATION*

*Attachment 1 to Appendix 1 (Collector Substation) of this Scope Book provides an Approved Manufacturers List. The Approved Manufacturers List in this Attachment 1 is in addition to the Approved Manufacturers and EPC Contractor List in Appendix 9 of the Scope Book.

## Attachment 1: Approved Manufacturers List

| Purchase Spec. | Class | **Description** | Qualifier | Approved Manufacturer(s) - (Preferred) | Preferred Supplier | Type | Notes |
|---|---|---|---|---|---|---|---|
| SA0102 | Arresters | Arrester, Surge | | (Cooper), Siemens, ABB | Cooper | Substation | |
| PM0201 | Battery | Batteries & Battery Racks | | (Enersys) | Nolan Power | Relay | 125VDC 58 Cell EC-XM/CC-XM only |
| PM0301 | Battery | Battery Charger | | (Hindel) | Nolan Power | Relay | AT-10 Models |
| PM0303 | Battery | Battery Charger Rack | | (Enersys) | Nolan Power | Relay | |
| | Bolts | Bolts Anchor | | Valmont, Distran, Threaded Fasteners | | Substation | |
| | Bolts | Anchor bolt cage for foundations | | Valmont, Distran, Threaded Fasteners-w/size limit | | Substation | |
| SD0203 | Breaker | Breaker, EHV | 500 & 345kV (Live Tank) | (MEPPI), ABB | MEPPI | Substation | |
| SD0203 | Breaker | Breaker, EHV | 500 & 345kV (Dead Tank) | (MEPPI), ABB | MEPPI | Substation | |
| SD0202 | Breaker | Breaker, HV, IPO | 245kV - 145kV | (Siemens), ABB, MEPPI | Siemens | Substation | Per Entergy review |
| SD0202 | Breaker | Breaker, HV | 245kV - 72.5kV | (Siemens), ABB, MEPPI | Siemens | Substation | See table below |
| SD0201 | Breaker | Breaker, MV | 27kV - 15kV | (ABB), MEPPI | ABB | Substation | |
| SD0201 | Breaker | Breaker, MV | 34.5 kV | (ABB) | ABB | Substation | |
| SB0101 | Bus | Bus, Aluminum Pipe | | (Williams Metals), AFL | (W illiams Metals) | Substation | |
| PB0401 | Cable, Control | Control Cable - Shielded and Non-Shielded | | (Southwire), Priority | Southwire | Relay | ICEA Method 1 for color coding |
| SA0301 | Capacitor Bank | Capacitor Banks, Shunt | | (Cooper), GE, ABB | Cooper-Eaton | Substation | |
| | Capswitcher | Capswitcher | 170kV - 72.5kV | (Southern States) | Preferred Sales | Substation | |
| | Carrier Relays | Power line Carrier | UPLC | Pulsar-Ametek | Ametek | Relay | |
| PN0201 | CCVT | CCVT | 500kV - 69kV | (GE-Alstom), Trench, ABB | Crescent Power | Relay | Polymer only. Trench required when Line |

| Purchase Spec. | Class | **Description** | Qualifier | Approved Manufacturer(s) - (Preferred) | Preferred Supplier | Type | Notes |
|---|---|---|---|---|---|---|---|
| | | | | | | | trap to be mounted on CCVT. |
| SD1801 | Circuit Switcher | Circuit Switcher | Series 2000 | (S&C) | Curtis Stout | Substation | |
| | Conductor | Cable, Aluminum | ACSS, ACSR | (General Cable), Southwire | Aertker Co. | Substation | |
| | Conductor | Copper (Not Control cable) | | Copperweld/Alcoa | Stuart Irby | Substation | Grounding conductor |
| | Conductor | Cable, Fiber | OPT-GW | AFL | Preferred Sales | T-Line | |
| | Conductor | Cable, Fiber | ADSS | AFL | Preferred Sales | T-Line | |
| | Conduit | Conduit & Accessories | | Cantex, Carlon | Stuart Irby | Substation | |
| | Connector | Connectors, T-Line | ACCR | AFL / 3M | Preferred Sales | T-Line | |
| | Connector | Connectors, T-Line | ACSS | AFL | Preferred Sales | | |
| | Connector | Connectors line (Fiber, OPGW, ACSR) | Fiber, OPGW, ACSR | AFL | Preferred Sales | T-Line | |
| | Connector | Connectors, T-Line | | Maclean Power Sys | Preferred Sales | T-Line | |
| | Connectors/ Fittings | Connectors/Fittings - Substation | | Anderson, AFL, Homac, Travis, Sefcor, Burndy | | Substation | |
| SL0403 | Control House | Control House | Drop-In (turnkey) | VFP | VFP | Relay | Concrete only. |
| SL0403 | Control House | Control House | | Modular Connections, VFP, Atkinson, Trachte, Oldcastle | | Substation | Concrete only. |
| PN0301 | CT | CT | Slipover only | ITEC, ABB, Meramac, Siemens | | Relay | |
| PN0301 | CT | CT | 34.5kV - 15kV | ABB, GE | | Relay | |
| PN0301 | CT | CT | 500kV - 69kV | (GE-Alstom), Trench, ABB | Cresent Power | Relay | Polymer only |
| | DFR | DFR (Digital Fault Recorder) | | MehtaTech | Louisiana, Mississippi, Arkansas only | Relay | |
| | DFR | DFR (Digital Fault Recorder) | | Qualitrol | Texas only | Relay | |
| | Fittings | Conductor Fittings Compression | | AFL, Secor, Anderson, Hubell | Stuart Irby | Substation | |
| | Grounds Rods Clamps | Ground Rods, Clamps | | Cadweld, Erico, Thermoweld | Stuart Irby | Substation | |
| TA0504 | Insulators | Insulator, Line, Toughened Glass | | Sediver | | T-Line | |

| Purchase Spec. | Class | **Description** | Qualifier | Approved Manufacturer(s) - (Preferred) | Preferred Supplier | Type | Notes |
|---|---|---|---|---|---|---|---|
| TA0504 | Insulators | Insulator, Line, Polymer | (Polymer Insulator Only) | Maclean Power Sys | Preferred Sales | T-Line | |
| TA0504 | Insulators | Insulator, Line, Polymer | (Polymer Insulator Hardware Assembly) | Maclean Power Sys | Preferred Sales | T-Line | |
| SA0502 | Insulators | Insulator, Station Post, Porcelain | 500kV-69kV | (Seves), Victor, Lapp,NGK, Newell, Vanguard | | Substation | |
| SA0502 | Insulators | Insulator, Station Post, Polymer | 230kV-15kV | (Maclean Power Sys) | | Substation | |
| | Junction Box | Junction Boxes | | MMR, SEL, Custom Automated, Premier Control | | Relay | |
| | Meter | Meter & Cables | Elite Model | Landis+Gyr | | Relay | |
| CP Approved Panels Appendix S | Panel | Panel - Battery Switching | | SEL | Power Connections | Relay | |
| CP Approved Panels Appendix S | Panel | Panel - AC & DC Stand Alone | | Peterson Electric Panel | Peterson | Relay | No AC/DC Combo Panel permitted |
| PM3507 | Panel | Panel - Autoxfmr Differential | | MMR, SEL, Custom Automated, Premier Control | | Relay | |
| PM3505 | Panel | Panel - Power xfmr Differential | | MMR, SEL, Custom Automated, Premier Control | | Relay | |
| PM0501 | Panel | Panel - Breaker Control | | MMR, SEL, Custom Automated, Premier Control | | Relay | |
| PM0602 | Panel | Panel - Bus Differential | | MMR, SEL, Custom Automated, Premier Control | | Relay | |
| PM1803 | Panel | Panel - Line, Line/Breaker | | MMR, SEL, Custom Automated, Premier Control | | Relay | |
| MI0200 | Panel | Panel - Meter | | MMR, SEL, Custom Automated, Premier Control | | Relay | |
| | Poles | Pole Caissons | | (Valmont) | Preferred Sales | T-Line | |
| TC0609 | Poles | Pole, Concrete | | (Valmont) | Preferred Sales | T-Line | |
| TC0608 | Poles | Pole, Steel | | (Valmont) | Preferred Sales | T-Line | |
| PN0701 | PT | PT | 34.5kV and below | ABB, GE, Trench | | Relay | |
| PN0701 | PT | PT | 230kV - 69kV | GE-Alstom, Trench, (ABB) | | Relay | Polymer only |

| Purchase Spec. | Class | **Description** | Qualifier | Approved Manufacturer(s) - (Preferred) | Preferred Supplier | Type | Notes |
|---|---|---|---|---|---|---|---|
| SN0903 | Reactor | Reactor, Dry Type Shunt | Below 230kV | Alstom Grid, Coil Innovations, Trench | | Substation | |
| SN0902 | Reactor | Reactor, Current Limiting | | Alstom Grid, Coil Innovations, Trench | | Substation | |
| SN0904 | Reactor | Reactor, Oil filled Shunt | 230kV, 500kV | ABB, Alstom Grid, Mitsubishi, Siemens, SMIT | | Substation | |
| SN1002 | Regulators | Regulator | | Pennsylvania Transformers | Curtis Stout | Substation | |
| | Relay | Protective Relays & associated accessories | | SEL | Power Connections | Relay | |
| | RTU | | Accessories & Cables | (ACS), GE Grid Solutions | Ruffin & Associates | Relay | |
| PM3002 | RTU | RTU | SEL RTAC | SEL | Power Connections | Relay | |
| SL1301 | Signs | Signs - Entergy Substation Switchyard Placard w/Address | | Impco | Impco | Substation | This is the substation name and address sign on the front fence. |
| SL1301 | Signs | Signs - General | | Stuart Irby | Stuart Irby | Substation | |
| SC0401, SL0505 | Structure | Steel | Substation, Tubular / Tapered | (Distran), Valmont | Distran | Substation | |
| SC0401, SL0505 | Structure | Steel | Substation, Lattice | (Distran), Industrial Steel | Distran | Substation | |
| SC0401, SL0505 | Structure | Steel Standard and Tapered Tubular | Substation, pre-existing designs w/details | (Distran), Valmont | Distran | Substation | |
| PM3401 | Switch | ATS (Automatic Transfer Switch) | | ASCO | Utility and Industrial Supply LLC, WESCO | Relay | |
| | Switch | Switch, T-Line | Switch group operated 245kV and below | SEECO | Southern Utility Sales Agency | T- Line | |
| SD1502 | Switch | Switch, Disconnect | 500 & 345kV | (Southern States), Pascor Atlantic | Preferred Sales | Substation | |
| SD1501 | Switch | Switch, Disconnect | 230kV - 69kV | (Southern States), USCO, Pascor Atlantic | Preferred Sales | Substation | |
| SD0601 | Switch | Switch, Disconnect | 34.5kV - 15kV | (Southern States), USCO | Preferred Sales | Substation | |
| SD0701 | Switch | Switch, Disconnect, Hookstick | 34.5kV - 15kV | (Southern States), USCO | Preferred Sales | Substation | |
| | Switch | Switch, Fuse (SMD style) | 34.5kV - 15kV | (S&C) | Curtis Stout | Substation | |

| Purchase Spec. | Class | **Description** | Qualifier | Approved Manufacturer(s) - (Preferred) | Preferred Supplier | Type | Notes |
|---|---|---|---|---|---|---|---|
| SD1601 | Switch/Motor Operators | Motor Operator | Southern States | (Southern States) | Preferred Sales | Substation | For Southern States switches |
| SN1101 | Transformer | SSVT; Station Service Voltage Transformer | 230kV - 69kV | Alstom Grid, ABB | | Substation | Polymer only |
| SN0103, SN0104 | Transformer | Transformer, Auto | 230kV and Above 100MVA | ABB, HICO, MEPPI, Siemens, SMIT, SPX-Waukesha Electric | | Substation | See chart below |
| SN0102 | Transformer | Transformer, Small Auto | below 230kV and 100MVA | (SPX-Waukesha Electric ), ABB, HICO, Howard | Aertker Co. | Substation | See chart below |
| SN0801 | Transformer | Power Transformers | 230kV and below | (SPX-Waukesha Electric ), ABB, HICO | Aertker Co. | | See chart below |
| PM0802 | Trap | Trap, Line Carrier | | Trench (No other supplier approved) | Curtis Stout | Relay | See CCVT note above |
| | Trench | Trench (Cable Trench) | | (Concast), Trenway, Old Castle | GHMR | Substation | |
| PM0804 | Tuner | Tuner, Line Carrier | | Trench | Curtis Stout | Relay | |
| | Xfmr Firewall | | | | | | |

| ENTERGY APPROVED SUBSTATION TRANSFORMER SUPPLIERS | | | | | |
|---|---|---|---|---|---|
| TWO-WINDING & AUTO-TRANSFORMERS RATED < 100MVA (3-phase) and HV ≤ 230kV | | | | | |
| Production Facility & Location | Currently qualifying or already qualified | Maximum ratings approved by Entergy | | Capabilities reported by facility | |
| | | MVA (3ø) | KV | MVA (3ø) | KV |
| ABB / Crystal Springs, MS USA | Qualified | 50 (MS) | 161 (MS) | ~60 (MS) | 161 (MS) |
| Delta Star / Lynchburg, VA | Qualified | 60 | 230 | ~200 | 230 |
| HICO-Memphis | Qualified | 1000 | 230 | 1000 | 230 |
| Waukesha Electric (SPX), Goldsboro, NC & Waukesha, WI USA | Qualified | 80 (NC), 100 (WI) | 230 (NC), 230 (WI) | ~80 (NC), 800 (WI) | 230 (NC), 345 (WI) |

| AUTO-TRANSFORMERS RATED ≥ 100MVA (3-phase) or HV > 230kV | | | | | |
|---|---|---|---|---|---|
| **Production Facility & Location** | Currently qualifying or already qualified | **Maximum ratings approved** by Entergy | | **Capabilities reported** by facility | |
| | | MVA (3ø) | KV | MVA (3ø) | KV |
| ABB / Varennes, Quebec, Canada; Guarulhos, Brazil; Cordoba, Spain | Qualified | 1000 (Can), 500 (Br), 800 (Sp) | 500 (Can), 500 (Br), 500 (Sp) | 1200 (Can), 600 (Br), 800 (Sp) | 765 (Can), 765 (Br), 500 (Sp) |
| HICO-Memphis | Qualified | 1000 | 765 | 1000 | 765 |
| Mitsubishi / Ako, Japan | Qualified | ~1000 | 500 | ~1500 | 1000+ |
| Siemens / Linz & Weiz, Austria; Nuremburg, Germany; Jundiai, Brazil; Bogota, Colombia | Qualified | 1000 (Aus, Ger), 750 (Br), 200 (Col) | 500 (Aus, Ger, Br), 230 (Col) | 2000 (Aus), 1100 (Ger), | 765 (Aus), 1000+ (Ger), 765 (Br), 345 (Col) |

| | | | | | |
|---|---|---|---|---|---|
| | | | | 1000 (Br), 250 (Col) | |
| SMIT / Nijmegen, Netherlands | Qualified | ~800 | 500 | ~1200 | 500 |
| Waukesha Electric (SPX), Waukesha, WI USA | Qualified | 400 | 345 | ~800 | 345 |

| ENTERGY APPROVED HV CIRCUIT BREAKER MODEL NUMBERS | | | | | | |
|---|---|---|---|---|---|---|
| Voltage | **Continuous** Current (A) | **Interrupting Rating (A)** | Siemens Breaker to be ordered | **CT Ratio and** Accuracy | **CT Quantity** | |
| 230 KV | 3000 | 50KA | SPS2-245-50-3000 | 3000:5 C800 | 3 per bushing | |
| | 3000 | 63KA | SPS2-245-63-3000(reference) | 3000:5 C1200 | 3 per bushing | non-standard |
| 161 KV | 3000 | 40KA | SPS2-170-40-3000 | 3000:5 C800 | 3 per bushing | |
| | 3000 | 63KA | SPS2-170-63-3000(reference) | 3000:5 C1200 | 3 per bushing | non-standard |
| 138 KV | 3000 | 40KA | SPS2-145-40-3000 | 3000:5 C800 | 2 per bushing | |
| | 3000 | 63KA | SPS2-145-63-3000(reference) | 3000:5 C1200 | 2 per bushing | non-standard |
| 115 KV | 3000 | 40KA | SPS2-145-40-3000 | 3000:5 C800 | 2 per bushing | |
| | 3000 | 63KA | SPS2-145-63-3000(reference) | 3000:5 C1200 | 2 per bushing | non-standard |
| 69 KV | 3000 | 40KA | SPS2-72.5-40-3000 | 3000:5 C800 | 2 per bushing | |
| | 3000 | 63KA | SPS2-145-63-3000(reference) | 3000:5 C1200 | 2 per bushing | non-standard |

ATTACHMENT 2: SITE ENVIRONMENTAL CHARACTERISTICS

The Project Site environmental data that Seller shall use for the design of the Collector Substation shall have been determined prior to bid submission. The minimum required Project Site environmental data to be included is shown in Table 2-1 below. This Table 2-1 shall have been completed by Seller and included with the bid. Additional pertinent criteria shall be provided as needed.

**Table 2-1. Project Site Environmental Characteristics**

| Description | Data (Units) |
|---|---|
| Elevation (substation) | |
| Contamination Level (light, medium, heavy, extra heavy) * | |
| Average Annual Temperature | |
| Average High Temperature | |
| Extreme High Temperature | |
| Average Low Temperature | |
| Extreme Low Temperature | |
| Average Annual Precipitation | |
| Maximum 24-hour Rainfall | |
| Maximum 1-hour Rainfall | |
| Maximum 24-hour Snowfall | |
| Ground Snow Load | |
| Design Ice Load | |
| Design Wind Speed | |
| Isokeraunic Level | |
| Seismic Referenced Code | |
| Mapped Spectral Response Acceleration at Short Period (0.2-Second) $S_S$ | |
| Mapped Spectral Response Acceleration at 1-Second Period $S_1$ | |
| Site Class | |
| Seismic Design Category | |

***All equipment external bushing creepage distance shall be based on this criterion. If not available, medium (35mm/kV) shall be used. This factor is applied to nominal line to ground voltage.**

***** END OF APPENDIX 1**

# Appendices 2-12 to
# BESS Scope Book

Revision 0

DATE: 10/31/2023

REVISION RECORD

| Revision No. | Approval Date | Section / Page Revised | Reason / Description of Change |
|---|---|---|---|
| 0 | 10/31/23 | All | Initial Issue |
| | | | |
| | | | |
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| | | | |
| | | | |
| | | | |

# BESS BOT SCOPE BOOK APPENDICES

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## 11.0 APPENDIX 2

Table 1: Buyer Supplied Project Specific Information

The following information shall be provided and filled out by BUYER / End User for each specific project.

| Item | Description | Notes: |
|---|---|---|
| Project Name | Entergy | |
| Project location (lat/long) | | |
| Expected COD | 2Q2026 | |
| Power @ BESS [MW] | 7.7 | Nameplate capacity |
| Project Nameplate Capacity (MWh) | 30.8 | |
| Power @ POI [MW] | 7.7 | |
| Duration [hrs] | 4 | |
| Interconnection Voltage | 24.5 | |
| Power Factor | +/- 0.95 | |
| Required Energy type | | |
| Project Life (years) | 20 | |
| Design Life (years) | 20 | |
| Maximum Inactive Period | | |
| Primary Application Type | | |
| Operation days/year | | |
| Cycles/day | | |
| Resting time before discharging (after fully charged) | | |
| Operation day/year | | |
| Secondary Application Type | | |
| Operation days/year | | |
| Cycles/day | | |
| Resting time before discharging (after fully charged) | | |
| Operation day/year | | |

| Item | Description | Notes: |
|---|---|---|
| Tertiary Application Type | | |
| Operation days/year | | |
| Cycles/day | | |
| Resting time before discharging (after fully charged) | | |
| Operation day/year | | |
| Quaternary Application Type | | |
| Operation days/year | | |
| Cycles/day | | |
| Resting time before discharging (after fully charged) | | |
| Operation day/year | | |
| Power/Energy Measuring point | | |
| Performance Warranty Period | | |
| Minimum defective warranty period for all components | | |
| Required Availability | | |
| Required Round Trip Efficiency (RTE) (BESS System) | | Seller to provide breakdown of RTE for all components |
| BESS Programming language | | |

## 12.0 APPENDIX 3: SELLER SUPPLIED PROJECT SPECIFIC INFORMATION

The following information shall be provided and filled out by the SELLER for each specific project.

Table 1:

| Item | Description | Notes |
|---|---|---|
| Ambient Temperature requirement at project site [degrees F] | | |
| Record minimum recorded temperature [degrees F] | | |
| Record maximum recorded temperature [degrees F] | | |
| Elevation [feet] | | |
| Augmentation Strategy to provided separate | | |
| Including Aux Consumption in the Battery Sizing [kW] | | |
| Total Land Use Requirements for design life of the project [acres] | | |
| Installation type: container, building, pack | | |
| Maximum Peak (Design Minimum Ambient Temperature) [degrees F] | | |
| Minimum Peak (Design Maximum Ambient Temperature) [degrees F] | | |
| Humidity [%] | | |
| Maximum relative humidity at 40degrees [%] | | |
| Pollution Level | | |
| Dust Storms | | |
| Ice Loading, Radial Thickness | | |
| Floodzone | | |
| 100 year / 24hour rainfall event [inches] | | |
| Design rainfall event [inches] | | |
| Seismic Loading (Seismic Requirement) | | |
| Rated Discharge Power – ESS [kW] | | |



Note 1: Value to be tested per ESIC Energy Storage Test Manual Sections 6.1.1 through 6.1.5.

Note 2: Seller to provide Degradation Curve model to display BESS System degradation prediction based on Use Case and Augmentation Plan.

| Item | Description | Notes |
|---|---|---|
| Rated Charge Power – ESS [kW] | | |
| Rated Reactive Power – ESS[kVar] | | |
| Rated Apparent Power – ESS[KVA] | | |
| Capability Curve | Attachment | |
| Voltage Tolerance [%] | | |
| Available Discharge Energy – ESS [kW] | | |
| Recommended Discharge Energy – BOL [kW] | | |
| Degradation Scale Until EOL [%] | | |
| Recommended Maximum State of Charge [%] | | |
| Recommended Minimum State of Charge [%]Average State of Charge [%] | | |
| Charge Duration [hour] | | |
| Recommended Charge Power [kW] | | |
| Roundtrip Efficiency - ESS AC to AC (RTEAC) [%] | | |
| Charge Ramp Rate [kW/h] | | |
| Discharge Ramp Rate[kW/h] | | |
| System Latency [seconds] | | |
| Self-Discharge Rate at 77 °F / 25 °C [kW/h] | | |
| Cycle Life Ratings | | |
| Specified Duty Cycle | | |
| Annual Degradation for Specified Duty Cycle | | |
| End of Life (EOL) Criteria | | |
| Overload Discharge Power [kW] | | |
| Overload Charge Power [kW] | | |
| Overload Reactive Power [kW] | | |
| Overload AC Current [kW] | | |
| Roundtrip Efficiency at Various Discharge Capacities-ESS AC to AC (RTEAC) [%] | | |



Note 1: Value to be tested per ESIC Energy Storage Test Manual Sections 6.1.1 through 6.1.5.

Note 2: Seller to provide Degradation Curve model to display BESS System degradation prediction based on Use Case and Augmentation Plan.

| Item | Description | Notes |
|---|---|---|
| *Response Time [seconds]* | **per use case* | |
| *Settling Time [seconds]* | **per use case* | |
| “Ready” State Energy Consumption [kW] | | |
| “Standby” State Energy Consumption [kW] | | |
| Auxiliary Power Provision [source] | | |
| Thermal Management System Type | | |
| Thermal System Capacity [Btu/hr] | | |
| “Sleep” State Energy Consumption [kW] | | |
| “OFF” State Energy Consumption [kW] | | |
| Auxiliary Power – Peak [kW] | | |
| Auxiliary Power – Continuous [kW] | | |
| Auxiliary Power Nominal Voltage [kW] | | |
| Thermal Tolerance Duration [hours] | | |
| Coolant Liquid Required (if Any) | | |
| ESS Operational Temperature Range [degrees F] | | |
| ESS Storage Temperature Range [degrees F] | | |
| ESS Operational Humidity Range [degrees F] | | |
| ESS Storage Humidity Range [degrees F] | | |
| Other Equipment Storage requirements | | |
| ESS Enclosure Rating | | |
| ESS Enclosure Coating Rating | | |
| Hazardous Location Classification | | |
| Dust, Rodent and Insect Barriers | | |
| Sound Emissions from Enclosure(s) [dB] | | |
| Warranty Period [years] | | |
| Performance Warranty Period | | |
| Defective Warranty Period | | |



Note 1: Value to be tested per ESIC Energy Storage Test Manual Sections 6.1.1 through 6.1.5.

Note 2: Seller to provide Degradation Curve model to display BESS System degradation prediction based on Use Case and Augmentation Plan.

| Item | Description | Notes |
|---|---|---|
| LTSA Option: | | |
| Expected System Availability | | |
| Expected battery refresh charge and discharge cycles per year | | |
| Expected Yearly Planned Down-Time for Maintenance | | |
| Expected Yearly Unplanned Down-Time of System for Repair | | |
| Expected Service Life before Major Replacement | | |
| Startup Time [seconds] | | |
| Wake Time [seconds] | | |
| Shutdown Time [seconds] | | |
| Control Power UPS Back-Up Time [hours] | | |
| Behavior when Main Power is Interrupted | | |
| Behavior when Main Power Returns | | |
| Behavior when Aux Power is Interrupted | | |
| System Behavior when Aux Power Recovers | | |
| Sleep Time [hours] | | |
| Long-Term Down-Time (Hibernation or Storage) [hours] | | |
| Hibernation Process | | |
| Expected filter replacement schedule [months] | | |
| MTBF [years] | | |
| System Power Factor Range [pu] | | |
| PT/CTs Requirements | | |
| Transformer Rating [kVA] | | |
| Transformer Specification | | |
| Transformer type | | |
| MV Protection Type | | |



Note 1: Value to be tested per ESIC Energy Storage Test Manual Sections 6.1.1 through 6.1.5.

Note 2: Seller to provide Degradation Curve model to display BESS System degradation prediction based on Use Case and Augmentation Plan.

| Item | Description | Notes |
|---|---|---|
| Output Voltage Range – ESS [kV] | | |
| Minimum DC Input Voltage [kV] | | |
| Maximum DC Input Voltage [kV] | | |
| Additional Interconnection Compliance Capability | | |
| Current THD [%] | | |
| Voltage THD [%] | | |
| DC Injection | | |
| Phase Imbalance Limits (IEEE 1547) | | |
| Voltage Unbalance Limits | | |
| Maximum AC short circuit current - ESS | | |
| Output Frequency Range [Hz] | | |
| Power Conversion System Switching Frequency | | |
| Withstand Voltage | | |
| Additional Power Quality Support Equipment | | |



Note 1: Value to be tested per ESIC Energy Storage Test Manual Sections 6.1.1 through 6.1.5.

Note 2: Seller to provide Degradation Curve model to display BESS System degradation prediction based on Use Case and Augmentation Plan.

# Appendix 4: Electrical System Studies

| **Electrical System Studies** | **Date to be provided** |
|---|---|
| Harmonic analysis of the proposed system. | |
| Minimum system requirements and configuration for proper operation of the BESS (i.e., requirements to stabilize a self-commutated power conversion system [PCS]). | |
| Minimum spacing requirements between equipment to maintain safe energization and maintenance conditions. | |
| Battery degradation and expected power output at end of life of the BESS. | |
| Charge and discharge curves of the project for potential tie into other renewable systems | |
| Requirements for Volt-Ampere Reactive (VAR) support, peak shaving, battery charging and other support services as described in this Technical Specification. | |
| Safety requirements for operation compliance with applicable codes and standards. | |

Appendix 5: Reserved

Appendix 6: Reserved

Appendix 7: Project Performance Test Procedures

[To be determined in project negotiations]

Appendix 8: Project Site Map

Insert conceptual layout drawing here

Appendix 9: Reserved

## Appendix 10: NERC Standards

| NERC Standard | Title | Deliverable | Due Date |
|---|---|---|---|
| CIP-002-5.1a | Cyber Security - BES Cyber System Categorization | 1)Provide real MW power capability of generator<br>2) Provide MVAR nameplate rating capability of generator | At FNTP |
| CIP-003-8 | Cyber Security — Security Management Controls | 1)Provide Physical Security Controls<br>2) Provide Electronic Access Controls<br>3) Provide Transient Cyber Assets and Removeable Media if required | 60 Days Prior to Substantial Completion |
| COM-001-3 | Communications | Documentation showing the interpersonal communications channels (phones, backup systems) exist and are functioning. | 30 Days Prior to Substantial Completion |
| FAC-002-2 | Facility Interconnection Studies | Evidence of the coordination/communication with the TO as port of GIA development | 120 Days Prior to Substantial Completion |
| FAC-008-5 | Facility Ratings | Facility Rating Report with supporting documentation supporting each equipment rating | 150 Days Prior to Substantial Completion |
| MOD-032-1 | Data for Power System Modeling and Analysis | Evidence that all required data has been provided. | 30 days prior to Substantial Completion<br><br>Final updates (if required) within 90 days of Post Substantial Completion |
| PRC-002-2 | Disturbance Monitoring and Reporting Requirements | Provide the required Dynamic Disturbance Recording equipment if required by the Generator Interconnection Agreement | 60 Days Prior to Substantial Completion |
| PRC-005-6 | Protection System, Automatic Reclosing, and Sudden Pressure Relaying Maintenance | 1) List of equipment that must be in the PSMP plan. Must include all facility equipment generation and substation. (Entergy uses a PRC-005 Component list).<br><br>2) Test reports or documentation that all listed equipment has been tested. | List of equipment and test documentation: 90 days prior to Substantial Completion |
| PRC-006-5<br>PRC-006-PRC-006-SERC-3 | Automatic Underfrequency Load Shedding | Attestation that no UFLS is included in facility design<br>OR<br>Specific documentation for under frequency/over frequency of protection and control devices included in the facility (including the control systems). | 90 Days Prior to Substantial Completion |
| PRC-012-2 | Remedial Action Schemes | Attestation that no RAS is included in facility design.<br>OR<br>Specific documentation for remedial action scheme settings of protection and control devices included in the facility (including the control systems). | 30 Days prior to Substantial Completion |
| PRC-017-1 | Remedial Action Scheme Maintenance and Testing | Attestation that no RAS is included in facility design.<br>OR<br>Specific documentation for remedial action scheme settings of protection and control devices included in the facility (including the control systems). | 30 Days prior to Substantial Completion |
| PRC-019-2 | Coordination of Generating Unit or Plant Capabilities, Voltage Regulating Controls, and Protection | Relay setting documentation and a specific report showing that all limiters operate before protection and control devices including the control systems and the protective system limits damage to equipment. | 90 Days Prior to Substantial Completion |

| NERC Standard | Title | Deliverable | Due Date |
|---|---|---|---|
| PRC-023-4 | Transmission Relay Loadability | Attestation that PRC-023-4 does not apply or evidence of compliance | 90 Days Prior to Substantial Completion |
| PRC-024-2 | Generator Frequency and Voltage Protective Relay Settings | Relay setting documentation and a specific report showing the frequency and voltage responsive relays and control function device comply with the setting requirements of PRC-024 by not tripping in the "No-Trip" zone. | 90 Days Prior to Substantial Completion |
| PRC-025-2 | Generator Relay Loadability | Relay setting documentation and a specific report showing the load responsive relays comply with the setting requirements of PRC-025. | 90 Days Prior to Substantial Completion |
| PRC-026-1 | Relay Performance During Stable Power Swings | Relay Setting Documentation and analysis showing the load responsive relays will not trip during power swings. | 90 Days Prior to Substantial Completion |
| PRC-027-1 | Coordination of Protection Systems for Performance During Faults | Complete package of relays setting documents including analysis to support review by Entergy Transmission. Documentation should include varication of electrical coordination for expected fault currents. | Should be provided before equipment is energized. |
| VAR-002-4.1 | Generator Operation for Maintaining Network Voltage Schedules | 1) Report showing facility design must include alarms for AVC mode off, PSS off, and out of voltage schedule.<br><br>2) Report showing pop-up notification in the HMI telling the operator that changing the AVR/controller from AVR to any other mode (PF, VAR control) MUST have documented/written approval from the TCC before changing modes. | 60 Days Prior to Substantial Completion |

## 13.0 APPENDIX 11: PROJECT CONTROLS

Our mutual goal is to have a safe construction environment in which we deliver a quality plant, on time, at the agreed upon cost, that can be safely, timely and efficiently operated for the next several decades by the Entergy Operating Company we are building it for. ***A key element of successful project delivery is having execution plans that clarify roles, responsibilities, and expectations for the various companies and persons managing the execution effort.*** It is presumed that Entergy is contracting with companies experienced in executing the work and that our partners already have their own set of plans. Entergy's execution team will then review our partners' plans to establish a confidence-level that the work will be executed safely, efficiently and to scope, and also offer suggestions based on lessons learned.

Entergy will not be providing templates of the required plans, because if we were to do so, we risk diminishing the ownership that a partner would have if the plan wasn't developed by their company with their own subject matter experts. However, the below guidelines may help provide context as to Entergy's minimum information expectations.

Entergy is not requiring its partners to rewrite or reformat their existing plans, we just want to confirm that our partners have established a methodical approach that serves as a roadmap for their internal management and their contractors to ensure successful project execution. Some plans might be stand-alone due to their complexity or importance, i.e. Environmental, Health and Safety or Quality plans, while other information may be embedded in an overall Project Execution Plan, as contemplated below.

**1. Health, Safety, and Environmental Plan**

*Purpose: Protocols to safeguard the health and safety of all persons who visit/work on the site, as well as environmental protections for the site, as well as adjacent landowners/public/communities.*

- Developer's and/or EPC's Corporate HS&E policy, setting forth minimum expectations and confirmation that all subcontractors' plans meet the minimum expectations
- Safety Programs
    - ✓ General Safety plan
    - ✓ Responsibilities of Contractors, Employees and Visitors
    - ✓ Subcontractor safety plans
    - ✓ Site specific safety protocols, including, but not limited to: drug testing, surveillance, on-site training/orientation, stop work authority, hazardous materials, LOTO-High Energy, emergency response, record retention, incident follow-up, commitment to action if a safety protocol and/or safeguard is violated, etc.
    - ✓ Reporting information: Timeline for reporting severe incidents between the contractors (sub to EPC to Developer) and to the Buyer, statistics information, incident investigations/lessons learned
    - ✓ Describe the steps that will be taken to educate and inform local law and EMS personnel about the site to increase their efficiency should their assistance be needed
- Extreme Weather / Hurricane Plan
    - ✓ Guidelines for protecting the workers and preparing the project site and loose materials for extreme weather i.e. hurricanes, tornadoes, freeze/ice-snow,

- ✓ Establishing management communication before, during and after severe weather events, and
- ✓ Assessing the site after an extreme weather event

- Environmental

  - ✓ Protection of the project land and biodiversity, as well as adjacent land/communities/public
  - ✓ Permitting: SWPPP, SPCC, Waters of the US, et al
  - ✓ Protocols for monitoring adherence to Best Management Practices listed in the permitting
  - ✓ Protocols for ensuring compliant disposal of damaged modules or other e-waste or haz waste
  - ✓ Protocols for preventing any new ENV issues from happening

- If a Developer's intention is to submit *their EPC's Environmental and/or Safety plan*, then articulate how the Developer will oversight their EPC's compliance with their plan

**2. Quality Assurance/Quality Control Plan**

*Purpose: Protocols for verification that the project is built in compliance with the Agreement, IFC drawings, the Scope of Work, and that the installation will meet the Performance Standard for a plant that can be safely maintained, and timely and efficiently operated.*

- Developer's and/or EPC's Corporate QA/QC policy, setting forth minimum expectations and confirmation that all subcontractors' plans meet the minimum expectations
- Accountability of contractors
- Process control
- Design Control
- Document Control
- Reporting
- Training
- Materials Quality
- Installation Quality Assurance (PV: civil, mechanical, electrical and HV: Collector Sub, transmission, distribution)
- Equipment calibration
- Identifying and managing nonconformance
- Articulate the process for tiered inspection oversight, i.e. Subs QA their work, the EPC then QAs the subs' work, the Developer then QAs the sub's work
- If a Developer's intention is to submit their EPC's QA/QC plan, then articulate how the Developer will oversight that EPC's compliance with their stated protocols
- Include information on the onsite inspection process/program that will conducted by the major materials OEMs' QA/QC teams, i.e. for trackers, inverters, modules, major Collector Substation components, etc.

**Project Execution Plan (PEP) Overview Guidance**

*Purpose: A Project Execution Plan (PEP) is a governing document that establishes the means and methods to execute, monitor and control projects. In the context of the business partners working with Entergy to execute renewable projects, the PEP should contain high-level information about the project, discuss stakeholders and provide an organizational chart of the entities and persons that will*

*manage the project. The PEP may include Design, Engineering and Construction management protocols, articulate the approach for contracting and procurement, intended methods for security of the site, people and material, how project performance will be monitored with scheduling and installation velocity tracking, identification or risks and risk-monitoring, and how documentation and required information will be transmitted. The following plans can be stand-alone or grouped as one over-arching document:*

**3. Project Organization Plan**

- Project Organization and Roles/Responsibilities
- Include primary companies (Developer and EPC), could also include Entergy's primary contacts
- Meeting and Report Distribution Matrix (listing of personnel to be included in mtgs/reports/etc.)

**4. Engineering Plan**

*Purpose: Acknowledge requirements in the Agreement and the Scope Of Work (SOW) by communicating the plan to meet key deliverables and expectations.*

- Articulates the engineering strategy, identify who is performing the engineering tasks
- Discuss Basis of Design document development (PV and HV)
- Provide a submittal list of ENG documents that correlates with the SOW and the engineering phase
- Design review cycle, i.e. 30-60-90 or Phase A/B/C, RFIs/tracking

  ✓ List the deliverables that will be in each deliverable phase
  ✓ Define what constitutes achieving IFC drawings

- Dates and Milestones for Engineering deliverables

  ✓ PV Engineering, including civil, mechanical, electrical, Cx, et al
  ✓ HV/Substation Engineering
  ✓ Drawings, etc.

- Approach for developing plans defined in the Agreement/SOW, i.e. the Hot Commissioning Plan, the Performance Testing Plan, Harmonics Studies, etc.
- Establishing, implementing, and adhering to NERC-CIP requirements (as will be further detailed in the
  stand-alone Cyber Security Plan)

**5. Document Control Plan**

- Describe the method for transmitting documentation deliverables to Entergy
- Articulate the process for tracking review comments and resolution of comments (ball-in-court process)
- Ensure that the external team members are aware of Entergy's >10MB email attachment restrictions

**6. Contracting Plan**

- Articulates the contracting strategies, identify primary suppliers, discuss long-lead times
- List of anticipated contractors for major services
- Key supply risks and mitigating actions
- Narrative on actively pursuing using qualified/capable local and diverse suppliers and labor resources, and sharing this information with Entergy

**7. Procurement Plan**

- Articulates the procurement strategies and approach used to purchase equipment and materials for the project
- Narrative of how procurement functions through contracts and responsibilities
- Estimated start and end delivery dates of equipment
- Key supply risks and mitigating actions

**8. Construction Plan**

- Narrative of how the work will be managed and by whom, include titles and corresponding roles and responsibilities
- Articulate the planned approach to constructing the plant, from initial grading to cold and hot commissioning
- Due to the importance of commissioning (Cx), as well as the increased safety focus that is required, include discussion on the Cx plan
- Reference applicable project plans, i.e. Safety/ENV, QA/QC, Procurement, Performance Monitoring, and how the Developer/EPC will provide engagement and oversight to ensure plans are being followed
- Include specific discussion acknowledging the challenges for building in the Deep South, including weather, terrain, labor availability - list construction practices that will be implemented to ensure safety and schedule optimization
- Describe the plan to minimize items that can/will be addressed during the construction cycle to minimize elongated periods to achieve Mechanical Completion, Substantial Completion and Final Acceptance (drainage and water conveyance, high vegetation, Pre-Punch List items with the EPC, rut remediation, trash/litter, damaged components, etc.)
- Describe the oversight and communications that will occur between all entities to ensure continued focus of safety, environmental, and quality when personnel changes occur and/or conditions change on site, for example the transformation that often occurs on the site when transitioning to the Substantial Completion through Final Acceptance phase

**9. Site Security Plan (Project Custody)**

- Explain how the site will be secured to protect the people on site as well as the project's assets
- Ensure how the site will restrict unauthorized access
- Describe the signage for the site that will communicate authorized access requirements, i.e. project signage, main gate(s) descriptor signage, directional signs, Site Rules and Required PPE signage, explanation of authorized access / badging if applicable, speed limit signs, muster locations, Hot Cx / LOTO signage/roping (i.e. Red Rope process)

**10. Project Risk Register**

- Identify, track and manage risks, i.e.:

  - ✓ Safety, environmental, weather, labor/contractor resources
  - ✓ Design/Engineering progressing to IFC
  - ✓ Supply chain issues
  - ✓ PV Installation: Civil, mechanical/electrical/civil work, electrical
  - ✓ HV Installation: Collector substation, transmission lines, etc.
  - ✓ Handover requirements/readiness
  - ✓ Political changes

- Ensure risks are listed with potential schedule and/or cost impacts
- Articulate the frequency that the Risk Matrix will reviewed, updated and shared with Entergy, i.e. included in the monthly Report
- Request Entergy to share lessons learned from previous projects
- *Please provide an example of your risk matrix for review*

Schedule and Performance Management: "Plan The Work – Work The Plan"

*Purpose: Planning the work involves having a project schedule that shows a sophisticated approach to planning the work, including demonstrating an understanding of the resources that will be required (Man Hours, equipment, subcontractors), weather, procurement, labor availability, etc. Communicating the plan to all supervisors, managers, and project leaders is critical in establishing universal and unified performance. Ensuring that the plan is being worked involves tracking progress and updating the schedule and plan when challenges or changes occur; to accomplish this, frequent reporting to all project leadership is critical.*

**11. Schedule Management Plan**

- Articulate the schedule strategy, control requirements, software tool selection, frequency of updates, etc. Refer to the detailed expectations in the Scope Of Work document
- Describe how installation velocity will be tracked
- Articulate how often the velocity reporting and schedules will reviewed and updated and how the information will be shared with Entergy, i.e. Weekly for velocity, monthly for P6 schedule updates, etc.
- Refer to the detailed expectations in the Scope Of Work document
- *Please provide an example of your weekly velocity tracker for review*

**12. Preliminary Baseline Level I and Level II Project Schedules and WBS**

- Baseline schedules – provide the initial baseline schedule for the project
- Refer to the detailed expectations in the Scope Of Work document

**13. Performance Measurement Baseline**

- Describe how performance will be tracked, managed and reported, i.e. in the monthly report
- Describe key commodities that will be tracked via Velocity Installation Curves
- Refer to the detailed expectations in the Scope Of Work document
- Articulate the information that will be shared in the Monthly Reporting/Weekly Reporting
- *Please provide an example of your Monthly Reporting / Weekly Reporting*

***** END OF APPENDIX 11 *****

Appendix 12: Contractor Environmental Guidelines for BESS BOT Agreements

# 1 Overview

This document is a guide to environmental requirements and issues related to site work activities associated with the construction of a battery energy storage system (BESS) facility. The Contractor who signs a contract with Entergy is stating he or she has read the Contractor Environmental Guidelines and that the Contractor, his employees, and his or her subcontractors shall abide by job specifications and these guidelines.

The local, state, and federal environmental rules and regulations that most commonly apply during construction projects are addressed in this appendix. Any activity not identified in this section should be conducted in accordance with applicable local, state, and federal requirements, and in consultation with Entergy's Environmental Services (ES) Team.

Seller is responsible for preparing permit applications, studies/evaluations, and obtaining authorizations necessary for complying with applicable local, county, state, and federal requirements for the construction of the BESS project. A Project/Project Site-specific health, safety, and environmental policy and associated procedures (HSE Plan) for the performance of the work outlined in Appendix 11 of the BESS Scope Book (i.e., Scope Book) shall be in alignment with Entergy's Environmental Guidelines contained in this document. Documentation of ongoing compliance activities is required to be maintained during construction of the project and provided to ES as outlined in the Scope Book.

## 1.1 Oversight

The Buyer's Environmental Specialist in conjunction with the Project Manager and/or ES will have ability to provide recommendations and oversight for environmental issues.

The Buyer's Environmental Specialist in conjunction with the Project Manager will have the authority to stop work if there is a violation of environmental requirements, or there is an observed immediate hazard to health or the environment.

The following sections outline Entergy's environmental guidelines for the rules and regulations applicable to BESS construction projects.

# 2 Phase I/II Site Evaluation

Seller shall cause the Environmental Consultant to conduct Environmental Assessments (EA) on behalf of Seller and Buyer in compliance with Good Industry Practices and the then-current requirements and Laws reasonably in advance of the FNTP Date and within 180 days prior to the Closing.

Seller shall provide to Buyer reasonable advance notice of any EA conducted by the Environmental Consultant. Buyer shall have to the right to witness the performance of the EA and to communicate directly and in real time with the Environmental Consultant regarding the inclusion or exclusion of any recognized environmental conditions (RECs) within any EA.

The accuracy of any identified REC, or the determination of "no RECs" within an EA will be assessed by the Buyer's Environmental Team prior to finalizing the EA.

The following should be considered when an EA identifies a REC on the property:

- Eliminate risk by avoiding the area(s) with the identified REC(s)
- Assess risk by completing a Phase II of the areas in question to better assess actual contamination.
- Mitigate risk by remediation

Each EA should be closely reviewed with the Environmental Team to understand and assess potential risk to the Buyer and to accurately report the conditions at the site. Any decision to complete a Phase II will be on a case-by-case basis.

# 3 Natural Resource Permitting

## 3.1 Wetland Delineation and T&E Survey

A wetland delineation is required to identify potential wetland areas within the footprint of the Project and associated construction activities for submittal to the U.S. Army Corps of Engineers (USACE) for a determination on potential wetlands impact to be made. Compensatory mitigation will be required by the USACE and State Department of Natural Resources for impacts to wetlands. It is Entergy's position that jurisdictional wetlands are to be avoided to the extent possible without inhibiting a successful project execution.

A wetlands delineation and JD is required to determine if construction activities will impact wetlands or waters of the U.S., and a T&E species survey be performed. These are typically conducted concurrently. As part of the T&E Survey, a habitat assessment will be performed and will focus on and offsite (adjacent properties) to determine if the proposed Project contains habitat for identified species. The habitat assessment will provide a characterization of the quality and quantity of habitat available to support the T&E species, if they exist. Habitats and sightings identified will be documented on a composite drawing. The assessment will be provided to the Entergy ES team for review. Actions that result from any sighting documentations (e.g., Agency notifications/discussions/subsequent communications, monitoring) shall be communicated as outlined in the Scope Book.

### 3.1.1 Wildlife Onsite

The Contractor shall evaluate the anticipated effects of the Project to protected species, and determine the need for an Incidental Take Permit and mitigation of impacts, or redesign to avoid impacts.

The Contractor and/or employees of the Contractor shall not take or possess any Endangered or Threatened Species as identified 50 CFR Part 10 under the authority of the U.S. Department of the Interior Fish and Wildlife Service. "Take" means to pursue, hunt, shoot, wound, kill, trap, capture, harass, harm or collect or attempt to collect these species. As this refers to animals, this is any part, product, egg, offspring, or the dead body or parts. Possession of feathers of these species will be construed as "take", even if found on the ground. Included are "Migratory Birds", whatever their origin, protected by the Migratory Bird Treaty Act, 16 U.S.C. 703711. The Entergy Environmental Specialist must approve any exceptions only after the Contractor has obtained a permit from the U.S. Fish and Wildlife Service for such activities.

The Contractor and/or employees of the Contractor shall not take or possess any species as identified by the State in which the Contractor offers service. Each State may have their own list of Endangered or Threatened Species, as well as their own prohibitions on other species as well. It is likely that nearly all animal species will be protected in some form. Any exceptions must be approved by the Entergy Environmental Specialist, including a permit from the State in which the activity will require the disturbance of protected species.

## 3.2 Prepare Wetlands Jurisdictional Determination

Seller will prepare a JD/Wetland Delineation report for submittal to the appropriate District of the USACE with a request for a JD. The report will contain a description of field activities, figures, Routine Wetland

Determination Data Forms, and site photographs. This report is required for the USACE to determine the limits of their jurisdiction for any wetlands or waters of the U.S. identified in the delineation.

# 4 Water Permitting and Compliance

## 4.1 **Acquire NPDES Construction Storm Water Permit**

Any Contractor that performs construction activities on one or more acres, must comply with Federal, state, and local environmental regulations, including, but not limited to, EPA NPDES General Permit for Storm Water Discharges From Construction Activities (40 CFR Part 122). The state issued Construction General Permit, authorizes stormwater discharges from large and small construction activities.
Projects with a state issued Construction General Permit, including construction activity clearing, grading and excavation that result in land disturbance must develop, implement, and maintain a Storm Water Pollution Prevention Plan (SWPPP) until stabilization of the project is complete.
Construction sites discharging stormwater must obtain coverage under the general construction permit and submit the following items to the permitting authority at least 2 weeks prior to commencement of construction:

1. A Notice of Intent (NOI) in accordance with the requirements of the construction permit

2. A complete Stormwater Pollution Prevention Plan (SWPPP) in accordance with the requirements of the construction permit

3. An initial permit fee (amounts vary by state) must accompany the NOI

The Contractor shall maintain and, if requested, provide the Entergy Environmental Specialist and Contract Manager with the documents listed below (as applicable) if construction activities will be equal to or greater than 5 contiguous acres:

- A Storm Water Pollution Prevention Plan (SWPPP)
- A subcontractor Certification to abide by the Contractor's SWPPP
- The Contractor's Storm Water Permit number and other pertinent information

Contractor must designate Best Management Practices (BMPs) to optimize erosion and sediment control during construction. BMPs can be a combination of non-structural controls such as good housekeeping inspections and emergency action planning and structural controls.
The Contractor shall conduct inspections at least once every 7 calendar days.
Inspections must include all areas of the site disturbed by construction activity and areas used for storage of materials that are exposed to precipitation. Inspectors must look for evidence of, or the potential for, pollutants entering the stormwater conveyance system. Contractor shall maintain copies of these inspections onsite.
The Contractor is responsible for proper management of all waste water on construction site as directed by applicable regulations. No un-permitted discharges are allowed. The Contractor shall maintain "good housekeeping," i.e., proper storage of materials, proper disposal of trash and construction waste, and clean up and report spills appropriately.

## 4.2 **Site Revegetation**

Adequate streamside vegetation buffers should be established based on project needs and site-specific conditions identified in the U.S. Army Corps of Engineers Jurisdictional Determination of wetlands and waters of the U.S. Considerations to soil type, slope, vegetation type, root structure, mean high water mark and average annual rain fall should be appropriately reviewed during development of buffers; where feasible, root structures should be left intact and undisturbed in close proximity to water features. If a streamside buffer cannot be feasibly established, adequate BMPs should be utilized for soil stabilization.

Low growth seed mix shall be planted on all ground inside the fence line. Where feasible, non-invasive, native seed mixes should be utilized for stabilization of disturbed soils outside the fence line. Seed mix shall be recommended by the local state extension agency, and consultation with local, regional, or state NGOs, universities, co-ops, and/or ag-business professionals should be taken into account as part of the seed selection process. Areas inside and outside the fence line disturbed during construction or site remediation shall be reseeded with low growth seed mix prior to closure of the construction stormwater permit.

Seller shall consult with the local state extension agency on recommended application timing offering successful seed germination in the project area. Consideration should be given to a late spring seeding when warmer soil temperatures will favor warm-season grasses. Planting after mid-July (i.e., July 15th) is not recommended as hot and dry weather conditions increase during summer months, limiting germination and seedling survival. When a project requires a summer or fall seeding to meet regulatory requirements, consider using a cover crop and wait to plant the final seed mix in a spring seeding. Drilling, broadcast seeding and hydroseeding are planting techniques that can be utilized during spring months.

## 4.3 **Develop a Spill Prevention, Control, and Countermeasures (SPCC) Plan for Construction**

A spill prevention, control and countermeasures plan is required to be prepared and implemented prior to construction work if there will be more than 1,320 gallons on oil onsite or substances listed in Louisiana Administrative Code (LAC) 33:IX.Chapter 9 (for sites in Louisiana). The SPCC plan shall include the applicable components specified under 40 CFR 112.7 and LAC 33:IX.Chapter 9.

The Contractor must evaluate the site for spill prevention and control prior to beginning work. Careful planning and consideration of placement of liquid material equipment must take into account the location of nearby water bodies, such as lakes, rivers, streams, and wetlands. In the event of a spill the contractor must immediately take action to contain the spill and remove contaminated soil. Buyer shall be notified of any spills as outlined in the Scope Book.

Liquid material storage containers with a potential to discharge liquids into nearby waters must have some form of containment and or diversionary structures that would prevent a discharge from reaching nearby waters. At a minimum, one of the following discharge prevention systems must be used (40 CFR 112.7(c)):

- Dikes, berms, or retaining walls sufficiently impervious to contain oil or spilled material.
- Curbing
- Culverting, gutters, or other drainage systems to retain spillage on-site
- Weirs, booms, or other barriers
- Spill diversion ponds
- Retention ponds
- Sorbent materials

The Contractor shall immediately report any instances where oil or hazardous substances are spilled, leaking, or improperly stored or released. If an oily sheen is observed in nearby ditches or other bodies of water or if there are signs of a chemical release, the Contractor shall immediately take action to respond to the incident. Buyer shall be notified of any spills or releases as outlined in the Scope Book. Any Contractor who refuels, repairs, replaces, or dismantles petroleum filled, or other hazardous material containers, shall meet the applicable Federal, state, and local regulations. This includes, but is not limited to EPA Spill Prevention, Control and Countermeasures (SPCC) (40 CFR Part 112), RCRA, DOT Loading and Unloading Procedures (49 CFR Parts 171, 173, 174, 177, and 179).

### 4.4 On-site Wastewater Disposal System

Onsite Wastewater Systems and their authorizations required are discussed in further detail in Section 7.4 of these Contractor Environmental Guidelines.

# 5 Hazard Communication and Chemical Approval

The Contractor shall comply with hazard communication requirements found in 29 CFR 1910.1200, (OSHA) Hazard Communication Standard for all hazardous chemicals used on site during the course of the job whether supplied by Entergy or the Contractor.

The Contractors shall label in accordance with 29 CFR 1910.1200 all portable containers into which hazardous chemicals are transferred that are not intended for immediate use by the employee who performs the transfer. Labeling shall indicate the hazardous material contained in the container and provide hazard warnings.

### 5.1 Storage and Use of Chemicals

The Contractor shall employ best management practices (BMPs) to help reduce stormwater pollution from the use and storage of chemicals. BMPs must meet the requirements of the appropriate construction storm water general permit at a minimum, in addition to any site specific BMPs included in the Spill Prevention, Control, and Countermeasures (SPCC) plan and Storm Water Pollution Prevention Plan (SWPPP). The Contractor will be required to review and acknowledge the requirements of the plans prior to beginning work on site. As required, a copy of the SWPPP and SPCC plan and records will be maintained on site in the Contractor's site office.

The Contractor shall ensure all containers of chemical products including but not limited to lubricants, grease, cutting fluids, oils, solvents, degreasers, cleaners, paints, coatings, paint thinners, glues, adhesives, resins, desiccants, or any water-soluble material shall be kept closed at all times except when adding or removing materials.

Container lids, bungs, rings, gaskets, bands, vents and caps shall be adequate and properly secured to prevent the intrusion of rainfall into the container and spillage or evaporation of the container contents. All containers shall be adequately labeled as to contents and hazards in compliance with the OSHA Hazard Communications Standard and with the name of the Contractor who either owns the container or is responsible for its use.

The Contractor shall maintain and not remove or deface warning labels and markings on any container of DOT hazardous materials.

The Contractor shall store all chemicals and liquid fluid materials in temporary storage facilities. Temporary storage facilities shall provide spill containment volume for stored material equal to the volume of the largest liquid filled container stored plus 10 percent allowance for rainfall for uncovered

containers. Covered containers spill containment volume area must contain the largest container's volume released into the containment area.
All chemicals stored in a temporary storage facility shall be elevated by use of pallets or similar devices to prevent contact with any accumulated rainfall or spilled material within the containment area and to facilitate leak detection.
Temporary storage facilities shall be impervious to the materials stored there for a minimum contact time of 72 hours.
Temporary storage facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, contaminated rainwater and spill material shall be placed into drums after each rainfall event. These drums shall be handled as hazardous waste unless testing determines them to be non-hazardous. Non-hazardous waste shall be disposed in accordance with the requirements of the EPC Contract.
Temporary storage facilities shall provide sufficient separation between stored containers to allow for inspection, spill cleanup, and emergency response. Drums shall not be double stacked.
Incompatible chemicals shall not be stored in the same temporary storage facility unless properly segregated.
Temporary storage facilities shall be covered during non-working days and prior to rain events. Covered facilities may include use of properly secured plastic tarps or constructed roofs with overhangs.
Container labels should remain clearly visible.
The Contractor shall employ appropriate signage at temporary storage facilities to indicate any hazards present, precautions or prohibitions (i.e., "no smoking or open flame") required to ensure the safe storage of the chemicals present and to prevent accidental release.

# 6 Waste Management

All waste generated by the Contractor or his or her subcontractors while performing task under contract to or authorized by Entergy shall be managed or disposed in accordance with the requirements of the EPC Contract.
The Contractor shall be responsible for ensuring that all wastes which he/she is herein required or authorized to dispose are disposed at a vendor approved by Entergy.
The Contractor is responsible for proper management of waste on site as directed by applicable regulations, and as directed herein.

## 6.1 Solid Waste Registration ID

A solid waste registration ID is required if more than 220 lbs of Class 1 waste, 220 lbs of hazardous waste, or 2.2 lbs of acutely hazardous waste is generated in a single month and more than once per year. The Contractor shall obtain a solid waste registration ID from the TCEQ, LDEQ, MDEQ, or ADEQ prior to shipping the waste offsite for disposal.
Seller is responsible for completing the required annual waste summaries and paying the associated hazardous waste generation fees.

## 6.2 Episodic Waste Generation

The generation of more than 220 lbs of hazardous waste, or 2.2 lbs of acutely hazardous waste, in a single month can qualify as Episodic Waste Generation as outlined under 40 CFR §262.232.
Unregistered/inactive and registered generators can have either one planned or one unplanned episodic event per calendar year.

Episodic waste generators must ship the episodic waste off-site within 60 days of the start date of the episodic event. The 60-day limit for a planned episodic event starts on the first day of any activities affiliated with the event. For an unplanned episodic event, the event begins on the first day the hazardous waste is generated, regardless of whether the generator has completed analysis confirming that the waste is hazardous.

## 6.3 General Requirements

The Contractor shall be able to properly profile waste to waste vendors including but not limited to samples, waste analysis, SDS, origin, quantity, weight, amount, composition, characteristics, intent and type of use, reason for disposal, and other required data.
The Contractor shall employ best management practices (BMPs) to help reduce stormwater pollution from the use and storage of waste.
The Contractor shall store all hazardous waste in temporary accumulation facilities or in a permanent hazardous waste accumulation area.
The Contractor shall manage waste and maintain records of waste accumulation and disposal in accordance with the appropriate state regulations and EPA (40 CFR Part 262) hazardous waste generator accumulation rules.
Temporary hazardous waste accumulation facilities shall provide spill containment volume for stored material equal to the volume of the largest liquid filled container stored plus 10 percent allowance for rainfall for uncovered containers. Covered containers spill containment volume area must contain the largest container's volume released into the containment area.
Temporary hazardous waste accumulation facilities shall be impervious to the materials stored there for a minimum contact time of 72 hours.
Temporary hazardous waste accumulation facilities shall be maintained free of accumulated rainwater and spills. In the event of spills or leaks, contaminated rainwater and spill material shall be placed into drums after each rainfall. These drums shall be handled as hazardous waste until a waste characterization is completed.
Temporary hazardous waste accumulation facilities shall provide sufficient separation between stored containers to allow for inspection, spill cleanup, and emergency response. Container labels shall also be clearly visible and faced into the aisles if they are formed.
Incompatible waste shall not be stored in the same temporary hazardous waste accumulation facility.
Temporary hazardous waste accumulation facilities shall be covered during non-working days and prior to rain events. Covered facilities may include use of properly secured plastic tarps or constructed roofs with overhangs.
Temporary hazardous waste accumulation facilities shall be inspected weekly for the presence of rainwater inside the containment, open or damaged containers, container closure, correct labeling and marking, spills, leaks, container integrity and general housekeeping. The Contractor shall maintain copies of these weekly inspections.

## 6.4 Oily Absorbent Pads and Cleaning Rags

The Contractor shall dispose of all oily absorbent pads or rags in trash receptacles and ensuring the following conditions are met:

- Pads and rags, once appropriately rung, do not contain any free liquids (liquids drip from waste at a rate of > 1 drop in 5 minutes).
- Pads and rags do not contain any hazardous waste such as ignitable or combustible solvents or chlorinated organic compounds such as but not limited to degreasers and cleaning compounds.

Disposal of any absorbent pads and rags that do not meet these conditions shall not be disposed. Pads and rags that contain free liquid must be rung dry prior to disposal or be contained in sufficient adsorbent to bind free liquids prior to disposal.

## 6.5 Aerosol Cans

All spent aerosol cans that have no propellant or chemical remaining can be disposed of as non-regulated trash or recycled. This means that no liquid is felt or heard when the can is shaken by hand, and no gas or liquid is released when the spray/discharge valve is activated and the container is rotated through all directions, and the valve is not observably or known to be clogged. Non spent aerosol cans may be punctured and drained. The remaining propellent or chemical drippings must be disposed of as hazardous waste.

All aerosol cans that have propellant or chemical remaining shall be considered a "Hazardous Waste" in Louisiana and Mississippi and "Universal Waste" in Texas and Arkansas and disposed accordingly. These aerosol cans must be placed in a drum in the waste storage area. The drum must be labeled with the words "Universal Waste Aerosol Cans" or "Hazardous Waste Aerosol Cans" as applicable. All container markings must be weatherproof and clearly visible. Containers must also be marked with the site's name. Containers must be kept closed except when adding or removing cans. When the container is full, a waste shipping paper or manifest must be completed and shipped with the container.

## 6.6 **Antifreeze/Ethylene Glycol**

The Contractor shall collect and place all waste antifreeze or ethylene glycol in a closed head 55-gallon drum appropriately labeled with a Waste Liquid Label as shown in Appendix II or alternately with the identity of the contents, Contractor's name, and date. The Contractor shall keep the drums closed at all times except when adding or removing waste.

## 6.7 **Batteries**

Rechargeable batteries must be managed as Universal Waste. Other small, non-rechargeable, single-use batteries may be disposed of as non-hazardous office waste. The Contractor shall collect and place all alkaline, dry cell, button, spent rechargeable and non-leaking sealed small lead acid batteries in 5-gallon plastic pails appropriately labeled with the words "Used Batteries" and the date or alternately the words or label "Universal Waste". The container must be marked with the date the first battery is placed in the container. The Contractor shall cover the terminals of all used batteries with electrical or duct tape to prevent electrical discharge or arcing prior to placing in the container. For larger batteries, terminals can be taped instead of putting the batteries in plastic bags. When the container is full but NO LATER THAN ONE YEAR from the date on the container, close up the container, and ship to the appropriate recycler. Larger lead acid batteries must be placed in containers and labeled "Lead-Acid Batteries for Recycling" and stored in a designated accumulation area at the site. Batteries should be stored on a level surface in an upright position and secured as appropriate to prevent tipping. Batteries designated for transport must be appropriately secured and prevented from electrical short-circuit.

## 6.8 Truck Wash Out and Excess Concrete Waste Management

The Contractor shall perform washout of concrete trucks offsite or in designated areas. The Contractor shall wash out concrete truck waste and excess concrete into a temporary pit where the concrete can be set, be broken up, and then disposed properly. Wash waters generated during this activity should be properly disposed of according to the applicable State construction storm water general permit. BMP's shall be established to prevent the concrete wash out water from contributing to groundwater contamination or entering the waters of the state.

## 6.9 Empty Containers

The Contractor shall ensure that all discarded containers (i.e., drums, buckets, cans, pails) meet the EPA's definition of empty (the entire residue has been removed that can be removed using normal means and no more than 1" of residue remains in the bottom of the container) prior to recycle or disposal. The Contractor may crush, flatten, or otherwise render useless metallic containers > 5 gallon capacity and dispose in a scrap metal receptacle.

## 6.10 Filters

The Contractor shall puncture and hot drain all used fuel, lubricating oil, and hydraulic oil filters into a labeled filter collection drum containing adsorbent media.
Once the filters are drained, the Contractor shall manage them as scrap metal. The absorbent media shall be disposed.
Alternatively, the entire filter may be placed into a container provided by a used oil recycle vendor for management at a recycle facility.
The Contractor shall place used air filters in receptacles.

## 6.11 **Lighting Waste**

All spent lamps which have bright green end caps, green paint on the end, a green "dimple" on the end or green writing on the lamp can be disposed of as non-regulated trash. All others must be recycled. For Mississippi, if the facility generates less than 220 pounds/month of hazardous waste including the lamps, the facility would be conditionally exempt and may dispose of the lamps as normal solid waste.

### 6.11.1 Arkansas, Louisiana, Mississippi (if small or large generator) and Texas

The Contractor shall place all used unbroken lighting waste (fluorescent bulbs, high intensity discharge lamps, and incandescent lamps) in containers designed to prevent breakage. The containers shall be labeled or marked with the words or label, "Universal Waste", date, and identity of the contents (i.e., HID Lamps). Containers must be marked with the site's name and must be kept closed except when adding or removing lamps. When the container is full, but no later than 1 year from the date on the container, send the container to the waste vendor. All container markings must be weatherproof and clearly visible.
The Contractor shall store and manage lighting waste to prevent breakage.
The Contractor shall place all broken lighting waste (fluorescent bulbs, high intensity discharge lamps, and incandescent lamps) in secure containers such as a 5 5-gallon bucket.

### 6.11.2 Louisiana, Mississippi (if small or large generator) and Texas

The containers shall be labeled or marked with the words or label, "Universal Waste Lamps for Recycling", with "Broken" added to the label in an indelible marker and with the date the first broken bulb is placed in the container and the site's name. Containers must be kept closed except when adding or removing lamps. When the container is full, but no later than 1 year from the date on the container, send the container to the waste vendor.

### 6.11.3 Arkansas

The containers shall be labeled or marked with the words or label, "Hazardous Waste – Broken Lamps". The container must be labeled using an indelible marker and with the date the first broken bulb is placed in the container and the site's name. Containers must be kept closed except when adding or removing lamps. When the container is full, send the container to the waste vendor for proper disposal.

## 6.12 Mercury Wastes

Any mercury containing wastes such as, switches, thermometers, etc., shall be double bagged by the contractor in sealed plastic zip-lock type bags, and appropriately labeled with the words or label, "Hazardous Waste", the date, and description of contents and disposed in accordance with the requirements of the EPC Contract.

## 6.13 Waste Paint Management

The Contractor shall ensure that wastes generated during painting operations are managed in a manner that is in compliance with applicable environmental regulations. (More info available if needed)

## 6.14 **Sanitary/Septic, Personnel Waste Management**

The Contractor shall arrange for regular sanitary/septic waste collection and off-site disposal by reputable, licensed sanitary/septic waste haulers.
The Contractor shall not dispose of wastewater from personnel washing stations, laundry or food service facilities into site stormwater drains, sanitary sewers, watercourses, conveyances, and surface impoundments.
Personnel washing station, laundry and/or food service wastewaters shall be collected, managed, and be disposed off-site by reputable, licensed sanitary/septic waste haulers.

## 6.15 Scrap Metal

The Contractor shall collect and place all scrap metals, metal turnings, and metal shavings in labeled scrap metal receptacles. The Contractor will ensure that no electronic or generally licensed radioactive devices are allowed to be placed into the scrap metal receptacles.

## 6.16 Storage Requirements

Hazardous waste must be stored in a designated waste storage area and in covered containers or be off the ground and covered so as not to be exposed to rainwater.
Each container used for on-site waste accumulation must be labeled or marked in accordance with the appropriate label (non-hazardous, hazardous, solid waste) compliant with the waste characterization. The label shall include an indication of the hazards of the contents, and the date on which accumulation began (sections 262.16(b)(6) and 262.17(a)(5)). Containers must be marked with the site's name. All container markings must be weatherproof and clearly visible.
Containers can also be labeled as "Hazardous Waste Pending Analysis" while analytical testing is being conducted, the hazard that is being analyzed, along with the date upon which accumulation began. If the waste is determined to be non-hazardous, the generator can remove the hazardous waste label at that point.

## 6.17 Spill Cleanup/Petroleum Contaminated Soils

The Contractor shall at all times perform his work in a manner to eliminate spills and take necessary precautions to prevent their occurrence especially around fuel and oil storage tanks, reservoirs, and containers.
The Contractor shall promptly notify the Buyer as outlined in Section 8 of all spills. The Contractor is responsible to cleanup and manage the spill material.
The Contractor shall immediately clean up and containerize petroleum contaminated soils resulting from spills in and around storage tanks, reservoirs, and containers of virgin or used fuels, oils, hydraulic fluids or used oil. The containers shall be labeled with a Waste Solid Label or with wording or labels identifying

the contents, the Contractor's name and the date. Containers shall be kept closed at all times except when adding or removing waste.

### 6.18 Trash

The Contractor shall place all nonhazardous solid waste (trash) in labeled containers. The Contractor shall ensure that his employees do not dispose of any hazardous, universal, industrial solid, Class I, or Class II waste in trash containers. (Examples of prohibited waste include but are not limited to batteries, solvents, aerosol cans, used blasting media, contaminated rags, etc.).

### 6.19 Used Oil

The Contractor must label all tanks, drums, and containers that contain used oil with a Waste Liquid Label or the words "Used Oil", including the type of oil. Maintain good records of used oil shipments from the facility.

The Contractor shall keep all tanks and containers of used oil securely closed with bungs. Vents should also be in place except when adding or removing oil. Oil must never be put in open top drums.

The Contractor shall not mix used oil with other substances, such as, but not limited to antifreeze, brake fluid, gasoline, paint thinner, solvents, because doing so may render the entire mixture as a hazardous waste.

The Contractor shall immediately report any instances where oil has spilled, leaked or been improperly disposed, or improperly stored. If an oily sheen is observed in nearby ditches or other bodies of water, the Contractor shall immediately take action to eliminate the source of the oil and remove and manage the spilled material. The Contractor shall promptly notify the Buyer as outlined in Section 8 of all spills

Only use permitted used oil processors/refiners for recycling and only use permitted transporters for the transport of used oil in quantities greater than 55 gallons. For quantities greater than 55 gallons, used oil shipments must be accompanied by the DOT used oil shipping document and the transporter must keep a record of the shipment.

The Contractor shall comply with the applicable oil spill prevention, control and countermeasure regulations.

# 7 Other Environmental Permitting

### 7.1 Aboveground Storage Tanks

The Contractor shall immediately notify the Entergy Environmental Specialist or Contract Manager should there be accidental contact with underground or aboveground storage tanks, piping and/or associated equipment that results in, or is anticipated to result in, a release of contents, or if they notice any leaks or spills.

Any Contractor who removes, repairs, replaces, or refuels/refills underground or aboveground storage tanks and/or associated equipment must meet all Federal, state, and local environmental regulations governing these tanks and equipment. This includes, but is not limited to, EPA Underground Storage Tanks (40 CFR Parts 280 and 281), EPA SPCC regulation (40 CFR 112), DOT Transportation of Hazardous Materials (49 CFR), and RCRA hazardous waste regulations (40 CFR 240281), and State specific requirements.

### 7.2 On-**Site Sewage Facilities (Septic Systems)**

#### 7.2.1 Texas Requirements

An on-site sewage facility (OSSF) permit and an approved plan are required to construct, alter, repair, extend, or operate an OSSF per 30 TAC Chapter 285, Subchapters A and D. Seller must construct and operate the wastewater system in accordance with all permit conditions and requirements per 30 TAC Chapter 285, Subchapters A and D.
Seller shall contact the TCEQ prior to construction of the OSSF to determine applicability of a TPDES permit. Seller shall comply with all reporting, testing, record keeping, and maintenance requirements associated with the TPDES permit, if required.

#### 7.2.2 Arkansas Requirements

An Onsite Wastewater System construction permit and operating permit are required from the Arkansas Division of Health or its authorized agent, prior to construction or operation of an on-site wastewater system.
An NPDES Individual No-Discharge Permit from the ADEQ is required prior to construction of an on-site wastewater system with a spray-field application of effluent. Seller shall contact ADEQ prior to construction to determine applicability of the NPDES permit. Seller shall comply with all reporting, testing, recordkeeping and maintenance requirements in the NPDES permit.

#### 7.2.3 Mississippi Requirements

A notice of intent (NOI) and Permit/Recommendation for water service connection must be filed with the Mississippi State Department of Health (MSDH) for approval of an on-site sewage treatment and disposal system per MSDH, Part 18, Subpart 77.

#### 7.2.4 Louisiana Requirements

Approval of the on-site sewage treatment system must be granted by the Louisiana Department of Health, Office of Public Health and the Louisiana DEQ. LDEQ authorizes wastewater discharges for General Sanitary Permits under the Louisiana Water Discharge Permit System in LAC 33: Part IX Chapters 3 and 7.

# 8 Project Environmental Considerations

For projects located in Texas, Buyer is required to submit a Certificate of Convenience and Necessity (CCN) application to the Public Utility Commission (PUC) for a new generating facility. In Arkansas, Buyer is required to submit a Certificate of Environmental Compatibility and Public Need to the Arkansas Public Service Commission for a new generating facility.

- Texas (see Rule 16 Texas Administrative Code [TAC] § 25.101(b)2).
- Arkansas: See Ark. Code Ann. § 23-18-501, et. Seq. (the “Utility Facility and Economic Production Act”)

The Buyer must be prepared to address its environmental considerations made while designing the proposed project. In Arkansas, Buyer shall prepare an Environmental Impact Statement to address the Project purpose and necessity, the existing environment, evaluation of alternatives, environmental impacts, unavoidable effects, irreversible/irretrievable commitments of resources, and recommended mitigation measures.

In Texas, an Environmental Assessment (EA) shall be prepared to address the CCN considerations provided below from the Public Utility Regulatory Act:

Sec. 37.056. GRANT OR DENIAL OF CERTIFICATE.

*(c) The commission shall grant each certificate on a nondiscriminatory basis after considering:*

*(4) other factors, such as:*

*(A) community values;*

*(B) recreational and park areas;*

*(C) historical and aesthetic values;*

*(D) environmental integrity;*

The content and format of the EA should be guided by the Texas Parks and Wildlife Department Suggested Guidelines for Preparation of Environmental Assessment Documents.

# 9 Site Conditions

Contractor shall have the sole responsibility of satisfying itself by personal inspection or otherwise concerning the nature and location of Work and the general and local conditions.

If in the performance of the work at the project the Contractor encounters any Hazardous Substance, pollution or contamination, Contractor will notify the Entergy Environmental Specialist or Contract Manager immediately, and before such conditions are disturbed. Handling or removal of any hazardous substance, pollution or contamination will be in accordance with Contractor's agreement or contractual provisions.

***** END OF APPENDIX 14 *****